GENERAL DESCRIPTION

The SGM452 is an industry standard digital temperature sensor which integrates sigma-delta analog-to-digital converter (ADC) and I^{2}C interface. This device provides 12-bit digital temperature readings with an accuracy of ±1.2℃ from -55℃ to +125℃.

The SGM452 operates with a single power supply from 2.7V to 5.5V. I^{2}C interface is used to communicate with SGM452 and it operates up to 400kHz. The device has three address pins to support up to eight SGM452 on the same I^{2}C bus. The SGM452 has a dedicated over-temperature output with programmable limit and hysteresis. This output has programmable fault tolerance, which can be defined the number of consecutive error conditions that must occur before OS is activated. The wide temperature, wide power supply range and I^{2}C interface make the SGM452 ideal for plenty of applications in which thermal management is critical for performance, such as wireless base stations, notebook computers, personal computers, etc.

The SGM452 is available in Green SOIC-8 and MSOP-8 packages and operates over an ambient temperature range of -55℃ to +125℃.

FEATURES

- **No External Components Required**
- **Shutdown Mode to Minimize Power Consumption**
- **Up to Eight SGM452 Devices can be Connected to a Single Bus**
- **Power-Up Defaults Permit Stand-Alone Operation as Thermostat**
- **Power Supply Voltage Range: 2.7V to 5.5V**
- **Support 1.8V I^{2}C Bus Voltage at 3.3V Power Supply**
- **Low Quiescent Current: 49µA (TYP)**
- **Shutdown Mode Current: 0.4µA (TYP)**
- **Temperature Accuracy:**
  -55℃ to +125℃: ±1.2℃ (MAX)
- **Operating Temperature Range: -55℃ to +125℃**
- **Available in Green SOIC-8 and MSOP-8 Packages**

APPLICATIONS

Thermal Management in Computing System
Telecom Infrastructure Equipment
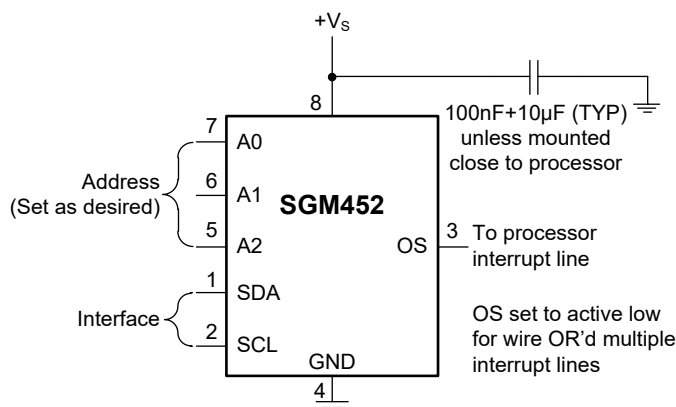Environmental Monitoring

TYPICAL APPLICATION

**Figure 1. Typical Application Circuit**

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM452	SOIC-8	-55℃ to +125℃	SGM452TS8G/TR	SGM 452TS8 XXXXX	Tape and Reel, 4000
	MSOP-8	-55℃ to +125℃	SGM452TMS8G/TR	SGM452 TMS8 XXXXX	Tape and Reel, 4000

MARKING INFORMATION

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

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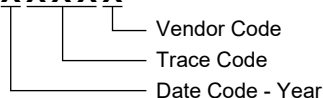
Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage Pin ($+V_S$).....................................-0.3V to 6V
Voltage at A0, A1 and A2 Pins..............-0.3V to ($+V_S$ + 0.3V)
Voltage at OS, SCL and SDA Pins ....-0.3V to 6V
Input Current at Any Pin [1].................................5mA
Package Input Current..................................20mA
OS Output Sink Current.................................10mA
OS Output Voltage..6V
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 ($+V_S$)...............................2.7V to 5.5V
Operating Temperature Range.....................-55℃ to +125℃

NOTE:

1. When the input voltage (V_{IN}) at any pin exceeds the power supplies (V_{IN} < GND or V_{IN} > $+V_S$) the current at that pin should be limited to 5mA. The 20mA maximum package input current rating limits the number of pins that can safely exceed the power supplies with an input current of 5mA to four.

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 by ESD if you don't pay attention to ESD protection. 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 very small parametric changes could cause the device not to meet its 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)

SDA	1	8 +V_S
SCL	2	7 A0
OS	3	6 A1
GND	4	5 A2

SOIC-8/MSOP-8
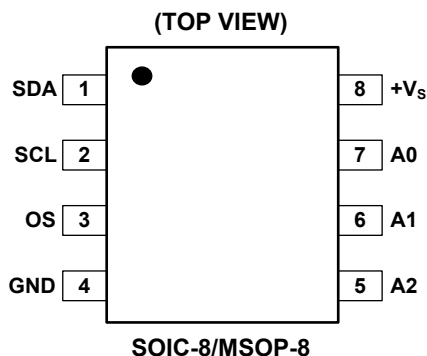
PIN DESCRIPTION

PIN	NAME	FUNCTION
1	SDA	I^2C Serial Bi-Directional Data Line. Open drain. From controller, tied to a pull-up resistor or current source.
2	SCL	I^2C Serial Clock Input. From controller, tied to a pull-up resistor or current source.
3	OS	Over-Temperature Shutdown Output. Open drain. Pull-up resistor, controller interrupt line.
4	GND	Power Supply Ground.
5	A2	User-Set I^2C Address Inputs. Ground = Low (0), +V_S = High (1).
6	A1	
7	A0	
8	+V_S	Positive Supply Voltage Input. DC voltage from 2.7V to 5.5V. A 100nF bypass capacitor with a 10µF bulk capacitance in the near vicinity.

