FUNCTIONAL BLOCK DIAGRAM

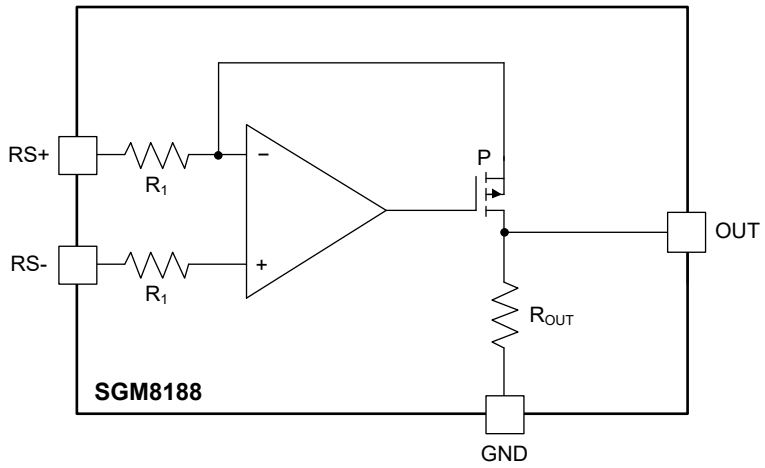

Figure 2. Block Diagram

DETAILED DESCRIPTION

The SGM8188 is a unidirectional high-side current-sense monitor with an input common mode range from 1.6V to 28V. This common mode voltage range allows measuring of a 1.8V battery system. The load current that flows through the external resistor R_{SENSE} generates a corresponding sense voltage that is amplified by the current-sense monitor.

The internal amplifier will force the load current through the resistor R_1 such that the voltage dropping over R_1 is equal to the sense voltage across the external resistor. To minimize the offset voltage, there is also a resistor connecting to the positive input of the internal operational amplifier. The PMOS, which is integrated inside the device, forces the current through R_1 to also flow through R_{OUT}, such that V_{OUT} is equal to $I_{LOAD} \times R_{SENSE} \times R_{OUT}/R_1$. Therefore, the two resistors R_1 and R_{OUT} will determine the gain, which is 25V/V for the SGM8188A0, 50V/V for the SGM8188A1, 100V/V for the SGM8188A2 and 200V/V for the SGM8188A3 (see Table 1). The output current-limit and a 6V clamp protection circuit are used for protecting the output from input overdrive.

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Table 1. Internal Gain-Setting Resistors (Typical Values)

Device	Gain (V/V)	R_1 (Ω)	R_{OUT} (kΩ)
SGM8188A0	25	400	10
SGM8188A1	50	200	10
SGM8188A2	100	100	10
SGM8188A3	200	100	20

APPLICATIONS INFORMATION

Choosing the Sense Resistor

The sense resistor should be selected by the following steps.

R_{SENSE} Voltage Loss

Due to Ohm's Law, the voltage drop across R_{SENSE} will be increased if the customer prefers higher R_{SENSE}. However, for obtaining the minimum voltage drop, the lowest R_{SENSE} should be taken into account.

OUT Swing vs. V_{RS+} and V_{SENSE}

The SGM8188 is powered through its RS+ pin, which means that there is no supply voltage pin. Therefore, the maximum output swing value is limited by the minimum voltage level of RS+.

$$V_{OUT(MAX)} = V_{RS+(MIN)} - V_{SENSE(MAX)} - V_{OH} \quad (1)$$

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

Moreover, when the SGM8188 is powered by a 3.6V power supply, the largest dynamic range will be achieved if R_{SENSE} is chosen such that the maximum V_{SENSE} voltage is 30mV (gain of 100V/V).

Accuracy

Within the linear region of the SGM8188 (V_{OUT} < $V_{OUT(MAX)}$), the input offset voltage and the gain error are the two main issues that affect the accuracy of the output voltage. For the SGM8188, the maximum offset voltage (V_{OS}) is 60μV and the maximum gain error (GE) is ±0.4%. The following equation illustrates the actual output voltage according to the gain error and offset voltage:

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

It is recommended to use a larger R_{SENSE} when measuring a small load current, as this minimizes the effect of the input offset voltage on the output error.

Efficiency and Power Dissipation

If the current level is increasing, the I^2R loss will be increased. So the trade-off between power dissipation and the value of resistor is significant. In addition, the resistance will be changed if the corresponding temperature is higher due to the power dissipation. The SGM8188 allows using lower external resistor so that the power dissipation and the hot spots are decreased dramatically.

Kelvin Connections

The current flowing through the R_{SENSE} will be significantly high, so that the external voltage drop caused by the PCB trace should also be considered. Use the sense resistor with four terminals or use Kelvin connections.

