SGM835T
Dual, High Precision, High Voltage, Current-Sense Amplifier

GENERAL DESCRIPTION

The SGM835T has a wide input common-mode voltage range from -0.3V to 70V, and is available with a gain of 20V/V. The bandwidth of small-signal can up to 160kHz.

The SGM835T is available in Green MSOP-8 and WLCSP-2×1-8B packages. It is specified over a junction temperature range of -40℃ to +125℃.

APPLICATIONS

Communication Equipment
Servers
Battery Chargers
Industrial Control
Automation Equipment
Energy Management

FEATURES

- **Input Common-Mode Voltage Range: -0.3V to 70V**
- **Low Input Offset Voltage: 450μV (MAX)**
- **Gain: 20V/V**
- **Low Gain Error: 0.4% (MAX)**
- **Available in Green MSOP-8 and WLCSP-2×1-8B Packages**

TYPICAL APPLICATION

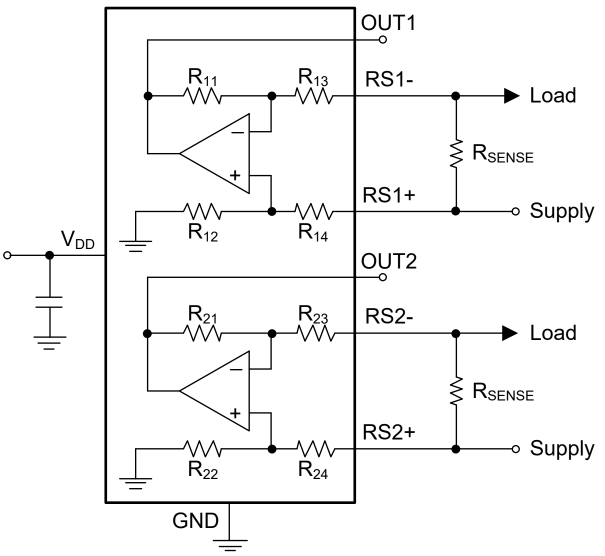


Figure 1. Simplified Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	GAIN (V/V)	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM835T	MSOP-8	-40℃ to +125℃	20	SGM835TXMS8G/TR	SGM835T XMS8 XXXXX	Tape and Reel, 4000
	WLCSP-2×1-8B	-40℃ to +125℃	20	SGM835TXG/TR	XXXXX SGM835	Tape and Reel, 3000

MARKING INFORMATION

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

XXXXX
- 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

V_{DD} to GND .... -0.3V to 6V
RSX+, RSX- to GND .... -0.3V to 76V
RSX+ to RSX-, MSOP-8 .... ±76V
RSX+ to RSX-, WLCSP-2×1-8B .... ±50V
Continuous Input Current at Any Pin .... ±20mA
Package Thermal Resistance
MSOP-8, θ_{JA} .... 158℃/W
WLCSP-2×1-8B, θ_{JA} .... 115℃/W
Junction Temperature .... +150℃
Storage Temperature Range .... -65℃ to +150℃
Lead Temperature (Soldering, 10s) .... +260℃
ESD Susceptibility
HBM 4000V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Supply Voltage Range .... 2.7V to 5.5V
Operating Junction Temperature Range .... -40℃ to +125℃

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

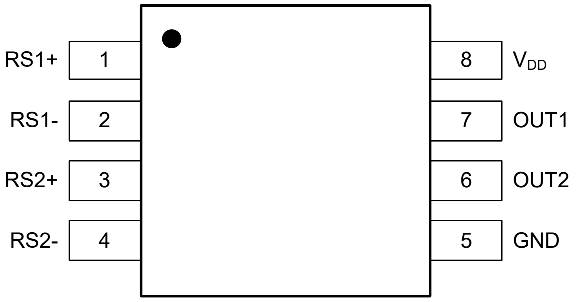
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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.

