

## DESCRIPTION

The MP8110 is a low-cost, precision, high-side current-sense amplifier. This device operates from a single 2.5V to 40V supply and typically consumes 12 $\mu$ A. It is ideal for today's notebook computers, cell phones and other systems where battery/DC current monitoring is critical.

High-side current monitoring is especially useful in battery-powered systems since it does not interfere with the ground path of the battery charger. The input common-mode range of 1.4V to 40V is independent of the supply voltage and ensures that the current-sense feedback remains viable even when connected to a 2-cell battery pack in deep discharge.

This device is available in 8-pin SOIC and MSOP packages.

## FEATURES

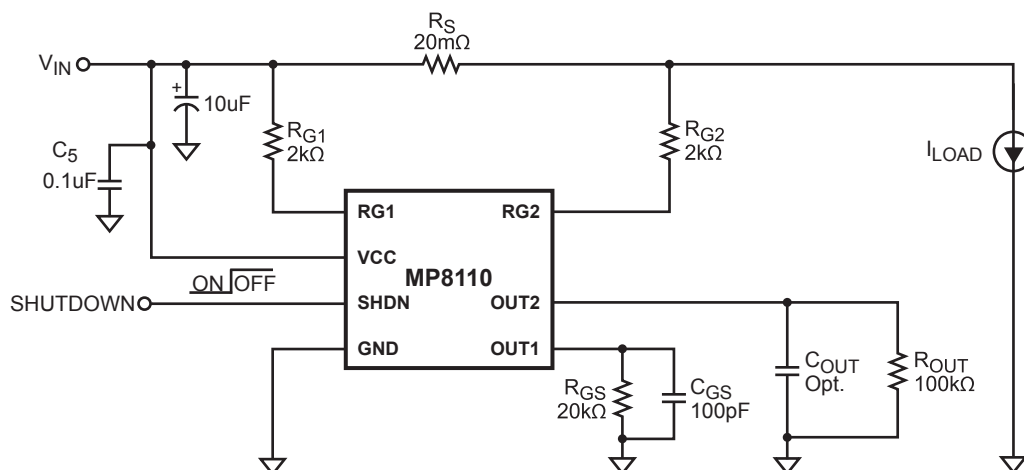
- Low-Cost, Compact Current-Sense Solution
- 12 $\mu$ A Typical Supply Current
- 2.5V to 40V Operating Supply Voltage
- 1.4V to 40V Input Common Mode Range
- 3 $\mu$ A Typical Shutdown Current
- 400 $\mu$ V Input Offset Voltage
- High Current Sensing Capability
- Integrated Buffer Amplifier
- Available in 8-Pin SOIC and MSOP packages,

## APPLICATIONS

- Portable PCs
- PDA's
- Smart Battery Packs
- Cell Phones
- Portable Test/Masurement Systems
- Battery-Operated Systems
- Energy Management Systems

"MPS" and "The Future of Analog IC Technology" are Registered Trademarks of Monolithic Power Systems, Inc.

## TYPICAL APPLICATION



## PACKAGE REFERENCE

TOP VIEW		
SHDN	1	8 OUT2
NC	2	7 VCC
RG1	3	6 RG2
GND	4	5 OUT1

Part Number*	Package	Temperature
MP8110DS	SOIC8	–40°C to +85°C

\* For Tape & Reel, add suffix –Z (eg. MP8110DS–Z)  
 For RoHS Compliant Packaging, add suffix –LF  
 (eg. MP8110DS–LF–Z)

ABSOLUTE MAXIMUM RATINGS <sup>(1)</sup>

V<sub>CC</sub>, RG1, RG2 to GND.....–0.3V to +42V  
 Max Differential Input Voltage, RG1 to RG2..... 5V  
 Max Junction Temperature (T<sub>j</sub>) ..... 150°C  
 Storage Temperature ..... –65°C to +150°C

Recommended Operating Conditions <sup>(2)</sup>

V<sub>CC</sub>, RG1, RG2 to GND .....2.5V to 40V  
 Operating Ambient Temperature–40°C to +85°C

