

Wide Input Range CC/CV Step-Down Converter

General Description

The NT3877 is a step-down PWM converter with a driving typical output current to 3A 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 NT3877 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 resistor during current sense amplifier input stage.

The NT3877 is suitable for the DC/DC switching power applications where current limit function is required. The devices are available in PSOP-8L package and require very few external devices for operation.

Ordering Information

Order Number	Package	Top Marking
NT3877ASW8	PSOP-8L	NT3877A

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.

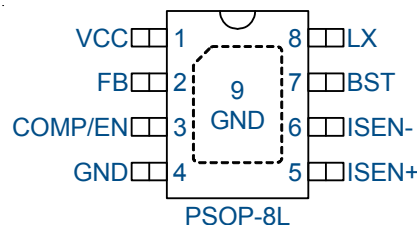
Features

- ❑ Operates from 8V to 40V Supply Voltage with UVLO Protection
- ❑ 1.2V Feedback Voltage with 1% Accuracy Over Line Voltage
- ❑ CV/CC Mode Control (Constant Voltage and Constant Current)
- ❑ $\pm 5\%$ Current Limit Accuracy
- ❑ Output Short Circuit Protection
- ❑ Output Over Voltage Protection (Typical 5.9V)
- ❑ Over Temperature Protection
- ❑ Internal Soft Start $\sim 12\text{ms}$
- ❑ Fixed Frequency 120kHz
- ❑ UVLO Protection
- ❑ Duty Cycle Range (0~90%)
- ❑ Single Pin to External Compensation and Shutdown Control
- ❑ Integrated 140m Ω Power N-MOSFET
- ❑ PSOP-8L Package
- ❑ RoHS Compliant and Halogen-Free

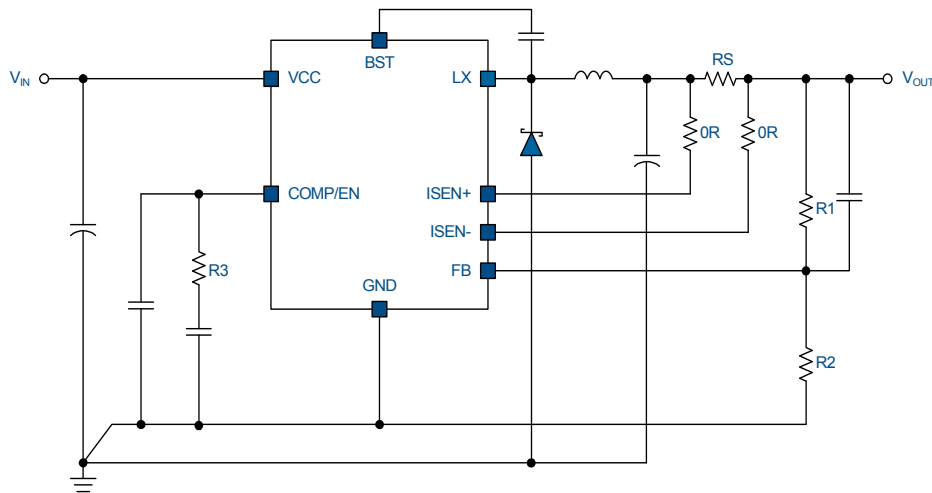
Applications

- ❑ Car Chargers
- ❑ Portable Charging Devices
- ❑ High-Brightness Lightings
- ❑ General-Purposed DC/DC Converters with Current Limit