ELECTRICAL CHARACTERISTICS

(+V_S = 3.3V, T_A = T_J = -55℃ to +125℃, typical values are at T_A = T_J = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Temperature-to-Digital Converter Characteristics						
Temperature Accuracy	T_{ACC}		-1.2	±0.2	1.2	℃
Power Supply Sensitivity				0.02	0.08	℃/V
Temperature Resolution				12		Bits
Temperature Conversion Time [1]	t_{CON}		90	100	110	ms
Quiescent Current	I_{DD}	I²C inactive, +V_S = 2.7V		46	65	µA
		I²C inactive, +V_S = 3.3V		49	70	
		I²C inactive, +V_S = 5.5V		64	85	
		Shutdown mode, +V_S = 5.5V		0.4	3	
OS Output Saturation Voltage		I_{OUT} = 3mA		0.06	0.3	V
OS Delay [2]			1		6	Conversion
T_{OS} Default Temperature				80		℃
T_{HYST} Default Temperature				75		℃
Digital DC Characteristics						
SCL SDA High-Level Input Voltage	V_{IH_S}	+V_S = 5.5V	1.7			V
		+V_S = 3.6V	1.4			
SCL SDA Low-Level Input Voltage	V_{IL_S}	+V_S = 2.7V			0.6	V
A0 A1 A2 High-Level Input Voltage	V_{IH_A}	+V_S = 5.5V	0.6 × (+V_S)			V
A0 A1 A2 Low-Level Input Voltage	V_{IL_A}	+V_S = 2.7V			0.4 × (+V_S)	V
High-Level Input Current	I_{IH}	+V_S = 5.5V		0.01	1	µA
All Digital Inputs	C_{IN}			5		pF
SDA High-Level Output Current	I_{OH}	V_{OH} = 5V		0.01	1	µA
SDA Low-Level Output Voltage	V_{OL}	I_{OL} = 3mA		0.06	0.3	V
I²C Digital Switching Characteristics						
SCL Clock Period	t_{CLK}	T_A = T_J = +25℃	2.5			µs
Data in Set-Up Time to SCL High	t_{HIGH}	T_A = T_J = +25℃	100			ns
Data Out Stable after SCL Low	t_{LOW}	T_A = T_J = +25℃	0			ns
SDA Low Set-Up Time to SCL Low (Start Condition)	t_{SUSTA}	T_A = T_J = +25℃	100			ns
SDA High Hold Time after SCL High (Stop Condition)	t_{HDSTO}	T_A = T_J = +25℃	100			ns
SDA Time Low for Reset of Serial Interface [3]	$t_{TIMEOUT}$	T_A = T_J = +25℃	20		30	ms

NOTES:

1. The conversion time specification is provided to indicate how often the temperature data is updated. The SGM452 can be accessed at any time and reading the temperature register will yield result from the last temperature conversion.

2. OS Delay is user programmable to up to 6 "over limit" conversions before OS is set, to minimize false tripping in noisy environments.

3. Holding the SDA line low for a period longer than $t_{TIMEOUT}$ will cause the SGM452 to reset SDA to the IDLE state of the serial bus communication (SDA set High).
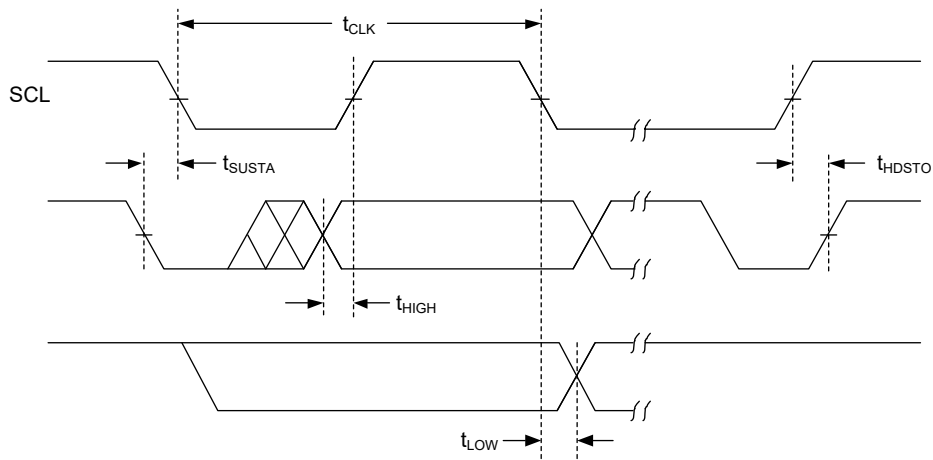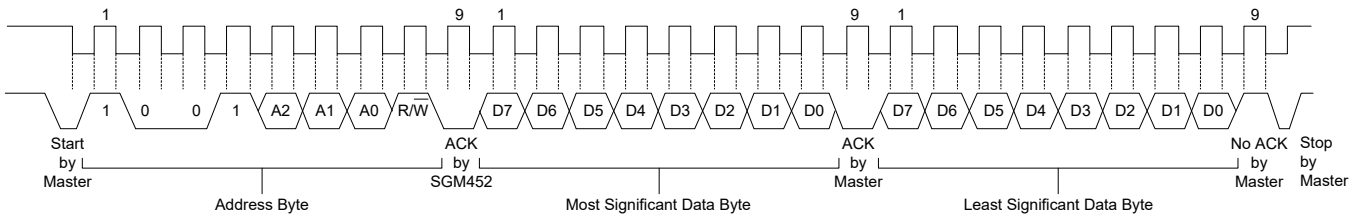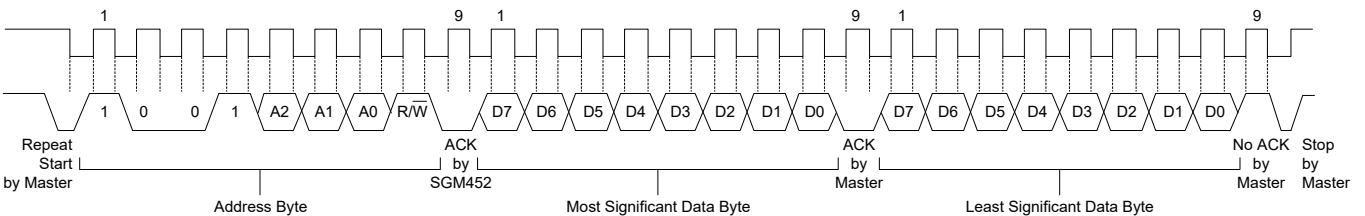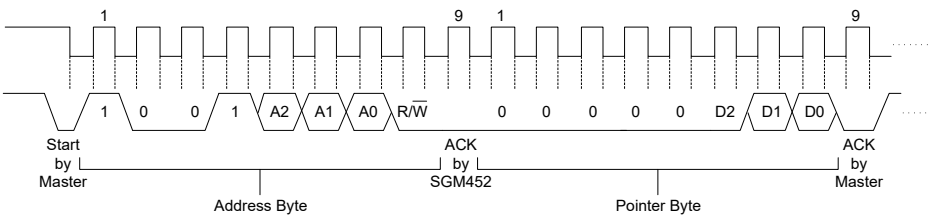
I^{2}C DIGITAL SWITCHING CHARACTERISTICS
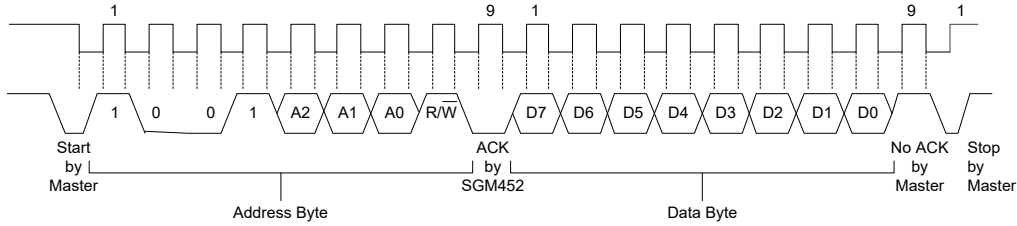