TOP VIEW		
SHDN	1	8 OUT2
NC	2	7 VCC
RG1	3	6 RG2
GND	4	5 OUT1

Part Number*	Package	Temperature
MP8110DK	MSOP8	–40°C to +85°C

\* For Tape & Reel, add suffix –Z (eg. MP8110DK–Z)  
 For RoHS Compliant Packaging, add suffix –LF  
 (eg. MP8110DK–LF–Z)

Thermal Resistance <sup>(3)</sup>

	$\theta_{JA}$	$\theta_{JC}$
SOIC8.....	90	42... °C/W
MSOP8.....	150	65... °C/W
Continuous Power Dissipation (T <sub>A</sub> =70°C) .....		800mW

## Notes:

- 1) Exceeding these ratings may damage the device.
- 2) The device is not guaranteed to function outside of its operating conditions.
- 3) Measured on approximately 1" square of 1 oz copper.

## ELECTRICAL CHARACTERISTICS

V<sub>CC</sub> = 24V, V<sub>SHDN</sub> = 0V, T<sub>A</sub> = +25°C, unless otherwise noted.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Supply Voltage	V <sub>CC</sub>		2.5		40	V
Supply Current	I <sub>CC</sub>	I <sub>LOAD</sub> = 0A, V <sub>CC</sub> = 40V		12	30	μA
Common Mode Input Voltage	V <sub>IN,CM</sub>	V <sub>CC</sub> > V <sub>IN</sub> Low		1.4		V
		V <sub>CC</sub> > V <sub>IN</sub> High		40		
OUT1 Input Offset Voltage	V <sub>OS1</sub>			0.4	2	mV
OUT2 Input Offset Voltage	V <sub>OS2</sub>			1	5	mV
Input Bias Current <sup>(4)</sup>	I <sub>RG1</sub> , I <sub>RG2</sub>			4	20	nA
OUT1 Current Accuracy	I <sub>RG1</sub> /I <sub>GS</sub>	V <sub>SENSE</sub> = 100mV		±2	±5	%
No-Load OUT1 Error		V <sub>SENSE</sub> = 0V		0.1	1	μA
Low-Level OUT1 Error		V <sub>SENSE</sub> = 5mV		0.3	2	μA
No-Load OUT2 Error		V <sub>SENSE</sub> = 0V		0.01	1	μA
Low-Level OUT2 Error		V <sub>SENSE</sub> = 5mV		0.05	2	μA
Power Supply Rejection Ratio	PSRR	2.5V < V <sub>CC</sub> < 40V, V <sub>SENSE</sub> = 100mV	70	97		dB
Shutdown Supply Current	I <sub>CC(SHDN)</sub>	V <sub>SHDN</sub> = 3V		3	6	μA

## ELECTRICAL CHARACTERISTICS (continued)

$V_{CC} = 24V$ ,  $V_{SHDN} = 0V$ ,  $T_A = +25^{\circ}C$ , unless otherwise noted.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
SHDN Threshold Voltage	$V_{TH\_SHUTDOWN}$	(Low - High)	0.7	0.9	1.2	V
SHDN Hysteresis				30		mV
OUT1 Rise, Fall Time <sup>(4)</sup>	$t_R$	$V_{SENSE} = 40mV$ , $R_{GS} = 20k\Omega$ , $R_{OUT} = 100k\Omega$ ,		17		$\mu s$
	$t_F$	$R_{G1} = R_{G2} = 2k\Omega$ , $C_{GS} = 100pF$ , $C_{OUT} = 100pF$ , 10% to 90%		29		
OUT2 Rise, Fall Time <sup>(4)</sup>	$t_R$	$V_{SENSE} = 40mV$ , $R_{GS} = 20k\Omega$ , $R_{OUT} = 100k\Omega$ ,		18		$\mu s$
	$t_F$	$R_{G1} = R_{G2} = 2k\Omega$ , $C_{GS} = 100pF$ , $C_{OUT} = 100pF$ , 10% to 90%		26		
OUT1 Output Voltage Range	$V_{GS}$			$V_{CC} - 0.15$	24	V
OUT2 Output Voltage Range	$V_{OUT}$			$V_{CC} - 1$	24	V
Maximum OUT1 Current <sup>(4)</sup>	$I_{GS}$			500		$\mu A$
Maximum OUT2 Current <sup>(4)</sup>	$I_{OUT2}$			5		mA

### Notes:

4) Guaranteed by design.

