Wide Input Range CC/CV Step Down Converter

General Description

The NT3875A/B is a step down PWM converter with a driving typical output current to 2.5A (NT3875A) and 1.5A (NT3875B) without additional transistor. It is designed to allow for operating a wide supply voltage range from 8V to 40V. The external shutdown function can be controlled by logic level to pull COMP/EN pin down, and then comes into standby mode. The external compensation makes feedback control have good line and load regulation with flexible external design.

The NT3875A/B features a programmable CV/CC mode control functions. The CV mode (constant voltage) function provides a regulated voltage output and the CC mode (constant current) function provides a current limitation function. The CC current value is set by external resister during current sense amplifier input stage.

The NT3875A/B is suitable for the DC/DC switching power applications when requested the current limit function. The devices are available in SOP-8L and PSOP-8L packages and require very few external devices for operation.

(Patent Pending)

Applications

- ☐ **Car Charger**
- ☐ **Portable Charger Devices**
- ☐ **High-Brightness Lighting**
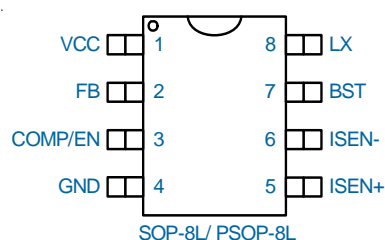- ☐ **General-Purpose DC/DC Converters with Current Limit**

Features

- ☐ **V_{IN} Operate with 8V ~ 40V Supply Voltage**
- ☐ **V_{OUT} Accuracy (Vref =1.2V) ±1.0% Over Line Voltage**
- ☐ **CC / CV Mode Control (Constant Current and Constant Voltage)**
- ☐ **+/- 5% Current Limit Accuracy**
- ☐ **Output Short Circuit Protection**
- ☐ **Output Over Voltage Protection (~120%)**
- ☐ **Over Temperature Protection**
- ☐ **Internal Soft Start ~ 7ms**
- ☐ **Fixed Frequency 120 KHz**
- ☐ **UVLO Protection (min=6V, typ=7V, max=8V)**
- ☐ **Duty Cycle Range (0~90%)**
- ☐ **Single Pin to External Compensation and Shutdown Control**
- ☐ **Integrated Power N-MOSFET**
  - ■ **Rds_on=150m ohm for NT3875A**
    Output Current=2.5A
  - ■ **Rds_on=240m ohm for NT3875B**
    Output Current=1.5A
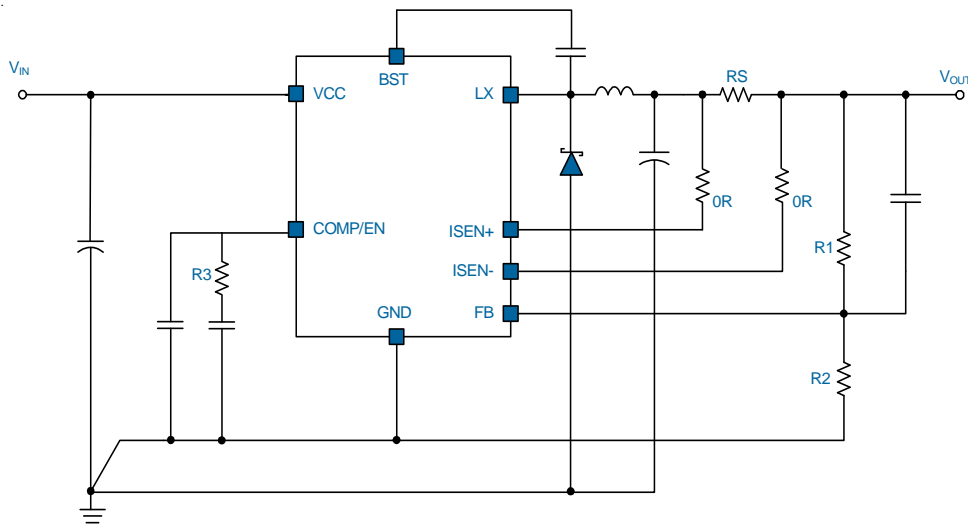- ☐ **(P)SOP- 8L Package**

Ordering Information

Order Number	Package	Remark
NT3875ASA8	SOP-8L	Output Current = 2.5A
NT3875ASW8	PSOP-8L	Output Current = 2.5A
NT3875BSA8	SOP-8L	Output Current = 1.5A