Pin Configuration



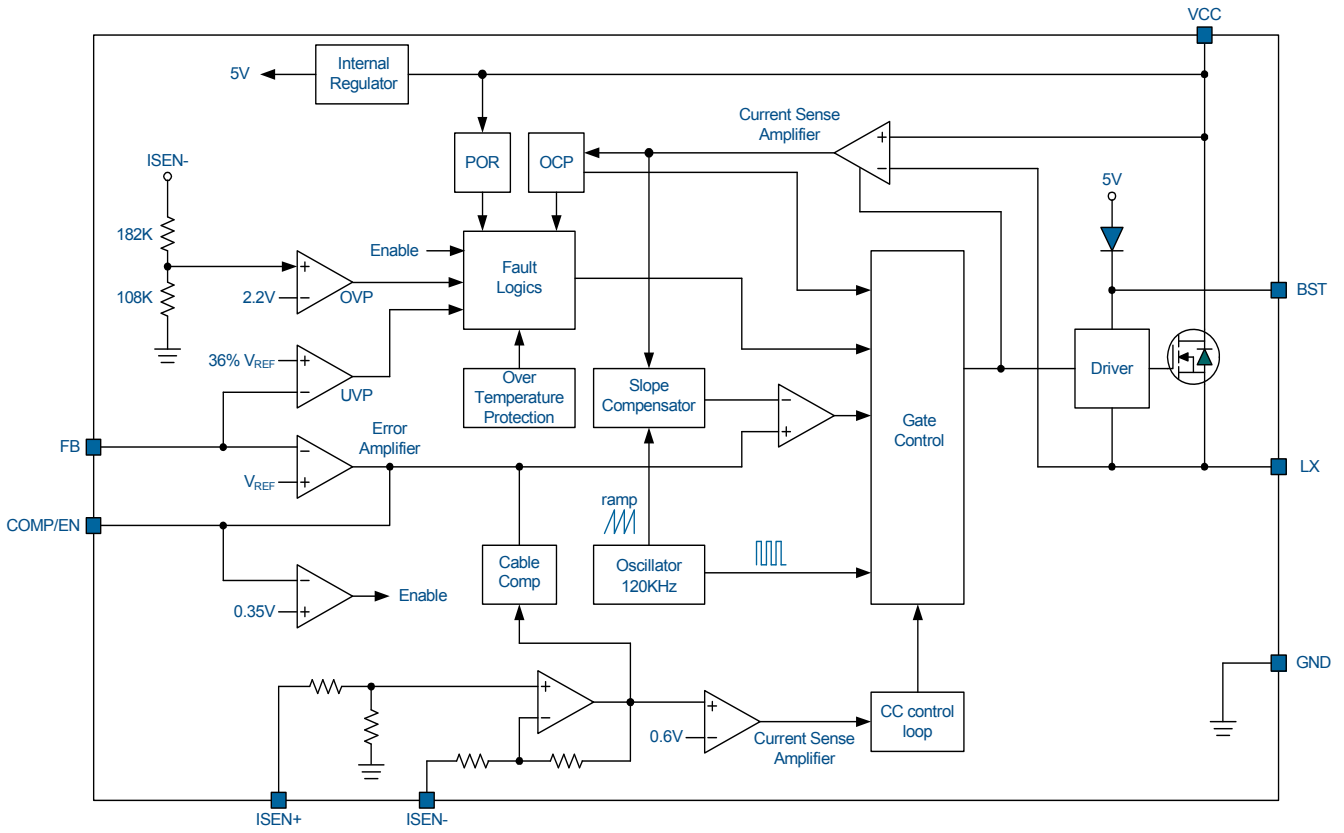
Typical Application Circuit



Functional Pin Description

Pin No.	Pin Name	Pin Function
1	VCC	Power Supply Input. Bypass this pin with a 0.1µF 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 FB pin to compensate the voltage control feedback loop of the converter. Pulling COMP/EN to a level below 0.35V nominal will disable the controller and stops the internal oscillator.
4	GND	Ground. Return FB, 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 100nF capacitor from BST pin to LX pin.
8	LX	Power Switching Output to External Inductor.
9	GND	Ground. Connect this pin to a large PCB copper area for best heat dissipation.

Functional Block Diagram



Functional Description

CV/CC mode control

The NT3877 provides CV/CC function. In the CV mode, the output voltage is controlled within $\pm 1\%$. In the CC mode, the output current variation is less than $\pm 5\%$ of the nominal value which can be set up to 3A by the current sensing resistor.

Over Voltage Protection

The NT3877 provides over voltage protection. Once the output voltage (measured the at ISEN- pin) 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 NT3877 provides under voltage protection. Once the feedback voltage drops below 36% 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 NT3877 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 NT3877 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 NT3877 has internal soft start function to control rise rate of the output voltage and limits the large inrush current at start up. The typical soft start interval is about 12ms.

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 shuts down.

Over Temperature Protection

The NT3877 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 Impedance Detection

The NT3877 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 520ms. Then, the average short circuit current can be greatly reduced.