5) Input common mode range cannot exceed the supply voltage.

## PIN FUNCTIONS

SOIC8	Name	Description
1	SHDN	Shutdown. Connect to ground for normal operation. When high, supply current is less than 3 $\mu A$ .
2	NC	Not Connected.
3	RG1	Gain Resistor. Connect to battery side of current-sense resistor through the gain resistor.
4	GND	Ground or Battery Negative Terminal.
5	OUT1	Output for Driving Resistor Load.
6	RG2	Gain Resistor. Connect to load side of current-sense resistor through the gain resistor.
7	VCC	Power Input. Connect to Battery Input.
8	OUT2	Output For Driving Capacitive Loads.

## OPERATION

The MP8110 is a current-sense amplifier with a wide operating input voltage range of 2.5V to 40V. It has 1.4V to 40V Common-Mode range.

This feature allows the monitoring of current flow out of a battery in deep discharge, and also enables high-side current sensing up to the supply voltage,  $V_{CC}$ . Current flows through the sense resistor,  $R_S$ , which generates a sense voltage  $V_{RS}$ . The high precision sense amplifier built into the MP8110 monitors the differential voltage across  $R_S$  and dynamically adjusts the gate voltage of the internal P-channel MOSFET to maintain an equal passing current as  $I_{RG1}$ . The current amplifier gain is therefore set as:  $R_{GS} / R_{G1}$ .

### Choosing Sensing Resistor

Given the gain and maximum load current, select  $R_S$  such that  $V_{RS}$  does not exceed +0.25V and  $V_{OUT1}$  does not exceed 5V. To measure lower currents more accurately, use a high value for  $R_S$ . A higher value develops a higher sense voltage, which overcomes offset voltage errors of the internal current amplifier.

In applications of monitoring very high current, ensure  $R_S$  is able to dissipate its own  $I^2R$  losses. If the resistor rating power is exceeded, its value may drift or it may fail altogether, causing a differential voltage across the terminals in excess of the absolute maximum range (0.25V).