Note: NT products are compatible with the current IPC/ JEDEC J-STD-020 requirement. They are halogen-free, RoHS compliant and 100% matte tin (Sn) plating that are suitable for use in SnPb or Pb-free soldering processes.
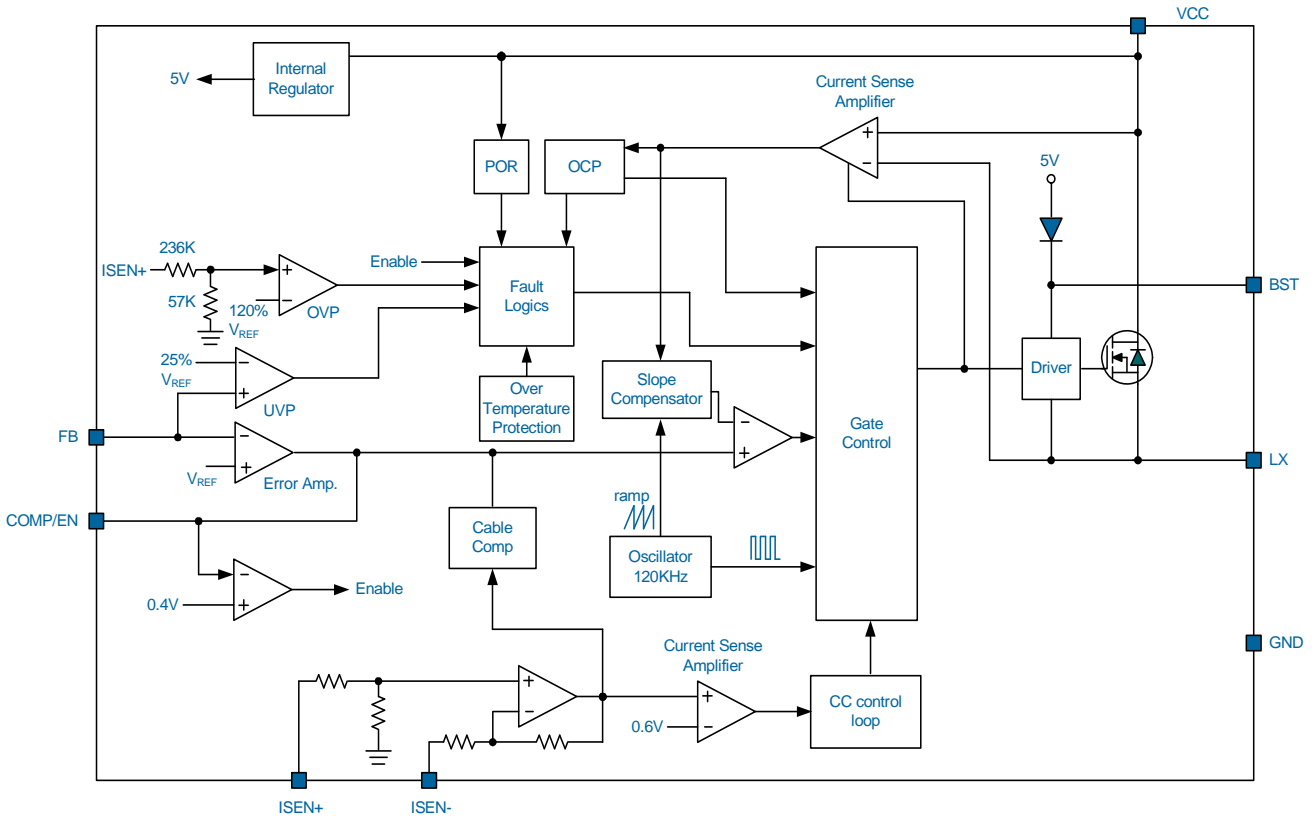
Pin Configuration