Cable Compensation

In charger applications, the large load will cause voltage drop in the output cable. The NT3877 has a built-in cable compensation function. When the load increases, the cable compensator will increase a 2.5%(typ.) regulation of the error amplifier that can make the output voltage constant. The typical cable compensation is calculated as follows :

$$\text{if } \Delta V_{\text{ISEN}} = 115\text{mV}, \Delta V_{\text{OUT}} = \frac{R_{\text{sense}} \times I_{\text{Load}}}{3.83} \times \left(\frac{R1+R2}{R2} \right)$$

Absolute Maximum Rating

(Note1)

Supply Input Voltage, V_{CC}	-0.3V to +45V
BST to LX	+0.3V to +7V
LX to GND	-1V to $V_{CC}+1V$
FB, COMP to GND	-0.3V to +7V
ISEN-, ISEN+ to GND	-0.3V to +9V
Storage Temperature Range	-65°C to +150°C
Operation Temperature Range	-40°C to +150°C
Lead Temperature Range (Soldering 10sec)	260°C
ESD Rating (Note2)	
MM (Machine Mode)	200V
HBM (Human Body Mode)	2kV

Thermal Information

Package Thermal Resistance (Note3)

PSOP-8L θ_{JA}	50°C/W
PSOP-8L θ_{JC} (junction to exposed pad)	5°C/W
PSOP-8L θ_{JC} (junction to center of case top) (Note 4)	30°C/W
Power Dissipation, P_D @ $T_A = 25^\circ\text{C}$	
PSOP-8L	2W

- 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 $T_A = 25^\circ\text{C}$ on a high effective thermal conductivity test board of JEDEC 51-7 thermal measurement standard.
- Note 4.** This parameter is highly dependent of PCB design and operating environments.

Electrical Characteristics

($V_{CC} = 12V$, $T_A = +25^{\circ}C$ unless otherwise specified.)

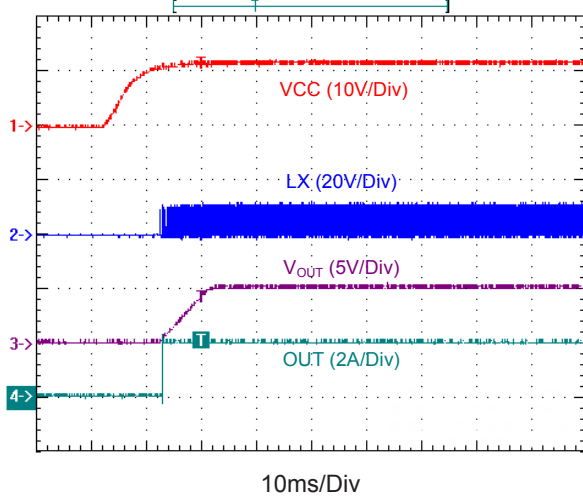
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Supply Input						
Supply Voltage Range	V_{CC}		8	--	40	V
Supply Input Current	I_{CCQ}	COMP/EN = 0V	--	1	1.3	mA
	I_{CC}		--	3	6	
Power On Reset						
V_{CC} POR Threshold	V_{CC-RTH}	V_{CC} Rising	6.5	7.0	7.5	V
	V_{CC-FTH}	V_{CC} Falling	5.5	6.0	6.5	
Oscillator						
Normal PWM Frequency	f_{OSC}		--	120	--	kHz
		$T_A = -25^{\circ}C$ to $80^{\circ}C$	102	--	138	
Minimum On-Time	t_{ON-MIN}		--	200	--	ns
Maximum Duty Cycle	D_{MAX}		--	90	--	%
Reference						
Reference Voltage	V_{REF}		--	1.2	--	V
Reference Voltage Tolerance			-1	--	+1	%
V_{REF} Load Compensator		$\Delta V_{ISEN} = 115mV$	--	2.5	--	%
PWM Error Amplifier						
FB Input Current	I_{FB}	$V_{FB} = 1.2V$	-1	0	+1	μA
COMP High Voltage	V_{COMP-H}		--	5.3	--	V
COMP Low Voltage	V_{COMP-L}		--	0.8	--	V
COMP Shutdown Voltage			--	0.35	--	V
COMP Source Current		$V_{COMP} = V_{COMP-H} - 1V$	--	80	--	μA
COMP Sink Current		$V_{COMP} = 1V$	--	80	--	μA
Current Sense Amplifier						
Difference Voltage Between ISEN- and ISEN+ at CC Mode Operation	ΔV_{ISEN}	$V_{ISEN-} = 4.8V$	109	115	121	mV
Protection						
Output Over Voltage Level	V_{OVP}	Measured at ISEN-	5.7	5.9	6.1	V
FB Under Voltage Level	V_{UVP}	Measured at FB	--	36	--	%
Current Limit	I_{LIM}		--	4.0	--	A
Over Temperature Shutdown		Guaranteed by Design	145	160	175	$^{\circ}C$
Over Temperature Hysteresis			--	40	--	$^{\circ}C$
Soft Start						
Soft Start Time	t_{SS}		--	12	--	ms
Recycle Time			--	520	--	ms