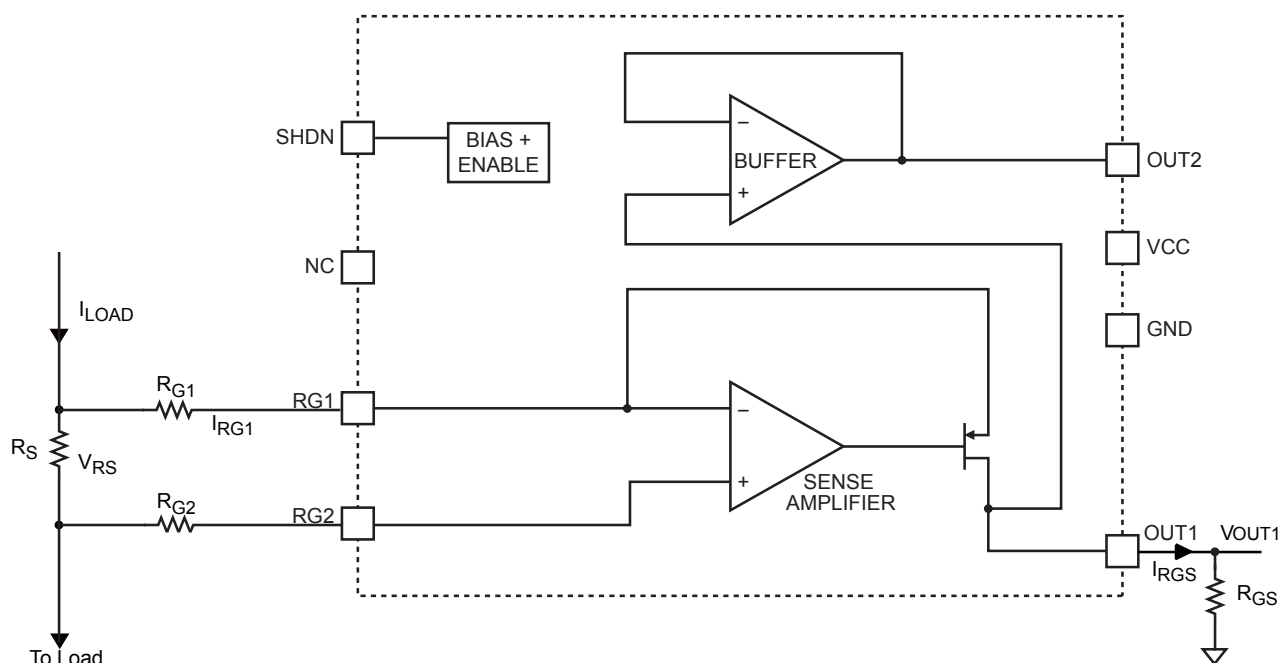


Figure 1—Functional Block Diagram

## APPLICATION INFORMATION

### COMPONENT SELECTION

Table 1—Suggested Component Values (refer to Typical Circuit on page 1)

Full-Scale Load Current, $I_{SENSE}$ (A)	Current Sense Resistor (mΩ)	Gain Setting Resistor (kΩ) ( $R_{G1} = R_{G2}$ )	$R_{GS}$ (kΩ)	Gain
0.1	500	2	20	10
1	50	2	20	10
5	10	2	20	10
10	5	2	20	10