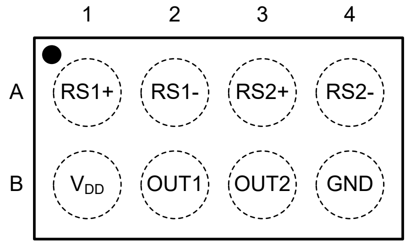
PIN CONFIGURATIONS

(TOP VIEW)



MSOP-8

(TOP VIEW)



WLCSP-2×1-8B

PIN DESCRIPTION

PIN		NAME	FUNCTION
MSOP-8	WLCSP-2×1-8B		
1	A1	RS1+	Power-Side Connection Pin. Channel 1.
2	A2	RS1-	Load-Side Connection Pin. Channel 1.
3	A3	RS2+	Power-Side Connection Pin. Channel 2.
4	A4	RS2-	Load-Side Connection Pin. Channel 2.
5	B4	GND	Ground Pin.
6	B3	OUT2	Output Pin. Channel 2.
7	B2	OUT1	Output Pin. Channel 1.
8	B1	V_{DD}	Supply Voltage Pin.

ELECTRICAL CHARACTERISTICS

(V_{RS+} = V_{RS-} = 70V, V_{DD} = 3.3V, V_{SENSE} = V_{RS+} - V_{RS-} = 1mV, T_J = -40℃ to +125℃, typical values are at T_J = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DC Characteristics							
Supply Voltage	V_{DD}	Guaranteed by PSRR		2.7		5.5	V
Supply Current	I_{DD}	T_J = +25℃			310	400	μA
		T_J = -40℃ to +125℃				420	
Power Supply Rejection Ratio	PSRR	2.7V ≤ V_{DD} ≤ 5.5V, V_{SENSE} = 20mV		100	130		dB
Input Common Mode Voltage Range	V_{CM}	Guaranteed by CMRR		-0.3		70	V
Input Bias Current at V_{RS+} and V_{RS-}	I_{RS+}, I_{RS-}					85	μA
Input Offset Current	I_{RS+}, I_{RS-}					1300	nA
Input Leakage Current	I_{RS+}, I_{RS-}	V_{DD} = 0V, V_{RS+} = 76V				62	μA
Common Mode Rejection Ratio	CMRR	4.5V < V_{RS+} < 70V, V_{SENSE} = 20mV		105	140		dB
Input Offset Voltage	V_{OS}	V_{RS+} = 2.5V, T_J = +25℃	V_{SENSE} = 20mV			±130	μV
		V_{RS+} = 2.5V, T_J = -40℃ to +125℃				±160	
		T_J = +25℃				±330	
		V_{SENSE} = 20mV, T_J = -40℃ to +125℃				±450	
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	V_{RS+} =2.5V				360	nV/℃
Input Sense Voltage	V_{SENSE}				125		mV
Gain (1)	G				20		V/V
Gain Error	GE	MSOP-8, T_J = +25℃	V_{SENSE1} = 20mV, V_{SENSE2} = 80mV			0.18	%
		MSOP-8, T_J = -40℃ to +125℃				0.2	
		WLCSP-1×2-8B, T_J = +25℃				0.35	
		WLCSP-1×2-8B, T_J = -40℃ to +125℃				0.4	
Output Resistance	R_{OUT}				0.1		mΩ
Output Low Voltage	V_{OL}	Sink 500μA				25	mV
		No load				10	
Output High Voltage	V_{OH}	Source 500μA		V_{DD} - 0.022			V

ELECTRICAL CHARACTERISTICS (continued)

(V_{RS+} = V_{RS-} = 70V, V_{DD} = 3.3V, V_{SENSE} = V_{RS+} - V_{RS-} = 1mV, T_J = -40℃ to +125℃, typical values are at T_J = +25℃, unless otherwise noted.)