Electrical Characteristics

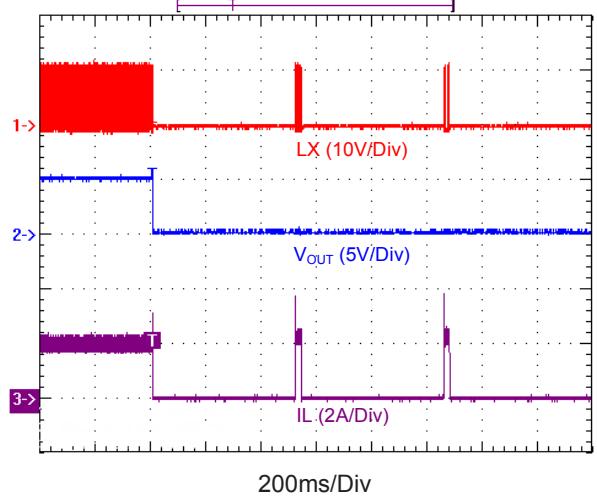
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
MOSFET						
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0V, I_{LX} = 250\mu A$	45	--	--	V
Drain-Source On-State Resistance	$R_{DS(ON)}$	$V_{IN} = 24V, I_{OUT} = 1A$	--	140	--	m Ω
Continuous Source Current	I_S		--	--	4	A
Pulsed Source Current	I_{SM}		--	--	6	A
LX Pin Rising Time	t_R	$V_{IN} = 12V, I_L = 2A$	--	35	--	ns
LX Pin Falling Time	t_F	$V_{IN} = 12V, I_L = 2A$	--	35	--	ns

