

12.8V 10A Boost Converter

General Description

The AS2080 is a high-power density, asynchronous boost converter with a 22mΩ power switch to provide a high efficiency and small size solution in portable systems. The AS2080 has wide input voltage range from 2.7V to 12V to support applications with single cell and two cell Lithium batteries. The device has 10A switch current capability and can provide an output voltage up to 12.8V.

The AS2080 also implements a programmable soft-start function and an adjustable switching peak current limit function. AS2080 integrates two modes with different tr/ff to balance different requirements of EMI and efficiency.

In addition, the device provides 13V output overvoltage protection, and thermal shutdown protection.

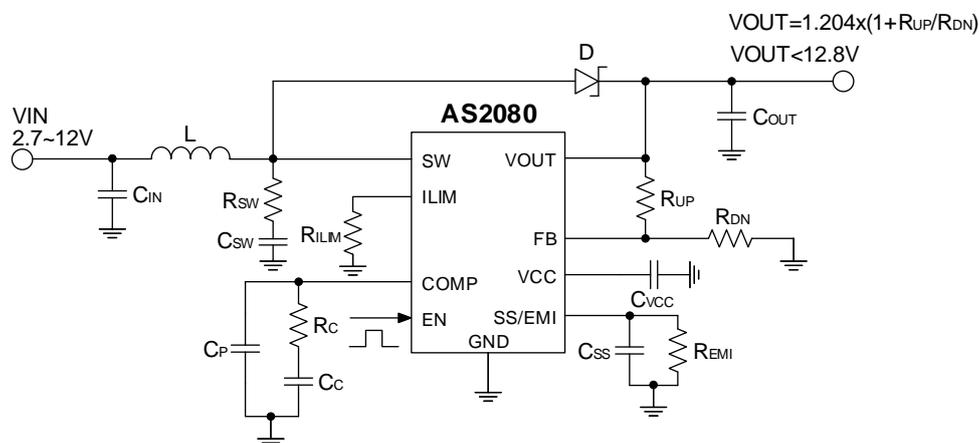
Features

- Input voltage range: 2.7V to 12V
- Output voltage range: up to 12.8V
- Internal Fixed PWM frequency: 500kHz
- Programmable switch peak current limit: up to 10A
- High Efficiency 94%
- 1.0μA current consumption during shutdown
- Two modes with different tr/ff for EMI solution
- Programmable soft start
- Output overvoltage protection (at 13V), thermal shutdown protection
- SOP-8 Packages

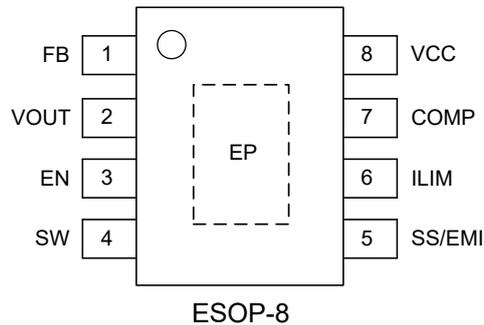
Applications

- Tablets
- USB Power Supply
- Battery Powered Products
- Power Banks, Battery Backup Units

Typical Application Circuit



Pin Configuration



Pin Descriptions

Pin No.	Name	I/O ¹	Description
1	FB	I	Voltage feedback.
2	VOUT	P	Power supply.
3	EN	I	Enable logic input. Logic high level enables the device. Logic low level disables the device and turns it into shutdown mode.
4	SW	P	The switching node pin of the converter.
5	SS/EMI	O	Soft-start programming pin. An external capacitor C_{SS} connected to ground sets the ramp rate of the internal error amplifier's reference voltage during soft-start, 100nF is usually recommended. Also used as mode setting for different tr/tf, an external resistor connected to ground sets a flatter tr/tf.
6	ILIM	I	Adjustable switch peak current limit. An external resistor should be connected between this pin and the GND pin.
7	COMP	O	Output of the internal error amplifier, the loop compensation network should be connected between this pin and the GND pin.
8	VCC	O	Output of the internal regulator. A ceramic capacitor of 1uF is required between this pin and ground.
EP	GND	G	Provides both electrical and thermal connection from the device to the board. A matching ground pad must be provided on the PCB and the device connected to it via solder. For proper electrical operation, this ground pad must be connected to the system ground.