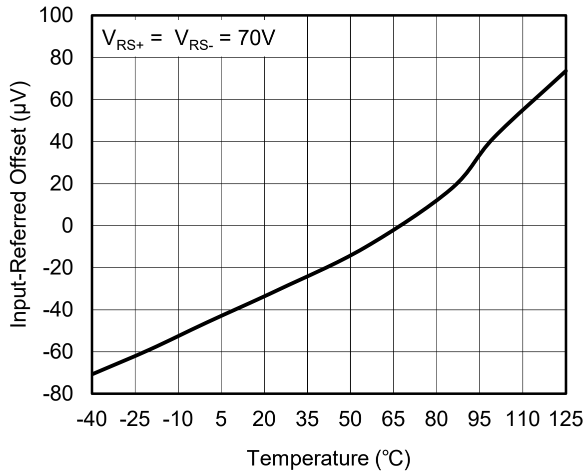
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
AC Characteristics						
-3dB Signal Bandwidth	BW	V_{SENSE} > 5mV		160		kHz
AC Power Supply Rejection Ratio	AC PSRR	f = 200kHz		-55		dB
AC Common Mode Rejection Ratio	AC CMRR	f = 200kHz, 20mV sine wave		-65		dB
Output Transient Recovery Time		ΔV_{OUT} = $2V_{P-P}$, 14-bit settling with 400Ω and 6nF ADC sampling capacitor		10		μs
Capacitive Load Stability	C_{LOAD}	With 250Ω isolation resistor		20		nF
		Without any isolation resistor		200		pF
Input Voltage Noise Density	e_n	f = 1kHz		60		nV/√Hz
Total Harmonic Distortion (Up to 7^{th} Harmonics)	THD	f = 1kHz, V_{OUT} = $1V_{P-P}$		-90		dB
Power-Up Time (2)		V_{SENSE} = 10mV		200		μs
Saturation Recovery Time				10		μs

NOTES:
1. Calculate the gain and offset voltage with the measured values of V_{SENSE1} and V_{SENSE2}. V_{SENSE1} = 20% × full-scale V_{SENSE}. V_{SENSE2} = 80% × full-scale V_{SENSE}.
2. The output is in a high impedance state during power-up.

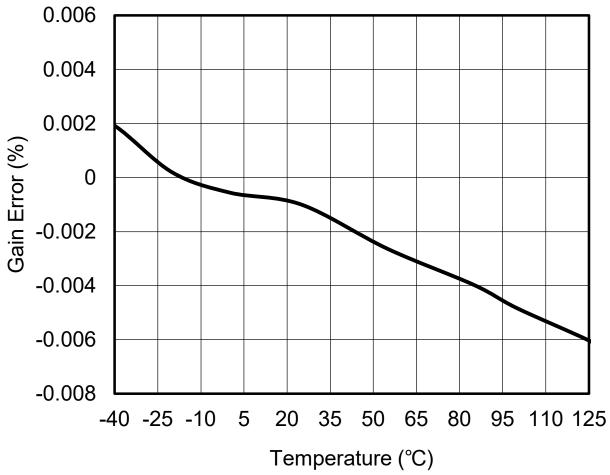
TYPICAL PERFORMANCE CHARACTERISTICS

G = 20V/V, V_{RS+} = V_{RS-} = 70V, V_{DD} = 3.3V, V_{SENSE} = V_{RS+} - V_{RS-} = 1mV, T_J = +25℃, unless otherwise noted.