Typical Operation Characteristics

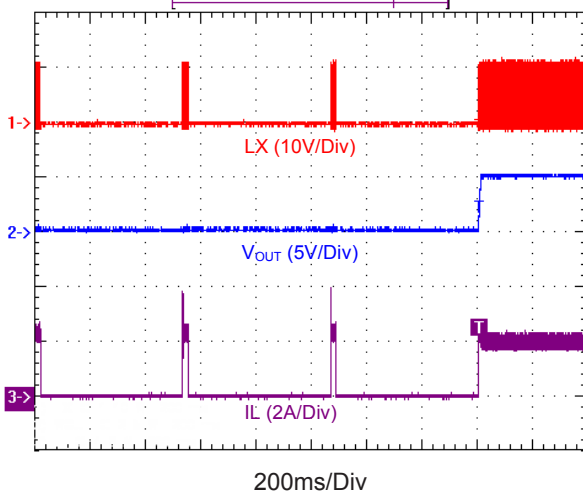
Power On from VCC



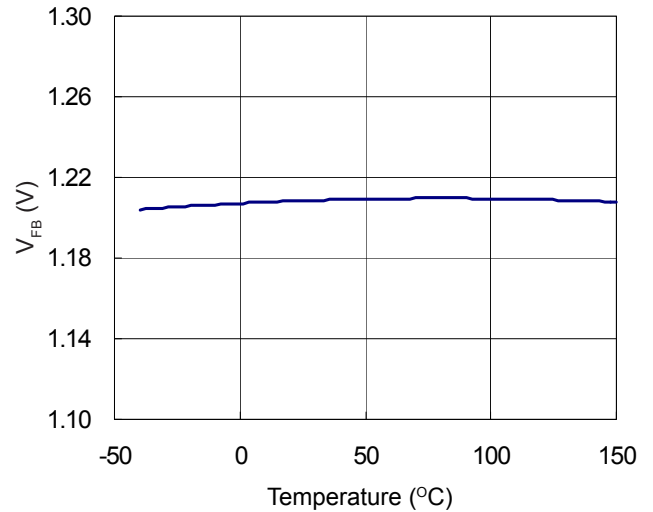
Short Circuit Protection



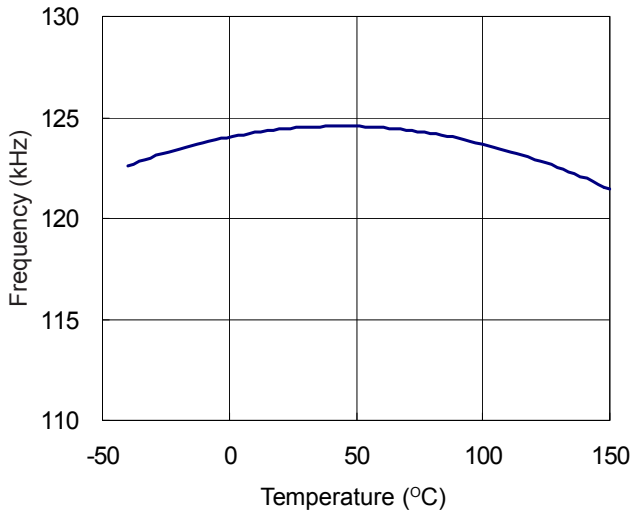
Short Circuit Recovery



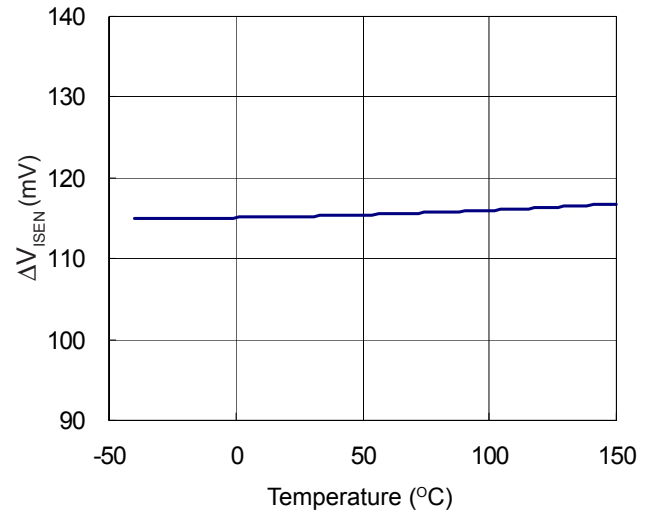
V_{FB} vs. Temperature



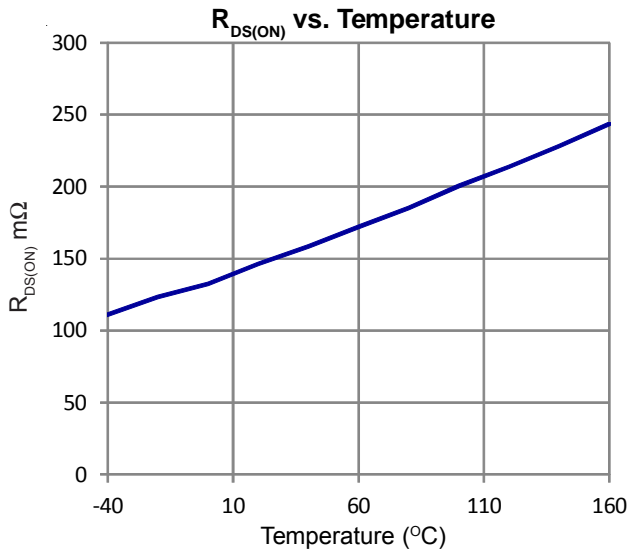
Frequency vs. Temperature



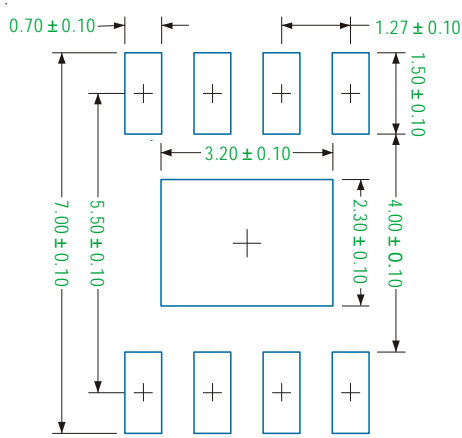
ΔV_{ISEN} vs. Temperature



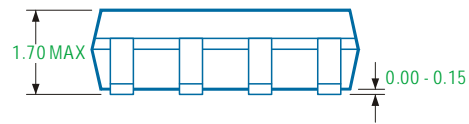
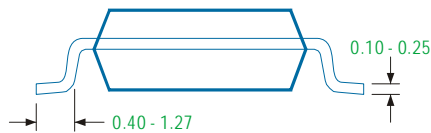
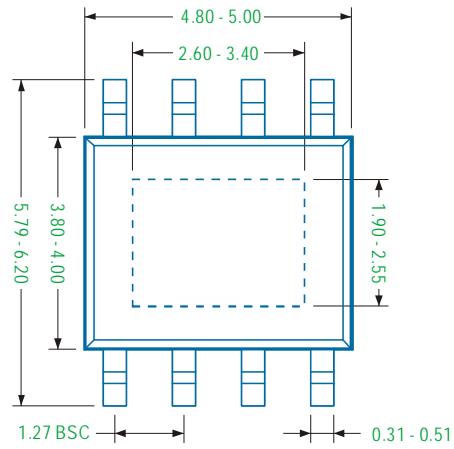
Typical Operation Characteristics



PSOP-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.