Optional Output Filter Capacitor

For the sample and hold stage in the ADC, the sampling capacitor would instantly load the output of the SGM8188 and thusly the output voltage will be decreased. If the sampling time of the ADC is short (less than 1μs), the ceramic capacitor will keep the output voltage stable. Also, the small-signal bandwidth and the corresponding noise are also reduced by using an additional capacitor at the output stage of the SGM8188.

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APPLICATIONS INFORMATION (continued)

Using the SGM8188 in Bidirectional Application

For the applications which are powered by battery, the bidirectional measurement is required as the customer needs to know the charging and discharging current of the battery. The following circuit provides an accuracy measurement for charging and discharging current, which is shown in Figure 3.

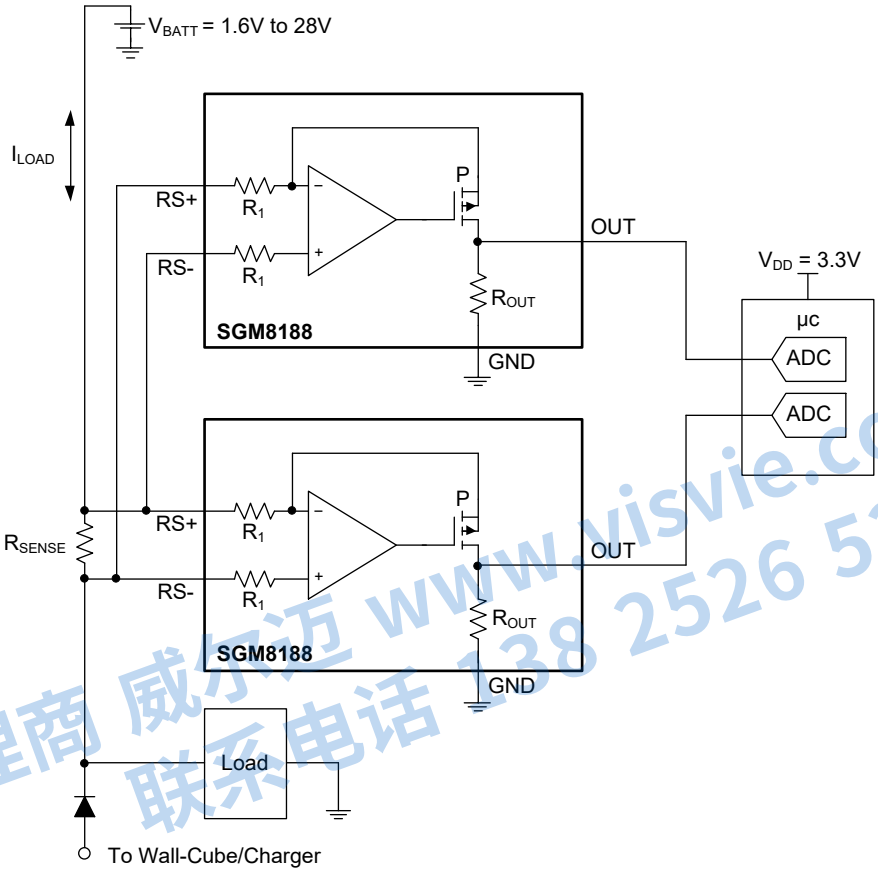

Figure 3. Bidirectional Application

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REVISION HISTORY

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

Changes from Original (JUNE 2023) to REV.A	Page
Changed from product preview to production data	All

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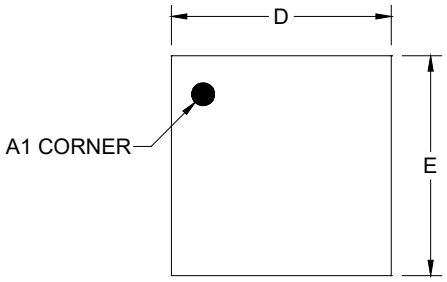
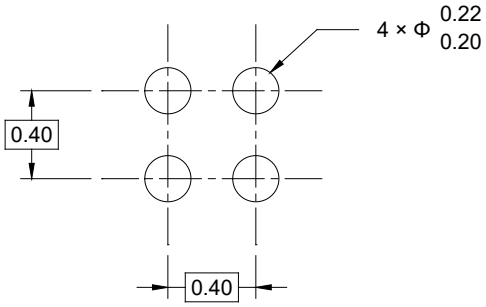
PACKAGE OUTLINE DIMENSIONS