1. I: Input; O: Output; G: Ground; P: Power.

Ordering Information

Part No.	Package	Logo	Tape & Reel
AS2080	SOP-8	AS2080	2500PCS

Absolute Maximum Ratings ¹

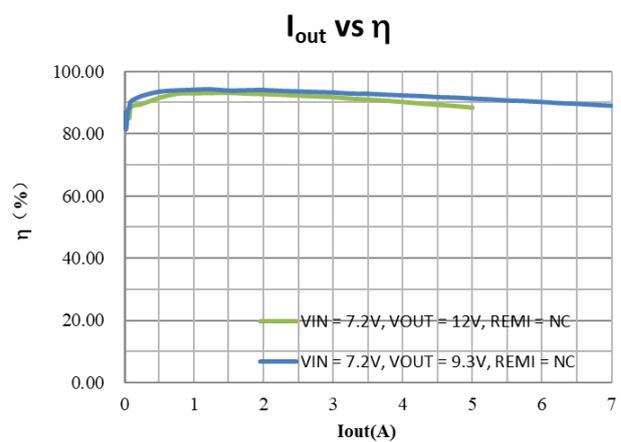
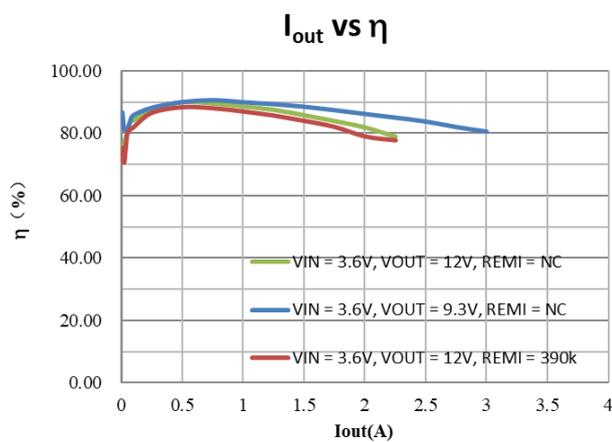
PARAMETER		Symbol	MIN	MAX	UNIT
Voltage range	VOUT		-0.3	13	V
	SW		-0.3	16	
	EN, VCC, COMP		-0.3	7	
	FB		-0.3	3.6	
Operating temperature range		T _A	-40	85	°C
Operating junction temperature range		T _J	-40	150	°C
Storage temperature range		T _{STG}	-50	150	°C

Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Recommended Operating Conditions

PARAMETER	Symbol	MIN	TYP	MAX	UNIT
Supply voltage range	V _{OUT}	2.7		12.8	V
Operating temperature	T _a	-40	25	85	°C
Operating junction temperature	T _J	-40		125	°C

Typical Operating Characteristics



Electrical Characteristics

Ta = 25°C, V_{IN} = 2.7V-13.2V, V_{OUT}=4.5-13.2V, unless otherwise specified.

PARAMETER	Symbol	CONDITION	MIN	TYP	MAX	UNIT
Power Supply and Reference Voltage						
Power voltage range	V _{OUT}		2.7		12.8	V
Under-voltage lockout (UVLO) threshold	V _{UVLO}	Rising		2.7		V
		Falling		2.5		V
Quiescent current	I _Q	V _{FB} = 1.3V, No switching		0.3		mA
Shutdown current	I _{SD}	IC disabled, no load, no feedback resistor divider		1		uA
VCC regulation	V _{CC}	V _{IN} = 3.6V, V _{OUT} = 12V, light load		5.7		V
		V _{IN} = 3.6V, V _{OUT} = 12V, I _{LOAD} = 0.5A		5.3		V
Reference voltage at the FB pin	V _{REF}			1.204		V
Output overvoltage protection	V _{OVP}			13		V
Soft-start charging current	I _{SS}			5		uA
EN Input						
EN high threshold voltage	V _{ENH}		1.5			V
EN low threshold voltage	V _{ENL}				0.4	V
EN internal pull-down resistance	R _{EN}			800		kΩ
POWER SWITCH						
MOSFET on-resistance	R _{DS(on)}	Including wire bond		22		mΩ
Operation Frequency	F _{osc}			500		kHz
Peak switch current limit	I _{LIM}				10	A
THERMAL SHUTDOWN						
Thermal shutdown threshold	T _{SD}			150		°C
Thermal shutdown hysteresis	T _{SD_HYS}			20		°C

Application Information

Operation

The AS2080 is a high-power density, asynchronous boost converter with a 22mΩ power switch to provide a high efficiency and small size solution in portable systems. The switching frequency is 500kHz. AS2080 operates with pulse width modulation (PWM), and improves the efficiency at light load with the pulse frequency modulation (PFM).