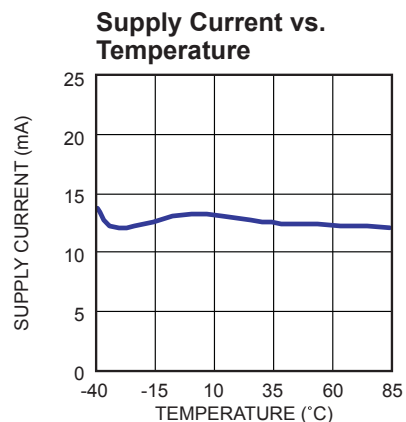
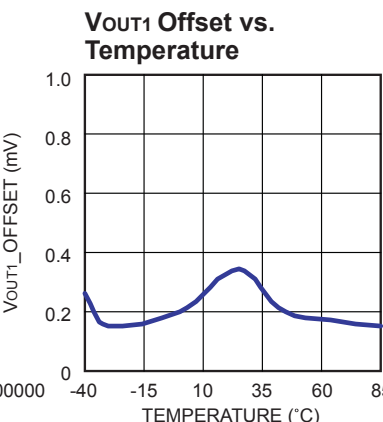
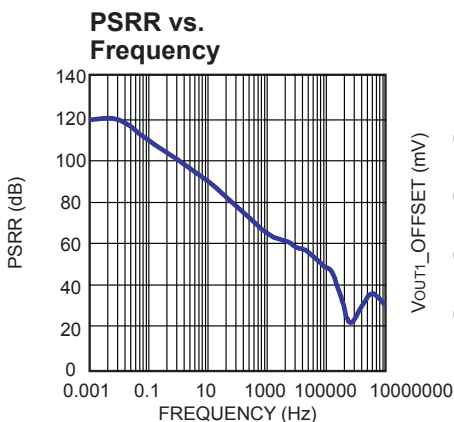
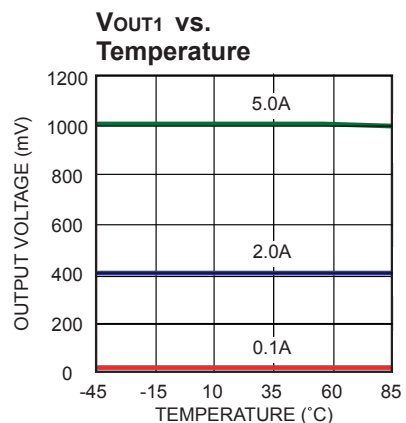
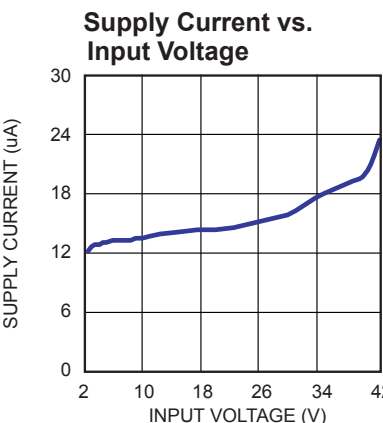
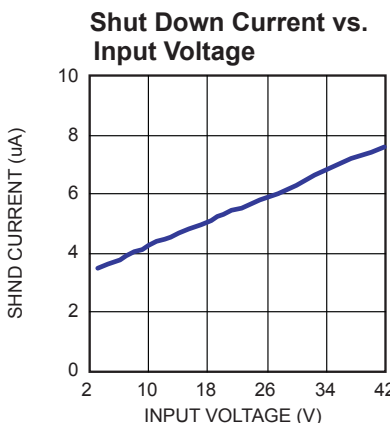
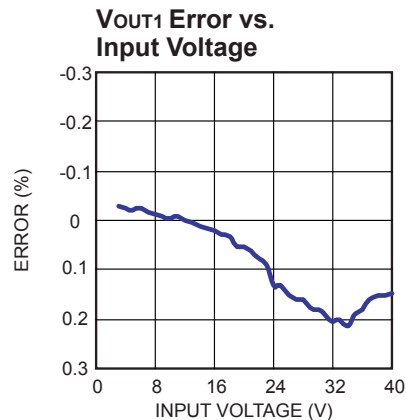
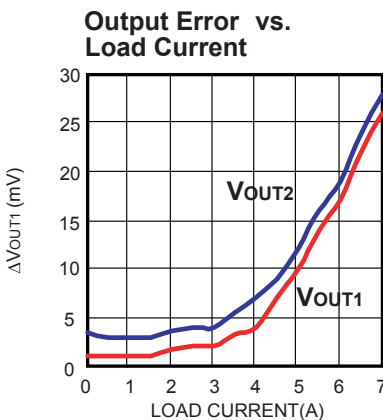
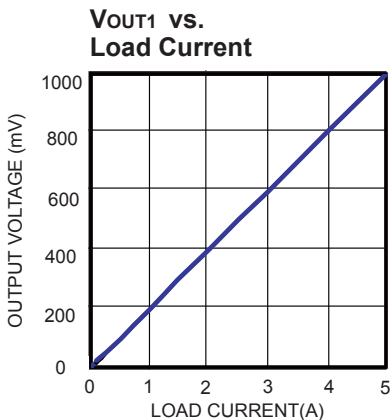
The value of  $V_{OUT1}$  can be obtained with the equation:

$$V_{OUT1} = \frac{I_{LOAD} \times R_S \times R_{GS}}{R_{G1}} = I_{LOAD} \times R_S \times \text{Gain}$$

Where  $R_{G1}$  is the sense resistor and  $I_{LOAD}$  is the load current.

# TYPICAL PERFORMANCE CHARACTERISTICS

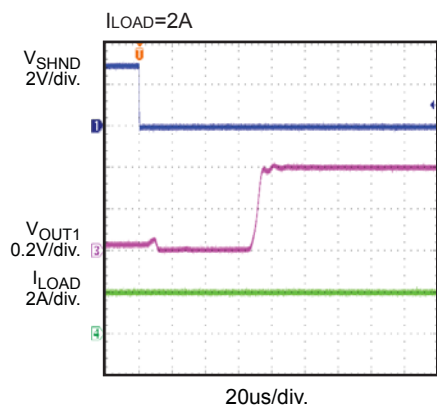
$V_{IN}=24V$ ,  $R_{G1}=R_{G2}=2K\Omega$ ,  $R_{G3}=20K\Omega$ ,  $R_S=20m\Omega$ ,  $C_{GS}=100pF$ ,  $C_S=0.1\mu F$ ,  $T_A=+25^{\circ}C$ , unless otherwise noted.