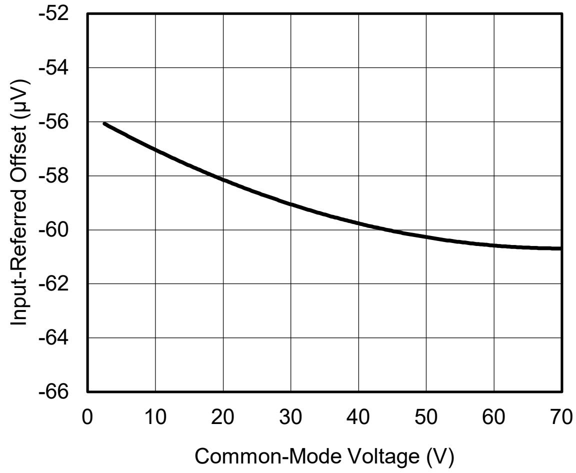
Input-Referred Offset vs. Temperature



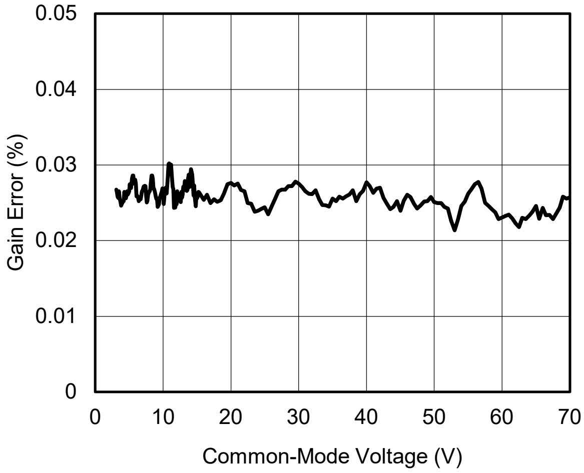
Gain Error vs. Temperature



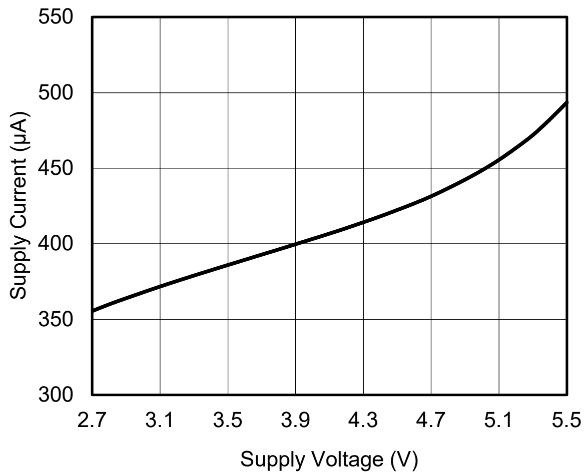
Input-Referred Offset vs. Common-Mode Voltage