Enable, Startup, and tr/ff (EN and SS/EMI pin)

The AS2080 has an adjustable soft start function to prevent high inrush current during start-up. To minimize the inrush current during start-up, an external capacitor, connected to the SS/EMI pin and charged with a constant current, is used to slowly ramp up the internal positive input of the error amplifier. The larger the capacitance at the SS/EMI pin, the slower the ramp of the output voltage and the longer the soft-start time. A 100-nF capacitor is usually sufficient for most applications.

AS2080 integrates two modes with different tr/ff. With a single capacitor (C_{SS}) connected between SS/EMI pin and Ground, the mode with steep tr/ff will be selected, AS2080 operates with a higher efficiency and poorer EMI performance. However, if a capacitor (C_{SS}) paralleled with a resistor 390k (R_{EMI}) is placed between SS/EMI pin and Ground, the mode with flatter tr/ff is selected, AS2080 operates with a lower efficiency and better EMI performance.

When the EN pin is pulled into logic low (below 0.4V), the AS2080 goes into the shutdown mode and stops switching. Only when EN pin is pulled into logic high (above 1.5V), the AS2080 works.

Adjustable Peak Current Limit (ILIM pin)

To avoid an accidental large peak current, an internal cycle-by-cycle current limit is adopted. The low-side switch is turned off immediately as soon as the switch current touches the limit. The peak switch current limit can be set by a resistor (R_{ILIM}) at the ILIM pin to ground. The relationship between the current limit and the resistance is as the following figure. The current limit should be set lower than 10A.

Output Voltage Setting (FB pin)

The output voltage is set by an external resistor divider (R_{UP} , R_{DN} in the Typical Application Circuit). To get the output voltage V_{OUT} , the Value of R_{UP} and R_{DN} can be calculated as:

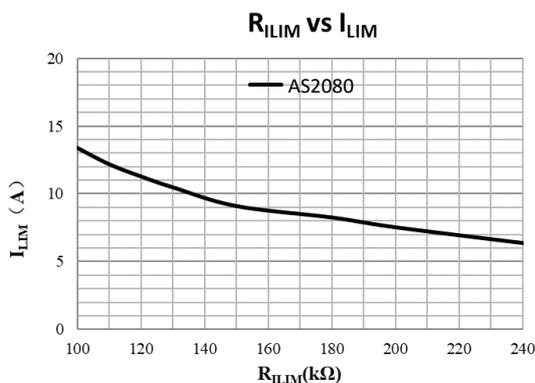


Figure 1 Peak Current Limit (ILIM) vs ILIM terminal resistor (R_{ILIM})

Table 1 Output Voltage Settings

V_{OUT} (V)	R_{UP} (Ω)	R_{DN} (Ω)
5	510k	162k
9.4	510k	75k
12.2	510k	56k

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R_{UP}}{R_{DN}}\right)$$

Where $V_{REF} = 1.204V$.

Some typical output voltages can be set as the Table 1.

Protection Function

Under-voltage Lockout (UVLO)

The UVLO circuit prevents the device from malfunctioning at low input voltage and the battery from excessive discharge. The AS2080 has both VOUT UVLO function and VCC UVLO function. It disables the device from switching when the falling voltage at the VOUT pin trips the UVLO threshold V_{UVLO} , which is typically 2.5V. The device starts operating when the rising voltage at the VOUT pin is above the V_{UVLO} , which is typically 2.7V. It also disables the device when the falling voltage at the VCC pin trips the UVLO threshold, which is typically 2.1V.

Over-voltage Protection

If the output voltage at the VOUT pin is detected above 13V (typical value), the AS2080 stops switching immediately until the voltage at the VOUT pin drops the hysteresis value lower than the output overvoltage protection threshold. This function prevents overvoltage on the output and secures the circuits connected to the output from excessive overvoltage.

Thermal Shutdown

A thermal shutdown is implemented to prevent damages due to excessive heat and power dissipation. Typically, the thermal shutdown happens at a junction temperature of 150°C. When the thermal shutdown is triggered, the device stops switching until the junction temperature falls below typically 130°C, then the device starts switching again.

Application Note

Inductor Selection

Because the selection of the inductor affects the power supply's steady state operation, transient behavior, loop stability, and boost converter efficiency, the inductor is the most important component in switching power regulator design. Three most important specifications to the performance of the inductor are the inductor value, DC resistance, and saturation current.