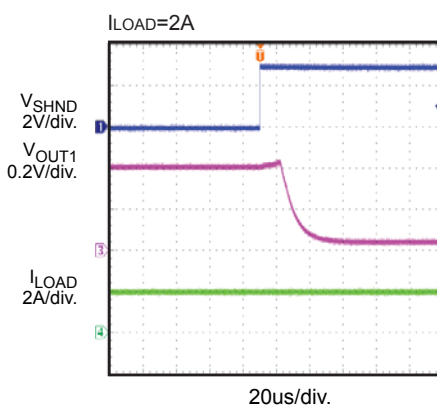
## TYPICAL PERFORMANCE CHARACTERISTICS *(continued)*

$V_{IN}=24V$ ,  $R_{G1}=R_{G2}=2K\Omega$ ,  $R_{G3}=20K\Omega$ ,  $R_S=20m\Omega$ ,  $C_{GS}=100pF$ ,  $C_5=0.1\mu F$ ,  $T_A=+25^\circ C$ , unless otherwise noted.

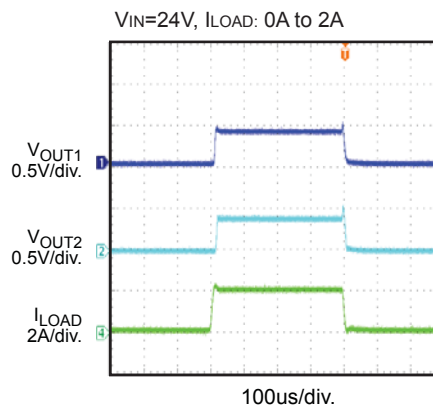
**SHND High to Low**



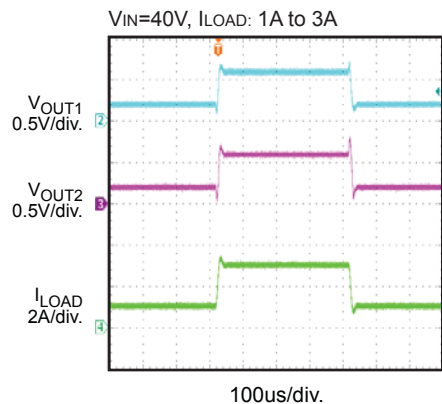
**SHDN Low to High**



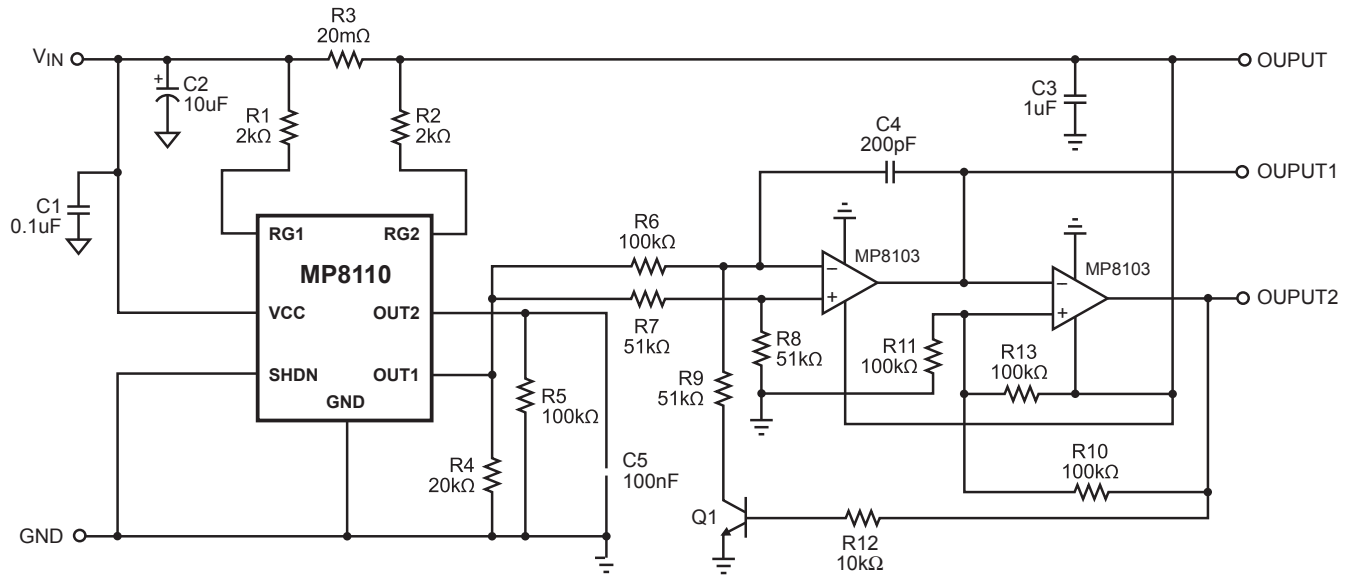
**Transient Response**



**Transient Response**



## TYPICAL APPLICATION

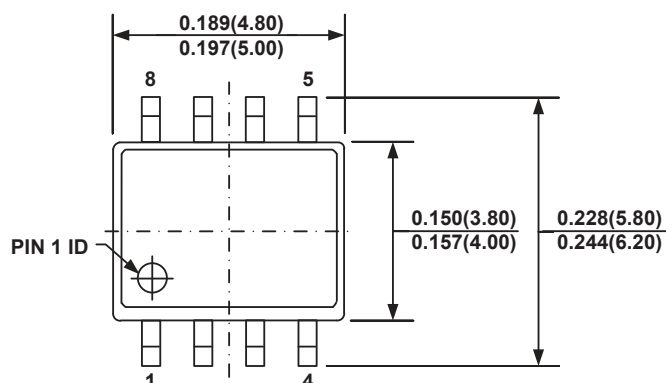


**Figure 2—Current Control Oscillator**

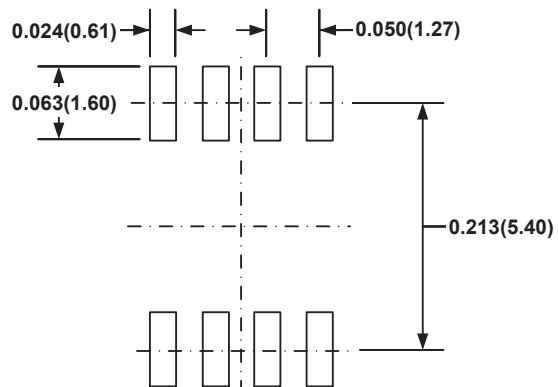


# PACKAGE INFORMATION

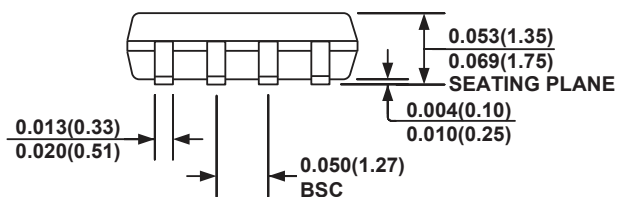