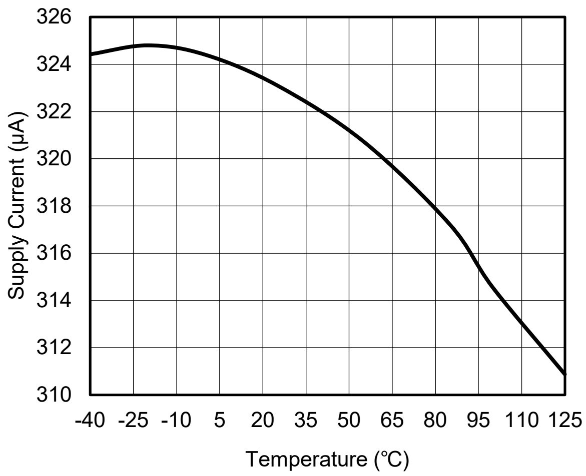
Gain Error vs. Common-Mode Voltage



Supply Current vs. Supply Voltage

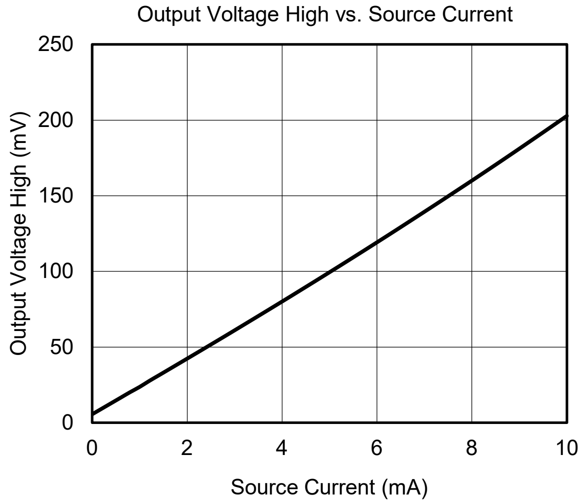


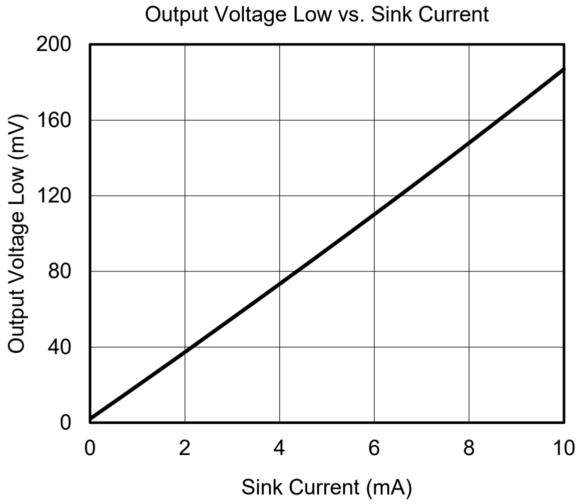
Supply Current vs. Temperature

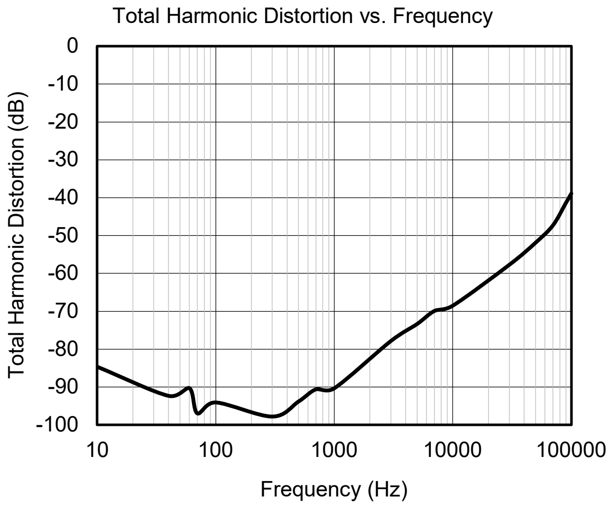


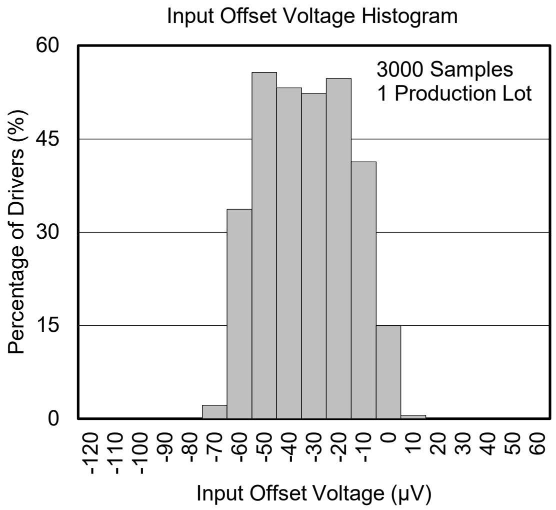
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

G = 20V/V, V_{RS+} = V_{RS-} = 70V, V_{DD} = 3.3V, V_{SENSE} = V_{RS+} - V_{RS-} = 1mV, T_J = +25℃, unless otherwise noted.









DETAILED DESCRIPTION

The SGM835T can operate with either single-supply or dual-supply. For single-supply configuration, the device features a wide -0.3V to 70V input common mode range completely independent of the supply voltage. In the dual-supply configuration, the common mode range is shifted by the value of the negative voltage applied on the GND pin. For instance, with GND = -15V, the input common mode range is -15.3V to 50V. This function allows monitoring the current of the high-side power supply or the low-side ground wire. High-side current monitoring has a relatively strong grounding interference resistance, and will not interfere with the grounding path of the load under test, which makes SGM835T is particularly suitable for collecting high current under high voltage environment. The SGM835T amplifies the voltage on the current-sense resistor, R_{SENSE}. The gain is 20V/V for the SGM835T.

Operational Principle

Figure 2 shows the operational principle of the SGM835T.

RS+ and RS- are high-side input voltage pins. Select a higher voltage between RS+ and RS- voltage through the VMAX selection circuit as the high power rail of the internal operational amplifier. VDD is the low power rail of the internal operational amplifier to insure its maximum output voltage.

Take channel 1 as an example, the resistor R_{SENSE} is set between RS+ and RS-. When the current flows from RS+ to RS-, a voltage drop (V_{SENSE}) occurs, and V_{SENSE} = V_{VRS+} - V_{VRS-}.

The SGM835T integrates an operational amplifier inside with low V_{OS}, and the amplifier is connected as a proportional amplifier. The voltage after amplified VSENSE can be measured at the OUT pin.

$$V_{OUT1} = \frac{R_{11}}{R_{13}} \times V_{SENSE} \quad (1)$$

The load current value can be calculated by measuring V_{OUT1} and combining with the R_{SENSE} value.

$$I_{LOAD} = \frac{R_{13}}{R_{11}} \times \frac{V_{OUT}}{R_{SENSE}} \quad (2)$$

In this way, the current flowing between RS+ and RS- can be detected.