SOP-8L/ PSOP-8L

Typical Application Circuit

Functional Pin Description

No.	Pin Name	Pin Function
1	VCC	**Power Supply Input**. Bypass this pin with a 10uF ceramic capacitor to GND, placed as close to the IC as possible.
2	FB	**Feedback Pin.** The voltage at this pin is regulated to 1.2V. Connect to the resistor divider between output and GND to set the output voltage.
3	COMP/EN	**Error Amplifier Output.** This is the output of the error amplifier (EA) and the non-inverting input of the PWM comparator. Use this pin in combination with the VSEN pin to compensate the voltage control feedback loop of the converter. Pulling COMP/EN to a level below 0.4V nominal disables the controller, causes the oscillator to stop, and makes the UGATE and LGATE outputs held low.
4	GND	**Ground.** Connect this pin to a large PCB copper area for best heat dissipation, Return VSEN, and COMP to this GND and connect this GND to power GND at a single point for best noise immunity.
5	ISEN+	**The Current Sense Input (+) Pin.**
6	ISEN-	**The Current Sense Input (-) Pin.**
7	BST	**Bootstrap Pin.** This provides power to the internal higher MOSFET gate driver**.** Connect a 10nF capacitor from BST pin to LX pin.
8	LX	**Power Switching Output to External Inductor.**

Functional Block Diagram

Functional Description

CV/CC mode control

The NT3875A/B provides CV/CC function. In the CV mode, the output voltage is controlled within ±1%. In the CC mode, the output current variation is less than ±5% of the nominal value which can be set up to 2.5A(NT3875A) and 1.5A(NT3875B) by the current sensing resistor.

Over Voltage Protection

The NT3875A/B provides over voltage protection. The external resistors and the built-in internal resistor divider can adjust OVP value. Once the output voltage is higher than OVP threshold, the OVP will be triggered to shut down the converter. When the OVP condition is disappeared, the converter will resume normal operation.

Under Voltage Protection

The NT3875A/B provides under voltage protection. Once the feedback voltage drops below 25% of the internal reference voltage, the UVP will be triggered to shut down the converter. When the UVP condition is disappeared, the converter will resume normal operation.

Over Current Protection

The NT3875A/B uses on-state resistance of the internal power MOSFET as a current sense element. Once the peak switch current through the power MOSFET is higher than OCP threshold, the OCP will be triggered to shut down the converter. When peak current is lower than OCP threshold, the converter will resume normal operation.

Short Circuit Protection

The NT3875 provides short circuit protection. Once the loader short circuit happens, the SCP will be triggered to shut down the converter. When the SCP condition is disappeared, the converter will resume normal operation.

Soft Start

The NT3875A/B has internal soft start function to control rise rate of the output voltage and limits the large inruch current at start up. The typical soft start interval is about 7mS.

Power On Reset

A power-on reset circuit monitors the input voltage. When the input voltage exceeds 7V, the converter will start operation. Once input voltage falls below 6V, the converter shut down.

Over Temperature Protection

The NT3875A/B provides over temperature protection. The OTP will shut down the converter when junction temperature exceeds 160°C. Once the junction temperature cools down by approximately 40°C, the converter will resume normal operation.

FB Impendance Detection

The NT3875A/B has FB impedance detection. Whenever the FB pin short circuit happens, the converter shuts down and turns off output drivers. In this case, the converter will start up via a soft start once the short circuit condition disappears. If the short circuit condition remains for a period, the converter will retry automatically. When the fault is removed, the converter will resume normal operation. The typical soft start recycle time is about 260mS. Then, the average short circuit current can be greatly reduced.

Absolute Maximum Rating

(Note1)

Supply Input Voltage, V_{CC} -- -0.3V to +45V

BST to LX -- 0.3V to +7V

LX to GND DC -- -1V to +VIN+1V

BST to GND DC --- VSW-0.3 to VSW+7V

FB, COMP to GND DC -- 0.3V to +7V

ISEN-, ISEN+ to GND DC --- 0.3V to +9V

Storage Temperature Range -- -65°C to +150°C

Junction Temperature -- -20°C to +150°C

Lead Temperature Range(Soldering 10sec) --- 260°C

ESD Rating (Note2)

 HBM(Human Body Mode) -- -2KV

 MM(Mechine Mode) --- 200V

Thermal Information

Package Thermal Resistance (Note3)

    SOP-8L θ_{JA} --- 160°C/W

    SOP-8L θ_{JC} --- 39°C/W

    PSOP-8L θ_{JA} --- 50°C/W

    PSOP-8L θ_{JC} --- 5°C/W

Power Dissipation, PD @ TA = 25°C

    SOP-8L -- 0.63W

    PSOP-8L --- 2W

Electrical Characteristics

(V_{CC} = 12V, T_A = +25°C unless otherwise specified.)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Supply Input						
Supply Voltage Range	V_{CC}		8	--	40	V
Supply Input Current	I_{CCQ}	COMP/EN = GND	--	0.3	0.5	mA
	I_{CC}		--	5	10	mA
Power-On-Reset						
VCC POR Threshold	V_{CCRTH}	VCC Rising.	7	7.7	8	V
	V_{CCFTH}	VCC Falling	6	6.7	7	V
Oscillator						
Normal PWM Frequency	F_{OSC}		--	120	--	KHz
		T_A = -25°C to 80°C	102	--	138	KHz
Minimum On-Time	T_{ON-MIN}		--	200	--	nS
Duty Cycle Range	Duty		0	--	90	%