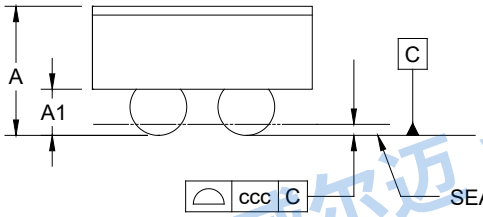
WLCSP-1×1-4B-A



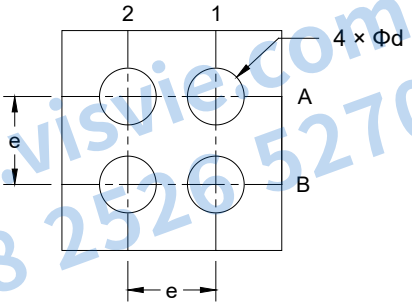
TOP VIEW



RECOMMENDED LAND PATTERN (Unit: mm)



SIDE VIEW



BOTTOM VIEW

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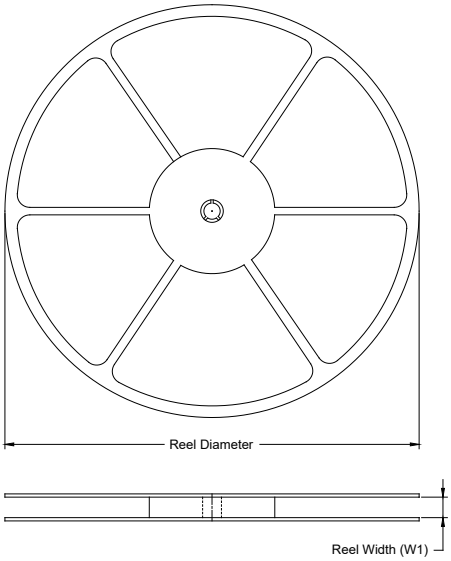
Symbol	Dimensions In Millimeters		
	MIN	MOD	MAX
A	-	-	0.625
A1	0.190	-	0.230
D	0.975	-	1.035
E	0.975	-	1.035
d	0.228	-	0.288
e	0.400 BSC		
ccc	0.050		

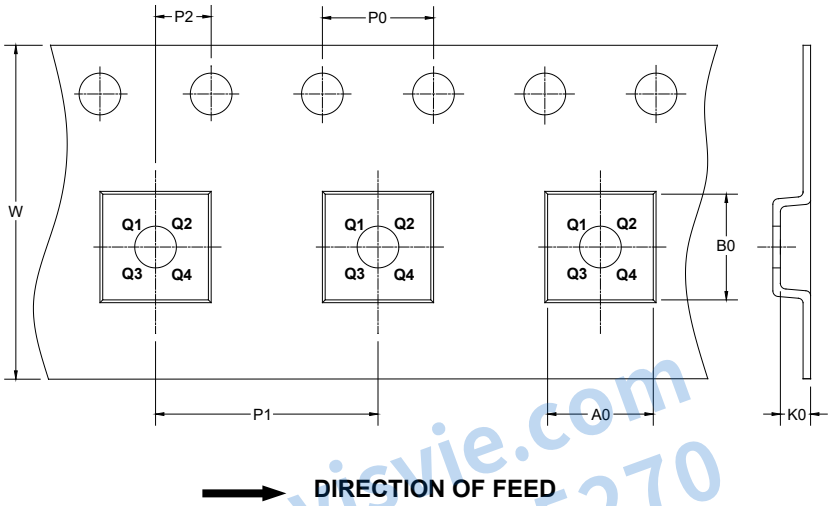
NOTE: This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



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

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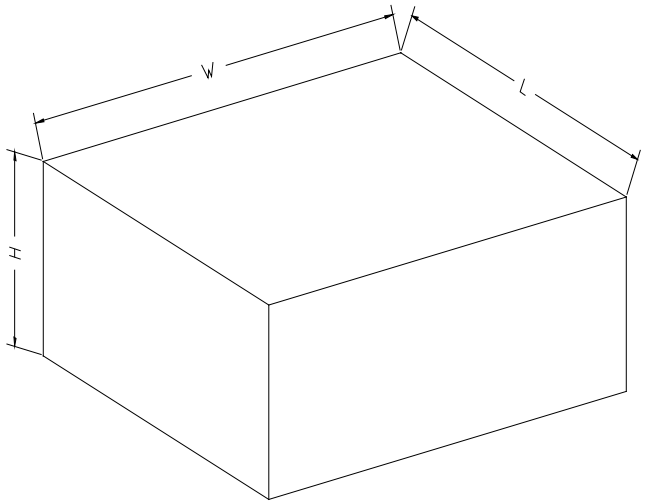
KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
WLCSP-1×1-4B-A	7"	9.5	1.07	1.07	0.72	4.0	4.0	2.0	8.0	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

DD0002

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