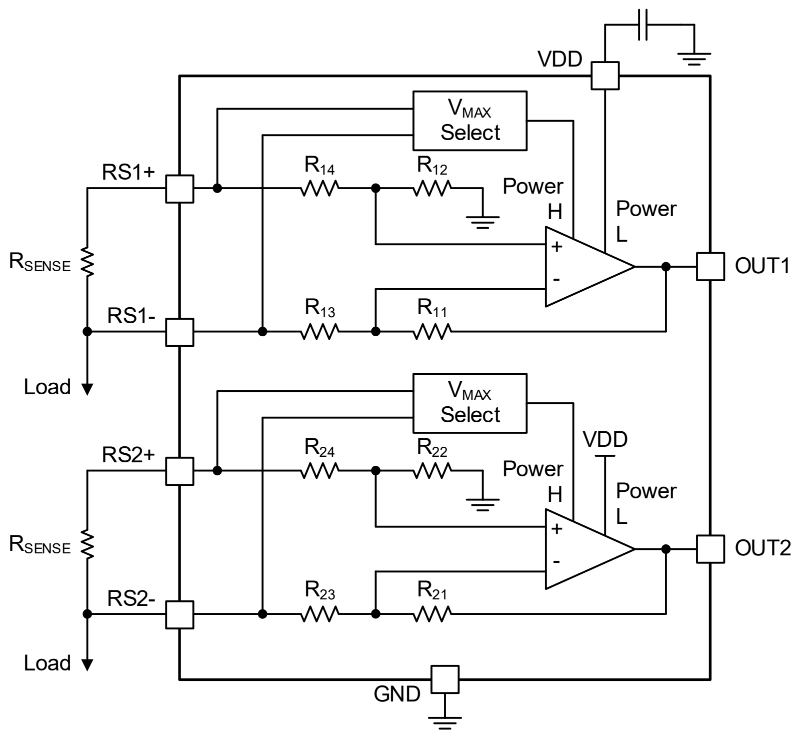


Figure 2. Typical Application Circuit

APPLICATION INFORMATION

Recommended Components Selection

The selection of appropriate parameters is usually required to establish the maximum load current on the current detection resistor to generate the full range detection voltage in the limiting application case. The gain is determined by generating the maximum output voltage of the application.

$$V_{OUT} = G \times V_{SENSE} \quad (3)$$

where:

V_{SENSE} = 125mV, it is the full range sensing voltage,

G = 20V/V, it is the gain of the device.

It is important to ensure that R_{SENSE} dissipates its own I^2R losses in high-current monitoring applications. The power consumption of the resistor should be higher than its nominal value to prevent its value drift or fail completely. The SGM835T has different sense resistance values to sense various currents.

The Sense Resistor Selection

Voltage Loss

High R_{SENSE} values result in reduced power supply voltage through infrared loss. It is recommended to use the lowest R_{SENSE} value to achieve minimum voltage loss.

Resistor Accuracy Control

The high R_{SENSE} value allows for more accurate measurement of low current. Because the offset will become less important if the detection voltage is large. For better performance, R_{SENSE} is selected to provide an induced voltage of approximately 125mV (20V/V gain) for full range current in the application.

Inductance

If the sense current has a large high-frequency component, the inductance should remain as low as possible. Generally, the inductance of wire-wound resistors is highest, metal-film resistors are slightly better. Metal-film and low-inductance resistors are also available. The metal-film or wire-wound resistors are spiraled around the cores, while this resistor is a straight metal strip that can be found with values below 1Ω.

In order to avoid errors in the test voltage due to high current passing through R_{SENSE}, eliminating parasitic trace resistances should be considered. Using four-terminal current to detect resistance or using kelvin (force and feel) PCB layout technology is the appropriate design.

Power Consumption and Efficiency Optimization

When selecting R_{SENSE} value and its rated power dissipation (wattage), its I^2R losses should be carefully taken into account because it is significant at high current levels. In addition, if the temperature is too high, the value of the sensor resistance may drift.