Figure 2. Timing Diagram

(a) Typical 2-Byte Read from Preset Pointer Location Such as Temperature, T$_{OS}$, T$_{HYST}$
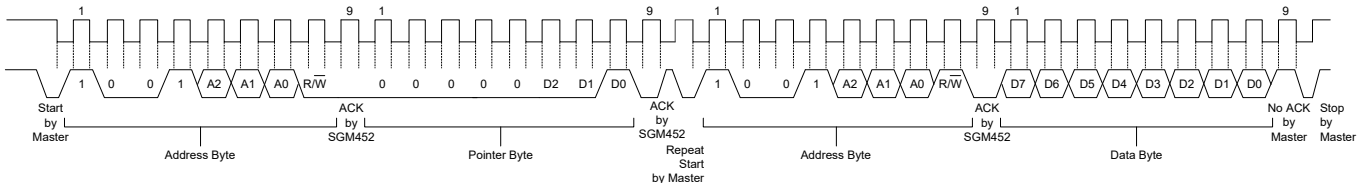

(b) Typical Pointer Set Followed by Immediate Read for 2-Byte Register Such as Temperature, T$_{OS}$, T$_{HYST}$

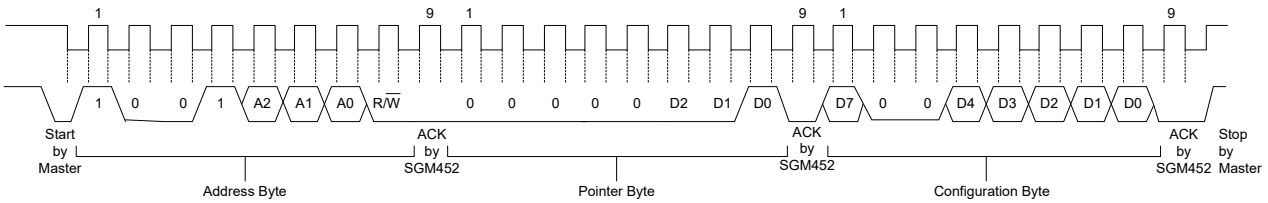## I²C DIGITAL SWITCHING CHARACTERISTICS (continued)

(c) Typical 1-Byte Read from Configuration Register with Preset Pointer
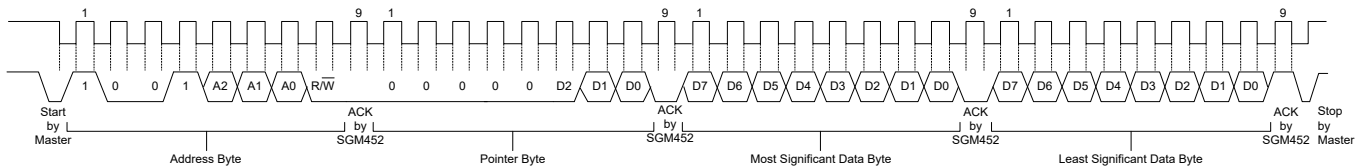
Figure 3. I²C Timing Diagram