To be simplified, the inductor value can be set as 2.2uH which can be used in most cases.

The rated current, especially the saturation current should be larger than the peak current during the whole operation. The peak current can be calculated as follows.

$$I_{Lpeak} = I_{DC} + \frac{I_{PP}}{2}$$
$$I_{DC} = \frac{V_{OUT} \times I_{OUT}}{V_{IN} \times \eta}$$
$$I_{PP} = \frac{1}{L \times \left(\frac{1}{V_{OUT} - V_{IN}} + \frac{1}{V_{IN}}\right) \times f_{SW}}$$

Boost converter efficiency is affected significantly by the inductor's DC resistance (DCR), equivalent series resistance (ESR) at the switching frequency, and the core loss. An inductor with lower DCR and ESR would increase the efficiency significantly.

The inductor should be placed as close as possible to the SW pin. For a lower EMI radiation, connecting a resistor and a capacitor in series to the ground would be helpful. 1ohm resistor and 3.3nF capacitor (the package of resistor and capacitor is recommended to be not smaller than 1206) would be recommended in most cases.

Output Capacitor Selection (C_{OUT})

To be simplified, we recommend low-ESR capacitors of 1uF//10uF//10uF//470uF (“//” represents paralleled) be placed as close as possible to the Schottky diode for small output voltage ripple.

Capacitors can lose most of their capacitance at rated voltage. Therefore, leave margin on the voltage rating to ensure adequate effective capacitance.

In detail, for the require output voltage ripple, use the following equations to calculate the minimum required effective capacitance C_{OUT} .

$$V_{ripple_dis} = \frac{(V_{OUT} - V_{IN_MIN}) \times I_{OUT}}{V_{OUT} \times f_{SW} \times C_{OUT}}$$

$$V_{ripple_ESR} = I_{Lpeak} \times R_{C_ESR}$$

Where

V_{ripple_dis} is output voltage ripple caused by charging and discharging of the output capacitor.

V_{ripple_ESR} is output voltage ripple caused by ESR of the output capacitor.

V_{IN_MIN} is the minimum input voltage of boost converter.

V_{OUT} is the output voltage.

I_{OUT} is the output current.

I_{Lpeak} is the peak current of the inductor.

f_{SW} is the converter switching frequency.

R_{C_ESR} is the ESR of the output capacitors.

Diode Selection

Schottky diode with fast recovery times and low forward voltages are recommended. Ensure the diode average and peak current rating exceed the average output current and peak inductor current. In addition, the diode's reverse breakdown voltage must exceed the output voltage.

Loop Stability

The AS2080 requires external compensation, which allows the loop response to be optimized for each application. The COMP pin is the output of the internal error amplifier. An external compensation network comprised of resistor R_C , ceramic capacitors C_C and C_P is connected to the COMP pin.

To be simplified, R_C is 33k Ω , C_C is 3.3nF, and C_P is 47pF. But notice that this setting can only be adopted in most cases. In detail, the compensation network parameters can be calculated as follows.

(1) Set the cross over frequency, f_C

The first step is to set the loop crossover frequency, f_C . The higher crossover frequency, the faster the loop response is. It is generally accepted that the loop gain cross over no higher than the lower of either 1/10 of the switching frequency, f_{SW} , or 1/5 of the RHPZ frequency, f_{RHPZ} . It's proper to use a fixed parameter of 10kHz for f_C .

$$f_{RHPZ} = \frac{R_O \times (1 - D)^2}{2\pi \times L}$$

(2) Set the compensation resistor, R_C .

$$R_C = \frac{2\pi \times V_{OUT} \times R_{sense} \times f_C \times C_O}{(1 - D) \times V_{REF} \times G_{EA}}$$

(3) Set the compensation zero capacitor, C_C .

$$C_C = \frac{R_O \times C_O}{2 \times R_C}$$

(4) Set the compensation pole capacitor, C_P .

$$C_P = \frac{R_{ESR} \times C_O}{R_C}$$

If the C_P is less than 10pF, it can be left open.

R_O is the output load resistance.

D is the switching duty cycle. $1 - D = V_{IN} / V_{OUT}$

R_{sense} is the equivalent internal current sense resistor, which is 0.084Ω.

C_O is output capacitor.

V_{REF} is the reference voltage at the FB pin, which is 1.204V.

G_{EA} is the amplifier's transconductance, which is 190uA/V.

R_{ESR} is the equivalent series resistance of the output capacitor.

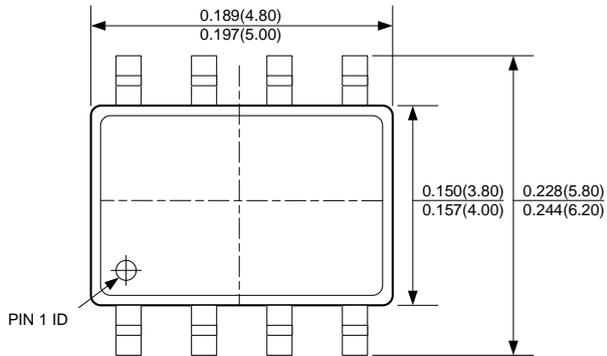
Layout Considerations

As for all switching power supplies, especially those running at high switching frequency and high currents, layout is an important design step. If layout is not carefully done, the regulator could suffer from instability and noise problems.

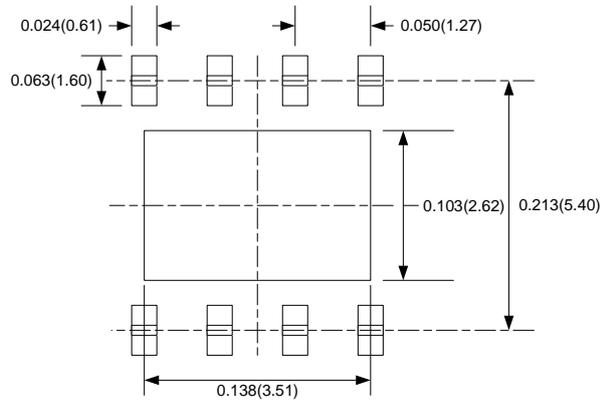
- Use integral GND ground plane under the chip
- Minimize the length and area of all traces connected to the SW pin
- The power traces, consisting of the GND trace, the SW trace, the VIN trace and the VOUT trace should be kept short, direct and wide.
- The input capacitor needs to be close to inductor L and GND pin in order to reduce the input supply ripple. The output capacitor needs to be close to Diode and GND pin in order to reduce the output supply ripple.
- The resistor divider RUP and RDN must be connected to FB pin directly as closely as possible.
- The layout should also be done with well consideration of the thermal as this is a high-power density device. A thermal pad that improves the thermal capabilities of the package should be soldered to the large ground plate, using thermal vias underneath the thermal pad.

Package Information

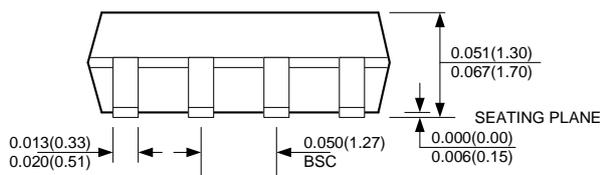
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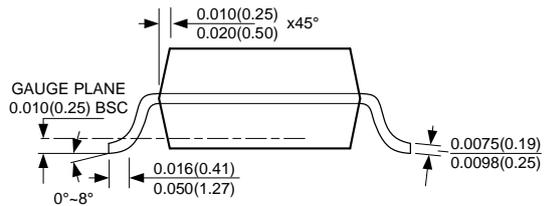
TOP VIEW



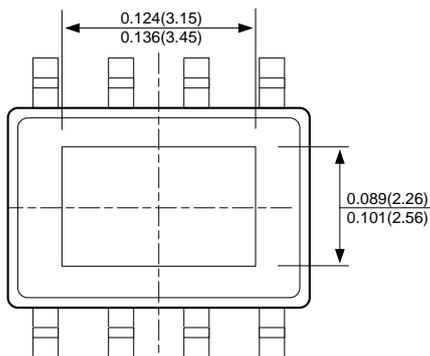
RECOMMENDED PAD LAYOUT



FRONT VIEW



SIDE VIEW



BOTTOM VIEW

NOTE:

1. CONTROL DIMENSION IS IN INCHES. DIMENSION IN BRACKET IS IN MILLIMETERS.
2. PACKAGE LENGTH DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
3. PACKAGE WIDTH DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS.
4. LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.004" INCHES MAX.
5. DRAWING CONFORMS TO JEDEC MS-012, VARIATION BA.
6. DRAWING IS NOT TO SCALE.