## SOIC8



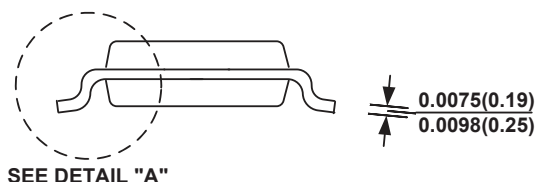
TOP VIEW



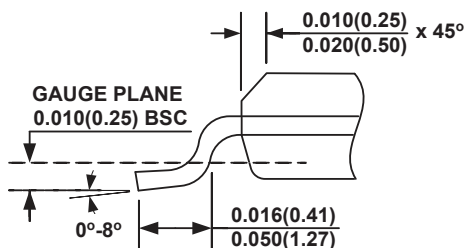
RECOMMENDED LAND PATTERN



FRONT VIEW



SIDE VIEW

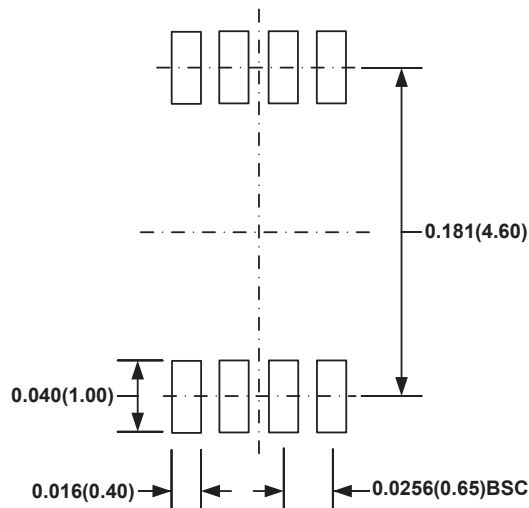
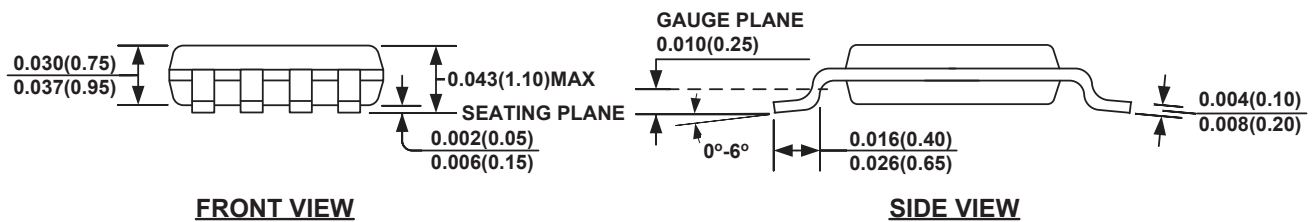
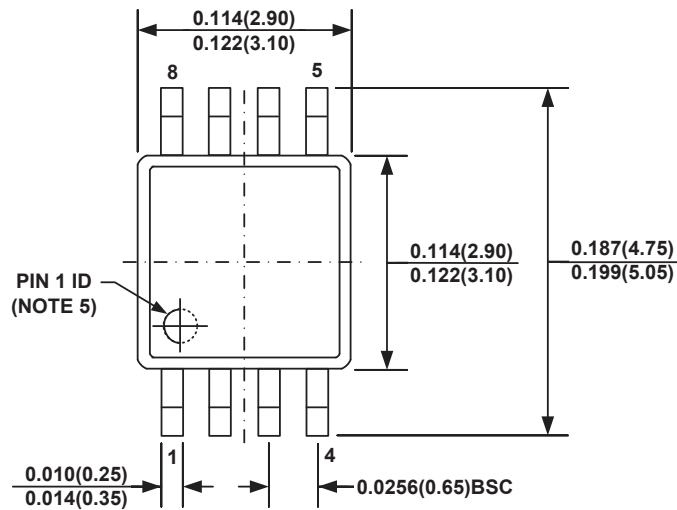


DETAIL "A"

## 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 AA.
- 6) DRAWING IS NOT TO SCALE.

## MSOP8



## NOTE:

- 1) CONTROL DIMENSION IS IN INCHES. DIMENSION IN BRACKET IS IN MILLIMETERS.
- 2) PACKAGE LENGTH DOES NOT INCLUDE MOLD FLASH, PROTRUSION OR GATE BURR.
- 3) PACKAGE WIDTH DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION.
- 4) LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.004" INCHES MAX.
- 5) PIN 1 IDENTIFICATION HAS HALF OR FULL CIRCLE OPTION.
- 6) DRAWING MEETS JEDEC MO-187, VARIATION AA.
- 7) DRAWING IS NOT TO SCALE.

**NOTICE:** The information in this document is subject to change without notice. Users should warrant and guarantee that third party Intellectual Property rights are not infringed upon when integrating MPS products into any application. MPS will not assume any legal responsibility for any said applications.

# Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

[Monolithic Power Systems \(MPS\):](#)

[MP8110DS-LF](#) [MP8110DK-LF-P](#) [MP8110DK-LF-Z](#) [MP8110DS-LF-Z](#) [MP8110DS-LF-P](#)