(a) Typical Pointer Set Followed by Immediate Read from Configuration Register

(b) Write to Configuration Register

(c) Write to T$_{OS}$ and T$_{HYST}$

Figure 4. I²C Timing Diagram (continued)
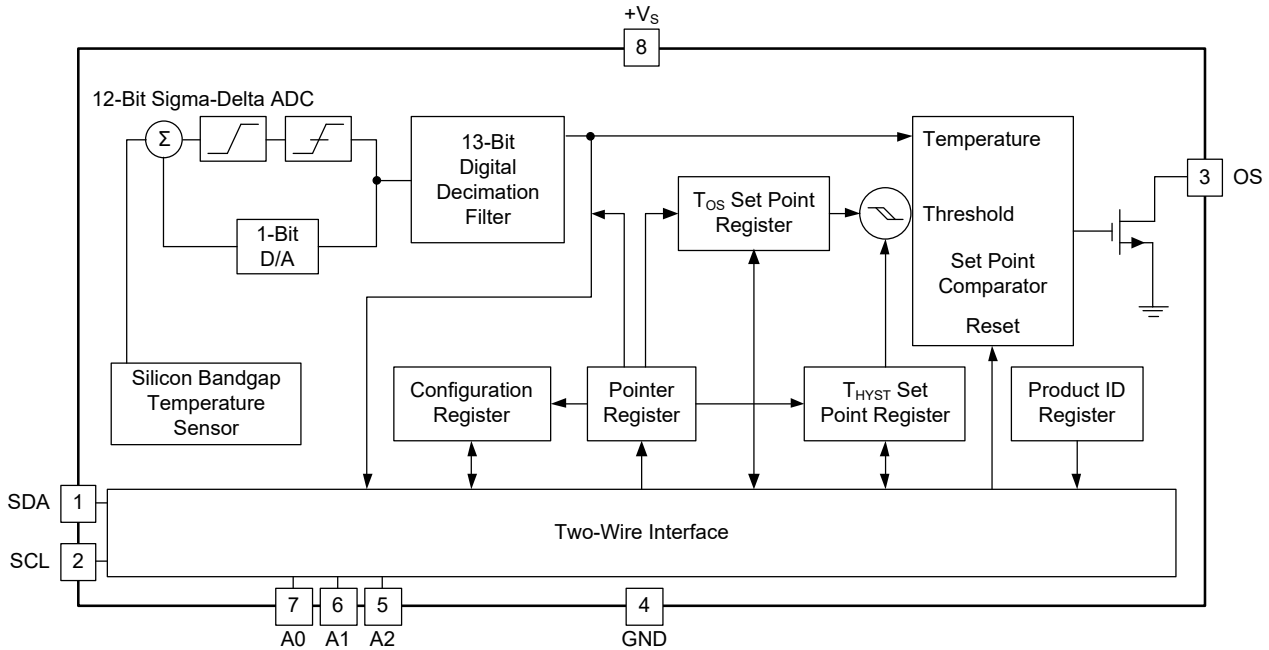
FUNCTIONAL BLOCK DIAGRAM

Figure 5. Block Diagram

DETAILED DESCRIPTION

General Operation

The SGM452 digital temperature sensor integrates a bandgap temperature sensor and a 12-bit sigma-delta ADC. The temperature data output of the SGM452 is available at all times via the I^2C bus. Reading temperature data has no effect on the conversion in progress. A digital comparator is also incorporated that compares a series of readings, the number of which is user-selectable, to user-programmable set point and hysteresis values. The comparator trips the OS output line, which is programmable for mode and polarity. The SGM452 has integrated low-pass filters on both the SDA and the SCL lines. These filters increase communications reliability in noisy environments.

The SGM452 also has a bus fault timeout feature. If the SDA line is held low for longer than $t_{TIMEOUT}$, the SGM452 will reset to the IDLE state (SDA set to high impedance) and wait for a new start condition. The timeout feature is not functional in shutdown mode.

Device Functional Modes

In comparator mode the OS output behaves like a thermostat. The output becomes active when temperature exceeds the T_{OS} limit, and leaves the active state when the temperature drops below the T_{HYST} limit. In this mode the OS output can be used to turn a cooling fan on, initiate an emergency system shutdown, or reduce system clock speed. Shutdown mode does not reset OS state in a comparator mode.

In interrupt mode exceeding T_{OS} also makes OS active but OS will remain active indefinitely until reset by reading any register via the I^2C interface. Once OS has been activated by crossing T_{OS}, then reset, it can be activated again only by temperature going below T_{HYST}. Again, it will remain active indefinitely until being reset by a read. Placing the SGM452 in shutdown mode also resets the OS Output.

The SGM452 always powers up in a known state. The power-up default conditions are:

• In comparator mode
• T_{OS} = +80℃
• T_{HYST} = +75℃
• OS active low
• Pointer = "00"

DETAILED DESCRIPTION (continued)

When the supply voltage is lower than about 2.6V, the SGM452 is considered powered down. As the supply voltage rises above the nominal 2.6V power-up threshold, the internal registers are reset to the power-up default values listed above.

If the SGM452 is not connected to the I²C bus on power-up, it will act as a stand-alone thermostat with the power-up default conditions listed above. It is optional, but recommended, to connect the address pins (A2, A1, A0) and the SCL and SDA pins together and to a 10kΩ pull-up resistor to +V$_S$ for better noise immunity. Any of these pins may also be tied high separately through a 10kΩ pull-up resistor.

I²C Bus Interface

The SGM452 operates as a slave on the I²C bus, so the SCL line is an input (no clock is generated by the SGM452) and the SDA line is a bi-directional serial data path. According to I²C bus specifications, the SGM452 has a 7-bit slave address. The four most significant bits of the slave address are hard wired inside the SGM452 and are "1001". The three least significant bits of the address are assigned to pins A2 to A0, and are set by connecting these pins to ground for a low, = 0; or to +V$_S$ for a high, = 1.

Therefore, the complete slave address is:

Table 1. Complete Slave Address

1	0	0	1	A2	A1	A0
MSB						LSB

Digital Temperature Output

The digital output from each temperature measurement is stored in the read-only temperature register. The temperature register of the SGM452 is configured as a 12-bit, read-only register. Temperature data can be read from the temperature, T$_{OS}$ set point, and T$_{HYST}$ set point registers; and written to the T$_{OS}$ set point, and T$_{HYST}$ set point registers. Data format is represented by a 12-bit, two's complement with an LSB (least significant bit) equal to 0.0625℃.