Electrical Characteristics

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Reference						
Reference Voltage	V_{REF}		--	1.2	--	V
Reference Voltage Tolerance			-1	--	+1	%
V_{REF} Load Compensator		ΔV_{ISEN} = 115mV		2.5		%
PWM Error Amplifier						
FB Input Current	I_{FB}	V_{FB} = 1.2V	--	0.1	1	uA
COMP High Voltage	V_{COMP_H}		--	5.5	--	V
COMP Low Voltage	V_{COMP_L}		--	0.8	--	V
COMP Shutdown Threshold Voltage			--	0.4	--	V
COMP Source Current		V_{COMP} = V_{COMP_H} -1V	--	42	--	uA
COMP Sink Current		V_{COMP} = 1V	--	42	--	uA
Current Sense Amplifier						
Difference Voltage between ISEN- and ISEN+	ΔV_{ISEN}		--	115	--	mV
Protection						
FB Over Voltage Level	V_{OVP}	Recent of V_{REF}	--	120	--	%
FB Under Voltage Level	V_{UVP}	Recent of V_{REF}		25		%
Current Limit	I_{LIM}			4.5		A
Over Temperature Shutdown			--	160	--	$^{\circ}$C
Over Temperature Hysteresis			--	40	--	$^{\circ}$C
Soft Start						
Soft Start Time	T_{SS}			7		mS
Recycle Time				260		mS

Note 1. Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

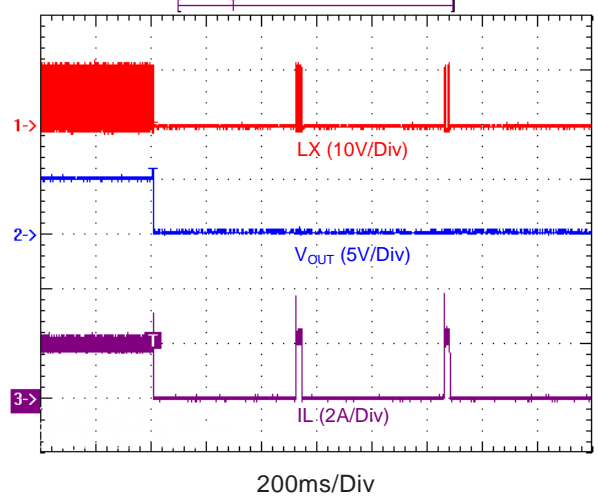**Note 2.** Devices are ESD sensitive. Handling precaution recommended.

