SGM8191
Current-Sense Amplifier with Reference and Comparator

GENERAL DESCRIPTION

The SGM8191 is a high voltage and high precision high-side current-sense amplifier which integrates voltage reference and comparator. The comparator has latching function which can control the comparator output transparent or latched by the latch control pin. The comparator also has power-on reset capability. The comparator has independent input and open-drain output, and its trip point can be set with external resistors. The gain of amplifier is also determined by external resistors.

The SGM8191 has typically 1μs overall propagation delay, so the device can quickly respond to over-current conditions. The SGM8191 has 2MHz bandwidth and it can detect errors in essential applications, such as current sensing and protection in motor control. The SGM8191 is well suited in high speed applications, because the comparator has high accuracy threshold and latching function.

The SGM8191 is available in Green TDFN-2×3-8CL and MSOP-8 packages. It is specified over the extended -40℃ to +125℃ temperature range.

FEATURES

- **High Precision Current-Sense Amplifier:**
  - **Low Input Offset Voltage: ±20μV (TYP) at +25℃**
  - **Low Gain Error: -0.05% (TYP)**
  - **Fast Step Response: 250ns**
- **Internal Comparator:**
  - **Power-On Reset Capability**
  - **Low Threshold Error**
  - **Fast Response Time: 0.5μs**
- **Internal Precision Reference: 400mV**
- **Wide Supply Voltage Range: 2.7V to 60V**
- **Supply Current: 65μA (TYP)**
- **-40℃ to +125℃ Operating Temperature Range**
- **Available in Green TDFN-2×3-8CL and MSOP-8 Packages**

APPLICATIONS

Industrial Equipment
Current Shunt Measurement
Battery Management System
Motor Control

TYPICAL APPLICATION

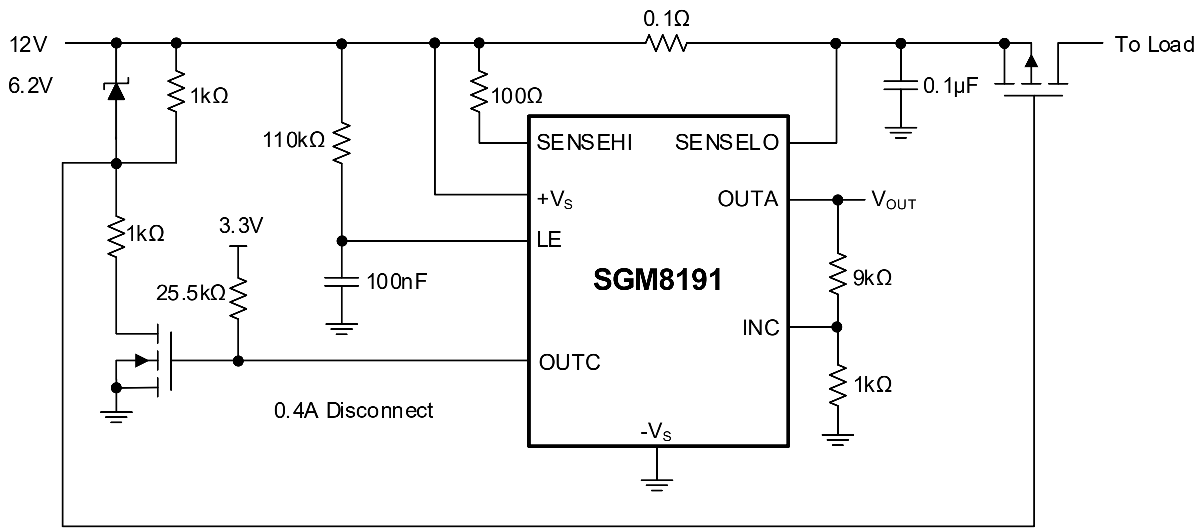


Figure 1. Typical Application

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8191	TDFN-2×3-8CL	-40℃ to +125℃	SGM8191XTGU8G/TR	8191 XXXX	Tape and Reel, 3000
	MSOP-8	-40℃ to +125℃	SGM8191XMS8G/TR	SGM8191 XMS8 XXXXX	Tape and Reel, 4000

MARKING INFORMATION

NOTE: XXXX = Date Code, Trace Code and Vendor Code. XXXXX = Date Code, Trace Code and Vendor Code.

TDFN-2×3-8CL

X XX X
- Vendor Code
- Trace Code
- Date Code - Year

MSOP-8

X XXX X
- Vendor Code
- Trace Code
- Date Code - Year

Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

ABSOLUTE MAXIMUM RATINGS

Total Supply Voltage, $+V_S$ to $-V_S$ 62V
Maximum Voltage, SENSELO, SENSEHI, OUTA
.... $(+V_S) + 1V$
Maximum LE Voltage .... $(+V_S) + 1V$
Maximum Comparator Input Voltage .... $(+V_S) + 1V$
Maximum Comparator Output Voltage 62V
Input Current [1] .... -10mA
Input Current, SENSELO, SENSEHI .... ±10mA
Differential Input Current, SENSELO or SENSEHI .... ±2.5mA
Amplifier Output Short-Circuit Duration (to $-V_S$) ....Indefinite
Package Thermal Resistance
TDFN-2×3-8CL, θ_{JA} .... 52.3℃/W
TDFN-2×3-8CL, θ_{JB} .... 24.3℃/W
TDFN-2×3-8CL, $\theta_{JC\ (TOP)}$ .... 57.6℃/W
TDFN-2×3-8CL, $\theta_{JC\ (BOT)}$ .... 4.4℃/W
MSOP-8, θ_{JA} .... 142.6℃/W
MSOP-8, θ_{JB} .... 85.6℃/W
MSOP-8, θ_{JC} .... 48.9℃/W
Junction Temperature .... +150℃
Storage Temperature Range .... -65℃ to +150℃
Lead Temperature (Soldering, 10s) .... +260℃
ESD Susceptibility [1] [2]
HBM .... ±4000V
CDM .... ±1000V

NOTES:

1. For human body model (HBM), all pins comply with ANSI/ESDA/JEDEC JS-001 specifications.

2. For charged device model (CDM), all pins comply with ANSI/ESDA/JEDEC JS-002 specifications.

RECOMMENDED OPERATING CONDITIONS

Operating Temperature Range .... -40℃ to +125℃

NOTE: 1. The input and output pins of the SGM8191 are connected to the GND directly. The SENSELO and SENSEHI pins have the ability to handle additional current for the input current of SENSELO and SENSEHI.

OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

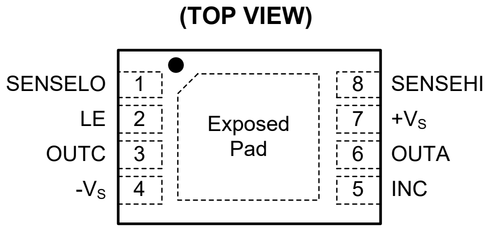
ESD SENSITIVITY CAUTION

This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.

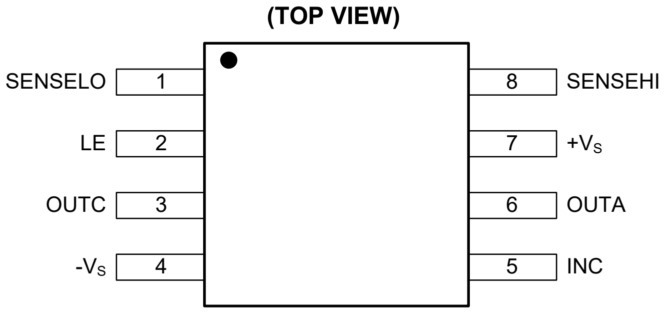
DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

PIN CONFIGURATIONS



TDFN-2×3-8CL



MSOP-8

PIN DESCRIPTION

PIN TDFN-2×3-8CL/MSOP-8	NAME	FUNCTION
1	SENSELO	Input of the Current-Sense Amplifier. Connect to the load-side of the current-sense resistor.
2	LE	Latch Control Pin. Pull this pin high to enable the latching function of comparator, and the comparator output will be latched at a low level once it is tripped. Pull this pin low to disable latching function of comparator, and the comparator output will be transparent.
3	OUTC	Open-Drain Output of the Comparator. The off-state voltage of comparator can be pulled to ($-V_S$) + 60V, independent of $+V_S$.
4	$-V_S$	Negative Power Supply Pin. Connect to ground in single-supply application.
5	INC	Inverting Input of the Comparator. Connect the positive input of comparator to the 400mV voltage reference internally.
6	OUTA	Current Output of the Current-Sense Amplifier. This pin can provide a source current, where $I_{OUTA} = V_{SENSE}/R_{IN}$, V_{SENSE} is the sense voltage and R_{IN} is the external input gain resistor.
7	$+V_S$	Positive Power Supply Pin. Connect to either side of the current-sense resistor directly. When this pin is connected to the load-side of the current-sense resistor, the voltage of SENSEHI pin can rise to ($+V_S$) + 0.1V. The supply current of the SGM8191 flows through this pin.
8	SENSEHI	Input of the Current-Sense Amplifier. The voltage of SENSEHI is pulled equal to SENSELO voltage by the current-sense amplifier. An external input gain resistor (R_{IN}) is connected between supply and the SENSEHI pin to configure the output current. Also, the output current of the SGM8191 is equal to V_{SENSE}/R_{IN}, and V_{SENSE} is defined as the voltage across R_{SENSE}.
Exposed Pad	$-V_S$	Only for the TDFN-2×3-8CL Package. Connect the exposed pad to $-V_S$ of the device or leave it floating. Connect it to $-V_S$ plane can maximize thermal performance in high voltage system. It is not recommended to use the exposed pad as the main connection of $-V_S$.

FUNCTIONAL BLOCK DIAGRAM

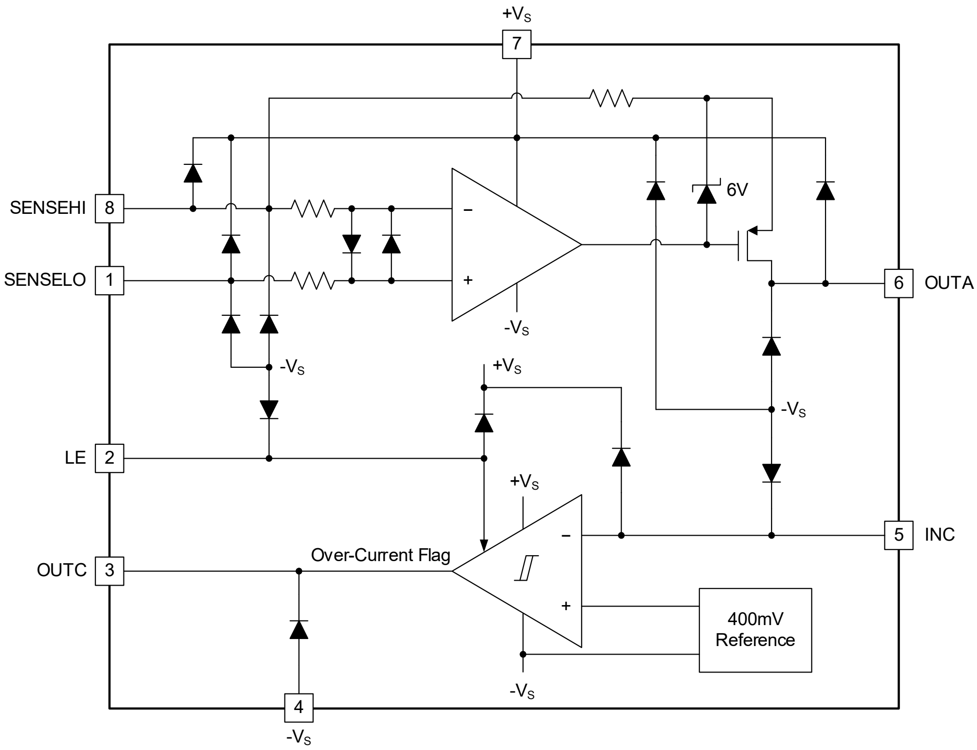


Figure 2. Block Diagram

TYPICAL CONNECTION

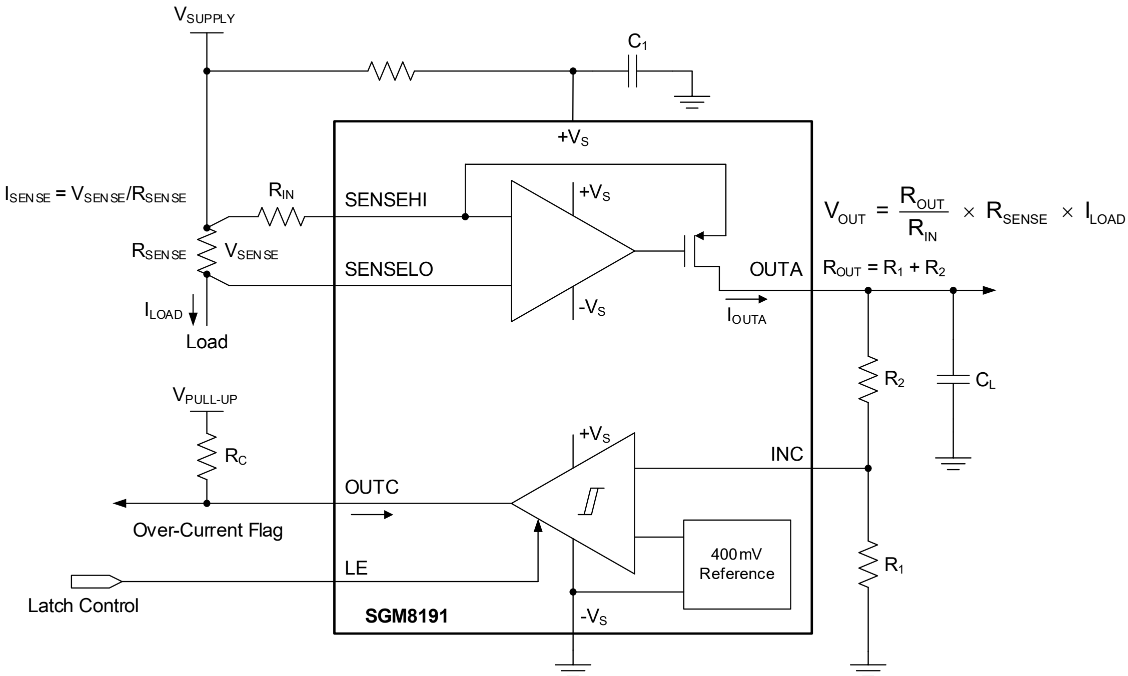


Figure 3. Typical Connection

ELECTRICAL CHARACTERISTICS

(V_S = 12V, $V_{PULL-UP}$ = V_S, V_{LE} = 2.7V, R_{IN} = 100Ω, R_{OUT} = R_1 + R_2 = 10kΩ, Gain = 100, R_C = 25.5kΩ, C_L = 2pF, Full = -40℃ to +125℃, typical values are at T_A = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Supply Voltage Range	V_S		+25℃	2.7		60	V
			Full	3		60	
Supply Current	I_Q	V_S = 60V, V_{SENSE} = 5mV	+25℃		65	100	μA
			Full			150	
LE Pin Current		V_S = 60V, V_{LE} = 0V	+25℃		±10	300	nA
LE Pin Input High Voltage	V_{IH}	V_S = 3V to 60V	+25℃	1.5			V
LE Pin Input Low Voltage	V_{IL}	V_S = 3V to 60V	+25℃			0.5	V
Current-Sense Amplifier							
Input Offset Voltage	V_{OS}	V_{SENSE} = 5mV	+25℃	-450	±20	450	μV
			Full	-1000		1000	
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	V_{SENSE} = 5mV	Full		±1.7		μV/℃
Input Bias Current (SENSELO, SENSEHI)	I_B	V_S = 3V to 60V	+25℃		10	150	nA
			Full			200	
Input Offset Current	I_{OS}	V_S = 3V to 60V	+25℃		±5	±70	nA
Output Current (1)	I_{OUTA}		Full	0.95			mA
Power Supply Rejection Ratio (2)	PSRR	V_S = 3V to 60V	+25℃	115	132		dB
			Full	114			
Common Mode Rejection Ratio (2)	CMRR	V_S = 60V, V_{SENSE} = 5mV, V_{CM} = 3V to 60V	+25℃	114	134		dB
			Full	103			
Full-Scale Input Sense Voltage (1)	$V_{SENSE(MAX)}$	R_{IN} = 500Ω	Full	500			mV
Gain Error (3)		V_S = 3V to 12V	+25℃		-0.05		%
		V_S = 3V to 60V, V_{SENSE} = 5mV to 100mV	Full	-0.35		0.35	
SENSELO Voltage		V_S = 3V, V_{SENSE} = 100mV, R_{OUT} = 2kΩ	Full	2.8			V
		V_S = 60V, V_{SENSE} = 100mV	Full	3			
Output Voltage Swing High (+V_S to V_{OUTA})		V_S = 3V, V_{SENSE} = 30mV	Full		0.16	0.3	V
		V_S = 12V, V_{SENSE} = 120mV	Full		0.68	1.25	
Signal Bandwidth	BW	I_{OUT} = 1mA	+25℃		2		MHz
		I_{OUT} = 100μA	+25℃		1.4		
Input Step Response (to 50% of Final Output Voltage)	t_r	V_S = 2.7V, V_{SENSE} = 24mV step, output rising edge	+25℃		350		ns
		V_S = 12V to 60V, V_{SENSE} = 100mV step, output rising edge	+25℃		250		
Settling Time to 1%	t_{SETTLE}	V_{SENSE} = 10mV to 100mV, R_{OUT} = 2kΩ	+25℃		1.8		μs

NOTES:

1. The maximum output current and the full-scale input sense voltage should be taken into account for the specified performance.
2. Power supply voltage and input common mode voltage are varied, when the input offset voltage of current-sense amplifier is monitored.
3. The specified gain error is not affected by external gain resistors (R_{IN} and R_{OUT}).

ELECTRICAL CHARACTERISTICS (continued)

(V_S = 12V, $V_{PULL-UP}$ = V_S, V_{LE} = 2.7V, R_{IN} = 100Ω, R_{OUT} = R_1 + R_2 = 10kΩ, Gain = 100, R_C = 25.5kΩ, C_L = 2pF, Full = -40℃ to +125℃, typical values are at T_A = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Reference and Comparator							
Rising Input Threshold Voltage (4)	$V_{TH(R)}$	V_S = 3V to 60V	Full	387	400	413	mV
Hysteresis (V_{HYS} = $V_{TH(R)}$ - $V_{TH(F)}$)	V_{HYS}	V_S = 3V to 60V	+25℃	0	10	25	mV
Comparator Input Bias Current		V_S = 60V, V_{INC} = 0V	Full	-50			nA
Output Low Voltage	V_{OL}	V_S = 3V, I_{OUTC} = 500μA	+25℃		60	100	mV
			Full			200	
Propagation Delay (High to Low)		5mV overdrive	+25℃		0.75		μs
		100mV overdrive	+25℃		0.5		
Output Fall Time			+25℃		0.08		μs
Reset Time	t_{RESET}		+25℃		1.8		μs
Minimum LE Reset Pulse Width (5)	t_{RPW}		Full	0.6			μs

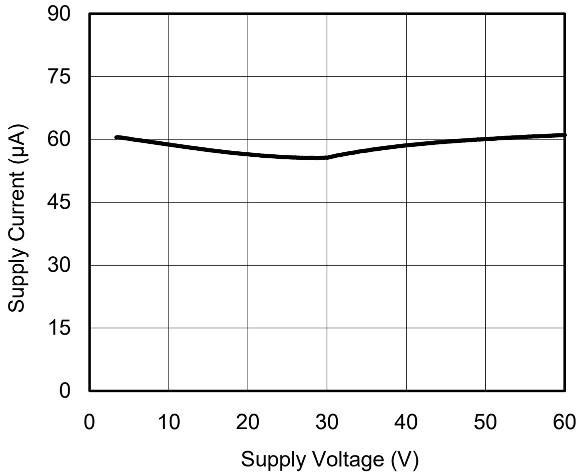
NOTES:

4. The rising input threshold of the SGM8191 is defined as the voltage which can make the comparator output voltage change from high to low, and the input threshold voltage is set to a specified value. The falling input threshold is defined as the voltage which can make the comparator output voltage change from low to high. The hysteresis is the gap between the rising and falling thresholds.
5. Specified by design and characterization, not production tested.

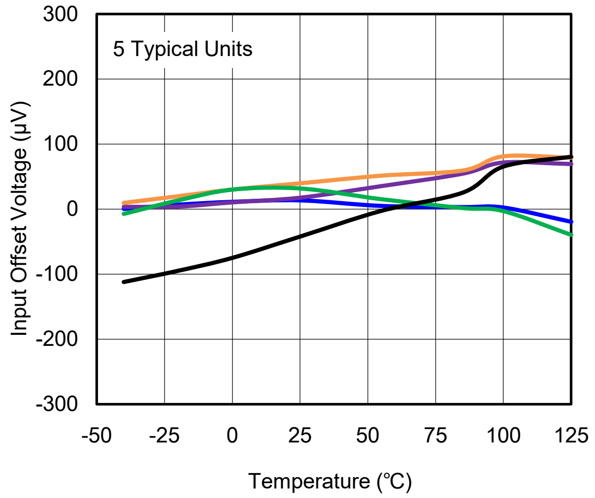
TYPICAL PERFORMANCE CHARACTERISTICS

T_A = +25℃, $+V_S$ = 12V, V_{PULLUP} = $+V_S$, V_{LE} = 2.7V, R_{IN} = 100Ω, R_{OUT} = R_1 + R_2 = 10kΩ, Gain = 100, R_C = 25.5kΩ, C_L = 2pF, unless otherwise noted.

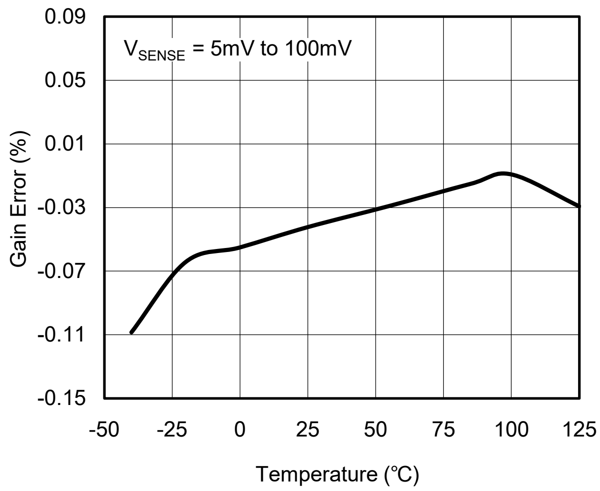
Supply Current vs. Supply Voltage



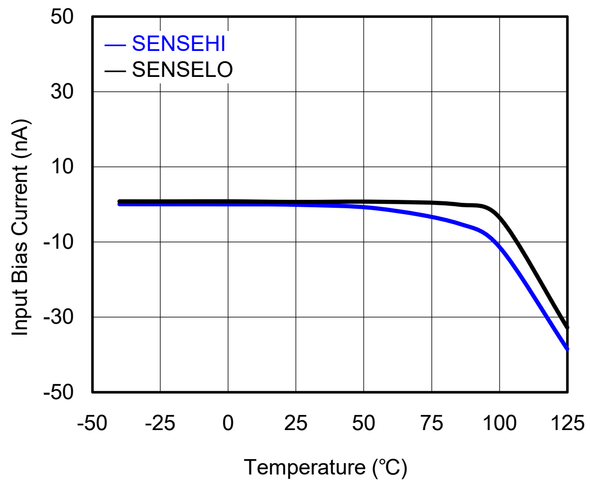
Input Offset Voltage vs. Temperature



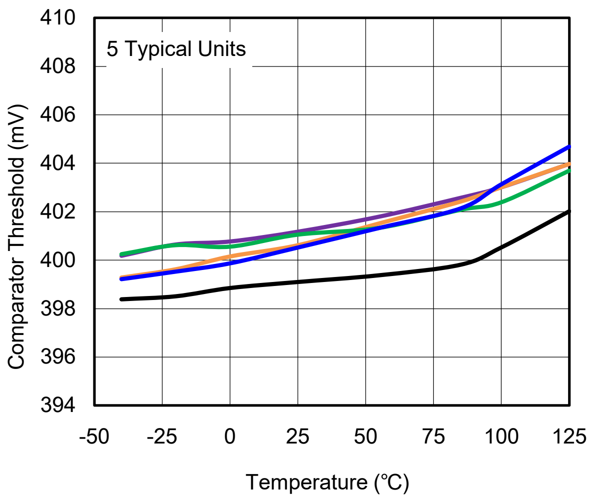
Amplifier Gain Error vs. Temperature



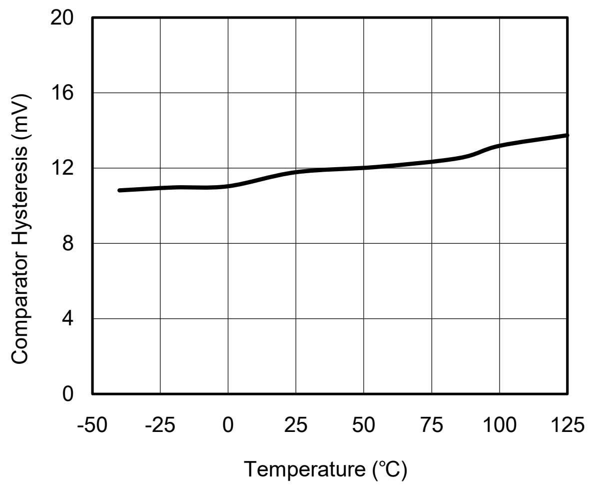
Amplifier Input Bias Current vs. Temperature



Comparator Threshold vs. Temperature



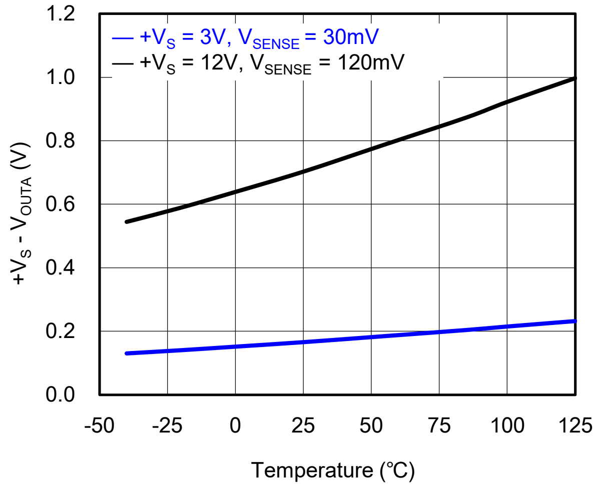
Hysteresis vs. Temperature



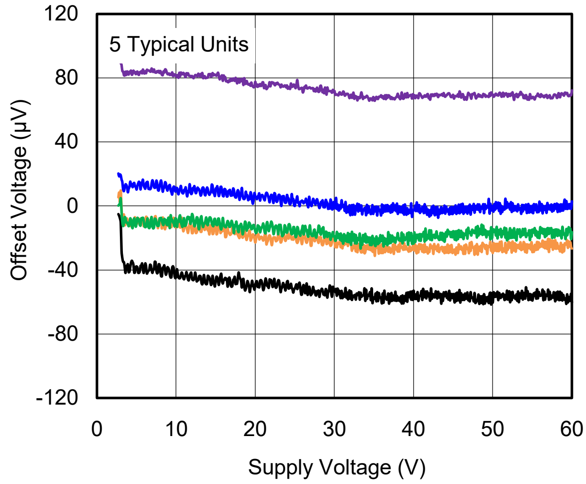
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_A = +25℃, $+V_S$ = 12V, V_{PULLUP} = $+V_S$, V_{LE} = 2.7V, R_{IN} = 100Ω, R_{OUT} = R_1 + R_2 = 10kΩ, Gain = 100, R_C = 25.5kΩ, C_L = 2pF, unless otherwise noted.

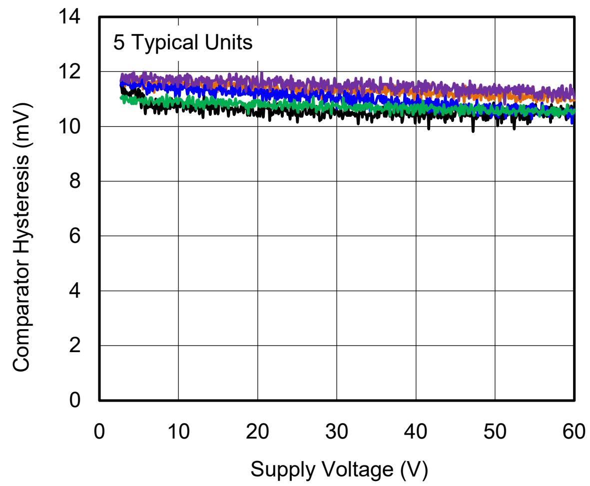
Amplifier Output Swing vs. Temperature



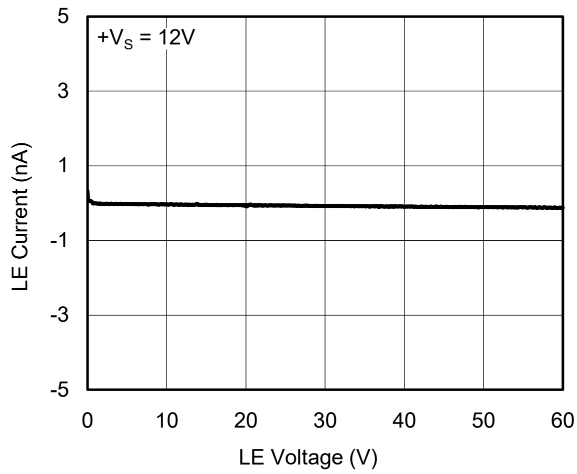
Amplifier Offset Voltage vs. Supply Voltage



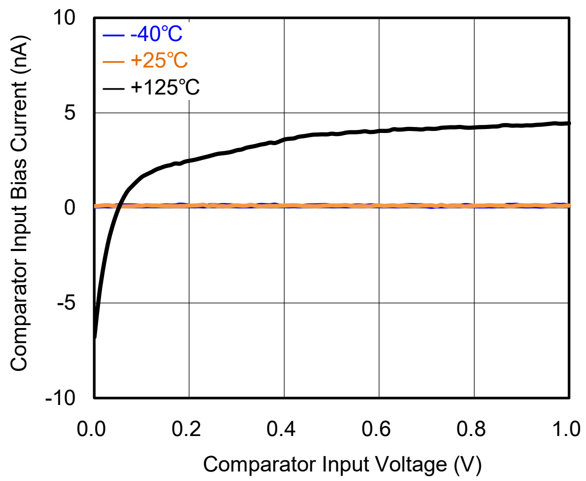
Hysteresis vs. Supply Voltage



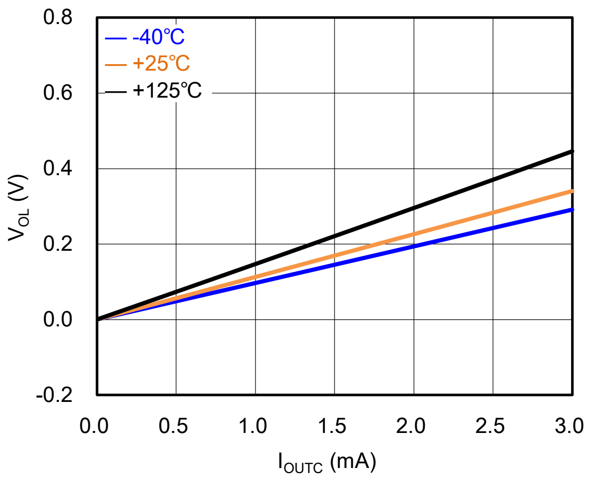
LE Current vs. Voltage



Comparator Input Bias Current vs. Input Voltage



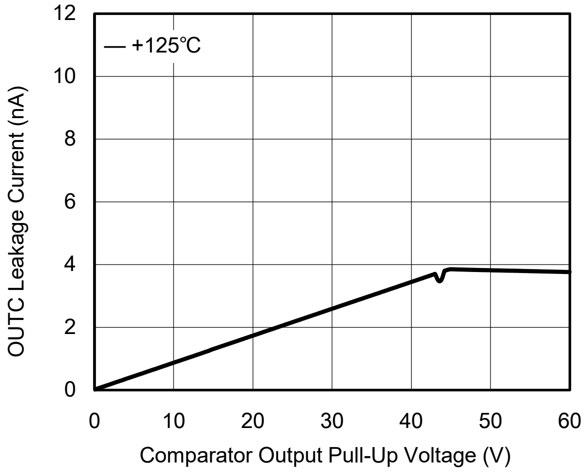
Comparator Output Low Voltage vs. Output Sink Current



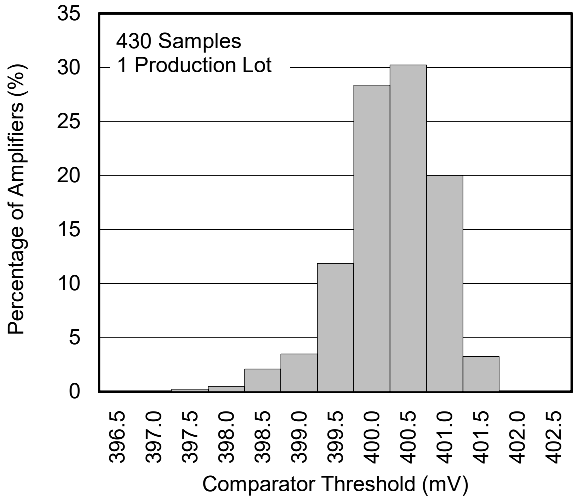
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_A = +25℃, $+V_S$ = 12V, V_{PULLUP} = $+V_S$, V_{LE} = 2.7V, R_{IN} = 100Ω, R_{OUT} = R_1 + R_2 = 10kΩ, Gain = 100, R_C = 25.5kΩ, C_L = 2pF, unless otherwise noted.

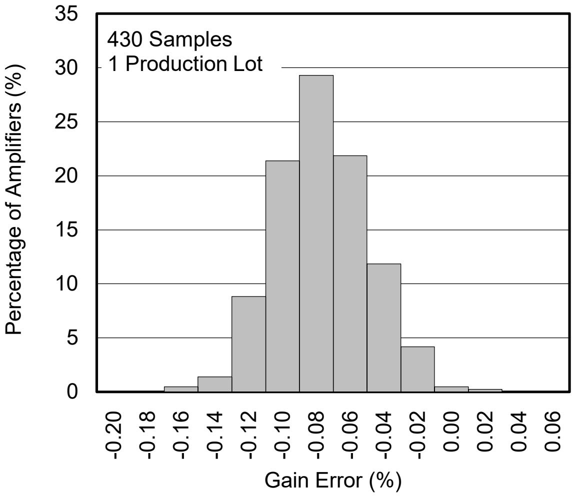
Amplifier Output Swing vs. Temperature



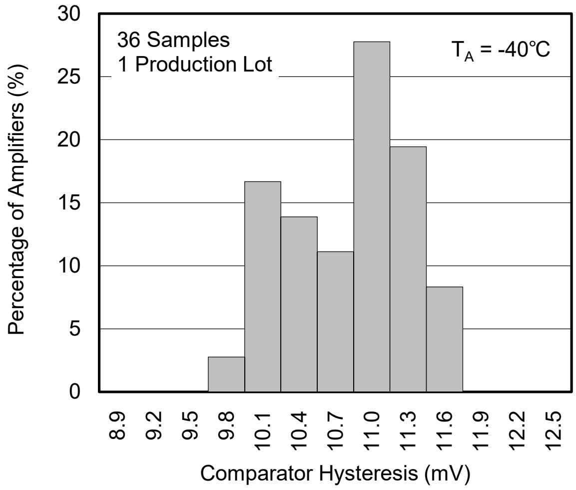
Comparator Threshold Distribution



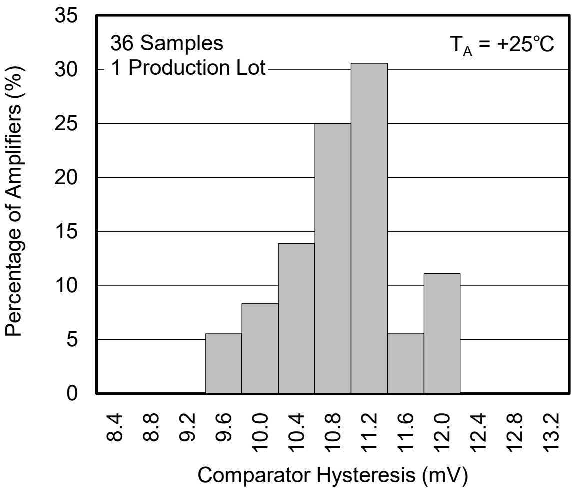
Amplifier Gain Error Distribution



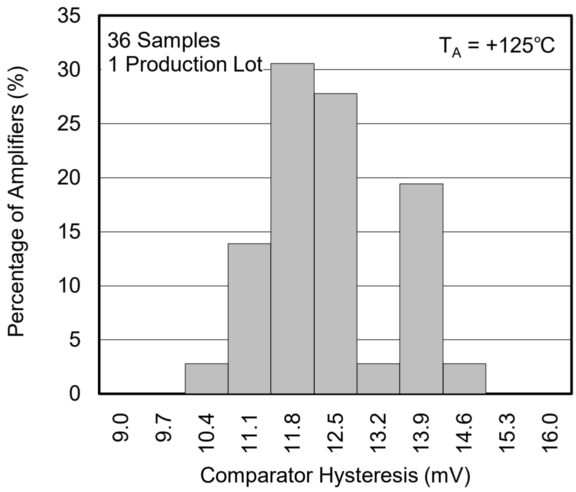
Hysteresis Distribution



Hysteresis Distribution

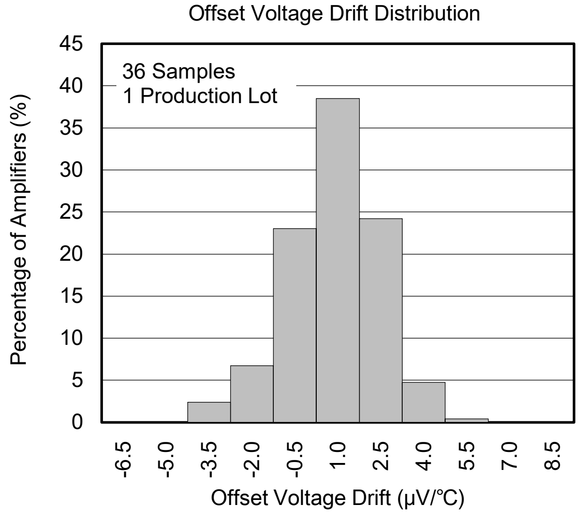


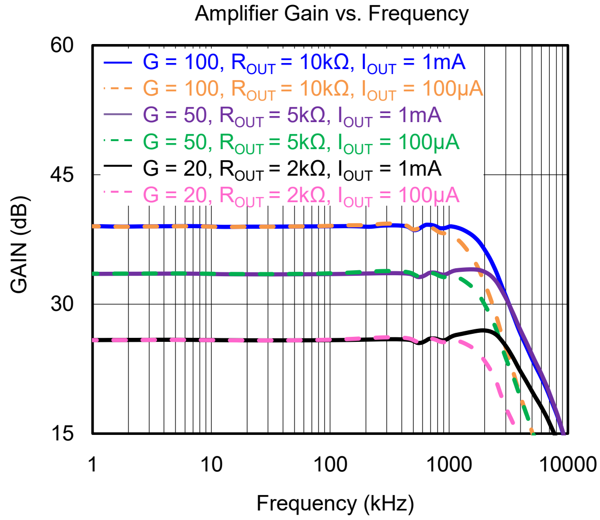
Hysteresis Distribution

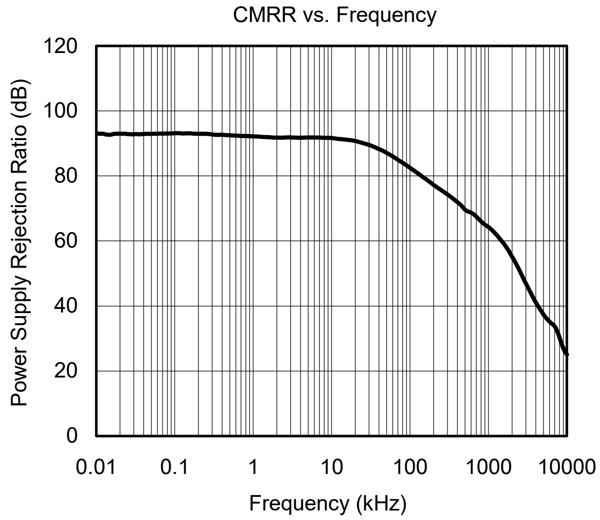


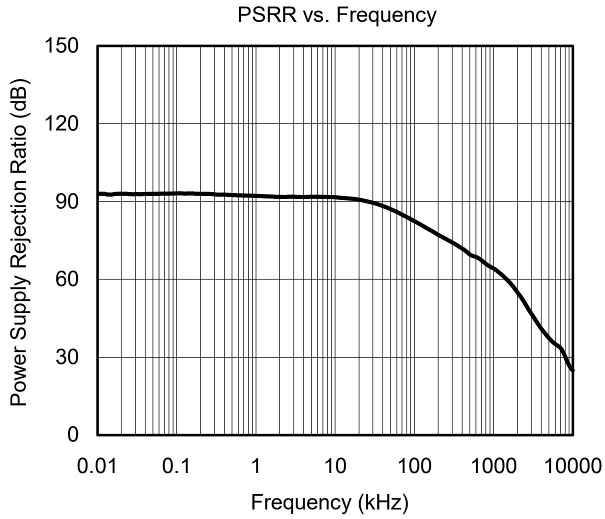
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

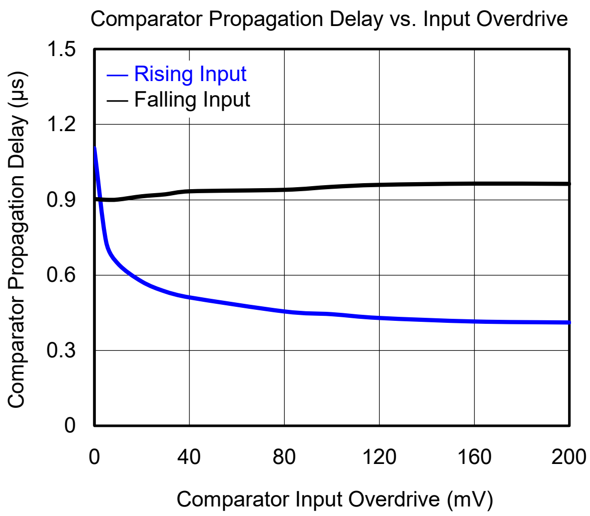
T_A = +25℃, $+V_S$ = 12V, V_{PULLUP} = $+V_S$, V_{LE} = 2.7V, R_{IN} = 100Ω, R_{OUT} = R_1 + R_2 = 10kΩ, Gain = 100, R_C = 25.5kΩ, C_L = 2pF, unless otherwise noted.

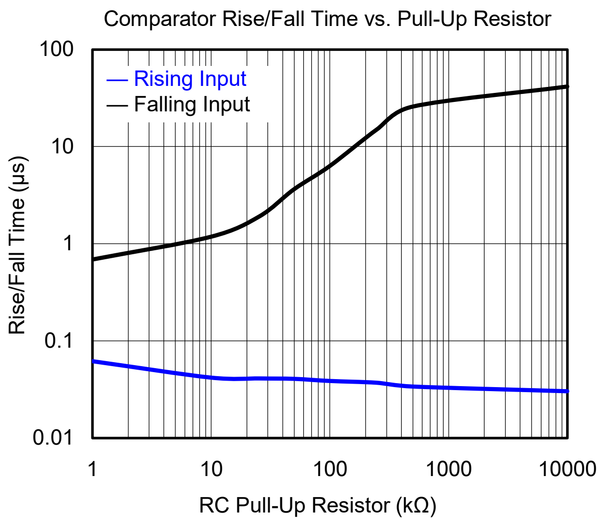








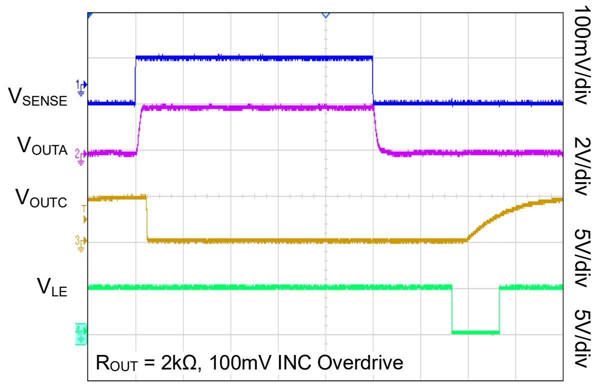




TYPICAL PERFORMANCE CHARACTERISTICS (continued)

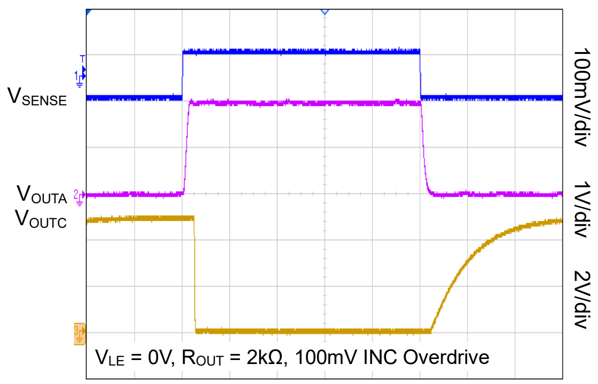
T_A = +25℃, $+V_S$ = 12V, V_{PULLUP} = $+V_S$, V_{LE} = 2.7V, R_{IN} = 100Ω, R_{OUT} = R_1 + R_2 = 10kΩ, Gain = 100, R_C = 25.5kΩ, C_L = 2pF, unless otherwise noted.

Step Response



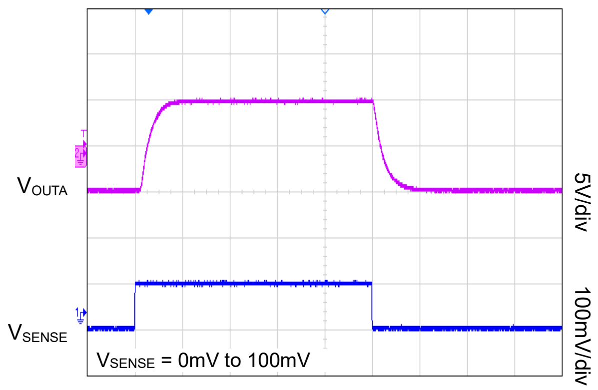
Time (2μs/div)

Step Response



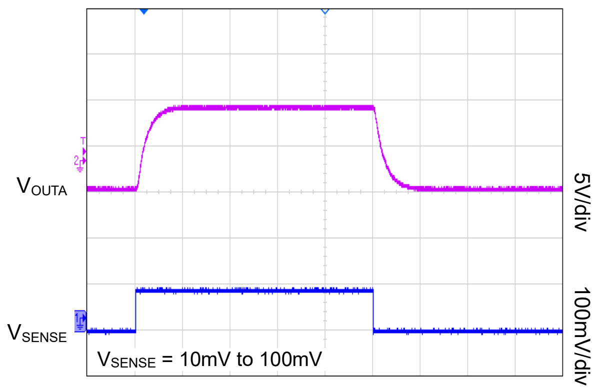
Time (2μs/div)

Amplifier Step Response



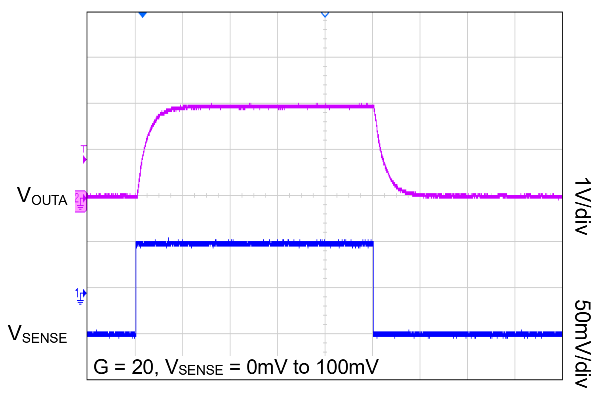
Time (2μs/div)

Amplifier Step Response



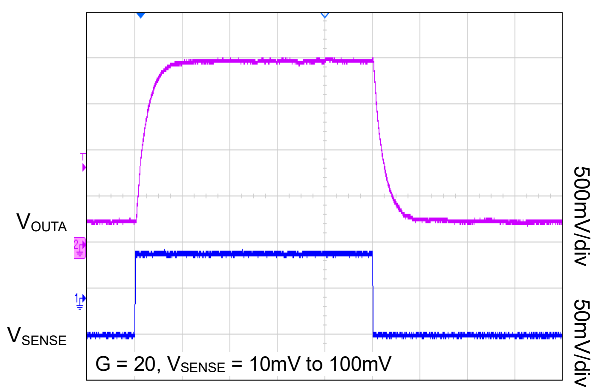
Time (2μs/div)

Amplifier Step Response



Time (2μs/div)

Amplifier Step Response

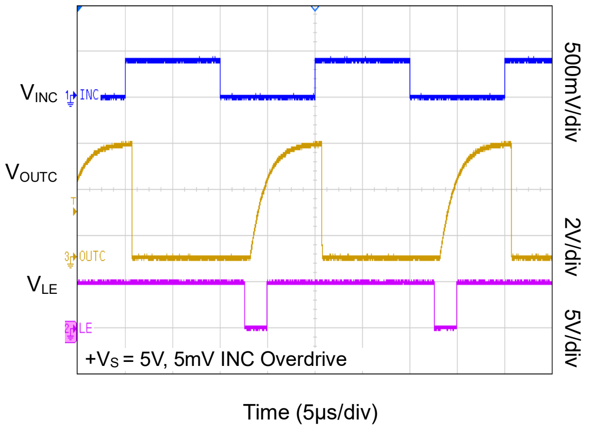


Time (2μs/div)

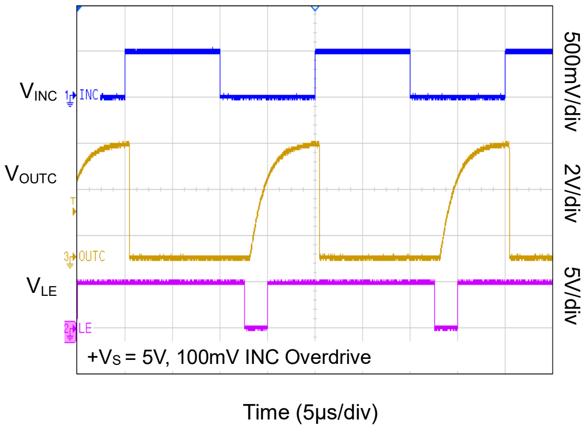
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_A = +25℃, $+V_S$ = 12V, V_{PULLUP} = $+V_S$, V_{LE} = 2.7V, R_{IN} = 100Ω, R_{OUT} = R_1 + R_2 = 10kΩ, Gain = 100, R_C = 25.5kΩ, C_L = 2pF, unless otherwise noted.

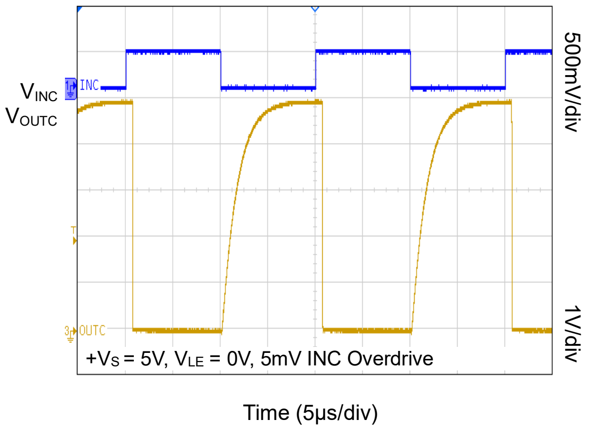
Comparator Step Response



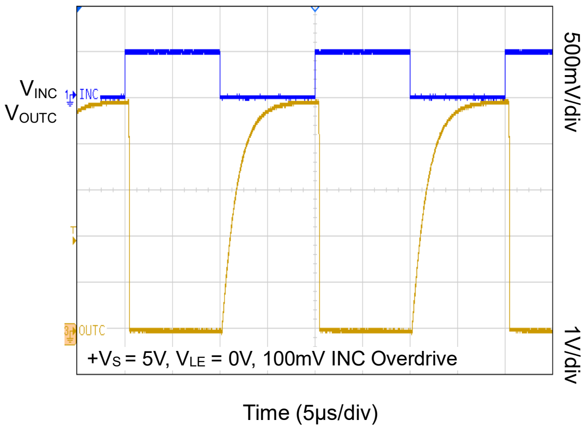
Comparator Step Response



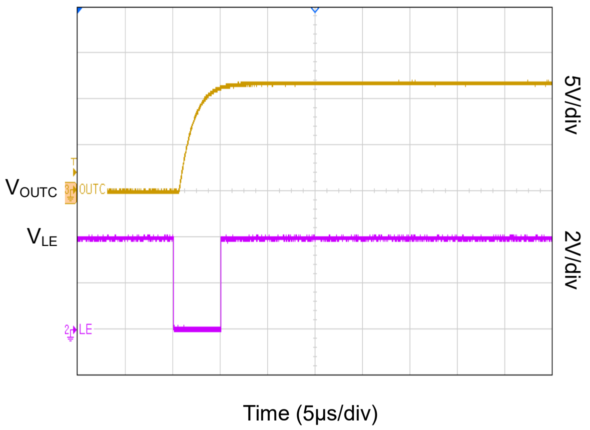
Comparator Step Response



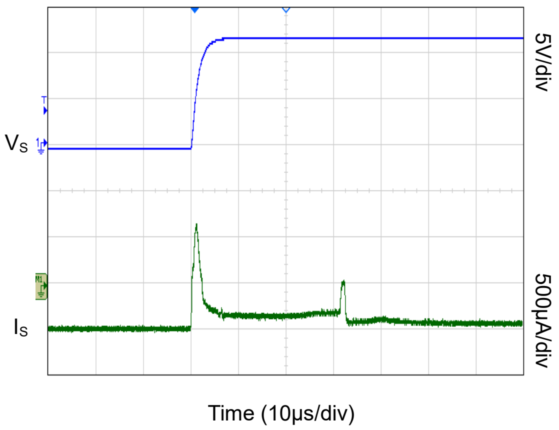
Comparator Step Response



Comparator Reset Response



Start-Up Supply Current



APPLICATION INFORMATION

Operation Theory

As depicted in Figure 7, an internal sense amplifier loop ensures that SENSEHI maintains an equivalent potential to that of SENSELO. The external resistor R_{IN} causes the sense voltage V_{SENSE} to be applied across its two terminals. The feedback around the internal amplifier of the SGM8191 results in the output current I_{OUTA} flowing through the external resistor R_{IN} and the internal PMOS transistor.

The relationship between the output current I_{OUTA} and the output voltage V_{OUT} is shown below, and the $-V_S$ part should be connected to the ground typically.

$$V_{OUT} = (-V_S) + I_{OUTA} \bullet R_{OUT} \quad (1)$$

where the value of R_{OUT} is equal to the sum of two voltage-divider resistors R_1 and R_2.

Table 1. Example Gain Configurations

Gain	R_{IN}	R_{OUT}	$V_{SENSE(MAX)}$ for V_{OUT} = 5V	I_{OUTA} at V_{OUT} = 5V
20	499Ω	10kΩ	250mV	500μA
50	200Ω	10kΩ	100mV	500μA
100	100Ω	10kΩ	50mV	500μA

Commonly Used Equations

Input Voltage: $V_{SENSE} = I_{SENSE} \bullet R_{SENSE}$ (2)

Voltage Gain: $\frac{V_{OUT}}{V_{SENSE}} = \frac{R_{OUT}}{R_{IN}}$ (3)

Current Gain: $\frac{I_{OUTA}}{I_{SENSE}} = \frac{R_{SENSE}}{R_{IN}}$ (4)

The $V_{SENSE(MAX)}$, which is shown in Table 1, can be exceeded without damaging the device. However, the accuracy of the SGM8191 will be degraded.

Power-On Reset

When the device is powered up, the state of the comparator output cannot be guaranteed and requires a power-on reset. This can be achieved, for instance, with an RC network connected to the LE pin. By keeping the LE pin low during startup, the comparator is kept in transparent mode until the comparator output is stable. A 110kΩ resistor connected between the $+V_S$ and LE pins and a 100nF capacitor between the LE and $-V_S$ pins keep the LE pin low for about 100μs after startup.

Setting Comparator Threshold

The internal reference of the comparator is 400mV. The following equations show how to set the trip sense voltage.

$$V_{SENSE(TRIP)} = I_{SENSE(TRIP)} \bullet R_{SENSE} \quad (5)$$

First of all, the value of R_{IN} should be selected. Then, the calculation for the value of $V_{SENSE(TRIP)}$ is as follows:

$$R_{OUT} = R_{IN} \frac{400mV}{V_{SENSE(TRIP)}} \quad (6)$$

As shown in Figure 6, the gain of the circuit is shown as below, as the output of the current-sense monitor is connected directly to the input of the comparator.

$$A_V = \frac{400mV}{V_{SENSE(TRIP)}} \quad (7)$$

If users want to increase the gain of the circuit without changing the $V_{SENSE(TRIP)}$, the resistor R_2 should be added as shown in Figure 7. First, the resistor R_1 is equal to:

$$R_1 = R_{IN} \frac{400mV}{V_{SENSE(TRIP)}} \quad (8)$$

The gain is now:

$$A_V = \frac{R_1 + R_2}{R_{IN}} \quad (9)$$

So, the value of R_2 is:

$$R_2 = A_V \bullet R_{IN} - R_1 \quad (10)$$

Figure 8 illustrates a scenario in which the gain of the current-sense monitor is reduced, allowing the value of gain to be easily calculated.

$$A_V = \frac{R_1}{R_{IN}} \quad (11)$$

Then, the value of R_1 is calculated:

$$R_1 = A_V \bullet R_{IN} \quad (12)$$

Then, the calculation for the value of R_2 is as follows:

$$R_2 = \frac{400mV \bullet R_{IN} - V_{SENSE(TRIP)} \bullet R_1}{V_{SENSE(TRIP)}} \quad (13)$$

APPLICATION INFORMATION (continued)

Power Supply Selection

The $+V_S$ can be either connected to the SENSELO or not which depends on the application scenario. In Figure 4, the $+V_S$ and SENSELO are separately supplied by the two independent sources. Also, the voltage range for $+V_S$ and SENSELO should be referred to the Electrical Characteristic for normal operation. Moreover, the $+V_S$ and SENSELO are connected together so that both the two pins are powered by V_{BATT} in Figure 5, which can simplify the application design.

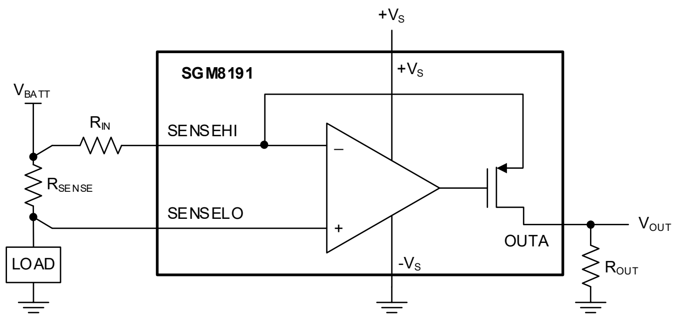


Figure 4. $+V_S$ Powered Separately from Load Supply (V_{BATT})

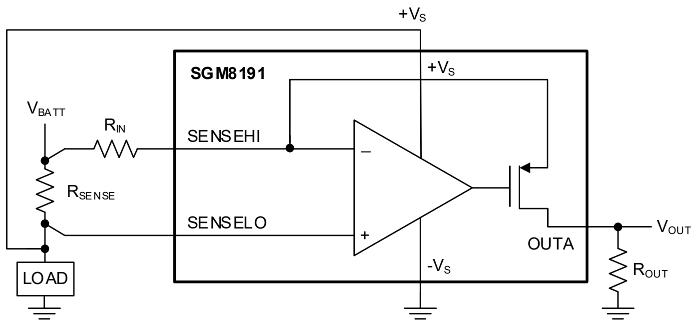


Figure 5. Supply Current Monitored with Load

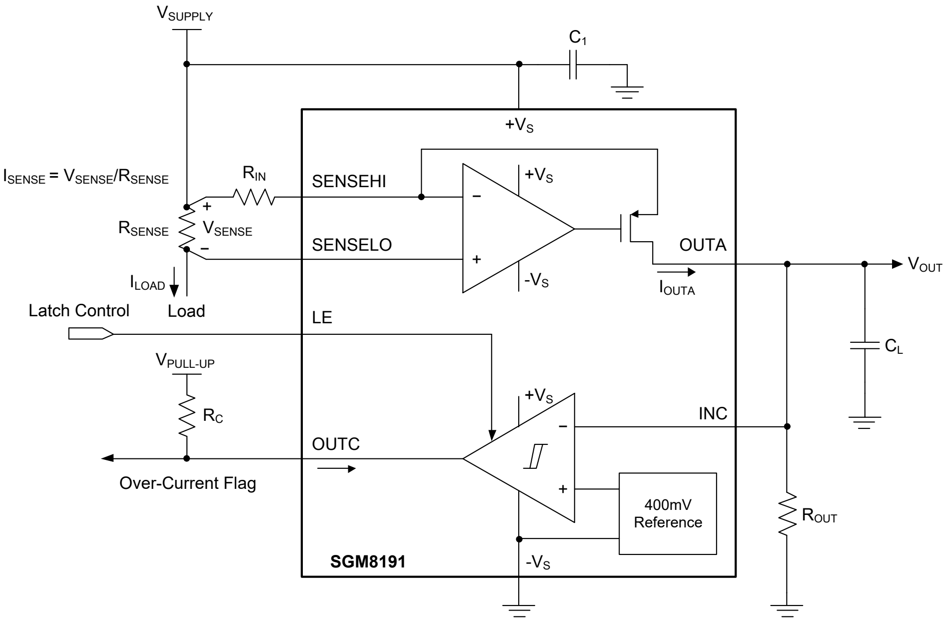


Figure 6. Basic Comparator Configuration

APPLICATION INFORMATION (continued)