Table 2. 12-Bit Temperature Data Format

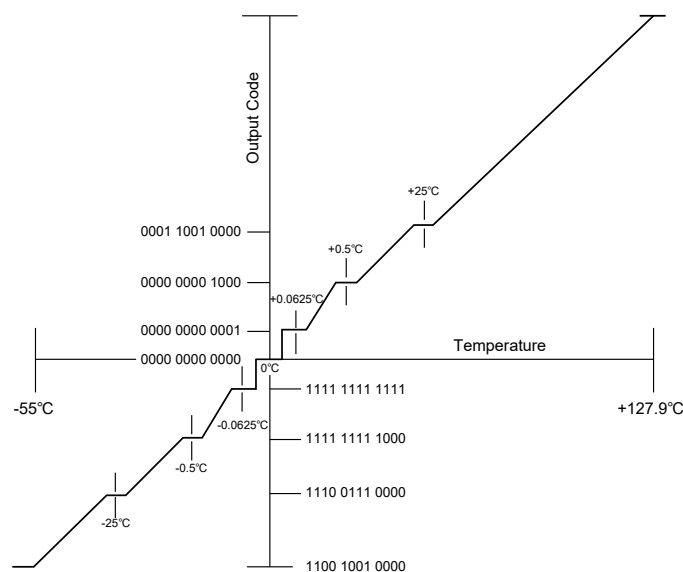| Temperature	Digital Temperature Output	
	Binary	**Hex**
+125℃	0111 1101 0000	7D0h
+25℃	0001 1001 0000	190h
+0.5℃	0000 0000 1000	008h
+0.0625℃	0000 0000 0001	001h
0℃	0000 0000 0000	000h
-0.0625℃	1111 1111 1111	FFFh
-0.5℃	1111 1111 1000	FF8h
-25℃	1110 0111 0000	E70h
-55℃	1100 1001 0000	C90h

Figure 6. Temperature-to-Digital Transfer Function (Not Linear Scale for Clarity)

DETAILED DESCRIPTION (continued)

Shutdown Mode

Shutdown mode is enabled by setting the SHUTDOWN bit in the configuration register via the I^{2}C bus. Shutdown mode reduces power supply current significantly. In interrupt mode OS is reset if previously set and is undefined in comparator mode during shutdown. The I^{2}C interface remains active. Activity on the clock and data lines of the I^{2}C bus may slightly increase shutdown mode quiescent current. T$_{OS}$, T$_{HYST}$, and configuration registers can be read from and written to in shutdown mode.

For the SGM452, the timeout feature is turned off in shutdown mode.

Fault Queue

A fault queue of up to 6 faults is provided to prevent false tripping of OS when the SGM452 is used in noisy environments. The number of faults set in the queue must occur consecutively to set the OS output.

Comparator and Interrupt Modes

As indicated in the Figure 7, the events that trigger OS are identical for either comparator or interrupt mode. The most important difference is that in interrupt mode the OS will remain set indefinitely once it has been set. To reset OS while in interrupt mode, perform a read from any register in the SGM452.

OS Output

The OS output is an open-drain output and does not have an internal pull-up. A high level will not be observed on this pin until pull-up current is provided from some external source, typically a pull-up resistor. Choice of resistor value depends on many system factors, but in general, the pull-up resistor should be as large as possible. This will minimize any errors due to internal heating of the SGM452.

OS Polarity

The OS output can be programmed via the configuration register to be either active low (default mode), or active high. In active low mode the OS output goes low when triggered exactly as shown in Figure 7. Active high simply inverts the polarity of the OS output.
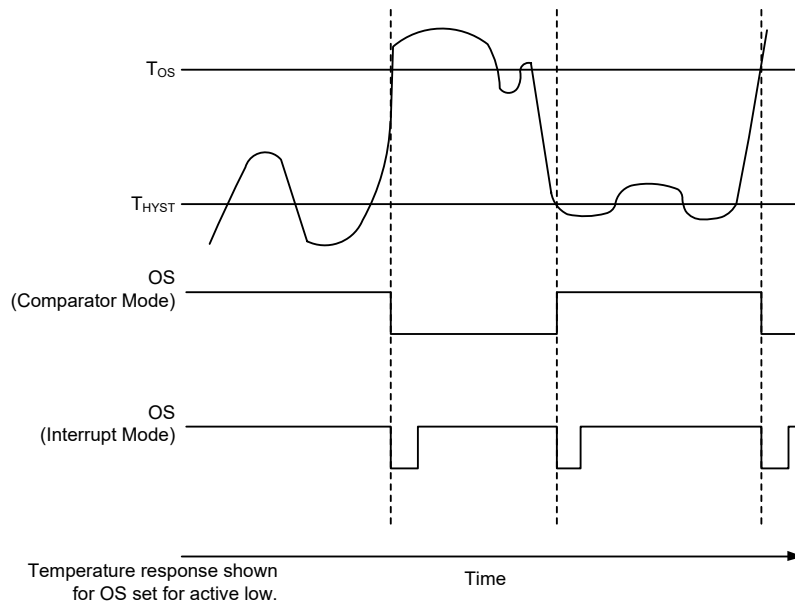
NOTE: These interrupt mode resets of OS occur only when SGM452 is read or placed in shutdown. Otherwise, OS would remain active indefinitely for any event.

Figure 7. OS Output Temperature Response Diagram

DETAILED DESCRIPTION (continued)
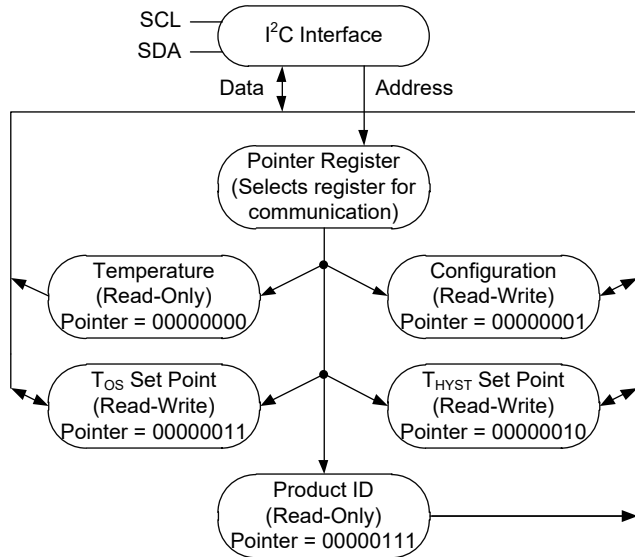
Internal Register Structure

Figure 8. Register Structure

Figure 8 shows the internal register structure of the SGM452 device. There are four data registers in the SGM452 and an additional product ID register selected by the pointer register. Table 4 identifies the bits of the pointer register byte. The power-up reset value of P2, P1 and P0 is 000. The pointer register latches whatever the last location it was set to. In interrupt mode, a read from the SGM452, or placing the device in shutdown mode, resets the OS output. All registers are read and write, except the temperature register and the SGM452's product ID register, which are read only.

A write operation to the SGM452 will always include the address byte and the pointer byte. A write to the configuration register requires one data byte, and the T_{OS} and T_{HYST} set point registers require two data bytes.

Reading from the SGM452 can take place either of two ways: If the location latched in the pointer is correct (most of the time it is expected that the pointer will point to the temperature register because it will be the data most frequently read from the SGM452), then the read can simply consist of an address byte, followed by retrieving the corresponding number of data bytes. If the pointer needs to be set, then an address byte, pointer byte, repeat start, and another address byte will accomplish a read.

The first data byte is the most significant byte with most significant bit first, permitting only as much data as necessary to be read to determine temperature condition. For instance, if the first four bits of the temperature data indicate an over-temperature condition, the host processor could immediately take action to remedy the excessive temperatures. At the end of a read, the SGM452 can accept either acknowledge or no acknowledge from the master (no acknowledge is typically used as a signal for the slave that the master has read its last byte).

REGISTER MAP

Pointer Register

Table 3. Pointer Register (Select which Registers will be Read from or Written to)

P7	P6	P5	P4	P3	P2	P1	P0
0	0	0	0	0	Register Select		

Table 4. Pointer Register Select Details

P2	P1	P0	Register
0	0	0	Temperature Register (Read-Only) (Power-Up Default)
0	0	1	Configuration Register (Read/Write)
0	1	0	T_{HYST} Register (Read/Write)
0	1	1	T_{OS} Register (Read/Write)
1	1	1	Product ID Register

P0-P2: Register select.

P3-P7: Must be kept "0" (zero).

Temperature Register

Register address: 00000000; R Only; two's complement format.

Table 5. Temperature Register Details

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
MSB	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	LSB	X	X	X	X

D0-D3: Undefined.

D4-D15: Temperature data.

One LSB = 0.0625℃.

Configuration Register

Register address: 00000001; R/W; power-up default is with all bits "0" (zero).

Table 6. Configuration Register Details

D7	D6	D5	D4	D3	D2	D1	D0
BUS_FLEX	0	0	FAULT_QUEUE[1:0]		OS_POLARITY	CMP_INT	SHUTDOWN

Table 7. FAULT_QUEUE[1:0] Register Select Details

D4	D3	Number of Faults
0	0	1 (Power-Up Default)
0	1	2
1	0	4
1	1	6

REGISTER MAP (continued)

D0: SHUTDOWN: When set to 1 the SGM452 goes to low power shutdown mode.

D1: CMP_INT: Comparator/Interrupt mode. 0 is comparator mode; 1 is interrupt mode.

D2: OS_POLARITY: 0 is active low; 1 is active high. OS is an open-drain output under all conditions.

D3-D4: FAULT_QUEUE[1:0]: Number of faults necessary to detect before setting OS output to avoid false tripping due to noise. Faults are determined at the end of a conversion. See specified temperature conversion time in the Electrical Characteristics table.

D6-D5: These bits are used for production testing and must be kept "0" (zero) for normal operation.

D7: BUS_FLEX: 0: Disable leakage blocking circuit for the scenario that I^{2}C bus voltage is lower than +V_S of the part. The I^{2}C interface is still functional but +V_S sees leakage when V_{BUS} < +V_S - 0.3V. At below two combinations V_{BUS} = 1.8V, +V_S = 3.3V, or V_{BUS} = 3.3V, +V_S = 5.0V, Set BUS_FLEX to 1 will remove leakage current with a little increase of power down current.

T$_{HYST}$ and T$_{OS}$ Set Point Registers

T$_{HYST}$ register address: 00000010; R/W

T$_{OS}$ register address: 00000011; R/W

Table 8. T$_{HYST}$ and T$_{OS}$ Registers Details

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
MSB	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	LSB	X	X	X	X

D0-D3: Undefined.

D4-D15: T$_{HYST}$ or T$_{OS}$ trip temperature data.

Power-up default is T$_{OS}$ = +80℃ (Binary: 0101 0000 0000), T$_{HYST}$ = +75℃ (Binary: 0100 1011 0000).

Product ID Register

Product ID register address: 00000111; R Only

Table 9. Product ID Register Details

D7	D6	D5	D4	D3	D2	D1	D0
1	0	1	0	0	0	0	1

D4-D7: Product Identification Nibble. Always returns Ah to uniquely identify this part as the SGM452.

D0-D3: Die Revision Nibble. Always returns 1h to uniquely identify the revision level as one.

APPLICATION INFORMATION

Simple Fan Controller, Interface Optional

The wide temperature, power supply range and I^2C interface make the SGM452 ideal for plenty of applications in which thermal management is critical for performance, such as wireless base stations, electronic test equipment, notebook computers, personal computers, etc.
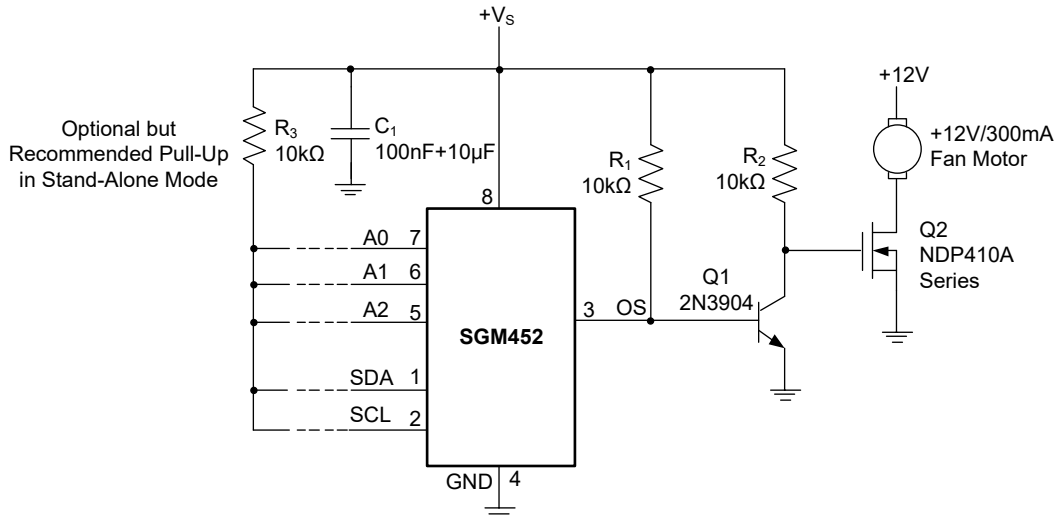
NOTE: When using the two-wire interface: program OS for active high and connect OS directly to Q2's gate.

Figure 9. Simple Fan Controller, Interface Optional

Design Requirements

The SGM452 requires positive supply voltage of 2.7V to 5.5V to be applied between $+V_S$ and GND. For best results, a 100nF bypass capacitor with a 10µF bulk capacitance near $+V_S$ are recommended as shown in Figure 9. The SGM452 device requires pull-up resistors on the SCL and SDA pins. The recommended value of the pull-up resistors is 10kΩ.

Detailed Design Procedure

Accessing the conversion result of the SGM452 consists of writing an address byte followed by retrieving the corresponding number of data bytes.

The first data byte is the most significant byte with the most significant bit first, permitting only as much data as necessary to be read to determine temperature condition. For instance, if the first four bits of the temperature data indicate an over-temperature condition, the host processor could immediately take action to remedy the excessive temperatures. At the end of a read, the SGM452 can accept either acknowledge or no acknowledge from the master (no acknowledge is typically used as a signal for the slave that the master has read its last byte). Temperature data is two's complement format and one LSB is equivalent to 0.0625℃.

APPLICATION INFORMATION (continued)
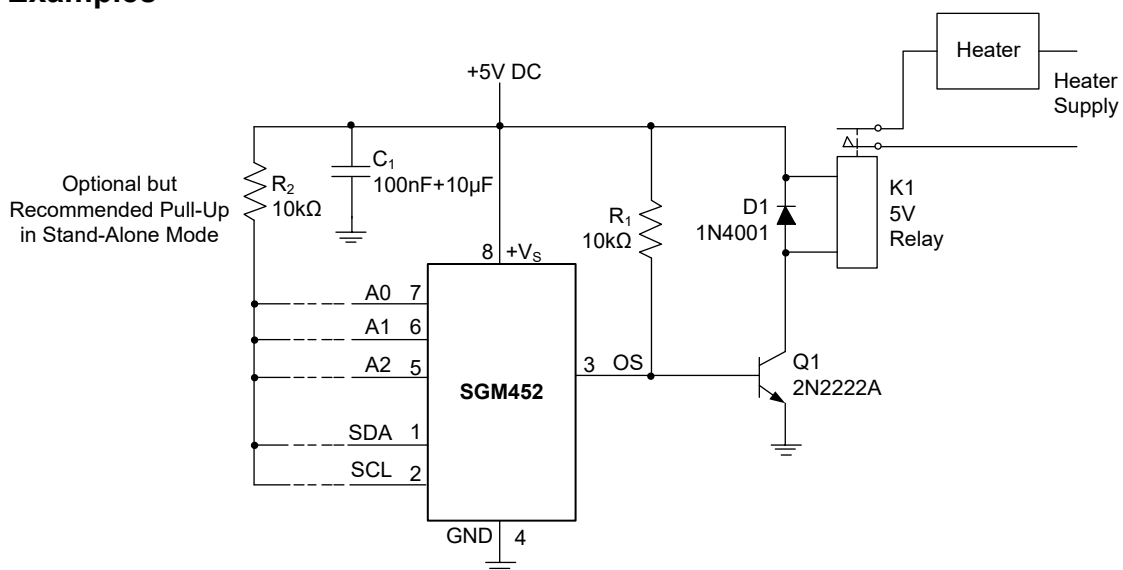
System Examples

Figure 10. Simple Thermostat, Interface Optional

LAYOUT

Layout Guidelines

Using the SGM452 to measure temperature, it is important to understand that the sensor measures its own die temperature. For the SGM452, the best thermal path between the die and the outside world is through the SGM452's pins. In the MSOP-8 package, the GND pin is directly connected to the die, so the GND pin provides the best thermal path. If other pins are at different temperatures, they will affect the die temperature, but not as strongly as the GND pin. In the SOIC-8 package, none of the pins is directly connected to the die, so they will all contribute similarly to the die temperature. Because the pins represent a good thermal path to the SGM452 die, the SGM452 will provide an accurate measurement of the temperature of the printed circuit board on which it is mounted. There is a less efficient thermal path between the plastic package and the SGM452 die. If the ambient air temperature is significantly different from the printed circuit board temperature, it will have a small effect on the measured temperature.

The SGM452 has an integrated low-pass filter on both the SCL and the SDA digital lines to mitigate the effects of bus noise. This noise filter makes the SGM452 communication robust in noisy environments, good layout practices are still recommended to reduce noise coupling, for example, the I^2C digital bus trace must be kept far away from switching power supplies, also, the digital lines containing high-speed data communications must cross at right angles to the SDA and SCL lines, overshoot greater than 300mV above $+V_S$, and undershoot more than 300mV below GND may prevent successful serial communication with the SGM452. Although the serial bus maximum frequency of communication is only 400kHz, care must be taken to ensure proper termination within a system with long printed circuit board traces or multiple parts on the bus.

REVISION HISTORY

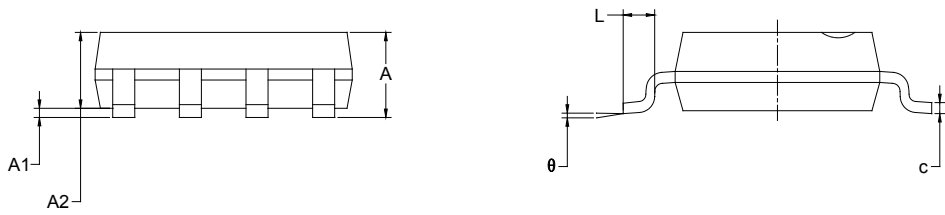NOTE: Page numbers for previous revisions may differ from page numbers in the current version.
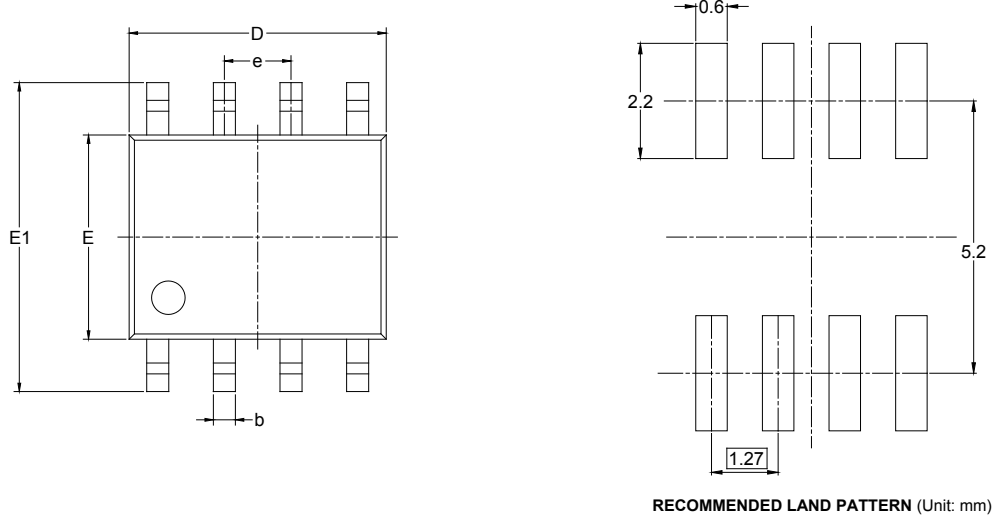
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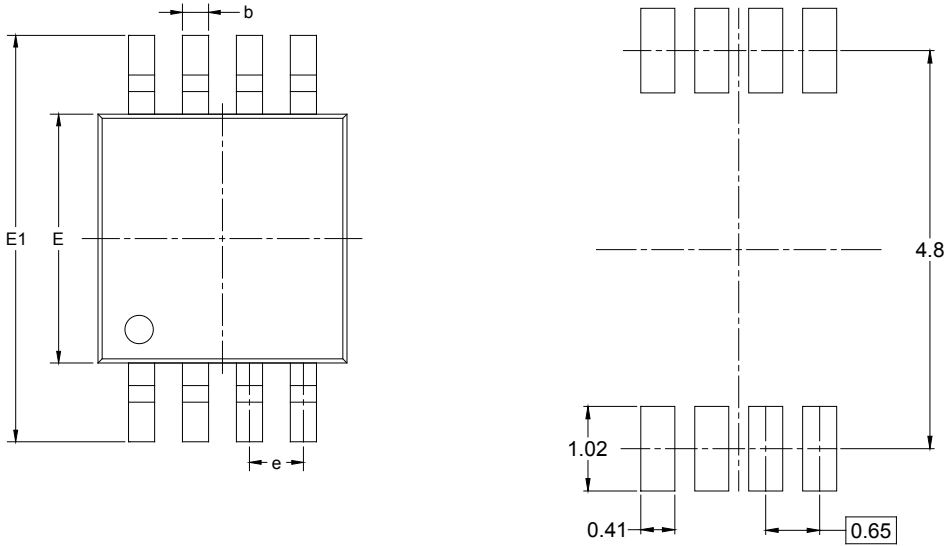
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PACKAGE OUTLINE DIMENSIONS

SOIC-8

RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

PACKAGE OUTLINE DIMENSIONS

MSOP-8

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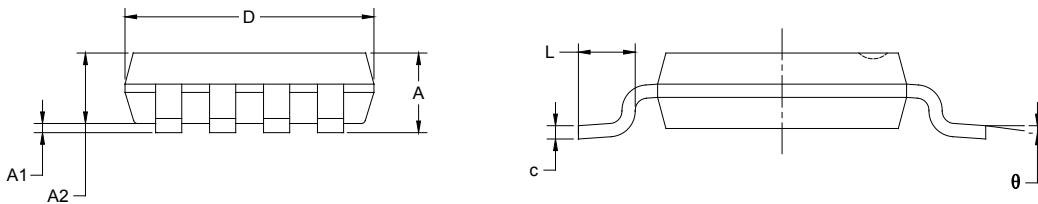
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026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

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
SOIC-8	13″	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
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	
13″	386	280	370	5	DD0002