Note 3. θ_{JA} is measured in the natural convection at T_A = 25°C on a high effective thermal conductivity test board of JEDEC 51-7 thermal measurement standard.
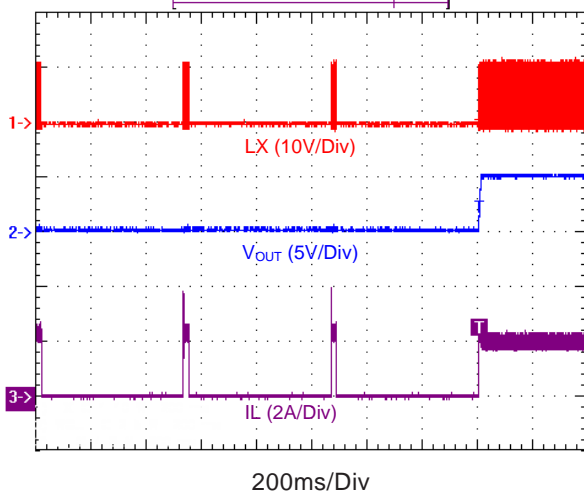
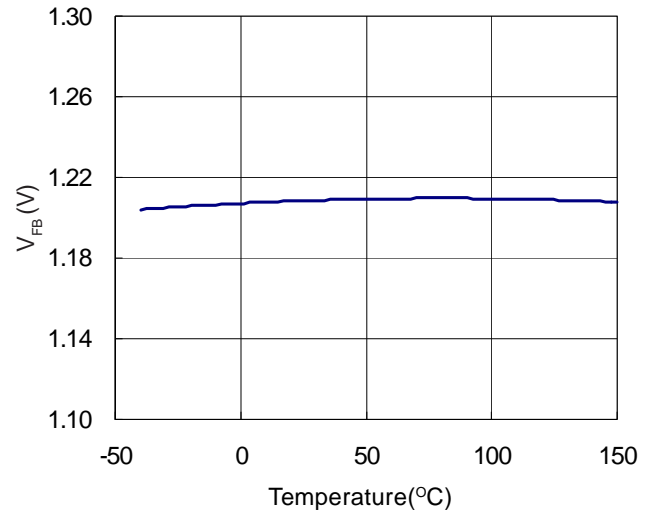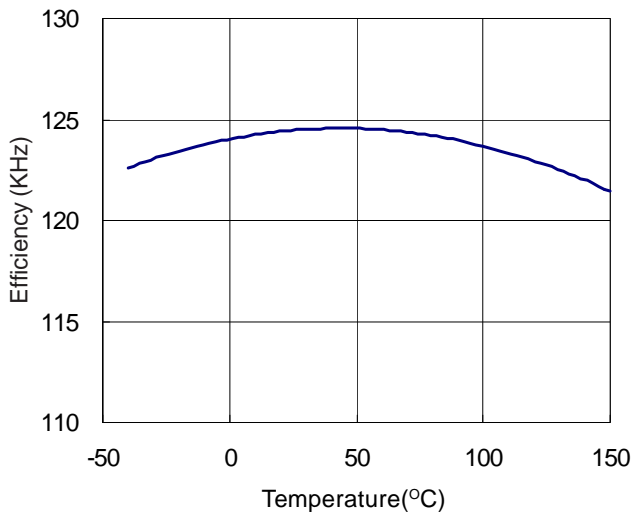*Typical Operation Characteristics*

Power On from VDD

VDD (10V/Div)

LX (20V/Div)

V_OUT (5V/Div)

OUT (2A/Div)

10ms/Div

Short Circuit Protection

LX (10V/Div)

V_OUT (5V/Div)

IL (2A/Div)

200ms/Div

Short Circuit Recovery
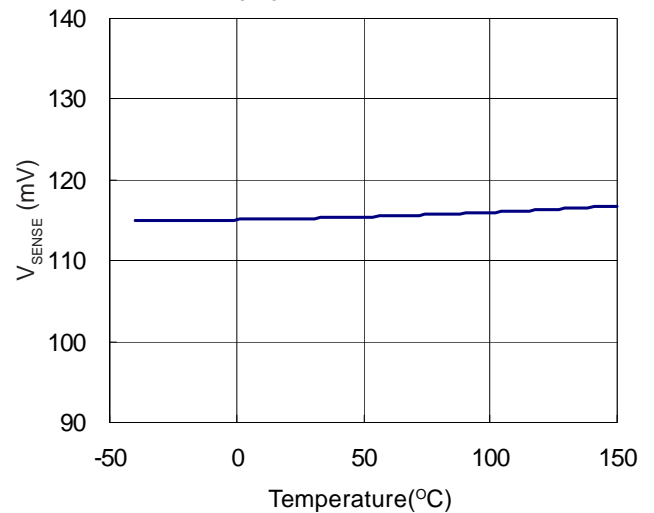

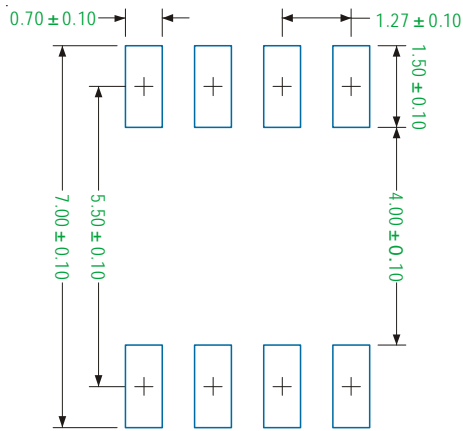LX (10V/Div)

V_OUT (5V/Div)

IL (2A/Div)