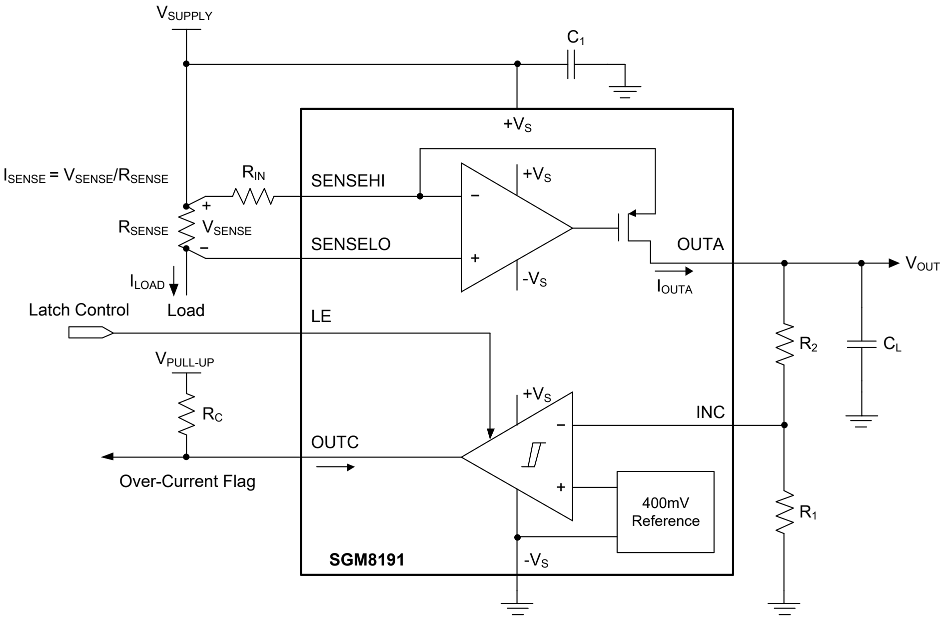


Figure 7. Comparator Configuration with Increased A_V

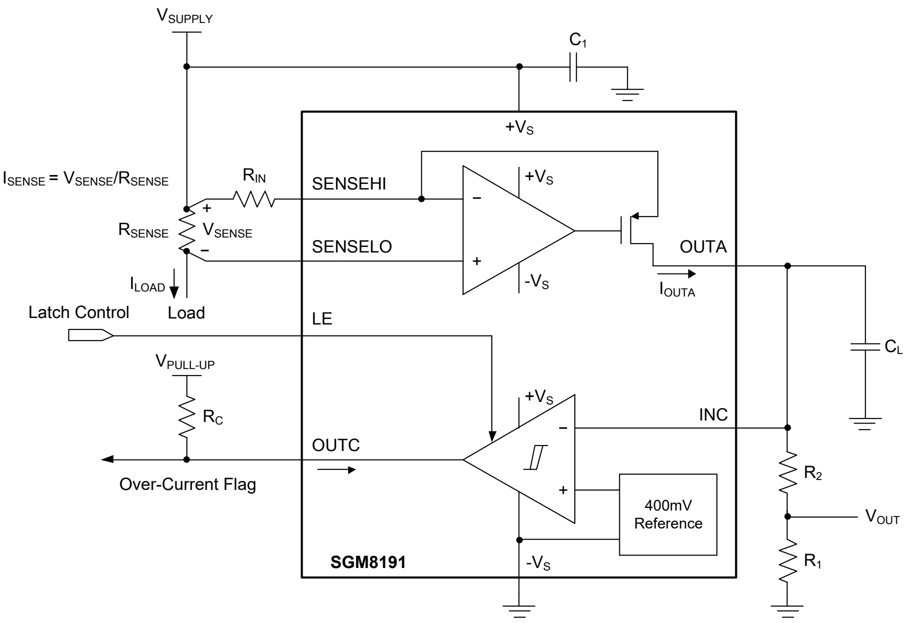


Figure 8. Comparator Configuration with Reduced A_V

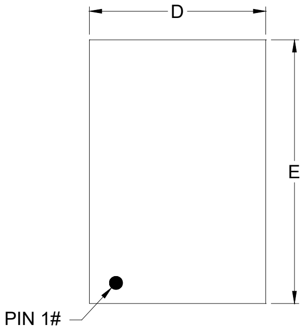
REVISION HISTORY

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

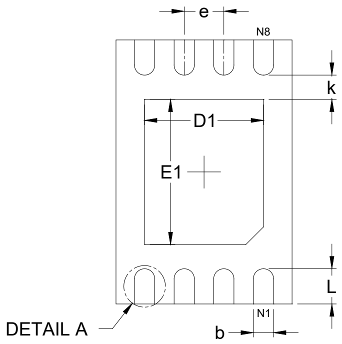
Changes from Original to REV.A (SEPTEMBER 2025)	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

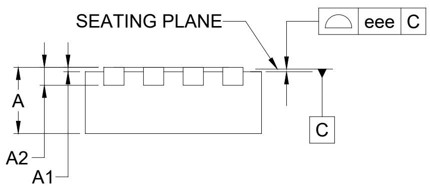
TDFN-2×3-8CL



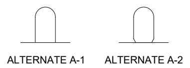
TOP VIEW



BOTTOM VIEW

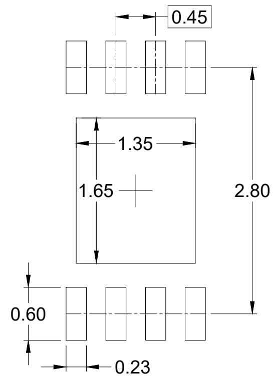


SIDE VIEW



DETAIL A

ALTERNATE TERMINAL CONSTRUCTION



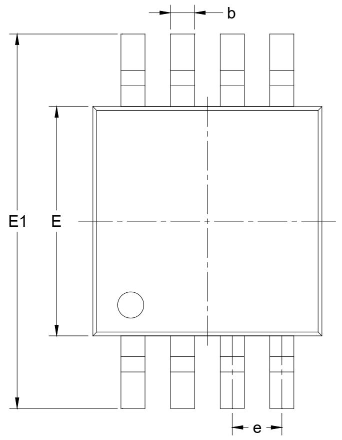
RECOMMENDED LAND PATTERN (Unit: mm)

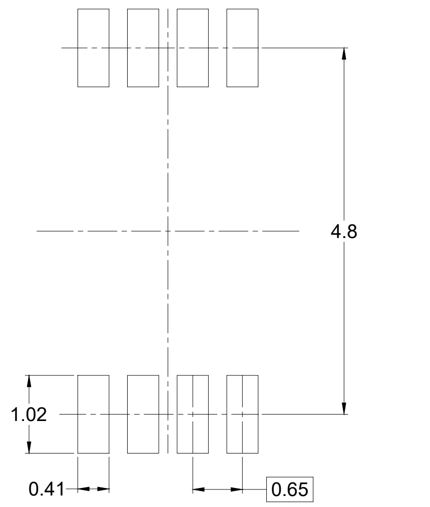
Symbol	Dimensions In Millimeters		
	MIN	**NOM**	**MAX**
A	0.700	-	0.800
A1	0.000	-	0.050
A2	0.203 REF		
b	0.180	-	0.280
D	1.900	-	2.100
E	2.900	-	3.100
D1	1.250	-	1.450
E1	1.550	-	1.750
e	0.450 BSC		
k	0.275 REF		
L	0.300	-	0.500
eee	0.080		

NOTE: This drawing is subject to change without notice.

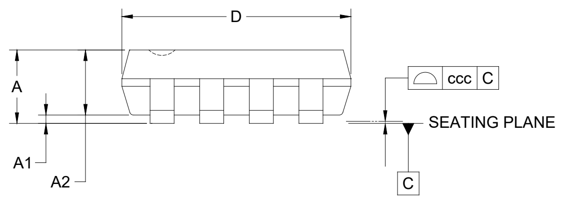
PACKAGE OUTLINE DIMENSIONS

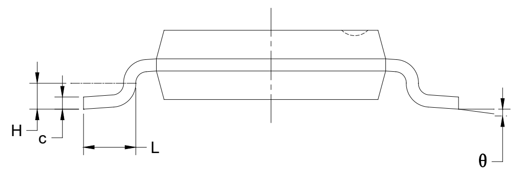
MSOP-8





RECOMMENDED LAND PATTERN (Unit: mm)



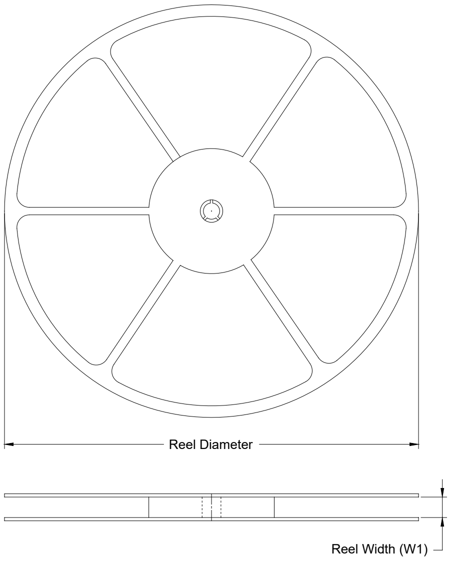


Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	-	-	1.100
A1	0.000	-	0.150
A2	0.750	-	0.950
b	0.220	-	0.380
c	0.080	-	0.230
D	2.800	-	3.200
E	2.800	-	3.200
E1	4.650	-	5.150
e	0.650 BSC		
L	0.400	-	0.800
H	0.250 TYP		
θ	0°	-	8°
ccc	0.100		

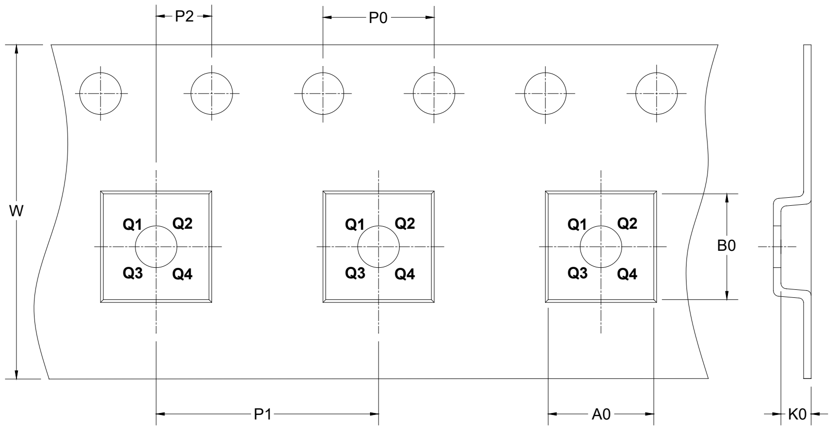
NOTES:
1. This drawing is subject to change without notice.
2. The dimensions do not include mold flashes, protrusions or gate burrs.
3. Reference JEDEC MO-187.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



DIRECTION OF FEED

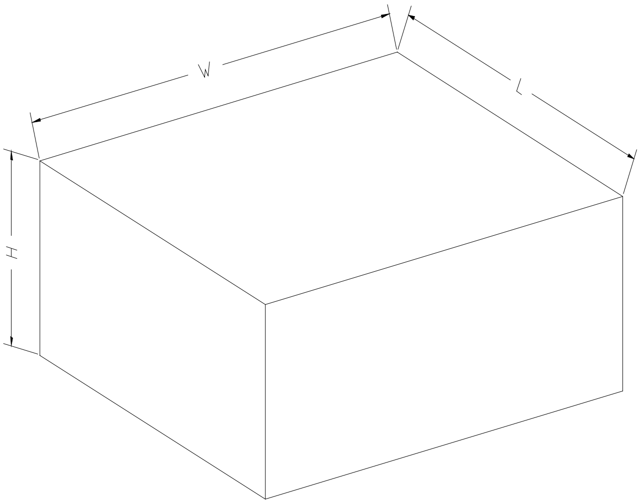
NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
TDFN-2×3-8CL	7″	9.5	2.30	3.30	1.10	4.0	4.0	2.0	8.0	Q2
MSOP-8	13″	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1

DD0001

CARTON BOX DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
7″ (Option)	368	227	224	8
7″	442	410	224	18
13″	386	280	370	5

DD0002