REVISION HISTORY

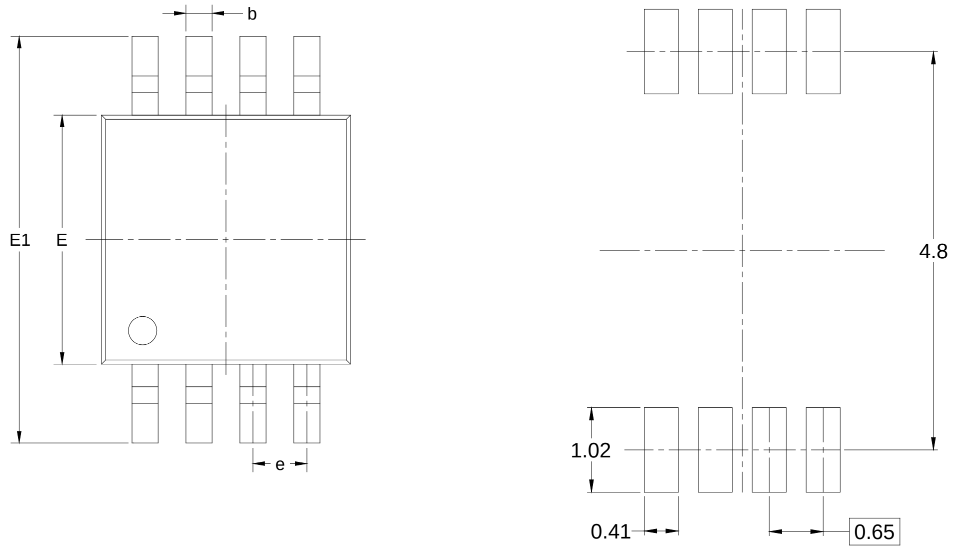
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

APRIL 2022 – REV.A to REV.A.1	Page
Updated Detailed Description section	8

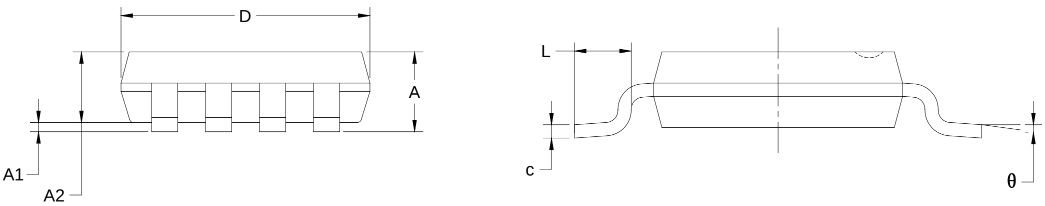
Changes from Original (MARCH 2022) to REV.A	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

MSOP-8



RECOMMENDED LAND PATTERN (Unit: mm)

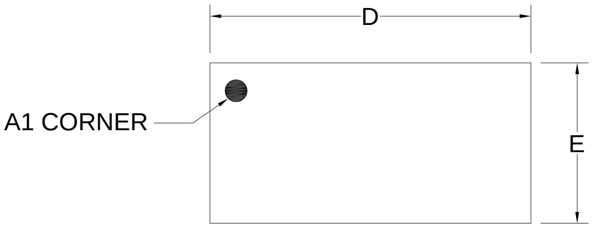


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026 BSC	
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

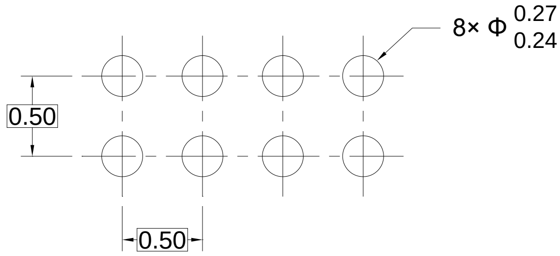
NOTES:
1. Body dimensions do not include mode flash or protrusion.
2. This drawing is subject to change without notice.

PACKAGE OUTLINE DIMENSIONS

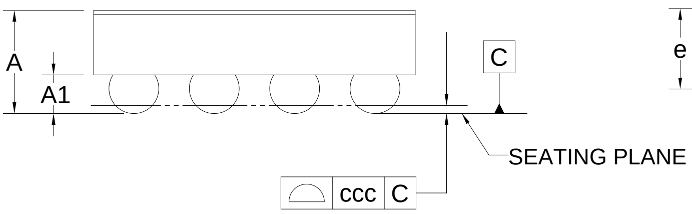
WLCSP-2×1-8B



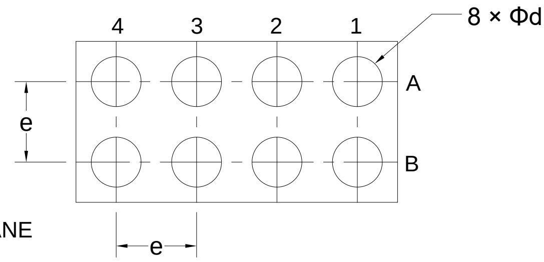
TOP VIEW



RECOMMENDED LAND PATTERN (Unit: mm)



SIDE VIEW



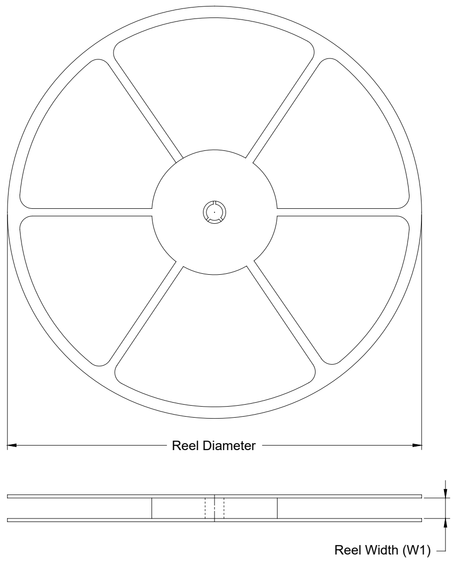
BOTTOM VIEW

Symbol	Dimensions In Millimeters		
	MIN	MOD	MAX
A	0.595	0.640	0.685
A1	0.210	0.240	0.270
D	1.970	2.000	2.030
E	0.970	1.000	1.030
d	0.280	0.310	0.340
e	0.500 BSC		
ccc	0.050		

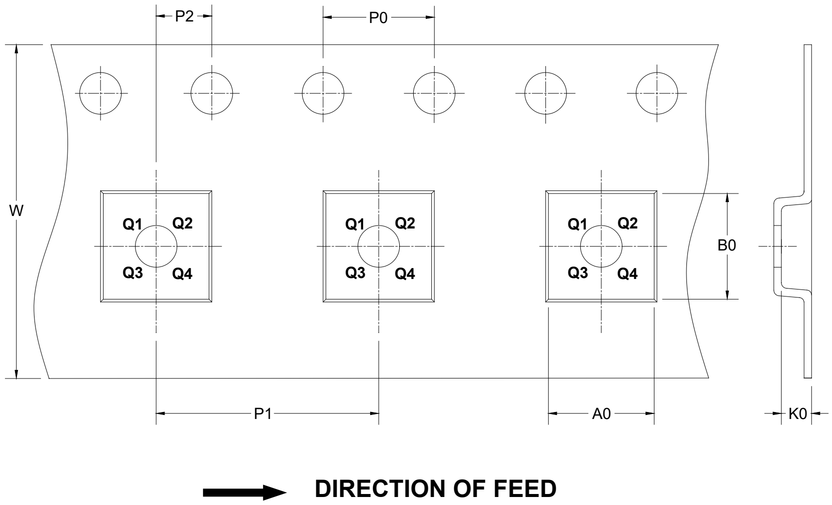
NOTE: This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



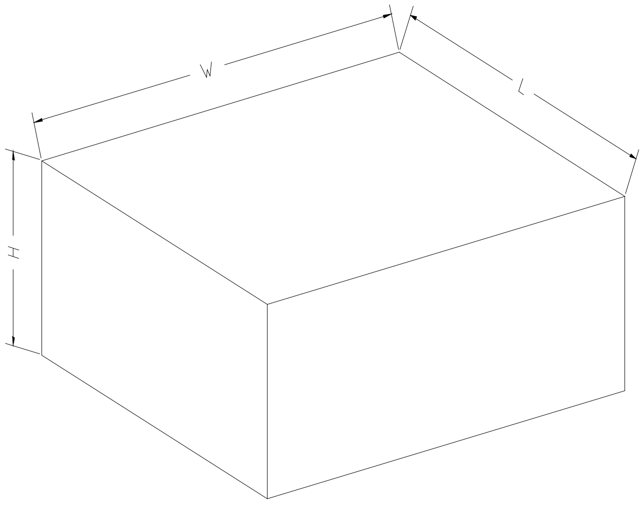
NOTE: The picture is only for reference. Please make the object as the standard.

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
MSOP-8	13″	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1
WLCSP-2×1-8B	7″	9.5	1.12	2.12	0.78	4.00	4.00	2.00	8.00	Q2

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