200ms/Div
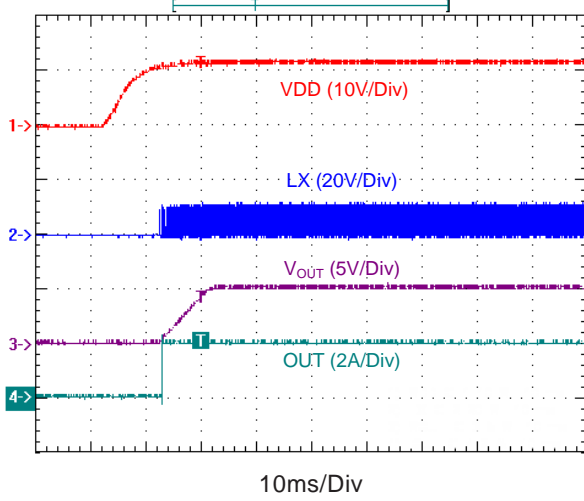
V_FB vs. Temperature

Frequency vs. Temperature

V_SENSE vs. Temperature

Package Information
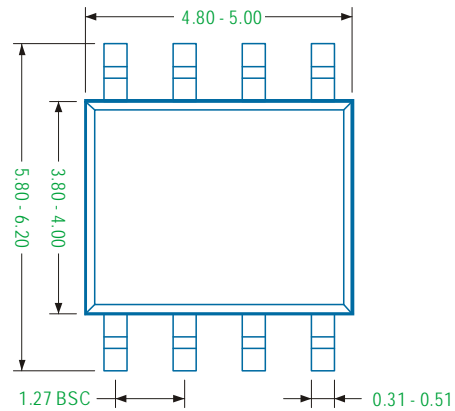
SOP-8L

Recommended Solder Pad Layout
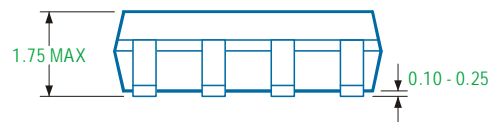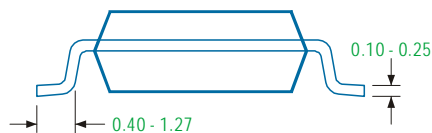
Note

1. Package Outline Unit Description:

   BSC: Basic. Represents theoretical exact dimension or dimension target

   MIN: Minimum dimension specified.

   MAX: Maximum dimension specified.

   REF: Reference. Represents dimension for reference use only. This value is not a device specification.

   TYP. Typical. Provided as a general value. This value is not a device specification.
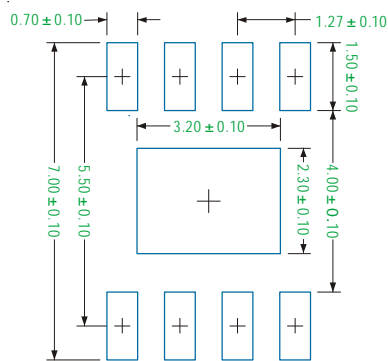
2. Dimensions in Millimeters.
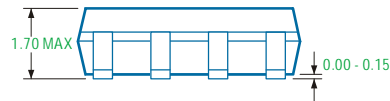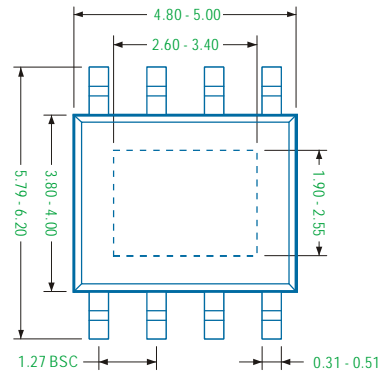
3. Drawing not to scale.

4. These dimensions do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm.

PSOP-8L

0.70 ± 0.10　1.27 ± 0.10

1.50 ± 0.10

3.20 ± 0.10

7.00 ± 0.10　5.50 ± 0.10　2.30 ± 0.10　4.00 ± 0.10

Recommended Solder Pad Layout

4.80 - 5.00

2.60 - 3.40

5.79 - 6.20　3.80 - 4.00　1.90 - 2.55

1.27 BSC　0.31 - 0.51

0.10 - 0.25

0.40 - 1.27

1.70 MAX　0.00 - 0.15

Note
1. Package Outline Unit Description:
   BSC: Basic. Represents theoretical exact dimension or dimension target
   MIN: Minimum dimension specified.
   MAX: Maximum dimension specified.
   REF: Reference. Represents dimension for reference use only. This value is not a device specification.
   TYP. Typical. Provided as a general value. This value is not a device specification.
2. Dimensions in Millimeters.
3. Drawing not to scale.
4. These dimensions do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm.