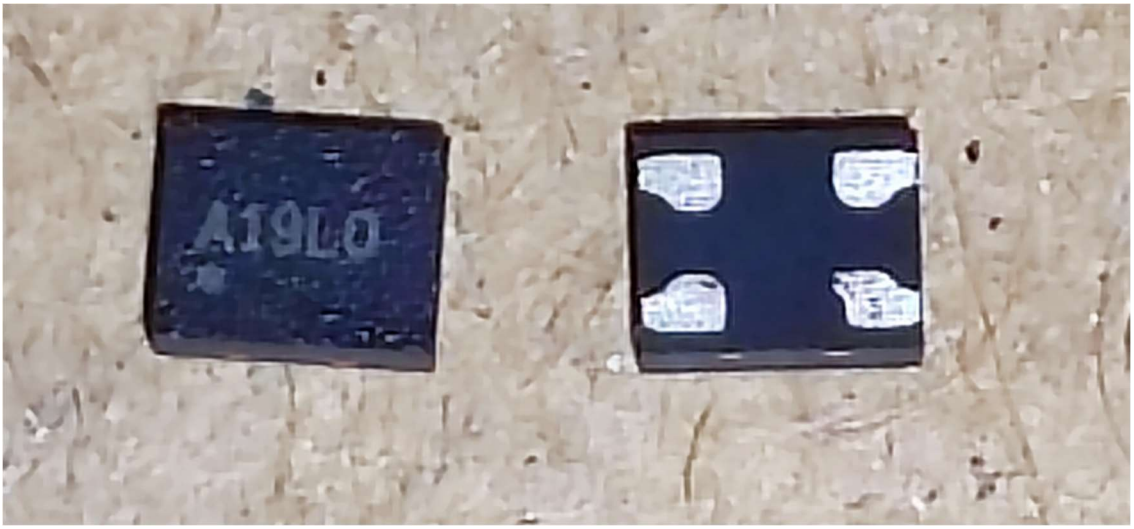


設計驗證
工程課
2024-07-23
發行
旺矽科技開發股份有限公司

廣為科技股份有限公司

Quantek Technology Co., Ltd

新北市汐止區新台五路一段 77 號 6F-8
TEL: 02-26988676 FAX: 02-26988678

承 認 書

(APPROVAL SHEET)

CUSTOMER: 鈺緯科技開發股份有限公司

BRAND: **SiTime**

PART NUMBER: **SIT8009BI-12-33N-125.000000E**

DIVA P/N: **3ZOS125032Y** (Z0533)

DATE: **2024/07/16**

MOQ: **1000(E)/3000(D)pcs**

Product Description: **SiT8009,125Mhz, 33V,25ppm,2520SMD**

零 件 承 認	
核準	負 責 人
設計驗證 工程課 2024 -07- 23 發行 鈺緯科技開發股份有限公司	
承 認 日 期	2024 年 07 月 16 日

廣為科技股份有限公司 *黃煌盛* 啟

SiT8009B

High Frequency, Low Power Oscillator

Features

- 100% pin-to-pin drop-in replacement to quartz-based XO
- Excellent total frequency stability as low as ±20 ppm
- Operating temperature from -40°C to 85°C. For 125°C and/or -55°C options, refer to SiT8919 and SiT8921
- Low power consumption of 4.9 mA typical at 1.8 V
- Standby mode for longer battery life
- Fast startup time of 5 ms
- LVCMOS/HCMOS compatible output
- Industry-standard packages: 2.0 x 1.6, 2.5 x 2.0, 3.2 x 2.5, 5.0 x 3.2, 7.0 x 5.0 mm x mm
- Instant samples with Time Machine II and field programmable oscillators
- RoHS and REACH compliant, Pb-free, Halogen-free and Antimony-free
- For AEC-Q100 oscillators, refer to SiT8924 and SiT8925

Applications

- Ideal for GPON/EPON, network switches, routers. servers, embedded systems
- Ideal for Ethernet, PCI-E, DDR, etc.

Related products for **automotive applications**.

For aerospace and defense applications SiTime recommends using only **Endura™ SiT8945**.



Electrical Characteristics

All Min and Max limits are specified over temperature and rated operating voltage with 15 pF output load unless otherwise stated. Typical values are at 25°C and nominal supply voltage.

Table 1. Electrical Characteristics

Parameters	Symbol	Min.	Typ.	Max.	Unit	Condition
Frequency Range						
Output Frequency Range	f	115	–	137	MHz	
Frequency Stability and Aging						
Frequency Stability	F_stab	-20	–	+20	ppm	Inclusive of Initial tolerance at 25°C, 1st year aging at 25°C, and variations over operating temperature, rated power supply voltage and load.
		-25	–	+25	ppm	
		-50	–	+50	ppm	
Operating Temperature Range						
Operating Temperature Range	T_use	-20	–	+70	°C	Extended Commercial
		-40	–	+85	°C	Industrial
Supply Voltage and Current Consumption						
Supply Voltage	Vdd	1.62	1.8	1.98	V	Contact SiTime for 1.5 V support
		2.25	2.5	2.75	V	
		2.52	2.8	3.08	V	
		2.7	3.0	3.3	V	
		2.97	3.3	3.63	V	
		2.25	–	3.63	V	
Current Consumption	Idd	–	6.2	7.5	mA	No load condition, f = 125 MHz, Vdd = 2.8 V, 3.0 V, 3.3 V or 2.25 to 3.63 V
		–	5.5	6.4	mA	No load condition, f = 125 MHz, Vdd = 2.5 V
		–	4.9	5.6	mA	No load condition, f = 125 MHz, Vdd = 1.8 V
OE Disable Current	I_OD	–	–	4.2	mA	Vdd = 2.5 V to 3.3 V, OE = GND, Output in high-Z state
		–	–	4.0	mA	Vdd = 1.8 V, OE = GND, Output in high-Z state
Standby Current	I_std	–	2.6	4.3	µA	ST = GND, Vdd = 2.8 V to 3.3 V, Output is weakly pulled down
		–	1.4	2.5	µA	ST = GND, Vdd = 2.5 V, Output is weakly pulled down
		–	0.6	1.3	µA	ST = GND, Vdd = 1.8 V, Output is weakly pulled down
LVCMOS Output Characteristics						
Duty Cycle	DC	45	–	55	%	All Vdds
Rise/Fall Time	Tr, Tf	–	1	2	ns	Vdd = 2.5 V, 2.8 V, 3.0 V or 3.3 V, 20% - 80%
		–	1.3	2.5	ns	Vdd =1.8 V, 20% - 80%
		–	0.8	2	ns	Vdd = 2.25 V - 3.63 V, 20% - 80%
Output High Voltage	VOH	90%	–	–	Vdd	IOH = -4 mA (Vdd = 3.0 V or 3.3 V)
Output Low Voltage	VOL	–	–	10%	Vdd	IOL = 4 mA (Vdd = 3.0 V or 3.3 V)

Table 1. Electrical Characteristics (continued)

Parameters	Symbol	Min.	Typ.	Max.	Unit	Condition
Input Characteristics						
Input High Voltage	VIH	70%	–	–	Vdd	Pin 1, OE or ST
Input Low Voltage	VIL	–	–	30%	Vdd	Pin 1, OE or ST
Input Pull-up Impedance	Z_in	50	87	150	kΩ	Pin 1, OE logic high or logic low, or ST logic high
		2	–	–	MΩ	Pin 1, ST logic low
Startup and Resume Timing						
Startup Time	T_start	–	–	5	ms	Measured from the time Vdd reaches its rated minimum value
Enable/Disable Time	T_oe	–	–	122	ns	f = 137 MHz. For other frequencies, T_oe = 100 ns + 3 * cycles
Resume Time	T_resume	–	–	5	ms	Measured from the time ST pin crosses 50% threshold
Jitter						
RMS Period Jitter	T_jitt	–	1.9	3	ps	f = 125 MHz, Vdd = 2.5 V, 2.8 V, 3.0 V or 3.3 V
		–	1.8	4	ps	f = 125 MHz, Vdd = 1.8 V
Peak-to-peak Period Jitter	T_pk	–	12	25	ps	f = 125 MHz, Vdd = 2.5 V, 2.8 V, 3.0 V or 3.3 V
		–	14	30	ps	f = 125 MHz, Vdd = 1.8 V
RMS Phase Jitter (random)	T_phj	–	0.5	0.9	ps	Integration bandwidth = 900 kHz to 7.5 MHz
		–	1.3	2	ps	Integration bandwidth = 12 kHz to 20 MHz

Table 2. Pin Description

Pin	Symbol		Functionality
1	OE/$\overline{ST}$/NC	Output Enable	H[1]: specified frequency output L: output is high impedance. Only output driver is disabled.
		Standby	H[1]: specified frequency output L: output is low (weak pull down). Device goes to sleep mode. Supply current reduces to I_std.
		No Connect	Any voltage between 0 and Vdd or Open[1]: Specified frequency output. Pin 1 has no function.
2	GND	Power	Electrical ground
3	OUT	Output	Oscillator output
4	VDD	Power	Power supply voltage[2]

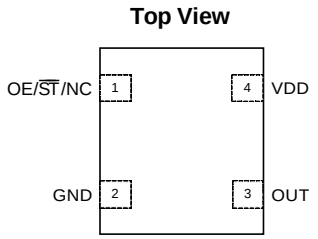


Figure 1. Pin Assignments

Notes:

1. In OE or $\overline{ST}$ mode, a pull-up resistor of 10 kΩ or less is recommended if pin 1 is not externally driven. If pin 1 needs to be left floating, use the NC option.
2. A capacitor of value 0.1 µF or higher between Vdd and GND is required.

Table 3. Absolute Maximum Limits

Attempted operation outside the absolute maximum ratings may cause permanent damage to the part. Actual performance of the IC is only guaranteed within the operational specifications, not at absolute maximum ratings.

Parameter	Min.	Max.	Unit
Storage Temperature	-65	150	°C
Vdd	-0.5	4	V
Electrostatic Discharge	–	2000	V
Soldering Temperature (follow standard Pb free soldering guidelines)	–	260	°C
Junction Temperature[3]	–	150	°C

Note:

3. Exceeding this temperature for extended period of time may damage the device.

Table 4. Thermal Consideration[4]

Package	θJA, 4 Layer Board (°C/W)	θJA, 2 Layer Board (°C/W)	θJC, Bottom (°C/W)
7050	142	273	30
5032	97	199	24
3225	109	212	27
2520	117	222	26
2016	152	252	36

Note:

4. Refer to JESD51 for θJA and θJC definitions, and reference layout used to determine the θJA and θJC values in the above table.

Table 5. Maximum Operating Junction Temperature[5]

Max Operating Temperature (ambient)	Maximum Operating Junction Temperature
70°C	80°C
85°C	95°C

Note:

5. Datasheet specifications are not guaranteed if junction temperature exceeds the maximum operating junction temperature.

Table 6. Environmental Compliance

Parameter	Condition/Test Method
Mechanical Shock	**MIL-STD-883F, Method 2002**
Mechanical Vibration	**MIL-STD-883F, Method 2007**
Temperature Cycle	**JESD22, Method A104**
Solderability	**MIL-STD-883F, Method 2003**
Moisture Sensitivity Level	**MSL1 @ 260°C**

Test Circuit and Waveform[6]

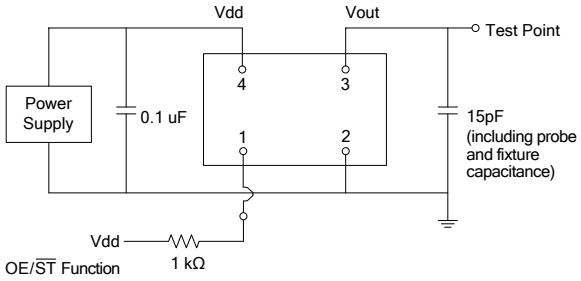


Figure 2. Test Circuit

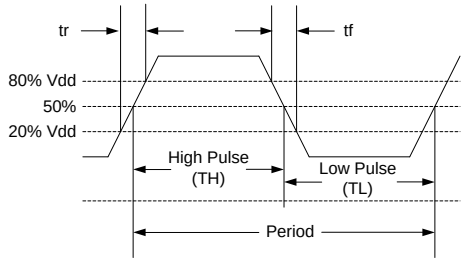


Figure 3. Waveform

Note:

6. Duty Cycle is computed as Duty Cycle = TH/Period.

Timing Diagrams

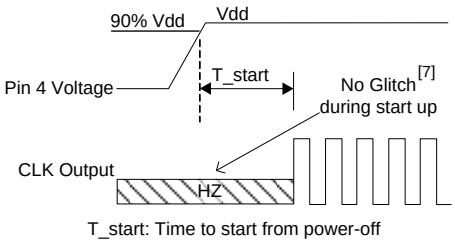


Figure 4. Startup Timing (OE/ $\overline{ST}$ Mode)

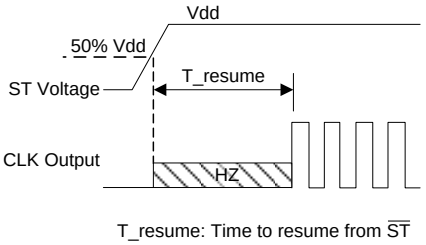


Figure 5. Standby Resume Timing ($\overline{ST}$ Mode Only)

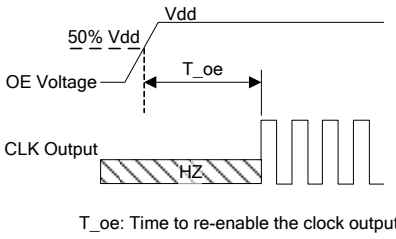


Figure 6. OE Enable Timing (OE Mode Only)

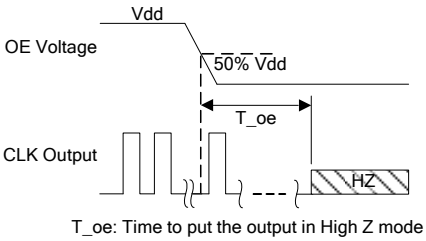


Figure 7. OE Disable Timing (OE Mode Only)

Note:

7. SiT8009 has “no runt” pulses and “no glitch” output during startup or resume.

Performance Plots[8]

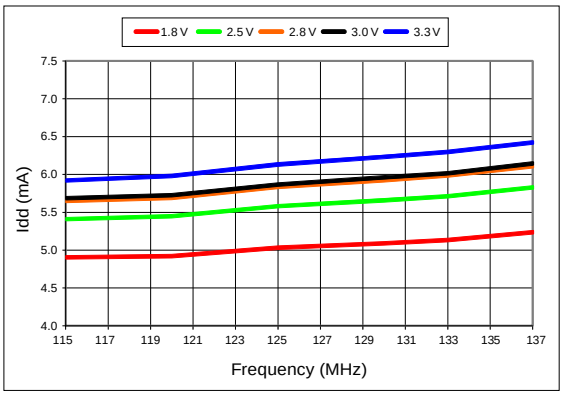


Figure 8. Idd vs Frequency

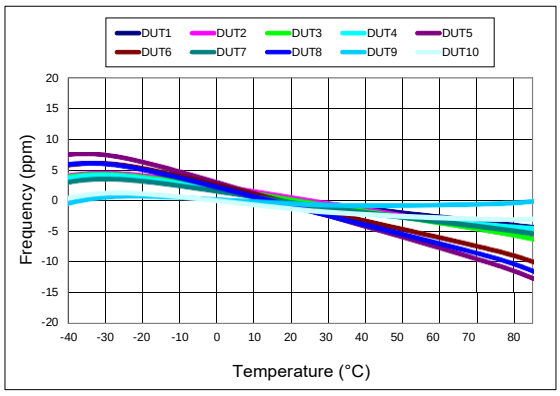


Figure 9. Frequency vs Temperature, 1.8 V

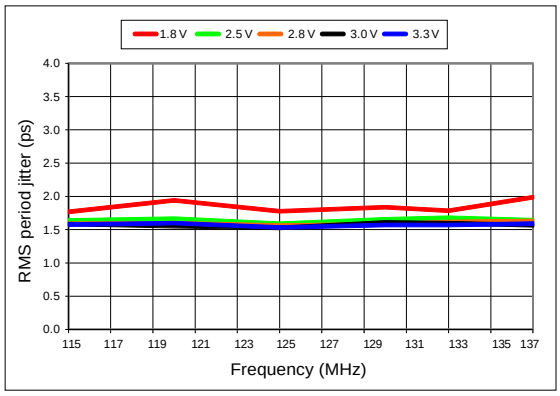


Figure 10. RMS Period Jitter vs Frequency

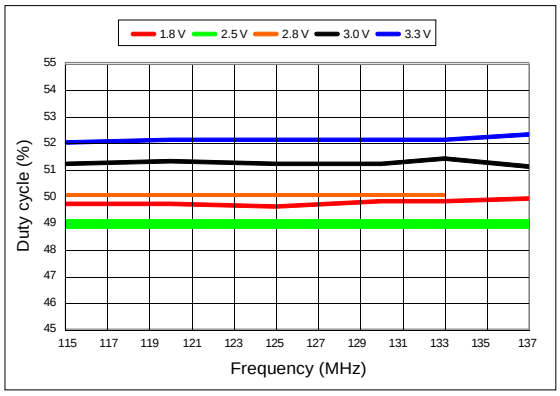


Figure 11. Duty Cycle vs Frequency

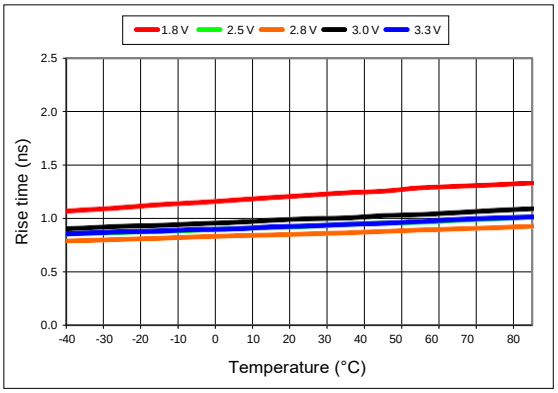


Figure 12. 20%-80% Rise Time vs Temperature

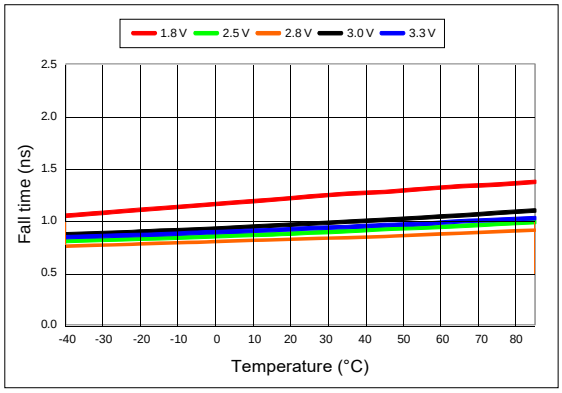


Figure 13. 20%-80% Fall Time vs Temperature

Performance Plots[8]

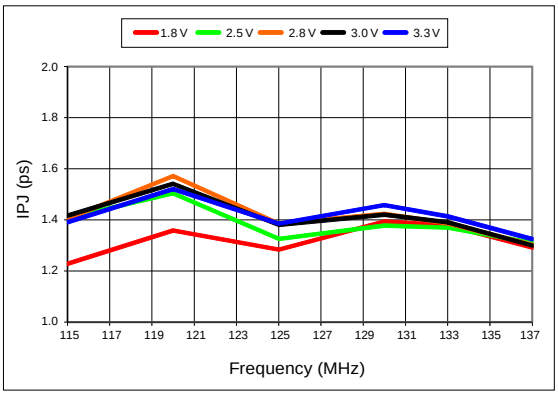


Figure 14. RMS Integrated Phase Jitter Random (12 kHz to 20 MHz) vs Frequency[9]

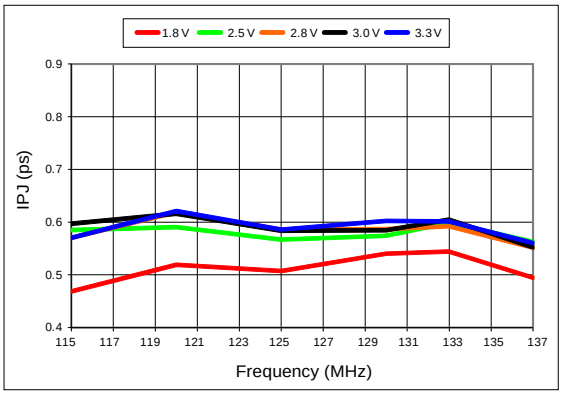


Figure 15. RMS Integrated Phase Jitter Random (900 kHz to 20 MHz) vs Frequency[9]

Notes:

8. All plots are measured with 15 pF load at room temperature, unless otherwise stated.
9. Phase noise plots are measured with Agilent E5052B signal source analyzer. Integration range is up to 5 MHz for carrier frequencies below 40 MHz.

Programmable Drive Strength

The SiT8009 includes a programmable drive strength feature to provide a simple, flexible tool to optimize the clock rise/fall time for specific applications. Benefits from the programmable drive strength feature are:

- Improves system radiated electromagnetic interference (EMI) by slowing down the clock rise/fall time
- Improves the downstream clock receiver's (RX) jitter by decreasing (speeding up) the clock rise/fall time.
- Ability to drive large capacitive loads while maintaining full swing with sharp edge rates.

For more detailed information about rise/fall time control and drive strength selection, see the SiTime Application Notes section.

EMI Reduction by Slowing Rise/Fall Time

Figure 16 shows the harmonic power reduction as the rise/fall times are increased (slowed down). The rise/fall times are expressed as a ratio of the clock period. For the ratio of 0.05, the signal is very close to a square wave. For the ratio of 0.45, the rise/fall times are very close to near-triangular waveform. These results, for example, show that the 11th clock harmonic can be reduced by 35 dB if the rise/fall edge is increased from 5% of the period to 45% of the period.

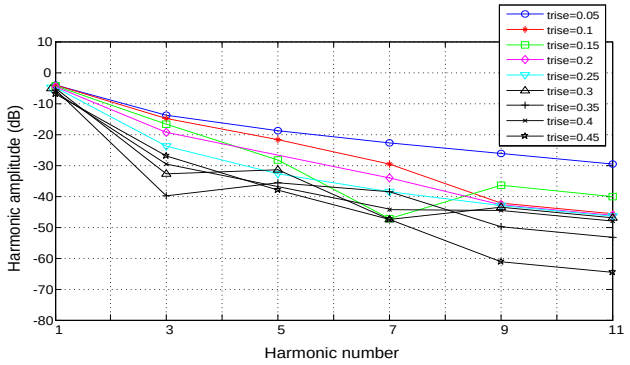


Figure 16. Harmonic EMI reduction as a Function of Slower Rise/Fall Time

Jitter Reduction with Faster Rise/Fall Time

Power supply noise can be a source of jitter for the down-stream chipset. One way to reduce this jitter is to speed up the rise/fall time of the input clock. Some chipsets may also require faster rise/fall time in order to reduce their sensitivity to this type of jitter. Refer to the Rise/Fall Time Tables (Table 7 to Table 11) to determine the proper drive strength.

High Output Load Capability

The rise/fall time of the input clock varies as a function of the actual capacitive load the clock drives. At any given drive strength, the rise/fall time becomes slower as the output load increases. As an example, for a 3.3 V SiT8009 device with default drive strength setting, the typical rise/fall time is 0.46 ns for 5 pF output load. The typical rise/fall time slows down to 1 ns when the output load increases to 15 pF. One can choose to speed up the rise/fall time to 0.72 ns by then increasing the driven strength setting on the SiT8009 to "F".

The SiT8009 can support up to 30 pF or higher in maximum capacitive loads with up to 3 additional drive strength settings. Refer to the Rise/Fall Time Tables (Table 7 to 11) to determine the proper drive strength for the desired combination of output load vs. rise/fall time.

SiT8009 Drive Strength Selection

Tables 7 through 11 define the rise/fall time for a given capacitive load and supply voltage.

1. Select the table that matches the SiT8009 nominal supply voltage (1.8 V, 2.5 V, 2.8 V, 3.0 V, 3.3 V).
2. Select the capacitive load column that matches the application requirement (5 pF to 30 pF)
3. Under the capacitive load column, select the desired rise/fall times.
4. The left-most column represents the part number code for the corresponding drive strength.
5. Add the drive strength code to the part number for ordering purposes.

Calculating Maximum Frequency

Based on the rise and fall time data given in Table 7 through 11, the maximum frequency the oscillator can operate with guaranteed full swing of the output voltage over temperature as follows:

$$\text{Max Frequency} = \frac{1}{5 \times \text{Trf_20/80}}$$

where Trf_20/80 is the typical value for 20%-80% rise/fall time.

Example 1

Calculate f_{MAX} for the following condition:

- Vdd = 3.3 V (Table 11)
- Capacitive Load: 30 pF
- Desired Tr/f time = 1.46 ns
  (rise/fall time part number code = U)

Part number for the above example:

SiT8009BI**U**12-33E-136.986300

↑

Drive strength code is inserted here. Default setting is "-"

Rise/Fall Time (20% to 80%) vs C_{LOAD} Tables

Table 7. Vdd = 1.8 V Rise/Fall Times for Specific C_{LOAD}

Rise/Fall Time Typ (ns)			
Drive Strength \ C_{LOAD}	5 pF	15 pF	30 pF
T	0.93	n/	n/a
E	0.78	n/	n/a
U	0.70	1.4	n/a
F or "-": default	0.65	1.3	n/a

Table 8. Vdd = 2.5 V Rise/Fall Times for Specific C_{LOAD}

Rise/Fall Time Typ (ns)			
Drive Strength \ C_{LOAD}	5 pF	15 pF	30 pF
R	1.45	n/a	n/a
B	1.09	n/a	n/a
T	0.62	1.28	n/a
E	0.54	1.00	n/a
U or "-": default	0.43	0.96	n/a
F	0.34	0.88	n/a

Table 9. Vdd = 2.8 V Rise/Fall Times for Specific C_{LOAD}

Rise/Fall Time Typ (ns)			
Drive Strength \ C_{LOAD}	5 pF	15 pF	30 pF
R	1.29	n/a	n/a
B	0.97	n/a	n/a
T	0.55	1.12	n/a
E	0.44	1.00	n/a
U or "-": default	0.34	0.88	n/a
F	0.29	0.81	1.48

Table 10. Vdd = 3.0 V Rise/Fall Times for Specific C_{LOAD}

Rise/Fall Time Typ (ns)			
Drive Strength \ C_{LOAD}	5 pF	15 pF	30 pF
R	1.22	n/a	n/a
B	0.89	n/a	n/a
T or "-": default	0.51	1.00	n/a
E	0.38	0.92	n/a
U	0.30	0.83	n/a
F	0.27	0.76	1.39

Table 11. Vdd = 3.3 V Rise/Fall Times for Specific C_{LOAD}

Rise/Fall Time Typ (ns)			
Drive Strength \ C_{LOAD}	5 pF	15 pF	30 pF
R	1.16	n/a	n/a
B	0.81	n/a	n/a
T or "-": default	0.46	1.00	n/a
E	0.33	0.87	n/a
U	0.28	0.79	1.46
F	0.25	0.72	1.31

Note:

10. "n/a" in Table 7 to Table 11indicates that the resulting rise/fall time from the respective combination of the drive strength and output load does not provide rail-to-rail swing and is not available.

Pin 1 Configuration Options (OE, $\overline{ST}$, or NC)

Pin 1 of the SiT8009 can be factory-programmed to support three modes: Output Enable (OE), standby ($\overline{ST}$) or No Connect (NC). These modes can also be programmed with the Time Machine using field programmable devices.

Output Enable (OE) Mode

In the OE mode, applying logic Low to the OE pin only disables the output driver and puts it in Hi-Z mode. The core of the device continues to operate normally. Power consumption is reduced due to the inactivity of the output. When the OE pin is pulled High, the output is typically enabled in <1µs.

Standby ($\overline{ST}$) Mode

In the $\overline{ST}$ mode, a device enters into the standby mode when Pin 1 pulled Low. All internal circuits of the device are turned off. The current is reduced to a standby current, typically in the range of a few µA. When $\overline{ST}$ is pulled High, the device goes through the "resume" process, which can take up to 5 ms.

No Connect (NC) Mode

In the NC mode, the device always operates in its normal mode and outputs the specified frequency regardless of the logic level on pin 1.

Table 12 below summarizes the key relevant parameters in the operation of the device in OE, $\overline{ST}$, or NC mode.

Table 12. OE vs. $\overline{ST}$ vs. NC

	OE	ST	NC
Active current 125 MHz (max, 1.8 V)	5.6 mA	5.6 mA	5.6 mA
OE disable current (max. 1.8 V)	4.0 mA	N/A	N/A
Standby current (typical 1.8 V)	N/A	0.6 uA	N/A
OE enable time at 125 MHz (max)	124 ns	N/A	N/A
Resume time from standby (max, all frequency)	N/A	5 ms	N/A
Output driver in OE disable/standby mode	High Z	weak pull-down	N/A

Output on Startup and Resume

The SiT8009 comes with gated output. Its clock output is accurate to the rated frequency stability within the first pulse from initial device startup or resume from the standby mode.

In addition, the SiT8009 has NO RUNT, NO GLITCH output during startup or resume as shown in the waveform captures in Figure 17 and Figure 18.

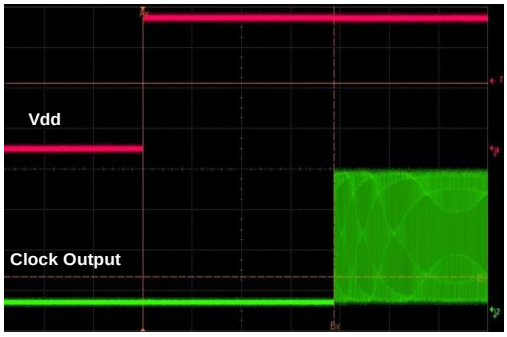


Figure 17. Startup Waveform vs. Vdd

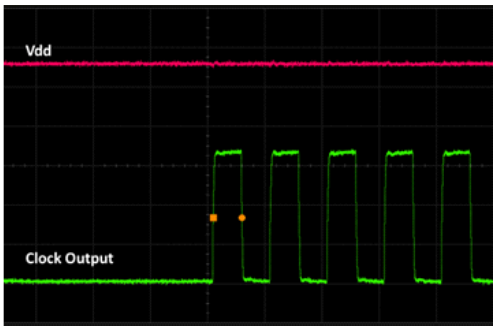


Figure 18. Startup Waveform vs. Vdd (Zoomed-in View of Figure 17)

Instant Samples with Time Machine and Field Programmable Oscillators

SiTime supports a field programmable version of the SiT8009 high frequency, high temperature oscillator for fast prototyping and real time customization of features. The field programmable devices (FP devices) are available for all five standard SiT8009 package sizes and can be configured to one's exact specification using the Time Machine II, an USB powered MEMS oscillator programmer.

Customizable Features of the SiT8009 FP Devices Include

- Frequencies between 115 MHz – 137 MHz
- Three frequency stability options, ±20 ppm, ±25 ppm, ±50 ppm
- Two operating temperatures, -20 to 70°C or -40 to 85°C
- Six supply voltage options, 1.8 V, 2.5 V, 2.8 V, 3.0 V, 3.3 V and 2.25 to 3.63 V continuous
- Output drive strength
- OE, $\overline{ST}$, or NC mode

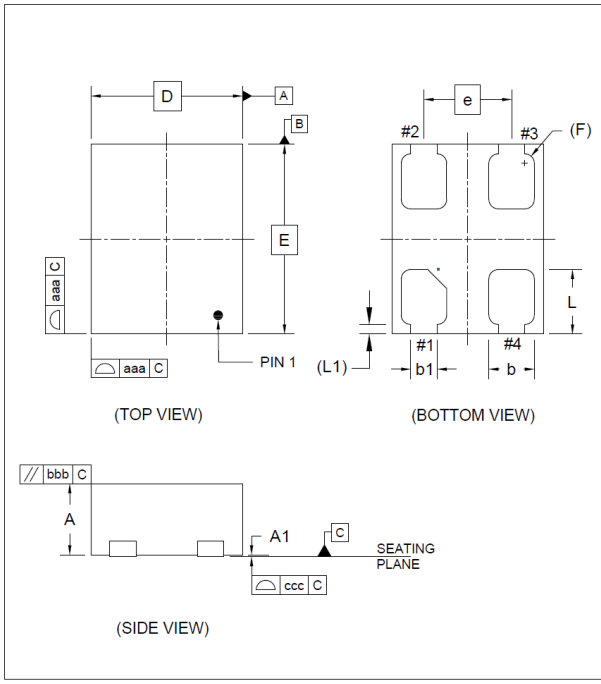
For more information regarding SiTime's field programmable solutions, see Time Machine II and Field Programmable Oscillators.

SiT8009 is factory-programmed per customer ordering codes for volume delivery.

Dimensions and Patterns

Package Size – Dimensions (Unit: mm)[11]	Recommended Land Pattern (Unit: mm)[12]

2.0 x 1.6 x 0.75 mm

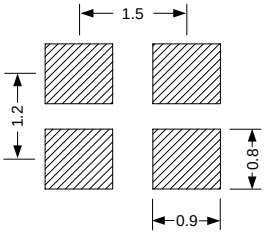


		SYMBOL	MIN	NOM	MAX
PACKAGE THICKNESS		A	0.700	0.750	0.800
STAND OFF		A1	0.000	0.020	0.050
BODY SIZE	X	D		1.600 BSC	
	Y	E		2.000 BSC	
LEAD WIDTH		b	0.430	0.480	0.530
		b1	0.230	0.280	0.330
LEAD LENGTH		L	0.580	0.680	0.780
		L1		0.100 REF	
LEAD PITCH		e		0.930 BSC	
RADIUS		F		0.100 REF	
PACKAGE TOLERANCE		aaa		0.050	
MOLD FLATNESS		bbb		0.100	
COPLANARITY		ccc		0.080	

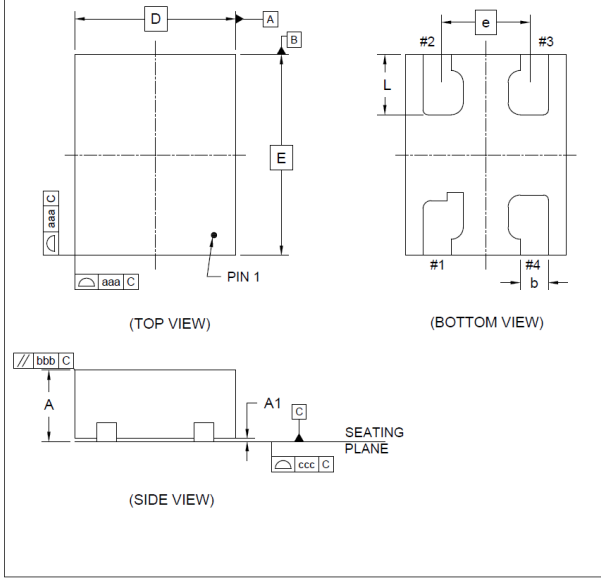
NOTES
1. Dimensioning and tolerance conform to ASME Y14.5-2009
2. All dimensions are in millimeters.

SiTime

TITLE	DWG NO.	
4L PQFN	POD-PQFN-004-X01620-026	
1.60x2.00x0.75 mm	REV.	SHEET
DATE 01-APR-2019	A02	1 OF 2



2.5 x 2.0 x 0.75 mm

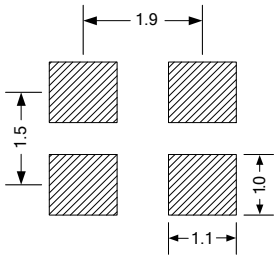


		SYMBOL	MIN	NOM	MAX
PACKAGE THICKNESS		A	0.700	0.750	0.800
THICKNESS		A1	0.000	0.020	0.050
BODY SIZE	X	D		2.000 BSC	
	Y	E		2.500 BSC	
LEAD WIDTH		b	0.300	0.350	0.400
LEAD LENGTH		L	0.650	0.750	0.850
LEAD PITCH		e		1.250 BSC	
PACKAGE TOLERANCE		aaa		0.050	
MOLD FLATNESS		bbb		0.100	
COPLANARITY		ccc		0.080	

NOTES
1. Dimensioning and tolerance conform to ASME Y14.5-2009
2. All dimensions are in millimeters.

SiTime

TITLE	DWG NO.	
4L PQFN	POD-PQFN-004-X02025-010	
2.00x2.50x0.75 mm	REV.	SHEET
DATE 01-APR-2019	A02	1 OF 2

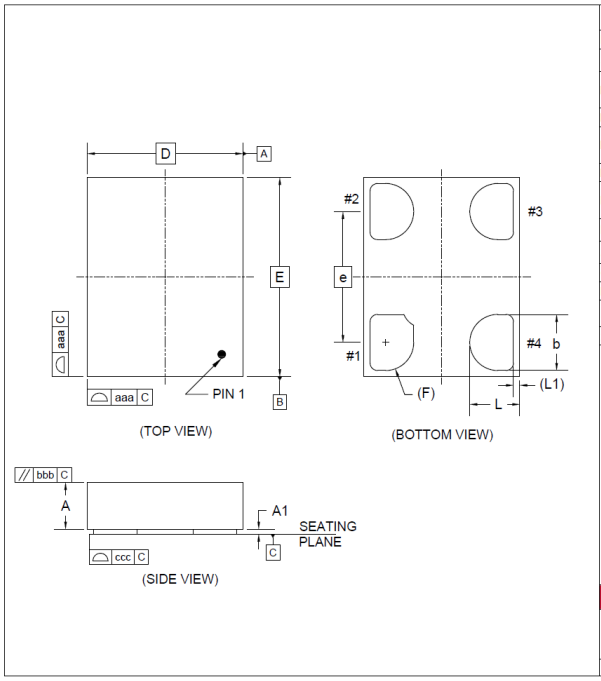


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工程課
2024-07-23
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鈺緯科技開發股份有限公司

Dimensions and Patterns (continued)

Package Size – Dimensions (Unit: mm)[11]	Recommended Land Pattern (Unit: mm)[12]

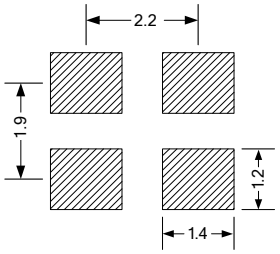
3.2 x 2.5 x 0.75 mm



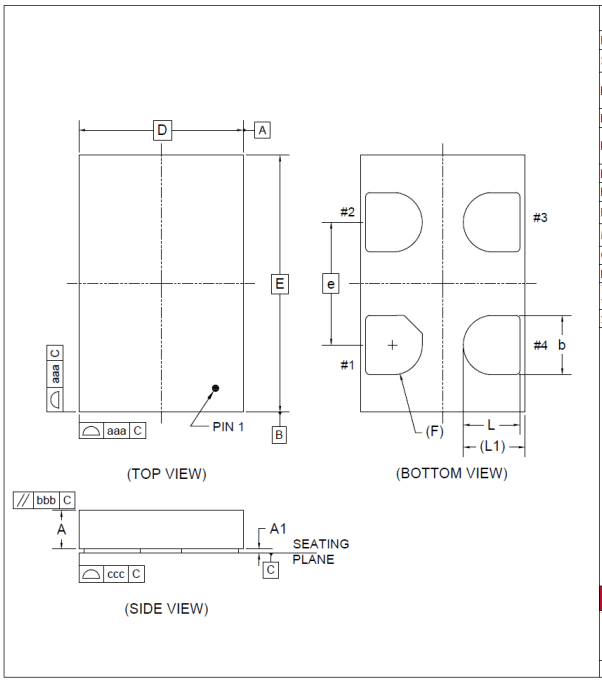
		SYMBOL	MIN	NOM	MAX
PACKAGE THICKNESS		A	0.700	0.750	0.800
STAND OFF		A1	0.000	0.020	0.050
BODY SIZE	X	D		2.500 BSC	
	Y	E		3.200 BSC	
LEAD WIDTH		b	0.800	0.900	1.000
LEAD LENGTH		L	0.700	0.800	0.900
		L1		0.100 REF	
LEAD PITCH		e		2.100 BSC	
RADIUS		F		0.450 REF	
		F1		0.120 REF	
PACKAGE TOLERANCE		aaa		0.050	
MOLD FLATNESS		bbb		0.100	
COPLANARITY		ccc		0.080	

NOTES
1. Dimensioning and tolerance conform to ASME Y14.5-2009
2. All dimensions are in millimeters.

SiTime			
TITLE 4L PQFN		DWG NO.	
		POD-PQFN-004-X03225-002	
3.20x2.50x0.75 mm		REV.	SHEET
DATE	01-APR-2019	A04	1 OF 2



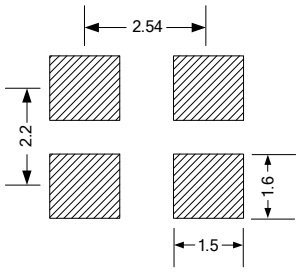
5.0 x 3.2 x 0.75 mm



		SYMBOL	MIN	NOM	MAX
PACKAGE THICKNESS		A	0.700	0.750	0.800
STAND OFF		A1	0.000	0.020	0.050
BODY SIZE	X	D		3.200 BSC	
	Y	E		5.000 BSC	
LEAD WIDTH		b	1.000	1.100	1.200
LEAD LENGTH		L	1.050	1.100	1.150
		L1		1.200 REF	
LEAD PITCH		e		2.390 BSC	
RADIUS		F		0.575	
PACKAGE TOLERANCE		aaa		0.050	
MOLD FLATNESS		bbb		0.100	
COPLANARITY		ccc		0.080	

NOTES
1. Dimensioning and tolerance conform to ASME Y14.5-2009
2. All dimensions are in millimeters.

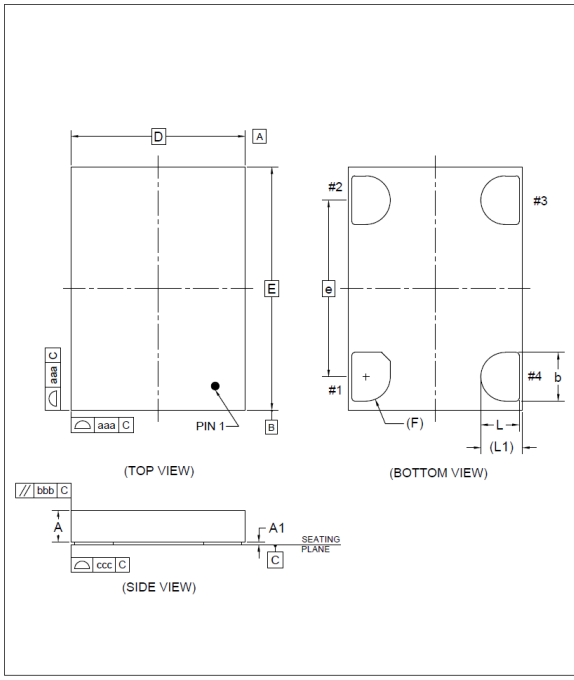
SiTime			
TITLE 4L PQFN		DWG NO.	
		POD-PQFN-004-X05032-003	
5.00x3.20x0.75 mm		REV.	SHEET
DATE	01-APR-2019	A04	1 OF 2



Dimensions and Patterns (continued)

Package Size – Dimensions (Unit: mm)[11]	Recommended Land Pattern (Unit: mm)[12]

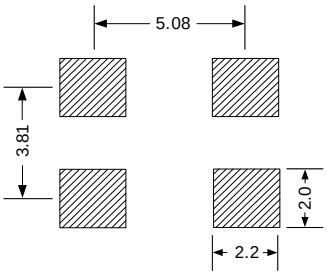
7.0 x 5.0 x 0.90 mm



		SYMBOL	MIN	NOM	MAX
PACKAGE THICKNESS		A	0.800	0.900	1.000
STAND OFF		A1	0.000	0.020	0.050
BODY SIZE	X	D		5.000 BSC	
	Y	E		7.000 BSC	
LEAD WIDTH		b	1.350	1.400	1.450
LEAD LENGTH		L	1.050	1.100	1.150
		L1		1.200 REF	
LEAD PITCH		e		5.080 BSC	
RADIUS		F		0.080 REF	
PACKAGE TOLERANCE		aaa		0.050	
MOLD FLATNESS		bbb		0.100	
COPLANARITY		ccc		0.080	

NOTES
1. Dimensioning and tolerance conform to ASME Y14.5-2009
2. All dimensions are in millimeters.

SiTime			
TITLE	4L PQFN	DWG NO.	POD-PQFN-004-X07050-011
	7.00x5.00x0.90 mm	REV.	SHEET
DATE	01-APR-2019	A02	1 OF 2



Notes:

11. Top marking: Y denotes manufacturing origin and XXXX denotes manufacturing lot number. The value of "Y" will depend on the assembly location of the device.
12. A capacitor of value 0.1 µF or higher between Vdd and GND is required.

Ordering Information

The Part No. Guide is for reference only.
To customize and build an exact part number, use the SiTime Part Number Generator.

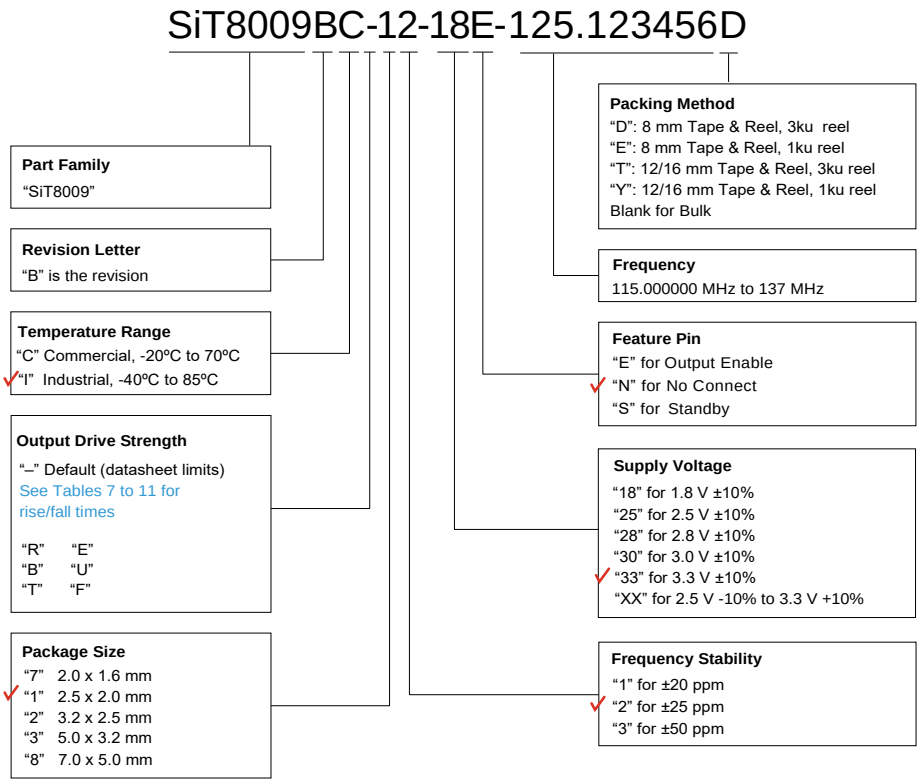


Table 13. Ordering Codes for Supported Tape & Reel Packing Method

Device Size (mm x mm)	16 mm T&R (3ku)	16 mm T&R (1ku)	12 mm T&R (3ku)	12 mm T&R (1ku)	8 mm T&R (3ku)	8 mm T&R (1ku)
2.0 x 1.6	–	–	–	–	D	E
2.5 x 2.0	–	–	–	–	D	E
3.2 x 2.5	–	–	–	–	D	E
5.0 x 3.2	–	–	T	Y	–	–
7.0 x 5.0	T	Y	–	–	–	–

Table 14. Additional Information

Document	Description	Download Link
Time Machine II	MEMS oscillator programmer	http://www.sitime.com/support/time-machine-oscillator-programmer
Field Programmable Oscillators	Devices that can be programmable in the field by Time Machine II	http://www.sitime.com/products/field-programmable-oscillators
Manufacturing Notes	Tape & Reel dimension, reflow profile and other manufacturing related info	https://www.sitime.com/sites/default/files/gated/Manufacturing-Notes-for-SiTime-Products.pdf
Qualification Reports	RoHS report, reliability reports, composition reports	http://www.sitime.com/support/quality-and-reliability
Performance Reports	Additional performance data such as phase noise, current consumption and jitter for selected frequencies	http://www.sitime.com/support/performance-measurement-report
Termination Techniques	Termination design recommendations	http://www.sitime.com/support/application-notes
Layout Techniques	Layout recommendations	http://www.sitime.com/support/application-notes

Table 15. Revision History

Revision	Release Date	Change Summary
1.0	10-Jun-2014	Final production release
1.01	7-May-2015	Revised the Electrical Characteristics, Timing Diagrams and Performance Plots Revised 2016 package diagram
1.02	18-Jun-2015	Added 16 mm T&R information to Table 13 Revised 12 mm T&R information to Table 13
1.03	30-Aug-2016	Revised part number example in the ordering information
1.04	9-Jan-2018	Updated logo and company address, other page layout changes Revised 2520 package land pattern
1.05	9-Jul-2020	Updated ordering information with “YY” supply voltage option Updated ordering information with note
1.06	15-Mar-2021	Updated hyperlinks, trademarks and changed rev table date format Updated Dimensions and Patterns drawings Removed “YY” supply voltage option from Ordering Information
1.07	1-Jan-2023	Updated company disclaimer, links, references and icons

SiTime Corporation, 5451 Patrick Henry Drive, Santa Clara, CA 95054, USA | **Phone:** +1-408-328-4400 | **Fax:** +1-408-328-4439

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For aerospace and defense applications, SiTime recommends using only Endura™ ruggedized products.

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Supplemental Information

The Supplemental Information section is not part of the datasheet and is for informational purposes only.

Best Reliability

Silicon is inherently more reliable than quartz. Unlike quartz suppliers, SiTime has in-house MEMS and analog CMOS expertise, which allows SiTime to develop the most reliable products. Figure 1 shows a comparison with quartz technology.

Why is SiTime Best in Class:

- SiTime's MEMS resonators are vacuum sealed using an advanced EpiSeal® process, which eliminates foreign particles and improves long term aging and reliability
- World-class MEMS and CMOS design expertise

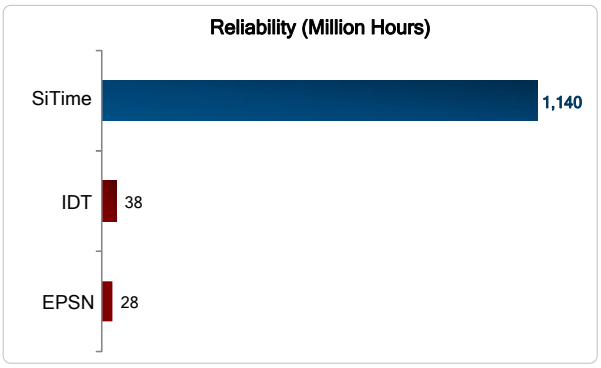


Figure 1. Reliability Comparison[1]

Best Aging

Unlike quartz, MEMS oscillators have excellent long term aging performance which is why every new SiTime product specifies 10-year aging. A comparison is shown in Figure 2.

Why is SiTime Best in Class:

- SiTime's MEMS resonators are vacuum sealed using an advanced EpiSeal® process, which eliminates foreign particles and improves long term aging and reliability
- Inherently better immunity of electrostatically driven MEMS resonator

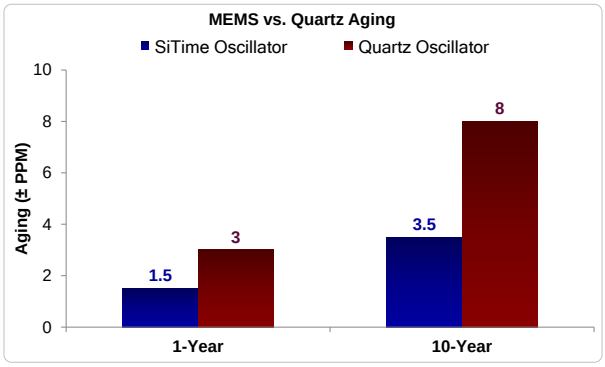


Figure 2. Aging Comparison[2]

Best Electro Magnetic Susceptibility (EMS)

SiTime's oscillators in plastic packages are up to 54 times more immune to external electromagnetic fields than quartz oscillators as shown in Figure 3.

Why is SiTime Best in Class:

- Internal differential architecture for best common mode noise rejection
- Electrostatically driven MEMS resonator is more immune to EMS

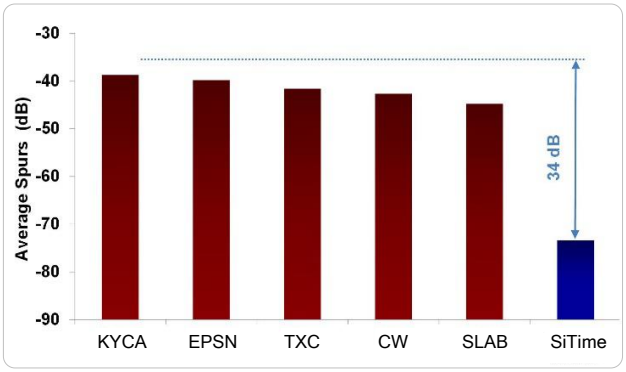


Figure 3. Electro Magnetic Susceptibility (EMS)[3]

Best Power Supply Noise Rejection

SiTime's MEMS oscillators are more resilient against noise on the power supply. A comparison is shown in Figure 4.

Why is SiTime Best in Class:

- On-chip regulators and internal differential architecture for common mode noise rejection
- MEMS resonator is paired with advanced analog CMOS IC

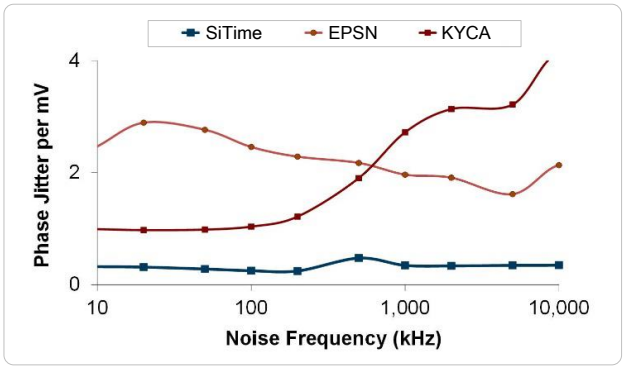


Figure 4. Power Supply Noise Rejection[4]

Best Vibration Robustness

High-vibration environments are all around us. All electronics, from handheld devices to enterprise servers and storage systems are subject to vibration. Figure 5 shows a comparison of vibration robustness.

Why is SiTime Best in Class:

- The moving mass of SiTime's MEMS resonators is up to 3000 times smaller than quartz
- Center-anchored MEMS resonator is the most robust design

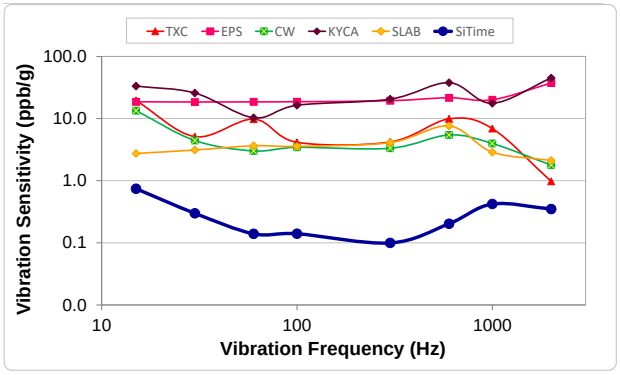


Figure 5. Vibration Robustness[5]

Figure labels:

- TXC = TXC
- Epson = EPSN
- Connor Winfield = CW
- Kyocera = KYCA
- SiLabs = SLAB
- SiTime = EpiSeal MEMS

Best Shock Robustness

SiTime's oscillators can withstand at least 50,000 *g* shock. They all maintain their electrical performance in operation during shock events. A comparison with quartz devices is shown in Figure 6.

Why is SiTime Best in Class:

- The moving mass of SiTime's MEMS resonators is up to 3000 times smaller than quartz
- Center-anchored MEMS resonator is the most robust design

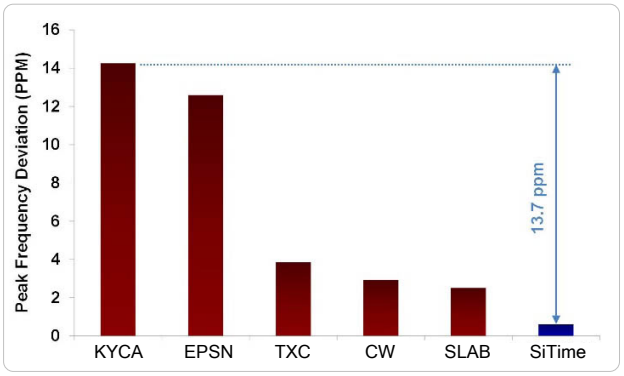


Figure 6. Shock Robustness[6]

Notes:

1. Data source: Reliability documents of named companies.
2. Data source: SiTime and quartz oscillator devices datasheets.
3. Test conditions for Electro Magnetic Susceptibility (EMS):
   - According to IEC EN61000-4.3 (Electromagnetic compatibility standard)
   - Field strength: 3V/m
   - Radiated signal modulation: AM 1 kHz at 80% depth
   - Carrier frequency scan: 80 MHz – 1 GHz in 1% steps
   - Antenna polarization: Vertical
   - DUT position: Center aligned to antenna

   Devices used in this test:

Label	Manufacturer	Part Number	Technology
EpiSeal MEMS	SiTime	SiT9120AC-1D2-33E156.250000	MEMS + PLL
EPSN	Epson	EG-2102CA156.2500M-PHPAL3	Quartz, SAW
TXC	TXC	BB-156.250MBE-T	Quartz, 3rd Overtone
CW	Conner Winfield	P123-156.25M	Quartz, 3rd Overtone
KYCA	AVX Kyocera	KC7050T156.250P30E00	Quartz, SAW
SLAB	SiLab	590AB-BDG	Quartz, 3rd Overtone + PLL

4. 50 mV pk-pk Sinusoidal voltage.

   Devices used in this test:

Label	Manufacturer	Part Number	Technology
EpiSeal MEMS	SiTime	SiT8208AI-33-33E-25.000000	MEMS + PLL
NDK	NDK	NZ2523SB-25.6M	Quartz
KYCA	AVX Kyocera	KC2016B25M0C1GE00	Quartz
EPSN	Epson	SG-310SCF-25M0-MB3	Quartz

5. Devices used in this test:
   same as EMS test stated in Note 3.
6. Test conditions for shock test:
   - MIL-STD-883F Method 2002
   - Condition A: half sine wave shock pulse, 500-g, 1ms
   - Continuous frequency measurement in 100 µs gate time for 10 seconds

   Devices used in this test:
   same as EMS test stated in Note 3.
7. Additional data, including setup and detailed results, is available upon request to qualified customer. Please contact productsupport@sitime.com.

SiTime Environmental Compliance Declaration

1. SiTime is committed to providing environmentally compliant products. SiTime actively works with its suppliers to restrict the use of hazardous substances in the manufacturing process and in all of its products and to meet or exceed the relevant environmental specifications provided in:
    a. European Union RoHS Directive EU 2011/65 + EU 2015/863 regarding the restriction of certain hazardous substances.
    b. European Union WEEE Directive 2012/19/EU regarding waste electrical and electronic equipment.
    c. Regulation (EC) No 1907/2006 concerning the Registration, evaluation, authorization, and restriction of chemical (REACH) on Substances of Very High Concern (SVHC) compliance. Substance content less than 0.1 % for the European Chemical Agency (ECHA) candidate list REACH 240 last updated on ECHA website on 23 January 2024 (Table attached).
    d. REACH Annex XVII (current version)
    e. EU Directive 2006/122/ECOF restriction on Perfluorooctane Sulfonates (PFOS) and Perfluorooctanoic acid (PFOA) content at <0.1% (wt%)
    f. IEC 61249-2-21 directive on the restriction of the use of Br<900ppm, Cl<900ppm, Br+Cl<1500ppm in electronic components.
    g. California Proposition 65 list (current version).
    h. Regulation of Certain Chemical Substances and mixtures under section 6 of The Toxic Substances Control Act" (TSCA).
2. SiTime works closely with suppliers to maintain the material content declaration for its products and SGS/ICP reports for the homogeneous materials used in the products. The updates to these documents are done when,
    a. There is any change in the material contents of the product.
    b. The regulation changes dictate that new analysis be done for compliance.
3. SiTime will make available to its customers, upon request, the material content declaration document and the SGS/ICP report documentation for the homogeneous materials used in the products and packing materials.

Jase Mah

Jase Mah

Quality Engineer

Table 1: SiTime REACH240 SHVC Substance List

№	Substances	CAS No.
1	Anthracene	120-12-7
2	4,4'-Diaminodiphenylmethane	101-77-9
3	Dibutyl phthalate (DBP)	84-74-2
4	Cobalt dichloride	7646-79-9
5	Diarsenic pentaoxide	1303-28-2
6	Diarsenic trioxide	1327-53-3
7	Sodium dichromate,dihydrate	7789-12-0, 10588-01-9
8	5-tert-butyl-2,4,6-trinitrom-xylene (musk xylene)	81-15-2
9	Bis(2-ethyl(hexyl)phthalate) (DEHP)	117-81-7
10	Hexabromocyclododecane (HBCDD)all major diastereoisomers identified (α-HBCDD, β-HBCDD, γ-HBCDD)	25637-99-4, 3194-55-6 (134237-51-7, 134237-50-6, 134237-52-8)
11	Alkanes,C10-13,chloro (Short Chain Chlorinated Paraffins)	85535-84-8
12	Bis(tributyltin)oxide	56-35-9
13	Lead hydrogen arsenate	7784-40-9
14	Benzyl butyl phthalate	85-68-7
15	Triethyl arsenate	15606-95-8
16	2,4-Dinitrotoluene	121-14-2
17	Anthracene oil	90640-80-5
18	Anthracene oil, anthracene paste, distn. Lights	91995-17-4
19	Anthracene oil, anthracene paste, anthracene fraction	91995-15-2
20	Anthracene oil, anthracene-low	90640-82-7
21	Anthracene oil, anthracene paste	90640-81-6
22	Diisobutyl phthalate	84-69-5
23	Lead chromate	7758-97-6
24	Lead chromate molybdate sulfate red (C.I. Pigment Red 104)	12656-85-8
25	Lead sulfochromate yellow (C.I. Pigment Yellow 34)	1344-37-2
26	Tris(2-chloroethyl) phosphate	115-96-8
27	Pitch, coal tar, high temperature	65996-93-2
28	Acrylamide	79-06-1
29	Trichloroethylene	79-01-6
30	Boric acid	10043-35-3, 11113-50-1
31	Disodium tetraborate, anhydrous	1330-43-4, 12179-04-3, 1303-96-4
32	Tetraboron disodium heptaoxide, hydrate	12267-73-1
33	Sodium chromate	11/3/7775
34	Potassium chromate	7789-00-6
35	Ammonium dichromate	9/5/7789

(Continued)

Table 1: SiTime REACH240 SHVC Substance List

№	Substances	CAS No.
36	Potassium dichromate	7778-50-9
37	Trioxochromium	1333-82-0
38	2-Ethoxyethanol	110-80-5
39	2-Methoxyethanol	109-86-4
40	Cobalt (di)acetate	71-48-7
41	Cobalt (II) carbonate	513-79-1
42	Cobalt dinitrate	10141-05-6
43	Cobalt (II) sulphate	10124-43-3
44	Acids generated from chromium trioxide and their oligomers: Chromic acid, Dichromic acid Oligomers of chromic acid and dichromic acid	7738-94-5, 13530-68-2, -
45	2-ethoxyethyl acetate	111-15-9
46	strontium chromate	6/2/7789
47	1,2-Benzenedicarboxylic acid, di-C7-11-branched and linear alkyl esters	68515-42-4
48	Hydrazine	7803-57-8, 302-01-2
49	1-methyl-2-pyrrolidone	872-50-4
50	1,2,3-trichloropropane	96-18-4
51	1,2-Benzenedicarboxylic acid, di-C6-8-branched alkyl esters, C7-rich	71888-89-6
52	Dichromium tris (chromate)	24613-89-6
53	Potassium hydroxyoctaoxodizincatedichromate	11103-86-9
54	Pentazinc chromate octahydroxide	49663-84-5
55	Aluminosilicate, Refractory Ceramic Fibres (RCF)	-
56	Zirconia Aluminosilicate refractory Ceramic Fibres (Zr-RCF)	-
57	Formaldehyde, oligomeric reaction products with aniline	25214-70-4
58	Bis(2-methoxyethyl) phthalate	117-82-8
59	2-Methoxyaniline; o-Anisidine	90-04-0
60	4-(1,1,3,3-tetramethylbutyl)phenol	140-66-9
61	1,2-dichloroethane	107-06-2
62	Bis(2-methoxyethyl) ether	111-96-6
63	Arsenic acid	7778-39-4
64	Calcium arsenate	7778-44-1
65	Trilead diarsenate	3687-31-8
66	N,N-dimethylacetamide (DMAC)	127-19-5
67	2,2'-dichloro-4,4'-methylenedianiline (MOCA)	101-14-4
68	Phenolphthalein	77-09-8
69	Lead diazide, Lead azide	13424-46-9
70	Lead styphnate	15245-44-0
71	Lead dipicrate	6477-64-1

(Continued)

Table 1: SiTime REACH240 SHVC Substance List

№	Substances	CAS No.
72	α,α-Bis[4-(dimethylamino)phenyl]-4 (phenylamino)naphthalene-1-methanol (C.I. Solvent Blue 4)	6786-83-0
73	N,N,N',N'-tetramethyl-4,4'-methylenedianiline (Michler's base)	101-61-1
74	1,3,5-tris[(2S and 2R)-2,3-epoxypropyl]-1,3,5-triazine-2,4,6-(1H,3H,5H)-trione (β-TGIC)	59653-74-6
75	Diboron trioxide	1303-86-2
76	1,2-bis(2-methoxyethoxy)ethane (TEGDME triglyme)	112-49-2
77	4,4'-bis(dimethylamino)-4''-(methylamino)trityl alcohol	561-41-1
78	Lead(II) bis(methanesulfonate)	17570-76-2
79	Formamide	75-12-7
80	[4-[4,4'-bis(dimethylamino) benzhydrylidene]cyclohexa-2,5-dien-1-ylidene]dimethylammonium chloride (C.I. Basic Violet 3)	548-62-9
81	1,2-dimethoxyethane ethylene glycol dimethyl ether (EGDME)	110-71-4
82	[4-[[4-anilino-1-naphthyl][4-(dimethylamino)phenyl]methylene]cyclohexa-2,5-dien-1-ylidene] dimethylammonium chloride (C.I. Basic Blue 26)	2580-56-5
83	1,3,5-Tris(oxiran-2-ylmethyl)-1,3,5-triazinane-2,4,6-trione (TGIC)	2451-62-9
84	4,4'-bis(dimethylamino)benzophenone (Michler's ketone)	90-94-8
85	Bis(pentabromophenyl) ether (DecaBDE)	1163-19-5
86	Pentacosafluorotridecanoic acid	72629-94-8
87	Tricosafluorododecanoic acid	307-55-1
88	Henicosafluoroundecanoic acid	2058-94-8
89	Heptacosafluorotetradecanoic acid	376-06-7
90	4-(1,1,3,3-tetramethylbutyl)phenol, ethoxylated – [covering well-defined substances and UVCB substances, polymers and homologues]	-
91	4-Nonylphenol, branched and linear –[substances with a linear and/or branched alkyl chain with a carbon number of 9 covalently bound in position 4 to phenol, covering also UVCB- and well-defined substances which include any of the individual isomers or a combination thereof]	-
92	Diazene-1,2-dicarboxamide (C,C'-azodi(formamide))	123-77-3
93	Cyclohexane-1,2-dicarboxylic anhydride (Hexahydrophthalic anhydride – HHPA)	85-42-7
94	Hexahydromethylphathalic anhydride, Hexahydro-4-methylphathalic anhydride, Hexahydro-1-methylphathalic anhydride, Hexahydro-3-methylphathalic anhydride	25550-51-0, 19438-60-9, 48122-14-1, 57110-29-9
95	Methoxy acetic acid	625-45-6
96	1,2-Benzenedicarboxylic acid, dipentylester, branched and linear	84777-06-0
97	Diisopentylphthalate (DIPP)	605-50-5
98	N-pentyl-isopentylphtalate	776297-69-9
99	1,2-Diethoxyethane	629-14-1
100	N,N-dimethylformamide; dimethyl formamide	68-12-2
101	Dibutyltin dichloride (DBT)	683-18-1
102	Acetic acid, lead salt, basic	51404-69-4

(Continued)

Table 1: SiTime REACH240 SHVC Substance List

№	Substances	CAS No.
103	Basic lead carbonate (trileadbis(carbonate)dihydroxide)	1319-46-6
104	Lead oxide sulfate (basic lead sulfate)	12036-76-9
105	[Phthalato(2-)]dioxotrilead (dibasic lead phthalate)	69011-06-9
106	Dioxobis(5ligomer)trilead	12578-12-0
107	Fatty acids, C16-18, lead salts	91031-62-8
108	Lead bis(tetrafluoroborate)	13814-96-5
109	Lead cynamidate	20837-86-9
110	Lead dinitrate	10099-74-8
111	Lead oxide (lead monoxide)	1317-36-8
112	Lead tetroxide (orange lead)	1314-41-6
113	Lead titanium trioxide	12060-00-3
114	Lead Titanium Zirconium Oxide	12626-81-2
115	Pentaleadtetraoxidesulphate	12065-90-6
116	Pyrochlore, antimony lead yellow	8012-00-8
117	Silicic acid, barium salt, lead-doped	68784-75-8
118	Silicic acid, lead salt	11120-22-2
119	Sulfurous acid, lead salt, dibasic	62229-08-7
120	Tetraethyllead	78-00-2
121	Tetralead trioxide sulphate	12202-17-4
122	Trilead dioxide phosphonate	12141-20-7
123	Furan	110-00-9
124	Propylene oxide; 1,2-epoxypropane; methyloxirane	75-56-9
125	Diethyl sulphate	64-67-5
126	Dimethyl sulphate	77-78-1
127	3-ethyl-2-methyl-2-(3-methylbutyl)-1,3-oxazolidine	143860-04-2
128	Dinoseb	88-85-7
129	4,4’-methylenedi-o-toluidine	838-88-0
130	4,4’-oxydianiline and its salts	101-80-4
131	4-Aminoazobenzene; 4-Phenylazoaniline	60-09-3
132	4-methyl-m-phenylenediamine (2,4-toluene-diamine)	95-80-7
133	6-methoxy-m-toluidine (p-cresidine)	120-71-8
134	Biphenyl-4-ylamine	92-67-1
135	o-aminoazotoluene	97-56-3
136	o-Toluidine; 2-Aminotoluene	95-53-4
137	N-methylacetamide	79-16-3
138	1-bromopropane; n-propyl bromide	106-94-5
139	Pentadecafluorooctanoic acid (PFOA)	335-67-1

(Continued)

Table 1: SiTime REACH240 SHVC Substance List

№	Substances	CAS No.
140	Cadmium oxide	1306-19-0
141	Ammoniumpentadecafluorootanoate (APFO)	3825-26-1
142	Cadmium	7440-43-9
143	4-Nonylphenol, branched and linear, ethoxylated	-
144	Dipentyl phthalate (DPP)	131-18-0
145	Cadmium sulphide	1306-23-6
146	Di-n-hexyl phthalate	84-75-3
147	Disodium 3, 3'-[[1 1'-biphenyl]-4 4'-diylbis(azo)]bis(4-aminonaphthalene-1-sulphonate) (C.I. Direct Red 28)	573-58-0
148	Disodium 4-amino-3-[[4'-[(2 4-diaminophenyl)azo][1 1'-biphenyl]-4-yl]azo] -5-hydroxy-6-(phenylazo)naphthalene-2 7-disulphonate (C.I. Direct Black 38)	1937-37-7
149	Imidazolidine-2-thione (2-imidazoline-2-thiol)	96-45-7
150	Lead di(acetate)	301-04-2
151	Trixylyl phosphate	25155-23-1
152	1 2-Benzenedicarboxylic acid dihexyl ester branched and linear	68515-50-4
153	Cadmium chloride	10108-64-2
154	Sodium peroxometaborate	7632-04-4
155	Sodium perborate perboric acid sodium salt	11138-47-9
156	Cadmium fluoride	7790-79-6
157	Calcium sulfate	10124-36-4; 31119-53-6
158	2-benzotriazol-2-yl-4,6-di-tert-butylphenol (UV-320)	3846-71-7
159	2-(2H-benzotriazol-2-yl)-4,6-ditertpentylphenol (UV-328)	25973-55-1
160	2-ethylhexyl 10-ethyl-4,4-dioctyl-7-oxo-8-oxa-3,5-dithia-4-stannatetradecanoate (DOTE)	15571-58-1
161	Reaction mass of 2-ethylhexyl 10-ethyl-4,4-dioctyl-7-oxo-8-oxa-3,5-dithia-4-stannatetradecanoate and 2-ethylhexyl 10-ethyl-4-[[2-[(2-ethylhexyl)oxy]-2-oxoethyl]thio]-4-octyl-7-oxo-8-oxa-3,5-dithia-4-stannatetradecanoate (reaction mass of DOTE and MOTE)	-
162	1,2-benzenedicarboxylic acid, di-C6-10-alkyl esters; 1,2-benzenedicarboxylic acid, mixed decyl and hexyl and octyl diesters with ≥ 0.3% of dihexyl phthalate (EC No. 201-559-5)	68515-51-5, 68648-93-1
163	5-sec-butyl-2-(2,4-dimethylcyclohex-3-en-1-yl)-5-methyl-1,3-dioxane [1], 5-sec-butyl-2-(4,6-dimethylcyclohex-3-en-1-yl)-5-methyl-1,3-dioxane [2] [covering any of the individual stereoisomers of [1] and [2] or any combination thereof]	-
164	1,3-propanesultone	214-317-9
165	2,4-di-tert-butyl-6-(5-chlorobenzotriazol-2-yl)phenol (UV-327)	223-383-8
166	2-(2H-benzotriazol-2-yl)-4-(tert-butyl)-6-(sec-butyl)phenol (UV-350)	253-037-1
167	Nitrobenzene	202-716-0
168	Perfluorononan-1-oic-acid and its sodium and ammonium salts	206-801-3
169	Benzo[def]chrysene (Benzo[a]pyrene)	50-32-8
170	p-(1,1-dimethylpropyl)phenol (PTAP)	80-46-6
171	Nonadecafluorodecanoic acid (PFDA) and its sodium and ammonium salts	335-76-2

(Continued)

Table 1: SiTime REACH240 SHVC Substance List

№	Substances	CAS No.
172	4-Heptylphenol, branched and linear	-
173	4,4'-isopropylidenediphenol	80-05-7
174	Perfluorohexane-1-sulphonic acid and its salts	-
175	Reaction products of 1,3,4-thiadiazolidine-2,5-dithione, formaldehyde and 4-heptylphenol, branched and linear (RP-HP)	-
176	Dodecachloropentacyclo[12.2.1.16,9.02,13.05,10]octadeca-7,15-diene ("Dechlorane Plus"™)	-
177	Chrysene	218-01-9; 1719-03-5
178	Cadmium nitrate	10022-68-1; 10325-94-7
179	Cadmium hydroxide	21041-95-2
180	Cadmium carbonate	513-78-0
181	Benz[a]anthracene	56-55-3; 1718-53-2
182	Terphenyl, hydrogenated	61788-32-7
183	Octamethylcyclotetrasiloxane	556-67-2
184	Lead	7439-92-1
185	Ethylenediamine	107-15-3
186	Dodecamethylcyclohexasiloxane	540-97-6
187	Disodium octaborate	12008-41-2
188	Dicyclohexyl phthalate	84-61-7
189	Decamethylcyclopentasiloxane	541-02-6
190	Benzo[ghi]perylene	191-24-2
191	Benzene-1,2,4-tricarboxylic acid 1,2 anhydride	552-30-7
192	Pyrene	129-00-0; 1718-52-1
193	Phenanthrene	85-01-8
194	Fluoranthene	206-44-0; 93951-69-0
194	Benzo[k]fluoranthene	207-08-9
196	2,2-bis(4'-hydroxyphenyl)-4-methylpentane	6807-17-6
197	1,7,7-trimethyl-3-(phenylmethylene)bicyclo[2.2.1]heptan-2-one 3-benzylidene camphor; 3-BC	15087-24-8
198	2-methoxyethyl acetate	110-49-6
199	Tris(4-nonylphenyl, branched and linear) phosphite (TNPP) with ≥ 0.1% w/w of 4-nonylphenol, branched and linear (4-NP)	-
200	2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)propionic acid, its salts and its acyl halides (covering any of their individual isomers and combinations thereof)	-
201	4-tert-butylphenol	98-54-4
202	2-benzyl-2-dimethylamino-4'-morpholinobutyrophenone	119313-12-1
203	2-methyl-1-(4-methylthiophenyl)-2-morpholinopropan-1-one	71868-10-5
204	Diisohexyl phthalate	71850-09-4

(Continued)

Table 1: SiTime REACH240 SHVC Substance List

№	Substances	CAS No.
205	Perfluorobutane sulfonic acid (PFBS) and its salts	-
206	1-vinylimidazole	1072-63-5
207	2-methylimidazole	693-98-1
208	Dibutylbis(pentane-2,4-dionato-O,O')tin	22673-19-4
209	Butyl 4-hydroxybenzoate (Butylparaben)	94-26-8
210	Bis(2-(2-methoxyethoxy)ethyl)ether	143-24-8
211	Dioctyltin dilaurate, stannane, dioctyl-, bis(coco acyloxy) derivs., and any other stannane, dioctyl-, bis(fatty acyloxy) derivs. Wherein C12 is the predominant carbon number of the fatty acyloxy moiety	-
212	2-(4-tert-butylbenzyl)propionaldehyde and its individual stereoisomers	-
213	Orthoboric acid, sodium salt	13840-56-7
214	2,2-bis(bromomethyl)propane1,3-diol (BMP); 2,2-dimethylpropan-1-ol, tribromo derivative/3-bromo-2,2-bis(bromomethyl)-1-propanol (TBNPA); 2,3-dibromo-1-propanol (2,3-DBPA)	3296-90-0, 36483-57-5, 1522-92-5, 96-13-9
215	Glutaral	111-30-8
216	Medium-chain chlorinated paraffins (MCCP) (UVCB substances consisting of more than or equal to 80% linear chloroalkanes with carbon chain lengths within the range from C14 to C17)	-
217	Phenol, alkylation products (mainly in para position) with C12-rich branched alkyl chains from 8ligomerization, covering any individual isomers and/ or combinations thereof (PDDP)	-
218	1,4-dioxane	123-91-1
219	4,4'-(1-methylpropylidene)bisphenol	77-40-7
220	6,6'-di-tert-butyl-2,2'-methylenedi-p-cresol	119-47-1
221	tris(2-methoxyethoxy)vinylsilane	1067-53-4
222	(±)-1,7,7-trimethyl-3-[(4-methylphenyl)methylene] bicyclo[2.2.1]heptan-2-one covering any of the individual isomers and/or combinations thereof (4-MBC)	-
223	S-(tricyclo(5.2.1.02,6)deca-3-en-8(or 9)-yl O-(isopropyl or isobutyl or 2-ethylhexyl) O-(isopropyl or isobutyl or 2-ethylhexyl) phosphorodithioate	255881-94-8
224	N-(hydroxymethyl)acrylamide	924-42-5
225	1,1'-[ethane-1,2-diylbisoxy]bis[2,4,6-tribromobenzene]	37853-59-1
226	2,2',6,6'-tetrabromo-4,4'-isopropylidenediphenol	79-94-7
227	4,4'-sulphonyldiphenol	80-09-1
228	Barium diboron tetraoxide	13701-59-2
229	bis(2-ethylhexyl) tetrabromophthalate covering any of the individual isomers and/or combinations thereof Bis(2-ethylhexyl) tetrabromophthalate	26040-51-7
230	Isobutyl 4-hydroxybenzoate	4247-02-3
231	Melamine	108-78-1

(Continued)

Table 1: SiTime REACH240 SHVC Substance List

№	Substances	CAS No.
232	Perfluoroheptanoic acid and its salts Ammonium perfluoroheptanoate potassium perfluoroheptanoate Perfluoroheptanoic acid Sodium perfluoroheptanoate	6130-43-4 21049-36-5 375-85-9 20109-59-5
233	reaction mass of 2,2,3,3,5,5,6,6-octafluoro-4-(1,1,1,2,3,3,3-heptafluoropropan-2-yl)morpholine and 2,2,3,3,5,5,6,6-octafluoro-4-(heptafluoropropyl)morpholine	-
234	Diphenyl(2,4,6-trimethylbenzoyl)phosphine oxide	75980-60-8
235	Bis(4-chlorophenyl) sulphone	80-07-9
236	Oligomerisation and alkylation reaction products of 2-phenylpropene and phenol	-
237	Bumetrizole (UV-326)	3896-11-5
238	2-(dimethylamino)-2-[(4-methylphenyl)methyl]-1-[4-(morpholin-4-yl)phenyl]butan-1-one	119344-86-4
239	2-(2H-benzotriazol-2-yl)-4-(1,1,3,3-tetramethylbutyl)phenol (UV-329)	3147-75-9
240	2,4,6-tri-tert-butylphenol	732-26-3

Table 2: Revision History

Version	Description of Change	Reason for Change
A00	Initial Release	
A01	Updated list to REACH211	Added Substances №210 and №211
A02	Formatting update	Formatting changes, Disclaimer changed
A03	Updated list to REACH219	Added Substances №212 to №219
A04	Updated list to REACH223	Added Substances №220 to 223
A05	Updated chapter 3 and signature	Added wording “Packing materials” and instead of Jim Pedicord added Dash Patel signature.
A06	Updated list to REACH224	Added Substance №224
A07	Updated list to REACH233	Added 9 substances
A08	Updated chapter 1	Added article h “Regulation of Certain Chemical Substances and mixtures under section 6 of The Toxic Substances Control Act” (TSCA).”
A09	Updated list to REACH235	Added 2 substances
A10	Updated list to REACH240	Added 5 substances

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1 Purpose and Scope

1.1 Purpose

To document the materials composition declaration for 4QFN packages for SiT160x/ SiT5008/SiT8008/SiT8009/SiT1618/SiT89xx products manufactured from Carsem and UTAC.

1.2 Scope

Products covered: SiT1602, SiT1603, SiT1604, SiT8008, SiT8009, SiT1618, SiT8918, SiT8919, SiT8920, SiT8921, SiT8924 and SiT8925 in 4QFN 2.0 mm x 1.6 mm, 2.5 mm x 2.0 mm, 3.2 mm x 2.5 mm, 5.0 mm x 3.2 mm, and 7.0 mm x 5.0 mm packages and SiT5008 in 2.0 mm x 1.6 mm, 2.5 mm x 2.0 mm packages.

2 Reference Documents

2.1 EU RoHS Directive 2002/95/EC and amendments

2.2 Internal References

2.2.1 QI-1 SiTime green partner and RoHS/Green Compliance

2.2.2 QI-73 RoHS Certificate for Homogeneous Materials in QFN Packages

2.2.3 QI-21 RoHS Certificate for CMOS die TSMC

2.2.4 QI-77 RoHS Certificate for MEMS die Bosch

3 Material Composition Declaration

3.1 The components (homogeneous materials) contained in the 4QFN packages used for SiT160x/SiT5008/SiT8008/SiT8009/SiT1618/SiT89xx Products are declared in the tables listed below. It should be noted that contents declared are from engineering estimates based on the MSDS as reference and material C of C provided by the material vendors and it is expected to have rounding errors. Engineering judgment/estimation based on part construction (generic or actual product) is used for the MCD table determination. Therefore, the amount and percentages shown in MCD table given in this document should not be compared with MSDS content. Main purpose of MSDS is for safety declaration of the material. Insignificant amount (<0.001 mg) may not be reported if total content is <1000 ppm.

3.2 As per industry standard practice (JEDEC Standard JESD46 and customer Green Partner requirements, such as Sony Green Program) the information provided in this document will be updated only when any change in the material content is implemented. Revised document will be uploaded to SiTime website. Annual update, when there is no change to the material content, is not necessary.

3.3 Table 1 Composition table for UTAC 2.5 mm x 2.0 mm 4QFN Package

3.4 Table 2 Composition table for UTAC 3.2 mm x 2.5 mm 4QFN Package

3.5 Table 3 Composition table for UTAC 5.0 mm x 3.2 mm 4QFN Package

3.6 Table 4 Composition table for UTAC 7.0 mm x 5.0 mm 4QFN Package

3.7 Table 5 Composition table for UTAC 2.0 mm x 1.6 mm 4QFN Package

3.8 Table 6 Composition table for Carsem 2.5 mm x 2.0 mm 4QFN Package

3.9 Table 7 Composition table for Carsem 3.2 mm x 2.5 mm 4QFN Package

3.10 Table 8 Composition table for Carsem 5.0 mm x 3.2 mm 4QFN Package

3.11 Table 9 Composition table for Carsem 2.0 mm x 1.6 mm 4QFN Package

3.12 Table 10 Composition table for Carsem 7.0 mm x 5.0 mm 4QFN Package

Table 1:
Base Products –
SiT1602, SiT1603, SiT1604, SiT1618, SiT5008, SiT8008, SiT8009, SiT8918, SiT8919, SiT8920, SiT8921, SiT8924, SiT8925

4L QFN 2.5 mm x 2.0 mm PACKAGE TABLE OF MATERIAL DECLARATION – UTAC

No.	Name of the Component	Material Type	Component Weight, mg	Materials Anallysis (element)	CAS Number	Element Weight, mg	Element wt % of Component	Element wt % of Package
1	Leadframe	C194 Alloy	3.4490	Copper	7440-50-8	3.364	97.54	32.09
				Iron	7439-89-6	0.081	2.35	0.77
				Zinc	7440-66-6	0.004	0.12	0.04
1a	Plating	NiPdAu	0.0480	Nickel	7440-02-0	0.046	95.83	0.44
				Palladium	7440-05-3	0.001	2.08	0.0095
				Gold	7440-57-5	0.001	2.08	0.0095
2	Die 1	CMOS Die	0.50	Si	7440-21-3	0.500	100.00	4.77
3	Die 2	MEMS Die	0.040	Si	7440-21-3	0.040	100.00	0.38
4	Die attach material 1	Non-Conductive epoxy	0.2560	Bisphenol A Liquid Epoxy Resin	25068-38-6	0.02960	11.56	0.28
				Specific Epoxy Resin	Trade secret	0.01350	5.27	0.13
				Hardener	Trade secret	0.00270	1.05	0.026
				Silica	7631-86-9	0.20210	78.95	1.93
				Additives	Trade Secret	0.0081	3.16	0.077
5	Die attach material 2	Conductive epoxy	0.02202	Silver	7440-22-4	0.0170	77.20	0.16
				exo-1,7,7-trimethylbicyclo [2.2.1]hept-2-yl methacrylate	7534-94-3	0.00330	14.99	0.031
				1,1'-(1,3-phenylene) bis-1H-pyrrole-2,5-dione	3006-93-7	0.00090	4.09	0.0086
				Epoxy resin	Proprietary	0.00040	1.82	0.0038
				2-(3,4-Epoxycyclohexyl)	3388-04-3	0.00040	1.82	0.0038
				2-Methylhydroquinone	95-71-6	0.000020	0.09	0.00019
6	Wire	Gold	0.10	Au	7440-57-5	0.10	100.00	0.95
7	Encapsulation	Epoxy Resin	6.0690	Fused silica	60676-86-0	5.493	90.51	52.39
				Epoxy resin	Proprietary	0.285	4.70	2.72
				Phenol resin	Proprietary	0.285	4.70	2.72
				Carbon black	1333-86-4	0.006	0.10	0.057
	Total Package Weight, mg:		10.48402					

Table 2:
Base Products –
SiT1602, SiT1603, SiT1604, SiT1618, SiT8008, SiT8009, SiT8918, SiT8919, SiT8920, SiT8921, SiT8924, SiT8925, SiT8944, SiT8945

4L QFN 3.2 mm x 2.5 mm PACKAGE TABLE OF MATERIAL DECLARATION – UTAC

No.	Name of the Component	Material Type	Component Weight, mg	Materials Anallysis (element)	CAS Number	Element Weight, mg	Element wt % of Component	Element wt % of Package
1	Leadframe	C194 Alloy	5.00500	Copper	7440-50-8	4.88100	97.52	29.03
				Iron	7439-89-6	0.11800	2.36	0.70
				Zinc	7440-66-6	0.00600	0.12	0.04
1a	Plating	NiPdAu	0.06800	Nickel	7440-02-0	0.06500	95.59	0.39
				Palladium	7440-05-3	0.00200	2.94	0.01
				Gold	7440-57-5	0.00100	1.47	0.01
2	Die 1	CMOS Die	0.50000	Si	7440-21-3	0.50000	100.00	2.97
3	Die 2	MEMS Die	0.04000	Si	7440-21-3	0.04000	100.00	0.24
4	Die attach material 1	Non-Conductive epoxy	0.25600	Bisphenol A Liquid Epoxy Resin	25068-38-6	0.02960	11.56	0.18
				Specific Epoxy Resin	Trade secret	0.01350	5.27	0.08
				Hardener	Trade secret	0.00270	1.05	0.02
				Silica	7631-86-9	0.20210	78.95	1.20
				Additives	Trade Secret	0.00810	3.16	0.05
5	Die attach material 2	Conductive epoxy	0.02202	Silver	7440-22-4	0.01700	77.20	0.101
				exo-1,7,7-trimethylbicyclo [2.2.1]hept-2-yl methacrylate	7534-94-3	0.00330	14.99	0.020
				1,1'-(1,3-phenylene) bis-1H-pyrrole-2,5-dione	3006-93-7	0.00090	4.09	0.005
				Epoxy resin	Proprietary	0.00040	1.82	0.0024
				2-(3,4-Epoxycyclohexyl) ethyltrimethoxysilane	3388-04-3	0.00040	1.82	0.0024
				2-Methylhydroquinone	95-71-6	0.00002	0.09	0.00012
6	Wire	Gold	0.10800	Au	7440-57-5	0.10800	100.00	0.64
7	Encapsulation	Epoxy Resin	10.81700	Fused silica	60676-86-0	9.78900	90.50	58.21
				Epoxy resin	Trade secret	0.50800	4.70	3.02
				Phenol resin	Trade secret	0.50800	4.70	3.02
				Carbon black	1333-86-4	0.01200	0.11	0.07
	Total Package Weight, mg:		16.81602					

Table 3:
Base Products –
SiT1602, SiT1603, SiT1604, SiT1618, SiT8008, SiT8009, SiT8918, SiT8919, SiT8920, SiT8921, SiT8924, SiT8925, SiT8944, SiT8945

4L QFN 5.0 mm x 3.2 mm PACKAGE TABLE OF MATERIAL DECLARATION – UTAC

No.	Name of the Component	Material Type	Component Weight, mg	Materials Anallysis (element)	CAS Number	Element Weight, mg	Element wt % of Component	Element wt % of Package
1	Leadframe	C194 Alloy	12.5820	Copper	7440-50-8	12.270	97.52	36.70
				Iron	7439-89-6	0.297	2.36	0.89
				Zinc	7440-66-6	0.015	0.12	0.04
1a	Plating	NiPdAu	0.0060	Nickel	7440-02-0	0.0057	95.51	0.02
				Palladium	7440-05-3	0.00018	3.02	0.00054
				Gold	7440-57-5	0.000088	1.47	0.00026
2	Die 1	CMOS Die	0.50	Si	7440-21-3	0.50	100.00	1.50
3	Die 2	MEMS Die	0.040	Si	7440-21-3	0.040	100.00	0.12
4	Die attach material 1	Non-Conductive epoxy	0.2560	Bisphenol A Liquid Epoxy Resin	25068-38-6	0.02960	11.56	0.09
				Specific Epoxy Resin	Trade secret	0.01350	5.27	0.04
				Hardener	Trade secret	0.00270	1.05	0.01
				Silica	7631-86-9	0.20210	78.95	0.60
				Additives	Trade Secret	0.0081	3.16	0.02
5	Die attach material 2	Conductive epoxy	0.02202	Silver	7440-22-4	0.0170	77.20	0.051
				exo-1,7,7-trimethylbicyclo [2.2.1]hept-2-yl methacrylate	7534-94-3	0.00330	14.99	0.010
				1,1'-(1,3-phenylene) bis-1H-pyrrole-2,5-dione	3006-93-7	0.00090	4.09	0.003
				Epoxy resin	Proprietary	0.00040	1.82	0.0012
				2-(3,4-Epoxycyclohexyl) ethyltrimethoxysilane	3388-04-3	0.00040	1.82	0.0012
				2-Methylhydroquinone	95-71-6	0.000020	0.09	0.00006
6	Wire	Gold	0.1080	Au	7440-57-5	0.1080	100.00	0.32
7	Encapsulation	Epoxy Resin	19.9190	Fused silica	60676-86-0	18.027	90.50	53.92
				Epoxy resin	Trade secret	0.936	4.70	2.80
				Phenol resin	Trade secret	0.936	4.70	2.80
				Carbon black	1333-86-4	0.020	0.10	0.06
	Total Package Weight, mg		33.432988					

Table 4:
Base Products –
SiT1602, SiT1603, SiT1604, SiT1618, SiT8008, SiT8009, SiT8918, SiT8919, SiT8920, SiT8921, SiT8924, SiT8925, SiT8944, SiT8945

4L QFN 7.0 mm x 5.0 mm PACKAGE TABLE OF MATERIAL DECLARATION – UTAC

No.	Name of the Component	Material Type	Component Weight, mg	Materials Anallysis (element)	CAS Number	Element Weight, mg	Element wt % of Component	Element wt % of Package
1	Leadframe	C194 Alloy	32.7760	Copper	7440-50-8	31.96300	97.52	41.09
				Iron	7439-89-6	0.77400	2.36	0.99
				Zinc	7440-66-6	0.03900	0.12	0.05
1a	Plating	NiPdAu	0.4510	Nickel	7440-02-0	0.43000	95.34	0.55
				Palladium	7440-05-3	0.01400	3.10	0.02
				Gold	7440-57-5	0.00700	1.55	0.01
2	Die 1	CMOS Die	0.50	Si	7440-21-3	0.50000	100.00	0.64
3	Die 2	MEMS Die	0.040	Si	7440-21-3	0.04000	100.00	0.05
4	Die attach material 1	Non-Conductive epoxy	0.2560	Bisphenol A Liquid Epoxy Resin	25068-38-6	0.02960	11.56	0.04
				Specific Epoxy Resin	Trade secret	0.01350	5.27	0.02
				Hardener	Trade secret	0.00270	1.05	0.003
				Silica	7631-86-9	0.20210	78.95	0.26
				Additives	Trade Secret	0.00810	3.16	0.01
5	Die attach material 2	Conductive epoxy	0.02202	Silver	7440-22-4	0.01700	77.20	0.022
				exo-1,7,7-trimethylbicyclo [2.2.1]hept-2-yl methacrylate	7534-94-3	0.00330	14.99	0.004
				1,1'-(1,3-phenylene) bis-1H-pyrrole-2,5-dione	3006-93-7	0.00090	4.09	0.001
				Epoxy resin	Proprietary	0.00040	1.82	0.0005
				2-(3,4-Epoxycyclohexyl) ethyltrimethoxysilane	3388-04-3	0.00040	1.82	0.0005
				2-Methylhydroquinone	95-71-6	0.00002	0.09	0.00003
6	Wire	Gold	0.4660	Au	7440-57-5	0.46600	100.00	0.60
7	Encapsulation	Epoxy Resin	43.2850	Fused silica	60676-86-0	39.17400	90.50	50.35
				Epoxy resin	Trade secret	2.03400	4.70	2.61
				Phenol resin	Trade secret	2.03400	4.70	2.61
				Carbon black	1333-86-4	0.04300	0.10	0.06
	Total Package Weight, mg		77.796020					

Table 5:
Base Products –
SiT1602, SiT1603, SiT1604, SiT1618, SiT5008, SiT8008, SiT8009, SiT8918, SiT8919, SiT8920, SiT8921, SiT8924, SiT8925

4L QFN 2.0 mm x 1.6 mm PACKAGE TABLE OF MATERIAL DECLARATION – UTAC

No.	Name of the Component	Material Type	Component Weight, mg	Materials Anallysis (element)	CAS Number	Element Weight, mg	Element wt % of Component	Element wt % of Package
1	Leadframe	C194 Alloy	1.90400	Copper	7440-50-8	1.85700	97.53	26.64
				Iron	7439-89-6	0.04500	2.36	0.65
				Zinc	7440-66-6	0.00200	0.11	0.03
1a	Plating	NiPdAu	0.02740	Nickel	7440-02-0	0.02600	94.89	0.37
				Palladium	7440-05-3	0.00100	3.65	0.01
				Gold	7440-57-5	0.00040	1.46	0.01
2	Die 1	CMOS Die	0.50000	Si	7440-21-3	0.50000	100.00	7.17
3	Die 2	MEMS Die	0.04000	Si	7440-21-3	0.04000	100.00	0.57
4	Die attach material 1	Non-Conductive epoxy	0.25600	Bisphenol A Liquid Epoxy Resin	25068-38-6	0.02960	11.56	0.42
				Specific Epoxy Resin	Trade secret	0.01350	5.27	0.19
				Hardener	Trade secret	0.00270	1.05	0.04
				Silica	7631-86-9	0.20210	78.95	2.90
				Additives	Trade Secret	0.00810	3.16	0.12
5	Die attach material 2	Conductive epoxy	0.02202	Silver	7440-22-4	0.01700	77.20	0.244
				exo-1,7,7-trimethylbicyclo[2.2.1]hept-2-yl methacrylate	7534-94-3	0.00330	14.99	0.047
				1,1'-(1,3-phenylene) bis-1H-pyrrole-2,5-dione	3006-93-7	0.00090	4.09	0.013
				Epoxy resin	Proprietary	0.00040	1.82	0.0057
				2-(3,4-Epoxycyclohexyl) ethyltrimethoxysilane	3388-04-3	0.00040	1.82	0.0057
				2-Methylhydroquinone	95-71-6	0.00002	0.09	0.00029
6	Wire	Gold	0.05400	Au	7440-57-5	0.05400	100.00	0.77
7	Encapsulation	Epoxy Resin	4.16600	Fused silica	60676-86-0	3.77000	90.49	54.09
				Epoxy resin	Trade secret	0.19600	4.70	2.81
				Phenol resin	Trade secret	0.19600	4.70	2.81
				Carbon black	1333-86-4	0.00400	0.10	0.06
	Total Package Weight, mg:		6.96942					

Table 6:
Base Products –
SiT1602, SiT1603, SiT1604, SiT1618, SiT5008, SiT8008, SiT8009, SiT8918, SiT8919, SiT8920, SiT8921, SiT8924, SiT8925

4L QFN 2.5 mm x 2.0 mm PACKAGE TABLE OF MATERIAL DECLARATION – Carsem

No.	Name of the Component	Material Type	Component Weight, mg	Materials Anallysis (element)	CAS Number	Element Weight, mg	Element wt% of Component	Element wt % of Package
1	Leadframe	C194	3.1680	Copper	7440-50-8	3.095	97.70	30.52
				Iron	7439-89-6	0.069	2.18	0.68
				Zinc	7440-66-6	0.004	0.12	0.04
1a	Plating	NiPdAu	0.0420	Nickel	7440-02-0	0.038	90.48	0.37
				Palladium	7440-05-3	0.003	7.14	0.03
				Gold	7440-57-5	0.001	2.38	0.01
2	Die 1	CMOS Die	0.50	Si	7440-21-3	0.500	100.00	4.93
3	Die 2	MEMS Die	0.040	Si	7440-21-3	0.040	100.00	0.39
4	Die attach material 1	Non-Conductive epoxy	0.080	Treated silica/Metal Oxides	Proprietary	0.035	43.75	0.35
				Epoxy resin	Proprietary	0.021	26.25	0.21
				Glycol ethers	Proprietary	0.020	25.00	0.20
				Additives	Proprietary	0.004	5.00	0.04
5	Die attach material 2	Conductive epoxy	0.010	Silver	7440-22-4	0.007	70.00	0.07
				Acrylate/Resin	Proprietary	0.002	20.00	0.02
				Additive	Proprietary	0.001	10.00	0.01
6	Wire	Gold	0.050	Au	7440-57-5	0.050	100.00	0.49
7	Encapsulation	Epoxy Resin	6.250	Silica Fused	60676-86-0	5.784	92.54	57.04
				Phenol Resin	Proprietary	0.228	3.65	2.25
				Epoxy resin	Proprietary	0.219	3.50	2.16
				Carbon Black	1333-86-4	0.019	0.30	0.19
	Total Package Weight, mg:		10.140					

Table 7:
Base Products –
SiT1602, SiT1603, SiT1604, SiT1618, SiT8008, SiT8009, SiT8918, SiT8919, SiT8920, SiT8921, SiT8924, SiT8925, SiT8944, SiT8945

4L QFN 3.2 mm x 2.5 mm PACKAGE TABLE OF MATERIAL DECLARATION – Carsem

No.	Name of the Component	Material Type	Component Weight, mg	Materials Anallysis (element)	CAS Number	Element Weight, mg	Element wt% of Component	Element wt % of Package
1	Leadframe	C194	5.4480	Copper	7440-50-8	5.323	97.71	32.26
				Iron	7439-89-6	0.118	2.17	0.72
				Zinc	7440-66-6	0.007	0.12	0.04
1a	Plating	NiPdAu	0.0720	Nickel	7440-02-0	0.065	90.28	0.39
				Palladium	7440-05-3	0.006	8.33	0.04
				Gold	7440-57-5	0.001	1.39	0.01
2	Die 1	CMOS Die	0.50	Si	7440-21-3	0.500	100.00	3.03
3	Die 2	MEMS Die	0.040	Si	7440-21-3	0.040	100.00	0.24
4	Die attach material 1	Non-Conductive epoxy	0.080	Treated silica/Metal Oxides	Proprietary	0.035	43.75	0.21
				Epoxy resin	Proprietary	0.021	26.25	0.13
				Glycol ethers	Proprietary	0.020	25.00	0.12
				Additives	Proprietary	0.004	5.00	0.02
5	Die attach material 2	Conductive epoxy	0.010	Silver	7440-22-4	0.007	70.00	0.04
				Acrylate/Resin	Proprietary	0.002	20.00	0.01
				Additive	Proprietary	0.001	10.00	0.01
6	Wire	Gold	0.050	Au	7440-57-5	0.050	100.00	0.30
7	Encapsulation	Epoxy Resin	10.30	Silica Fused	60676-86-0	9.532	92.54	57.77
				Phenol Resin	Proprietary	0.376	3.65	2.28
				Epoxy resin	Proprietary	0.361	3.50	2.19
				Carbon Black	1333-86-4	0.031	0.30	0.19
	Total Package Weight, mg:		16.50					

Table 8:
Base Products –
SiT1602, SiT1603, SiT1604, SiT1618, SiT8008, SiT8009, SiT8918, SiT8919, SiT8920, SiT8921, SiT8924, SiT8925, SiT8944, SiT8945

4L QFN 5.0 mm x 3.22 mm PACKAGE TABLE OF MATERIAL DECLARATION – Carsem

No.	Name of the Component	Material Type	Component Weight, mg	Materials Anallysis (element)	CAS Number	Element Weight, mg	Element wt% of Component	Element wt % of Package
1	Leadframe	C194	10.7780	Copper	7440-50-8	10.531	97.71	32.02
				Iron	7439-89-6	0.234	2.17	0.71
				Zinc	7440-66-6	0.013	0.12	0.04
1a	Plating	NiPdAu	0.1420	Nickel	7440-02-0	0.128	90.14	0.39
				Palladium	7440-05-3	0.012	8.45	0.04
				Gold	7440-57-5	0.002	1.41	0.01
2	Die 1	CMOS Die	0.50	Si	7440-21-3	0.500	100.00	1.52
3	Die 2	MEMS Die	0.040	Si	7440-21-3	0.040	100.00	0.12
4	Die attach material 1	Non-Conductive epoxy	0.080	Treated silica/Metal Oxides	Proprietary	0.035	43.75	0.11
				Epoxy resin	Proprietary	0.020	25.00	0.06
				Glycol ethers	Proprietary	0.004	5.00	0.01
				Additives	Proprietary	0.021	26.25	0.06
5	Die attach material 2	Conductive epoxy	0.010	Silver	7440-22-4	0.007	70.00	0.02
				Acrylate/Resin	Proprietary	0.002	20.00	0.01
				Additive	Proprietary	0.001	10.00	0.003
6	Wire	Gold	0.050	Au	7440-57-5	0.050	100.00	0.15
7	Encapsulation	Epoxy Resin	21.290	Silica Fused	60676-86-0	19.703	92.55	59.91
				Phenol Resin	Proprietary	0.777	3.65	2.36
				Epoxy resin	Proprietary	0.746	3.50	2.27
				Carbon Black	1333-86-4	0.064	0.30	0.19
	Total Package Weight, mg:		32.890					

Table 9:
Base Products –
SiT1602, SiT1603, SiT1604, SiT1618, SiT5008, SiT8008, SiT8009, SiT8918, SiT8919, SiT8920, SiT8921, SiT8924, SiT8925

4L QFN 2.0 mm x 1.6 mm PACKAGE TABLE OF MATERIAL DECLARATION – Carsem

No.	Name of the Component	Material Type	Component Weight, mg	Materials Anallysis (element)	CAS Number	Element Weight, mg	Element wt% of Component	Element wt % of Package
1	Leadframe	C194	2.5070	Copper	7440-50-8	2.450	97.73	35.66
				Iron	7439-89-6	0.054	2.15	0.79
				Zinc	7440-66-6	0.003	0.12	0.04
1a	Plating	NiPdAu	0.0330	Nickel	7440-02-0	0.030	90.91	0.44
				Palladium	7440-05-3	0.002	6.06	0.03
				Gold	7440-57-5	0.001	3.03	0.01
2	Die 1	CMOS Die	0.50	Si	7440-21-3	0.500	100.00	7.28
3	Die 2	MEMS Die	0.040	Si	7440-21-3	0.040	100.00	0.58
4	Die attach material 1	Non-Conductive epoxy	0.080	Treated silica/Metal Oxides	Proprietary	0.035	43.75	0.51
				Epoxy resin	Proprietary	0.021	26.25	0.31
				Glycol ethers	Proprietary	0.020	25.00	0.29
				Additives	Proprietary	0.004	5.00	0.06
5	Die attach material 2	Conductive epoxy	0.010	Silver	7440-22-4	0.007	70.00	0.10
				Acrylate/Resin	Proprietary	0.002	20.00	0.03
				Additive	Proprietary	0.001	10.00	0.01
6	Wire	Gold	0.050	Au	7440-57-5	0.050	100.00	0.73
7	Encapsulation	Epoxy Resin	3.650	Silica Fused	60676-86-0	3.378	92.55	49.17
				Phenol Resin	Proprietary	0.133	3.64	1.94
				Epoxy resin	Proprietary	0.128	3.51	1.86
				Carbon Black	1333-86-4	0.011	0.30	0.16
	Total Package Weight, mg:		6.870					

Table 10:
Base Products –
SiT1602, SiT1603, SiT1604, SiT1618, SiT8008, SiT8009, SiT8918, SiT8919, SiT8920, SiT8921, SiT8924, SiT8925, SiT8944, SiT8945

4L QFN 7.0 mm x 5.0 mm PACKAGE TABLE OF MATERIAL DECLARATION – Carsem

No.	Name of the Component	Material Type	Component Weight, mg	Materials Anallysis (element)	CAS Number	Element Weight, mg	Element wt% of Component	Element wt % of Package
1	Leadframe	C194	23.020	Copper	7440-50-8	22.492	97.71	27.34
				Iron	7439-89-6	0.499	2.17	0.61
				Zinc	7440-66-6	0.029	0.12	0.04
1a	Plating	NiPdAu	0.30320	Nickel	7440-02-0	0.274	90.37	0.33
				Palladium	7440-05-3	0.025	8.25	0.03
				Gold	7440-57-5	0.004	1.32	0.00
2	Die 1	CMOS Die	0.50	Si	7440-21-3	0.500	100.00	0.61
3	Die 2	MEMS Die	0.040	Si	7440-21-3	0.040	100.00	0.05
4	Die attach material 1	Non-Conductive epoxy	0.080	Treated silica/Metal Oxides	Proprietary	0.035	43.75	0.04
				Epoxy resin	Proprietary	0.021	26.25	0.03
				Glycol ethers	Proprietary	0.020	25.00	0.02
				Additives	Proprietary	0.004	5.00	0.00
5	Die attach material 2	Conductive epoxy	0.010	Silver	7440-22-4	0.007	70.00	0.01
				Acrylate/Resin	Proprietary	0.003	30.00	0.00
				Additive	Proprietary	0.000	0.00	0.000
6	Wire	Gold	0.130	Au	7440-57-5	0.130	100.00	0.16
7	Encapsulation	Epoxy Resin	58.190	Silica Fused	60676-86-0	53.852	92.55	65.46
				Phenol Resin	Proprietary	2.125	3.65	2.58
				Epoxy resin	Proprietary	2.038	3.50	2.48
				Carbon Black	1333-86-4	0.175	0.30	0.21
	Total Package Weight, mg:		82.27320					

Revision History

Table 11: Revision History

Version	Description of Change	Reason for Change
A00	Initial Release	Created new document with Composition declaration tables for SiT1602 products in 4QFN packages.
A01	Added Table-3 to Table-14	The below package sizes are available for SiT1602 product family: package size 2016, 2520, 3225, and 7050 from Carsem and UTAC; and 2520, 3225, 5032 and 7050 from ASE
A02	Revised sec1.2 and Table-1 to Table-14	Added SiT1618, SiT8918, SiT8920, and SiT8924
A03	Revised document title	To clarify the product applicability of the document; customer request
A04	Revised sec. 2.2.1	Typo in document name.
A05	Edited sections 2.2.3, 2.2.4	Typo in documents' name.
A06	Edited Table 1 – Table 5	Edited according to the new revision from UTAC
A07	Updated parts list	Added SiT8944, SiT8945
A08	Updated parts list	Deleted SiT8944, SiT8945. Added SiT5008 for 2016 and 2520 package sizes.
A09	Formatting update	Formatting changes, Disclaimer changed

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Manufacturing Notes for SiTime MEMS-Based Silicon Timing Products

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1 Introduction

These manufacturing notes apply to all SiTime MEMS-based silicon timing products in quad flat no-lead (QFN), SOT23-5, 2.0 x 1.2 mm SMD, WLCSP, ceramic, and stacked-PCB packages. The information in this document is provided to assist customers with manufacturing set-up and use of SiTime products designed into systems.

The materials used in the construction of SiTime products comply with Green standards. They are compliant to current RoHS and REACH SVHC requirements. Material composition reports are available on the SiTime website and can be made available upon request from your sales representative. SiTime products meet all governmental hazardous material regulations. MSDS reports are available upon request for the homogeneous materials used to make SiTime products but are not required for finished SiTime products.

All SiTime products have been qualified to JEDEC JESD47, AEC-Q100, or MIL STD 883 requirements, as applicable to the product and package. Reliability reports are available on the SiTime website or upon request from your sales representative.

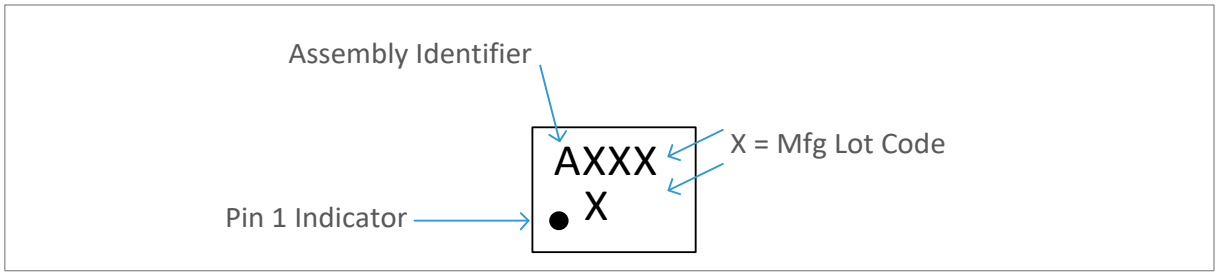
2 Device Packaging

Detailed mechanical dimensions for the various body sizes are provided in the datasheets as package outline drawings.

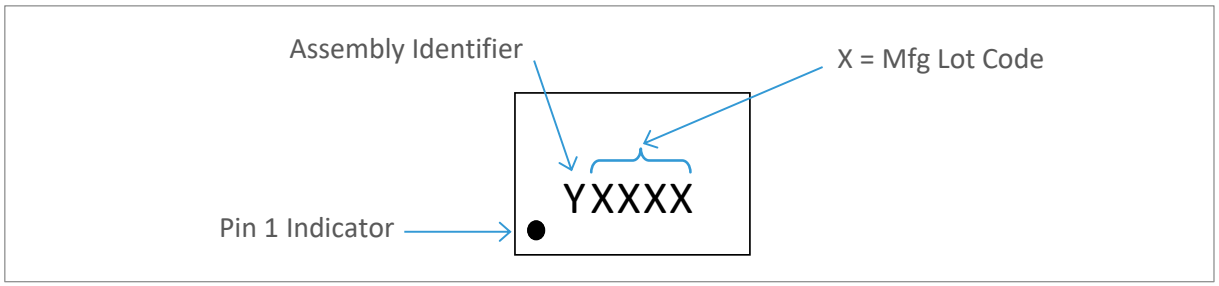
2.1 Package Marking Details – Standard Mark

The standard mark for all SiTime products is shown below. It contains an assembly location code and lot code to allow tracing the manufacturing origin. This marking is used on all samples, low volume and mass production orders. The marking method is laser mark.

2.0 x 1.6 mm package marking diagram



Other packages marking diagram



In the above diagrams, which show the "STANDARD MARK":

"**Y**" denotes assembly identifier:

A or Z as a first letter to indicate Vendor Carsem
B or Y as a first letter to indicate Vendor UTAC
C or X as a first letter to indicate Vendor ASE
E or V as a first letter to indicate Vendor KDS
G or T as a first letter to indicate Vendor HANA

X, Y, Z, V, T character used for marking of Conditional Released parts where full qualification is not completed.

"**XXXX**" denotes four alpha-numeric characters of the manufacturing lot code without any dashes, periods, or symbols.

For QFN 2.0 x 1.2, following are the marking requirements to identify the assembly sites.

- Line 1 : Last 4 digits of Lot code (4 characters max)
- Line 2 : Assembly location (Underline) – depending on assembly location.

- Underline under 2nd digit to indicate Vendor Carsem
- Underline under 3rd digit to indicate Vendor UTAC
- Underline under 4th digit to indicate Vendor HANA

Top Marking Dimensions (otherwise indicated differently)

- All dimensions are in mm
- Font type: LLGOTHIC_ STD or EO135P or EO145
- Tolerance for:
    - Dimensions X, X1, Y and Y1: ±0.25 mm
    - Dimension Y2: ±0.1 mm
    - Char Pitch: ±0.1 mm
    - Char Height/Width: ±0.1 mm
    - Pin 1 Dot Diameter: ±0.1 mm
    - All other tolerances: ±0.20 mm

QFN7050

(as example)

Body size = 7.0 mm x 5.0 mm

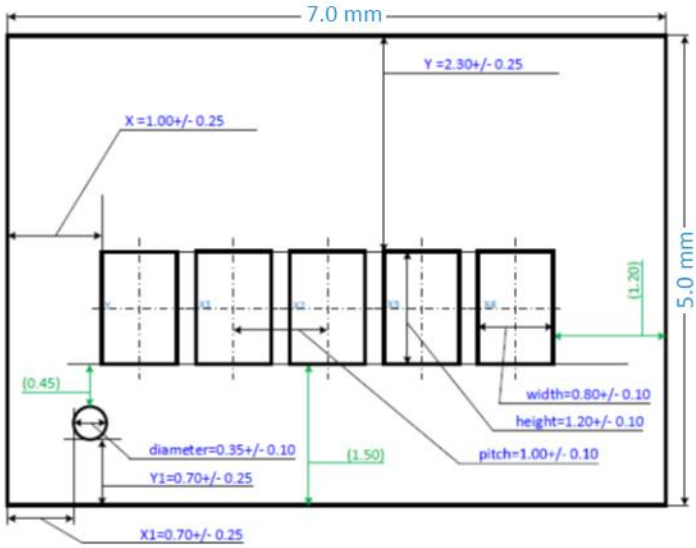


Figure 1: Standard Marking Dimensions – 5.0 x 2.0, 3.2 x 2.5, 5.0 x 3.2, 7.0 x 5.0 mm, and SOT23 Packages

QFN2016

Body size = 2.0 mm x 1.6 mm

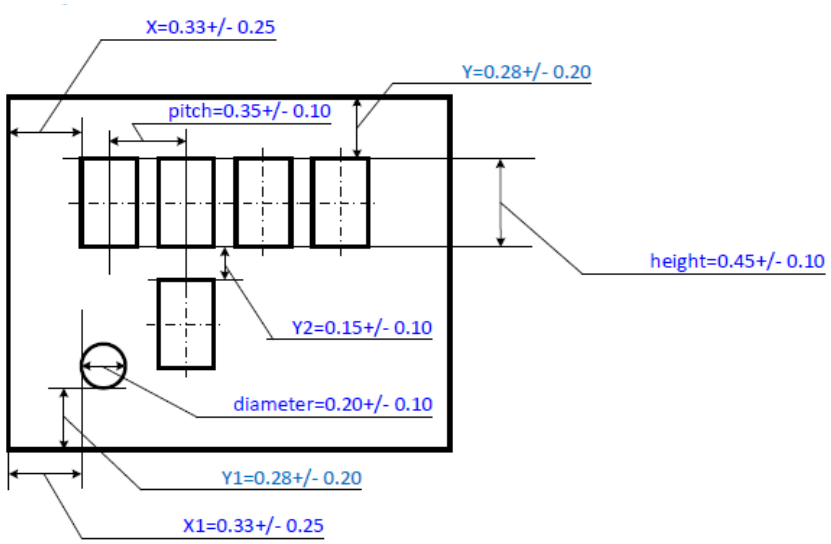


Figure 2: Standard Marking Dimensions for 2.0 x 1.6 mm Package

Table 1: Marking Dimensions for Package Type

Package	X	X1	Y	Y1	Y2	Char Height	Char Width	Char Pitch	Pin 1 Dot diameter
2.5 x 2.0	0.30	0.30	0.85	0.25	N/A	0.45	N/A	0.35	0.25
SOT23	0.55	0.30	0.81	0.25	N/A	0.40	N/A	0.35	0.16
2.7 x 2.4	0.30	0.30	0.85	0.25	N/A	0.45	N/A	0.35	0.25
3.5 x 3.0	0.30	0.30	1.10	0.35	N/A	0.45	N/A	0.45	0.25
3.2 x 2.5	0.30	0.20	1.10	0.35	N/A	0.45	N/A	0.45	0.25
5.0 x 3.2	0.80	0.35	1.80	0.5	N/A	0.90	0.60	0.80	0.25
7.0 x 5.0	1.00	0.70	2.30	0.7	N/A	1.20	0.80	1.00	0.35
2.0 x 1.6	0.33	0.33	0.28	0.28	0.15	0.45	N/A	0.35	0.20

QFN2012

Body size = 2.0 mm x 1.2 mm

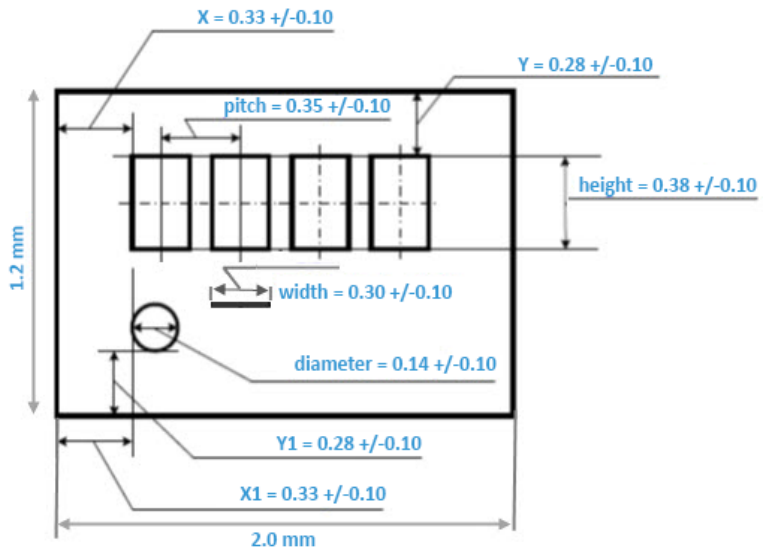
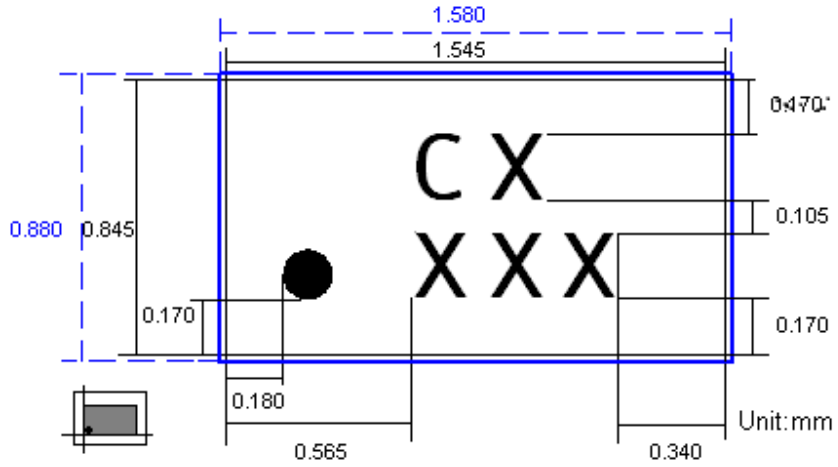


Figure 3: Standard Marking Dimensions for 2.0 mm x 1.2 mm Package

Table 2: Marking Dimensions for SMD Package Type (2.0 mm x 1.2 mm)

Package	Char Height	Underline Width	Char Pitch	Pin 1 Diameter	X	Y	Y1
2.0 x 1.2	0.38	0.3	0.35	0.14	0.33	0.28	0.28



- **Font size tolerance:** (±0.05 mm)
- **Marking shift tolerance:** (±0.15 mm)

Figure 4: Standard Marking Dimensions for WLCSP Package (1.5 mm x 0.8 mm)

Table 3: Marking Dimensions for WLCSP Package (1.5 mm x 0.8 mm)

Item	Description	Position	Font Type	Height	Width	Space	Max Marking Width	Max chars
				↕	↔	↔	←——→	
Pin 1 Dot	Dot	NA	NA	0.15 mm	0.15 mm	NA	NA	NA
Line 1	CX	Left	S_X.FNT	0.20 mm	0.18 mm	0.05 mm	0.41 mm	2
Line 2	XXX	Left	S_X.FNT	0.20 mm	0.18 mm	0.05 mm	0.64 mm	3

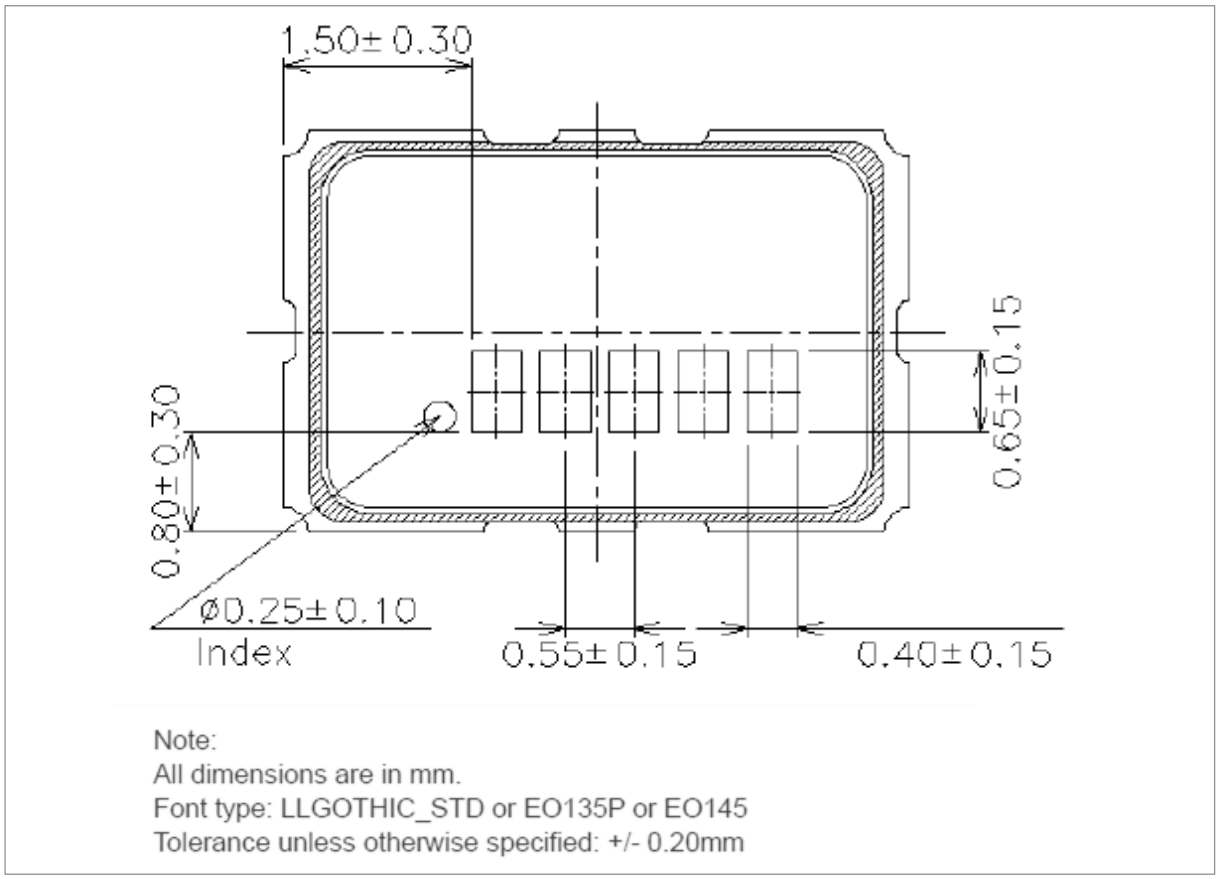


Figure 5: Standard Marking Dimensions for Ceramic Package (5.0 mm x 3.2 mm)

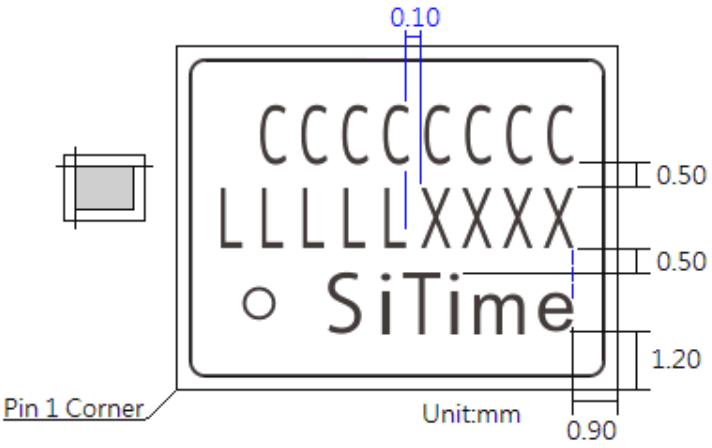


Figure 6: Marking Dimensions for Emerald Package (9.0 mm x 7.0 mm)

Table 4: Marking Dimensions for Emerald Package (9.0 mm x 7.0 mm)

Item	Description	Position	Font Type	Height	Width	Space	Max Width	Max chars
				↕	↔	↔	← →	
Logo	SiTime	NA	NA	1.20 mm	5.20 mm	NA	NA	NA
Line 1	CCCCCCCC	Right	EO145.FNT	1.20 mm	0.70 mm	0.10 mm	7.10 mm	9
Line 2	LLLLL	Right	EO145.FNT	1.20 mm	0.70 mm	0.10 mm	3.90 mm	5
Line 2	XXXX	Right	EO145.FNT	1.20 mm	0.70 mm	0.10 mm	3.10 mm	4

Where,

Tolerance: Font size: =/- 0.10 mm; Marking Shift: =/- 0.25 mm
Line 1: CCCCCCCC – this is frequency mark request (empty if not required)
Line 2: LLLLL – 5-digit lot code marking
Line 2: XXXX – part serial number from production panel
Line 3: Pin 1 dot and “SiTime” logo

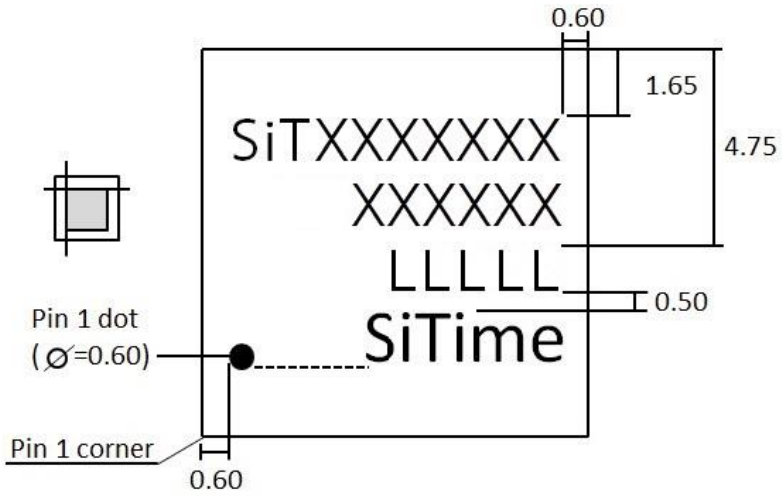


Figure 7: Marking Dimensions for Cascade Package (QFN 9.0 mm x 9.0 mm)

Note: Line 1 and 2 marking will be done post testing and line 3 and logo1 marking will be done during assembly builds.

Table 5: ASSY Marking

Item	Description	Position	Font Type	Height ↕	Width ↔	Space ↔	Max Width ←→	Max chars	Logo Name
Logo1	SiTime	Right	NA	1.05 mm	4.55 mm	NA	NA	NA	SiTime
Item	**Description**	**Position**	**Font Type**	**Height**	**Width**	**Space**	**Max Width**	**Max chars**	**Char Limit**
Line 3	LLLLL	Right	EO145.FNT	1.05 mm	0.60 mm	0.20 mm	3.80 mm	5	A

Table 6: FT Post Marking

Item	Description	Position	Font Type	Height	Width	Space	Max Width	Max chars	Char Limit
Line 1	SiTXXXXXXX	Right	EO145.FNT	1.05 mm	0.60 mm	0.20 mm	3.80 mm	10	A
Line 2	XXXXXXX	Right	EO145.FNT	1.05 mm	0.60 mm	0.20 mm	3.80 mm	6	A

Where,

Tolerance: ±0.20 mm
Line 1: "SiTXXXXXXX", 1st to 10th characters of part number
Line 2: "XXXXXX", 11th to 16th characters of part number, excluding tape and reel suffix
Line 3: "LLLLL", 5 digits lot code marking
Line 4: Pin 1 dot and "SiTime" logo

All dimensions are in mm.

Font type: LLGOTHIC_STD or EO135P or EO145

Font Size Tolerance unless otherwise specified: +/- 0.10mm

Top (1) Marking shift tolerance: (+/- 0.25 mm)

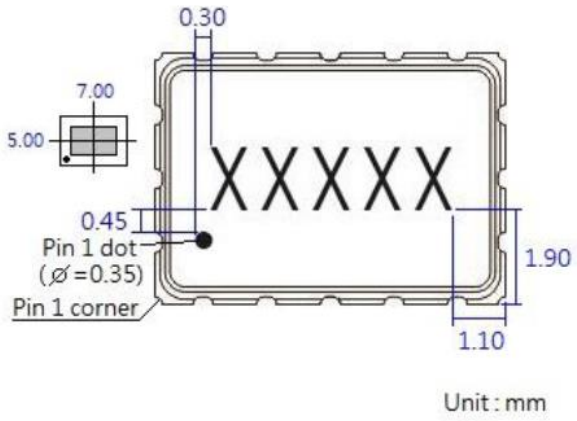


Figure 8: Standard Marking Dimensions for Ceramic Package (7.0 mm x 5.0 mm)

Top(1) Item	Description	Position	Font Type	Height (mm)	Width (mm)	Space (mm)	Max Width (mm)	Max Chars	Chars Limit
				□↕	□ ↔	□↔□	□□□□ ←——→		
Line1	XXXXX	Center	EO145.FNT	1.20	0.80	0.20	4.80	5	B

3 Product Packing

3.1 Tape & Reel

The carrier tape basic dimensions are based on EIA481. The pocket is designed to hold the part for shipping and loading onto SMT manufacturing equipment, while protecting the body and the solder terminals from damaging stresses. The individual pocket design can vary from vendor to vendor, but width and pitch will be consistent.

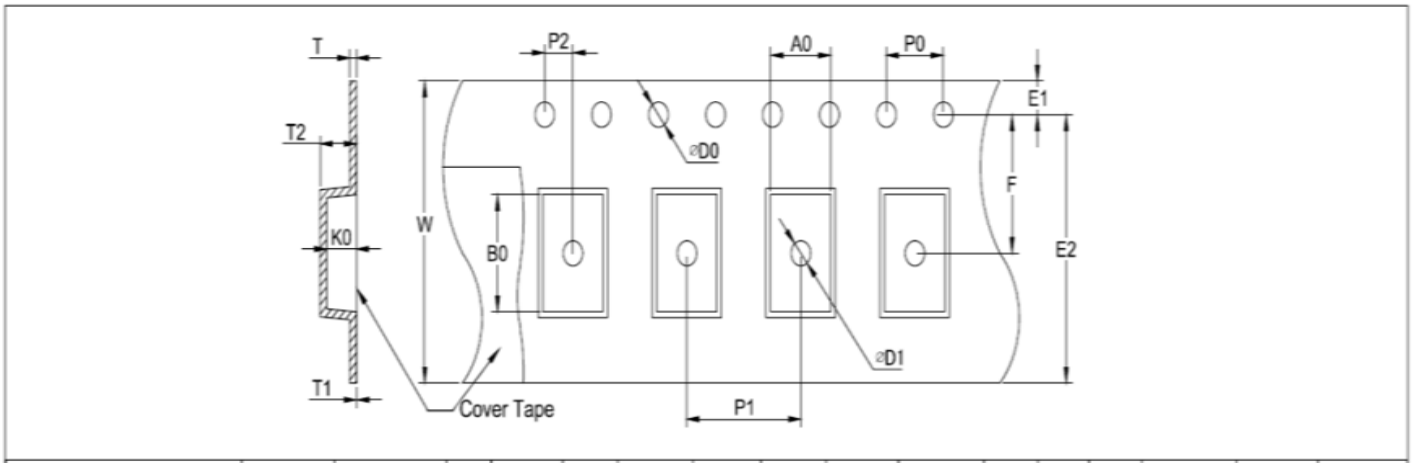
Carrier tape is wound or placed onto a 7” or 13” shipping reel depending on the quantity of parts on the reel and the package body size.

The center hub design is large enough to ensure the radius formed by the carrier tape around it does not put unnecessary stress on the parts.

Prior to shipping, parts are placed into the pockets of the carrier tape. Moisture sensitive parts (MSL level 2a-5a) are baked prior to placement into the pockets of the carrier tape (refer to Sections 4, 6, and 7 for the baking/storage conditions). A cover tape is sealed over the top of the entire length of the carrier tape. The reel is sealed in a protective bag with a dry N2 backfill.

The reel is made with high impact polystyrene and is anti-static material. It is possible that color of the reels may be different in two different shipments depending on drop shipment location. However, the specifications of the reel are identical. The carrier tape is made with polystyrene with carbon impregnation and is static dissipative material. The cover tape is made with polystyrene antistatic material.

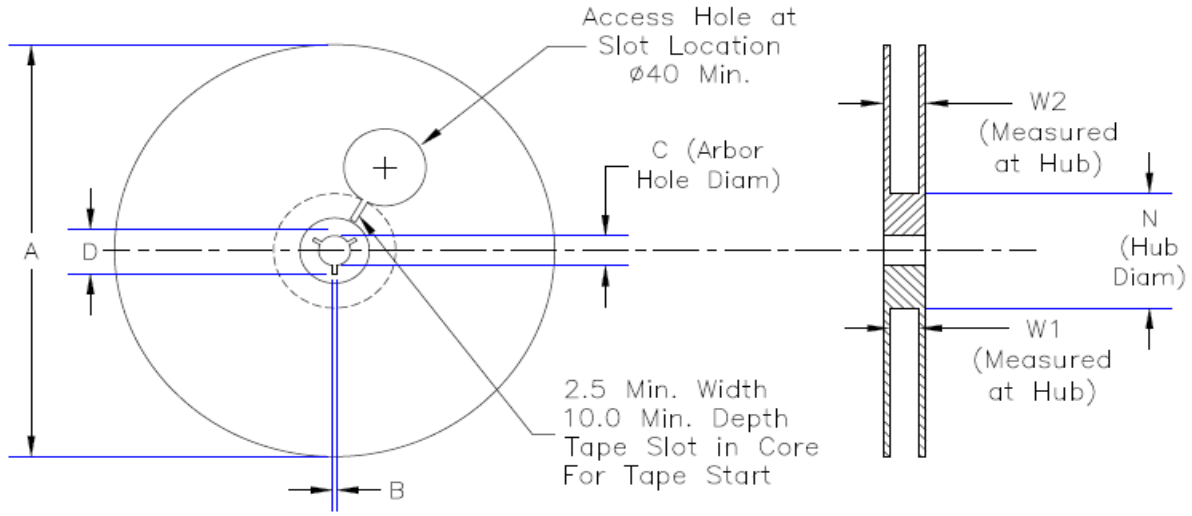
Figure 8 provides relevant dimensions of the carrier tape of Tape & Reel for all packages/PODs in production. Figure 9 provides the dimensions of the reel of the Tape & Reel packing.



Package Outline Drawing	Tape Size	D0	D1 Min	E1	E2 Min	F	PO	P1	P2	T	T1 Max	T2 Max	W Max	A0	B0	K0
POD-001-PQFN-004-X02025	12	1.5 + 0.1/-0.0	1.5	1.75±0.1	10.25	5.5±0.05	4.0 ± 0.1	4.0 ± 0.1	2.0 ± 0.05	0.6	0.1	1.65	12.3	2.3 ± 0.10	2.8 ± 0.10	1.10 ± 0.10
POD-001-PQFN-004-X02025	8	1.55 ± 0.05	1	1.75 ± 0.1	5.85	3.5 ± 0.05	4.0 ± 0.1	4.0 ± 0.1	2.0 ± 0.05	0.3 ± 0.05	0.1	1.65	8.3	2.25 ± 0.05	2.8 ± 005	1.10 ± 0.10
POD-023-PQFN-004-A2724	12	1.55 ± 0.05	1	1.75 ± 0.1	9.85	5.5 ± 0.05	4.0 ± 0.1	4.0 ± 0.1	2.0 ± 0.05	0.3 ± 0.05	0.1	1.55	12.3	2.65 ± 0.10	2.95 ± 0.10	1.00 ± 0.10
POD-023-PQFN-004-A2724	8	1.55 ± 0.05	1	1.75 ± 0.1	5.85	3.5 ± 0.05	4.0 ± 0.1	4.0 ± 0.1	2.0 ± 0.05	0.3 ± 0.05	0.1	1.55	8.3	2.65 ± 0.10	2.95 ± 0.10	1.00 ± 0.10
POD-002-PQFN-004-X03225	12	1.5 +0.1/-0.0	1.5	1.75 ± 0.1	10.25	5.5 ± 0.05	4.0 ± 0.1	4.0 ± 0.1	2.0 ± 0.05	0.6	0.1	1.65	12	2.9 ± 0.10	3.5 ± 0.10	1.10 ± 0.10
POD-002-PQFN-004-X03225	8	1.5 +0.1/-0.0	1	1.75 ± 0.1	5.95	5.5 ± 0.05	4.0 ± 0.1	4.0 ± 0.1	2.0 ± 0.05	0.2 ± 0.05	0.1	1.65	8.2	2.7 ± 0.10	3.4 ± 0.10	1.15 ± 0.10
POD-003-PQFN-004-XO5032	12	1.5 +0.1/-0.0	1.5	1.75 ± 0.1	10.25	5.5 ± 0.05	4.0 ± 0.1	8.0 ± 0.1	2.0 ± 0.05	0.6	0.1	1.65	12.3	3.5 ± 0.10	5.3 ± 0.10	1.10 ± 0.10
POD-004-PQFE-004-X07050	16	1.5 +0.1/-0.0	1.5	1.75 ± 0.1	14.25	7.5 ± 0.1	4.0 ± 0.1	80 ± 0.1	2.0 ± 0.1	0.6	0.1	1.8	16.3	5.4 ± 0.10	7.4 ± 0.10	1.3 ± 0.10
POD-009-PQFT-004-803530	12	1.5 +0.1/-0.0	1.5	1.75 ± 0.1	10.25	5.5 ± 0.05	4.0 ± 0.1	4.0 ± 0.1	2.0 ± 0.05	0.6	0.1	1.65	12.3	3.3 ± 0.10	3.8 ± 0.10	0.65 ± 0.10
POD-026-PQFN-004-X01620	8	1.55 ± 0.05	0.9	1.75 ± 0.1	6.05	3.5 ± 0.05	4.0 ± 0.1	4.0 ± 0.1	2.0 ± 0.05	0.3 ± 0.05	0.1	1.55	8.3	1.9 ± 0.05	2.3 ± 0.05	1.00 ± 0.10
POD-029-PQFN-004-A02012	8	1.55 ± 0.05	1	1.75 ± 0.1	6.05	3.5 ± 0.05	4.0 ± 0.1	4.0 ± 0.1	2.0 ± 0.05	0.25 ± 0.05	0.1	1.55	8.3	1.9 ± 0.05	2.3 ± 005	1.00 ± 0.10
POD-032-NCSP-004-C01508	8	1.55 ± 0.05	0.18	1.75 ± 0.1	6.05	3.5 ± 0.05	4.0 ± 0.1	4.0 ± 0.1	2.0 ± 0.05	0.2 ± 0.02	0.1	1.55	8.3	0.96 ± 0.03	1.66 ± 0.03	0.63 ± 0.03
POD-030-SO23-005-X02829	8	1.55 ± 0.05	1	1.75 ± 0.1	6.05	3.5 ± 0.05	4.0 ± 0.1	4.0 ± 0.1	2.0 ± 0.05	0.25 ± 0.02	0.1	1.62	8.3	3.23 ± 0.10	3.17 ± 0.10	1.37 ± 0.10
POD-036-CQFN-010-X05032	12	1.5 + 0.1/-0.0	1.5	1.75 ± 0.1	9.85	5.5 ± 0.05	4.0 ± 0.1	8.0 ± 0.1	2.0 ± 0.05	0.3 ± 0.05	0.1	1.65	12.3	3.5 ± 0.10	5.3 ± 0.10	1.10 ± 0.10
POD-038-PQFD-006-C03225	8	1.5 +0.1/-0.0	1	1.75 ± 0.1	5.95	5.5 ± 0.05	4.0 ± 0.1	4.0 ± 0.1	2.0 ± 0.05	0.2 ± 0.05	0.1	1.65	8.2	2.7 ± 0.10	3.4 ± 0.10	1.15 ± 0.10
POD-037-PQFV-006-C07050	16	1.5 + 0.1/-0.0	1.5	1.75 ± 0.1	14.25	7.5 ± 0.1	4.0 ± 0.1	8.0 ± 0.1	2.0 ± 0.1	0.6	0.1	1.8	16.3	5.4 ± 0.10	7.4 ± 0.10	1.3 ± 0.10
POD-086-CQFN-010-X07050	16	1.5 + 0.1/-0.0	1.5	1.75 ± 0.1	14.05	7.5 ± 0.1	4.0 ± 0.1	8.0 ± 0.1	2.0 ± 0.1	0.3	0.1	2.05	16.13	5.32 ± 0.10	7.30 ± 0.10	2.35 ± 0.10
POD-051-PCBA-010-X09070	24	1.5 + 0.1/-0.0	1.5	1.75 ± 0.1	22.3	11.5 ± 0.1	4.0 ± 0.1	120 ± 0.1	2.0 ± 0.1	0.5 ± 0.05	0.1	6.9	24.25	7.35 ± 0.10	9.35 ± 0.10	6.35 ± 0.10
POD-054-PQFN-054-C09090	16	1.55 ± 0.05	1.5	1.75 ± 0.1	13.85	7.5 ± 0.1	4.0 ± 0.1	120 ± 0.1	2.0 ± 0.1	0.3 ± 0.05	0.1	1.65	16.03	9.30 ± 0.10	9.30 ± 0.10	1.10 ± 0.10

Note: All dimensions are in mm

Figure 8: Carrier Tape Dimensions



Tape Size	A Max.	B Min.	C	D Min.	N	W1	W2 Max
8	180	1.5	13.0 +0.6/-0.2	20.2	60+/-0.5	8.4+1.5/-0	14.4
8	330	1.5	13.0 +0.6/-0.2	20.2	100+/-0.5	8.4+1.5/-0	14.4
12	330	1.5	13.0 +0.6/-0.2	20.2	100+/-0.5	12.4+1.5/-0	18.4
12	180	1.5	13.0 +0.6/-0.2	20.2	60+/-0.5	12.4+1.5/-0	18.4
16	330	1.5	13.0 +0.6/-0.2	20.2	100+/-0.5	16.4+1.5/-0	22.4
16	180	1.5	13.0 +0.6/-0.2	20.2	60+/-0.5	16.4+1.5/-0	22.4
24	330	1.5	13.0 +0.6/-0.2	20.2	100+/-0.5	24.4+1.5/-0	30.4

Figure 9: Reel Dimensions

Device orientation in the carrier tape is shown in the diagram below for all QFN, WLCSP, and module (SIP LGA) packages (Figure 10) and SOT23-5 package (Figure 11).

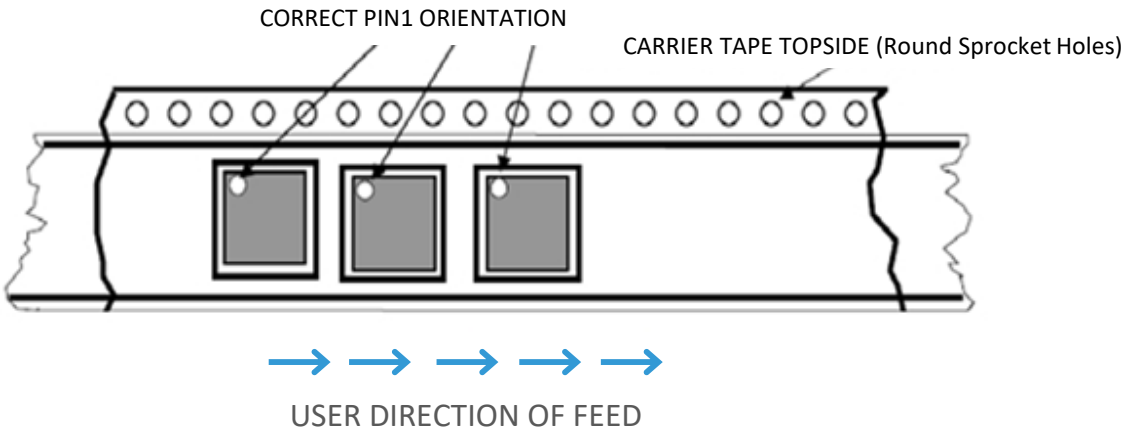


Figure 10: Standard Tape and Reel Pin 1 Orientation (Except for SOT-23)

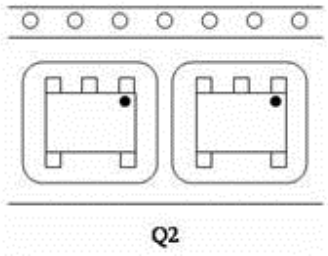


Figure 11: SOT23 Tape and Reel Pin 1 Orientation

Table 7 below provides the ordering details for tape and reel quantity, reel size, and top mark options. The "Suffix" character is the last character in the part number string as shown in the example below. Deviation from this table will be indicated via a custom part number (CS).

SiT8002AI-23-33E-30.00000**Y**

Suffix Character

Table 7: Marking and Tape & Reel Option Selections with Part Number Coding

Suffix	Packaging Method	Package Size (mm)	Reel Size (inches)	Qty per Reel	Top Mark
M	Bulk	All	N/A	Shipped in canister or ESD bag or tube – any qty	2 Lines Frequency Mark
V	16mm Tape & Reel	7.0 x 5.0	13	3000	2 Lines Frequency Mark
	12mm Tape & Reel	5.0 x 3.2	13	3000	
	12mm Tape & Reel	3.2 x 2.5	7	3000	
	12mm Tape & Reel	2.7 x 2.4	7	3000	
	12mm Tape & Reel	2.5 x 2.0	7	3000	
Z	16mm Tape & Reel	7.0 x 5.0	7	1000	2 Lines Frequency Mark
	12mm Tape & Reel	5.0 x 3.2	7	1000	
	12mm Tape & Reel	3.2 x 2.5	7	1000	
	12mm Tape & Reel	2.7 x 2.4	7	1000	
	12mm Tape & Reel	2.5 x 2.0	7	1000	
W	16mm Tape & Reel	7.0 x 5.0	7	250	2 Lines Frequency Mark
	12mm Tape & Reel	5.0 x 3.2	7	250	
	12mm Tape & Reel	3.2 x 2.5	7	250	
	12mm Tape & Reel	2.7 x 2.4	7	250	
	12mm Tape & Reel	2.5 x 2.0	7	250	
H	8mm Tape & Reel	3.2 x 2.5	7	3000	2 Lines Frequency Mark
	8mm Tape & Reel	2.5 x 2.0	7	3000	
	8mm Tape & Reel	SOT23	7	3000	
J	8mm Tape & Reel	3.2 x 2.5	7	1000	2 Lines Frequency Mark
	8mm Tape & Reel	2.5 x 2.0	7	1000	
	8mm Tape & Reel	SOT23	7	1000	
K	8mm Tape & Reel	3.2 x 2.5	7	250	2 Lines Frequency Mark
	8mm Tape & Reel	2.5 x 2.0	7	250	
	8mm Tape & Reel	SOT23	7	250	
T	16mm Tape & Reel	7.0 x 5.0	13	3000	1 Line Standard Mark
	16mm Tape & Reel	9.0 x 9.0	13	3000	
	12mm Tape & Reel	5.0 x 3.2	13	3000	
	12mm Tape & Reel	3.2 x 2.5	7	3000	
	12mm Tape & Reel	2.7 x 2.4	7	3000	
	12mm Tape & Reel	2.5 x 2.0	7	3000	

Table 7: Marking and Tape & Reel Option Selections with Part Number Coding (continued)

Suffix	Packaging Method	Package Size (mm)	Reel Size (inches)	Qty per Reel	Top Mark
Y	16mm Tape & Reel	7.0 x 5.0	7	1000	1 Line Standard Mark
	16mm Tape & Reel	9.0 x 9.0	7	1000	
	12mm Tape & Reel	5.0 x 3.2	7	1000	
	12mm Tape & Reel	3.2 x 2.5	7	1000	
	12mm Tape & Reel	2.7 x 2.4	7	1000	
	12mm Tape & Reel	2.5 x 2.0	7	1000	
N	24mm Tape & Reel	9.0 x 7.0	13	500	1 Line Standard Mark
X	24mm Tape & Reel	9.0 x 7.0	13	250	1 Line Standard Mark
	24mm Tape & Reel	9.0 x 7.0	7	250	
	16mm Tape & Reel	7.0 x 5.0	7	250	
	12mm Tape & Reel	9.0 x 9.0	7	250	
	12mm Tape & Reel	5.0 x 3.2	7	250	
	12mm Tape & Reel	3.2 x 2.5	7	250	
	12mm Tape & Reel	2.7 x 2.4	7	250	
	12mm Tape & Reel	2.5 x 2.0	7	250	
D	8mm Tape & Reel	3.2 x 2.5	7	3000	1 Line Standard Mark
	8mm Tape & Reel	2.5 x 2.0	7	3000	
	8mm Tape & Reel	2.0 x 1.6	7	3000	
	8mm Tape & Reel	2.0 x 1.2	7	3000	
	8mm Tape & Reel	SOT23	7	3000	
	8mm Tape & Reel	1.5 x 0.8	7	3000	
C	8mm Tape & Reel	3.2 x 2.5	7	3000	1 Line Standard Mark
	8mm Tape & Reel	2.5 x 2.0	7	3000	
	8mm Tape & Reel	2.0 x 1.6	7	3000	
	8mm Tape & Reel	2.0 x 1.2	7	3000	
	8mm Tape & Reel	SOT23	7	3000	
	8mm Tape & Reel	1.5 x 0.8	7	3000	
	12mm Tape & Reel	5.0 x 3.2	7	3000	
E	8mm Tape & Reel	3.2 x 2.5	7	1000	1 Line Standard Mark
	8mm Tape & Reel	2.5 x 2.0	7	1000	
	8mm Tape & Reel	2.0 x 1.6	7	1000	
	8mm Tape & Reel	2.0 x 1.2	7	1000	
	8mm Tape & Reel	SOT23	7	1000	
	8mm Tape & Reel	1.5 x 0.8	7	1000	

Table 7: Marking and Tape & Reel Option Selections with Part Number Coding (continued)

Suffix	Packaging Method	Package Size (mm)	Reel Size (inches)	Qty per Reel	Top Mark
B	8mm Tape & Reel	3.2 x 2.5	7	1000	1 Line Standard Mark
	8mm Tape & Reel	2.5 x 2.0	7	1000	
	8mm Tape & Reel	2.0 x 1.6	7	1000	
	8mm Tape & Reel	2.0 x 1.2	7	1000	
	8mm Tape & Reel	SOT23	7	1000	
	8mm Tape & Reel	1.5 x 0.8	7	1000	
	12mm Tape & Reel	5.0 x 3.2	7	1000	
G	8mm Tape & Reel	3.2 x 2.5	7	250	1 Line Standard Mark
	8mm Tape & Reel	2.5 x 2.0	7	250	
	8mm Tape & Reel	2.0 x 1.6	7	250	
	8mm Tape & Reel	2.0 x 1.2	7	250	
	8mm Tape & Reel	SOT23	7	250	
	8mm Tape & Reel	1.5 x 0.8	7	250	
A	8mm Tape & Reel	3.2 x 2.5	7	250	1 Line Standard Mark
	8mm Tape & Reel	2.5 x 2.0	7	250	
	8mm Tape & Reel	2.0 x 1.6	7	250	
	8mm Tape & Reel	2.0 x 1.2	7	250	
	8mm Tape & Reel	SOT23	7	250	
	8mm Tape & Reel	1.5 x 0.8	7	250	
	12mm Tape & Reel	5.0 x 3.2	7	250	
Q	8mm Tape & Reel	3.2 x 2.5	7	5000	1 Line Standard Mark
	8mm Tape & Reel	2.5 x 2.0	7	5000	
	8mm Tape & Reel	2.0 x 1.6	7	5000	
	8mm Tape & Reel	2.0 x 1.2	7	5000	
	8mm Tape & Reel	SOT23	7	5000	
	8mm Tape & Reel	1.5 x 0.8	7	5000	
S	8mm Tape & Reel	2.0 x 1.2	13	10000	1 Line Standard Mark
	8mm Tape & Reel	SOT23	13	10000	
	8mm Tape & Reel	1.5 x 0.8	13	10000	
F	8mm/12mm Tape & Reel	All	All	Below 250pcs	1 Line Standard Mark
"Blank"	Bulk	All	N/A	Shipped in canister or ESD bag or tube – any qty	1 Line Standard Mark

Tape leader and trailer are per EIA-481 as shown below:

Table 8: Leader and Trailer Lengths

All Reels	Minimum Length
Leader	400 mm
Trailer	160 mm

Peel Strength: The force required to peel off the cover tape from the carrier tape will fall within the range of 0.1 Newton to 1.3 Newton (10 grams to 130 grams) at a peeling speed to 300 mm per minute. This complies with the EIA standard.

4 Storage and Handling

SiTime Emerald and Cascade products are moisture sensitive and need to be handled within proper MSL3 guidelines to avoid damage from moisture absorption and exposure to solder reflow temperatures. Deviation from these guidelines may result in yield and reliability degradation.

Devices are baked and dry-packed before shipment from the SiTime factory. The packing uses a moisture barrier bag (MBB). A humidity indicator card (HIC) and drying desiccant are included inside the MBB. An MSL3 label is attached to caution that the bag contains moisture sensitive devices.

Shelf life of devices in a sealed bag is 12 months at <40°C and <90% room humidity (RH). Upon opening the MBB, the HIC should be checked immediately. Devices require baking before board mounting if the HIC is >10% when read at 23°C ±5°C.

After the MBB is opened, devices should go through reflow for board assembly within 48 hours at factory conditions of <30°C/60% RH or stored at <10% RH. Baking is required before board mounting if the above conditions are not met.

If baking is required, devices should be baked for a minimum of 8 hours at 125°C ±5°C. Retaping and dry packing in a MBB with HIC and drying desiccant may be required if the devices will not be used within 48 hours at factory conditions of <30°C/60% RH or stored at <10% RH conditions.

For other SiTime products which are MSL1 rated, it is recommended that the sealed tape be stored in conditions where the environment does not exceed the following conditions.

→ Temperature: 40°C maximum
→ Relative humidity: 90% maximum
→ No direct exposure to sunlight

5 ESD

SiTime's products are semiconductor based and as such have sensitivity to electro-static discharge (ESD). Care must be taken to ensure careful handling to avoid damaging the components. Refer to JEDEC document JESD625, Requirements for Handling Electrostatic-Discharge-Sensitive Devices. This standard establishes the minimum requirements for ESD control methods, and the materials used to protect electronic devices that are susceptible to damage or degradation from ESD. The passage of a static charge through an electrostatic-discharge-sensitive (ESDS) device can result in catastrophic failure or performance degradation of the part. Device sensitivity to ESD is determined by test methods such as EIA/JESD22-A114/A115/C101.

6 Moisture Sensitivity Level

SiTime Emerald and Cascade products have been qualified to moisture sensitivity level 3 (MSL3). Refer to Section 4 for storage and handling instructions (including rebaking, if required).

Other SiTime products have been qualified to moisture sensitivity level 1 (MSL1) for Pb-Free devices per JEDEC J-STD-020 and are deemed to not be moisture sensitive. This means partially consumed reels may be stored under the conditions outlined in Section 4 indefinitely without re-sealing the protective storage bags in which the reels are shipped. It also means unused reels with a damaged bag seal may be used without baking. Because the parts meet MSL1, the protective storage bags in which the reels are shipped do not require desiccant or HIC cards and are not required to maintain a tight vacuum seal or dry nitrogen purge.

7 PCB Assembly Guidelines

7.1 Solder Reflow Profile

The solder reflow profile shown in Figure 12 is IPC/JEDEC J-STD-020 compliant and applies to all SiTime products and packages. Table 10 provides relevant details of the profile. Refer to Table 9 for the maximum reflow temperature as it is dependent on the package volume and thickness. An optimized reflow profile depends on several factors such as the solder paste, board density, and type of reflow equipment used. Additional reflow information can be obtained from solder paste vendor datasheets. It is recommended that any reflow profile be characterized with a fully populated production PCB and thermocouple placed on or closest to the SiTime component during profile. Thermocouples are generally used to record temperatures across the surface and any sensitive components on the PCB. Ensure that a thermocouple is placed in contact with the top surface of any moisture sensitive component to ensure maximum temperature is not exceeded.

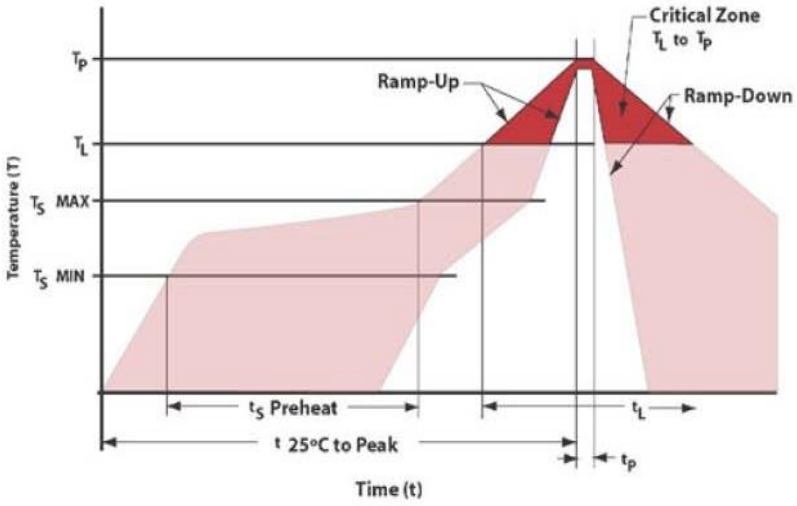


Figure 12: Convection Reflow Soldering Profile, per IPC/JEDEC J-STD-020

Table 9: Lead-Free Process Classification Temperature (Tc)

Package Thickness	Volume, mm^3 < 350	Volume, mm^3 350 - 2000	Volume, mm^3 >2000
<1.6 mm	260°C	260°C	260°C
1.6 to 2.5 mm	260°C	250°C	245°C
>2.5 mm	260°C	245°C	245°C

Table 10: High Temperature Infrared/Convection Reflow Conditions IPC/JEDEC J-STD-020

IPC/JEDEC Standard	IPC/JEDEC J-STD-020
Moisture Sensitivity Level	Level 1
T_S MAX to T_L (Ramp-up Rate)	3°C/second Maximum
Preheat	
Temperature Minimum (T_S MIN)	150°C
Temperature Typical (T_S TYP)	175°C
Temperature Maximum (T_S MAX)	200°C
Time (t_S)	60 - 180 Seconds
Ramp-up Rate (TL to TP)	3°C/second Maximum
Time Maintained Above	
Temperature (T_L) **60 - 150 Seconds**	217°C 260°C Maximum for 10 Seconds
Time (T_L)	60 - 150 Seconds
Peak Temperature (T_P) **60 - 150 Seconds**	260°C Maximum 260°C Maximum for 10 Seconds
Target Peak Temperature (T_P Target)	255°C
Time within 5°C of Actual Peak (t_P)	20 - 40 seconds
Max. Number of Reflow Cycles	3; see Note 2
Ramp-down Rate	6°C/second Maximum
Time 25°C to Peak Temperature (t)	8 minutes Maximum

Note 1: Temperatures shown are applied to body of device.

Note 2: For 9.0 mm x 7.0 mm 10L stacked PCB package Max. Number of Reflow Cycles are 2.

Table 11: Manual Soldering Conditions

Manual Soldering (Iron)	
350°C Maximum for 3 seconds	Caution: Small package body parts heat up very quickly and can be damaged. Proper baking needs to be done prior to manual soldering/desoldering, if not stored as per Section 4, for MSL3 classified products to avoid device damage.

7.2 PCB Cleaning Assembly Notes

Cleaning PCB assemblies after reflow is a common process requirement to remove residual flux and loose solder. No-Clean and water-soluble fluxes are left behind and require removal to meet assembly inspection standards. The package materials of the SiTime products are not susceptible to water or other common solvents (alcohol and acetone) used for assembly cleaning. SiTime recommends not using cleaning and manufacturing equipment (e.g., ultrasonic plastic fusion, plastic saw, plastic test machines, cleaning baths) operating at ultrasonic frequencies. Instead, SiTime recommends that the customer use IPA (Isopropyl Alcohol) baths.

SiTime products, which are in WLCSP package, include a protective, opaque polymer topcoat. If the part will be exposed to intense light, especially in the 1.0-1.2 µm IR spectrum, we recommend a protective "glob-top" epoxy or other cover to keep the light from negatively impacting the frequency stability.

One of the key elements enabling extremely stable MEMS resonators is the SiTime EpiSeal® process which hermetically seals the resonators during wafer processing, eliminating the need for hermetically sealed ceramic packaging. The SiTime EpiSeal resonator is impervious to the highest concentration elements in the atmosphere, nitrogen, and oxygen, and therefore acts as a perfect seal. Previous generations of EpiSeal resonators may have been impacted by large concentrations of small-molecule gas. Newer EpiSeal resonators are impervious to all small-molecule gases. Please contact SiTime for recommended gas-impervious parts for applications where SiTime parts may be exposed to a large concentration of small-molecule gas.

8 Product Packing

8.1 TNR Packing in Inner/Pizza Box

The sealed reel is placed in a static dissipative ESD bag. An ESD label and product label is placed on the ESD bag. One reel/ESD bag is wrapped in anti-static bubble wrap and placed in an inner box/pizza box (Figure 13). Pizza Box packing flow is shown in Figure 14. Desiccants and HICs (humidity indicator cards) are not included for MSL1 products.



Figure 13: ESD Bag Packing in Inner Box

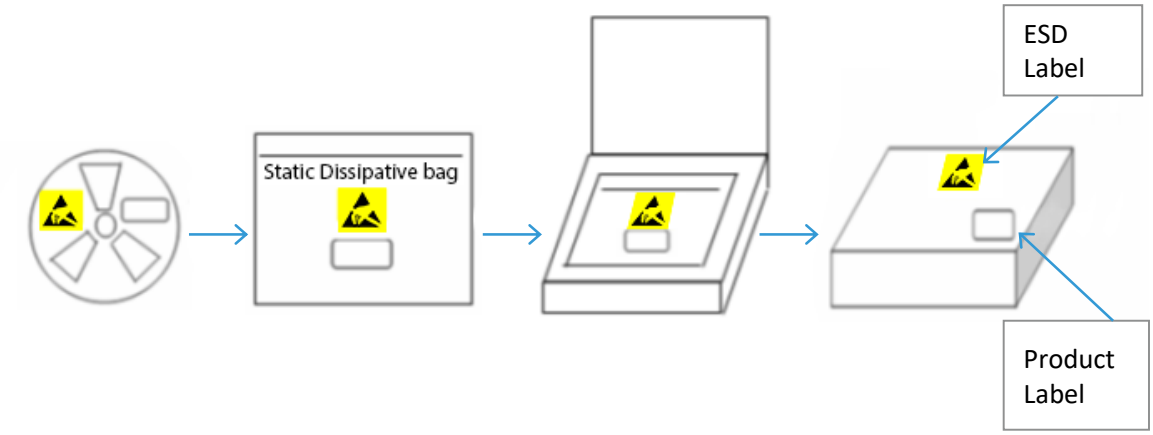


Figure 14: Inner Box/Pizza Box Packing Flow

8.2 Pizza box/Inner box dimensions are provided below

Table 12: Thick Pizza Box Dimension

Reel size	Length (L)	Width (W)	Height (H)
7 inch reel	220 mm	205 mm	50 mm
13 inch reel	370 mm	355 mm	55 mm
			Tolerance 20 mm

Table 13: Thin Pizza Box Dimension

Reel size	Length (L)	Width (W)	Height (H)
7 inch reel	220 mm	205 mm	35 mm
13 inch reel	346 mm	346 mm	35 mm
			Tolerance 5 mm

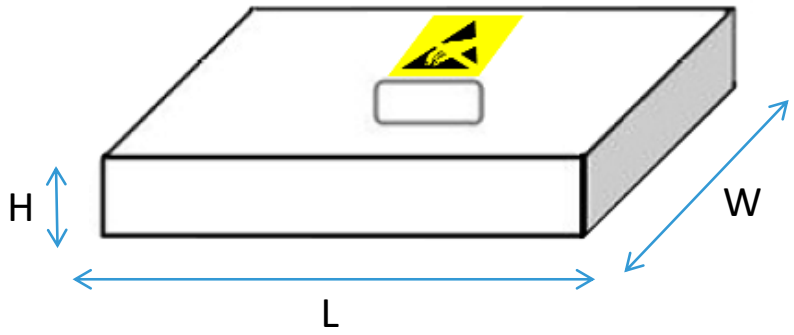


Figure 15: Pizza Box dimensions

8.3 Packing pizza boxes in shipping carton

All pizza boxes will be placed vertically in the shipping carton. Each shipping carton will have the maximum number of pizza boxes which will fit in the carton. Antistatic bubble wrap or popcorn will be used as filler for empty space.

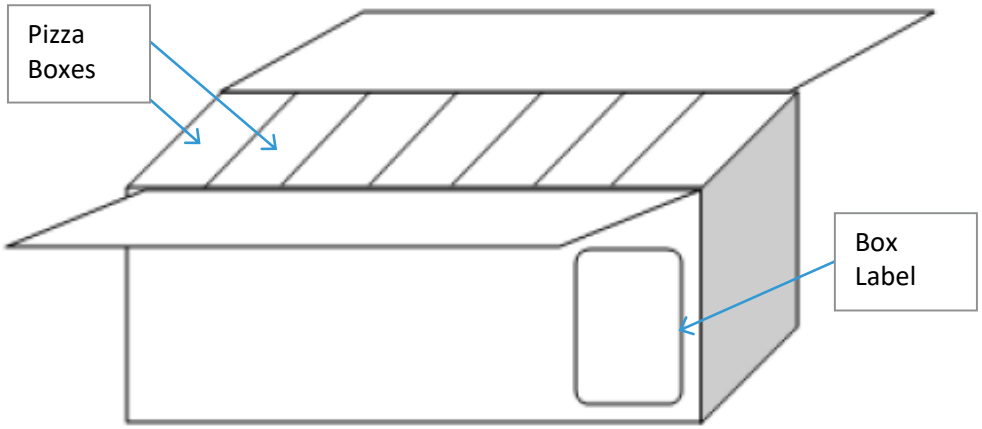


Figure 16: Shipping Carton Packing

9 Package Labeling

9.1 Inner Box/ Pizza Box Labeling

The pizza box or inner box label is shown in Figure 16.



Figure 17: Inner Box/Pizza Box Label

1. **Lot Code:** Five-digit SiTime lot code*
2. **Device:** SiTime marketing part number identified on datasheet
3. **Marketing Part Number:** SiTime marketing part number identified on datasheet
4. **Date Code*:** Product manufacturing date code
5. **Quantity:** Quantity of units in the TNR/box
6. **The following un-barcoded information**

   Company Name: SiTime

   RoHS symbol: **ESD symbol:**





*Note: Up to two lots/date codes can be merged in one TNR

9.2 Outer Box/Carton Labeling

The outer box/carton label is shown in Figure 18.

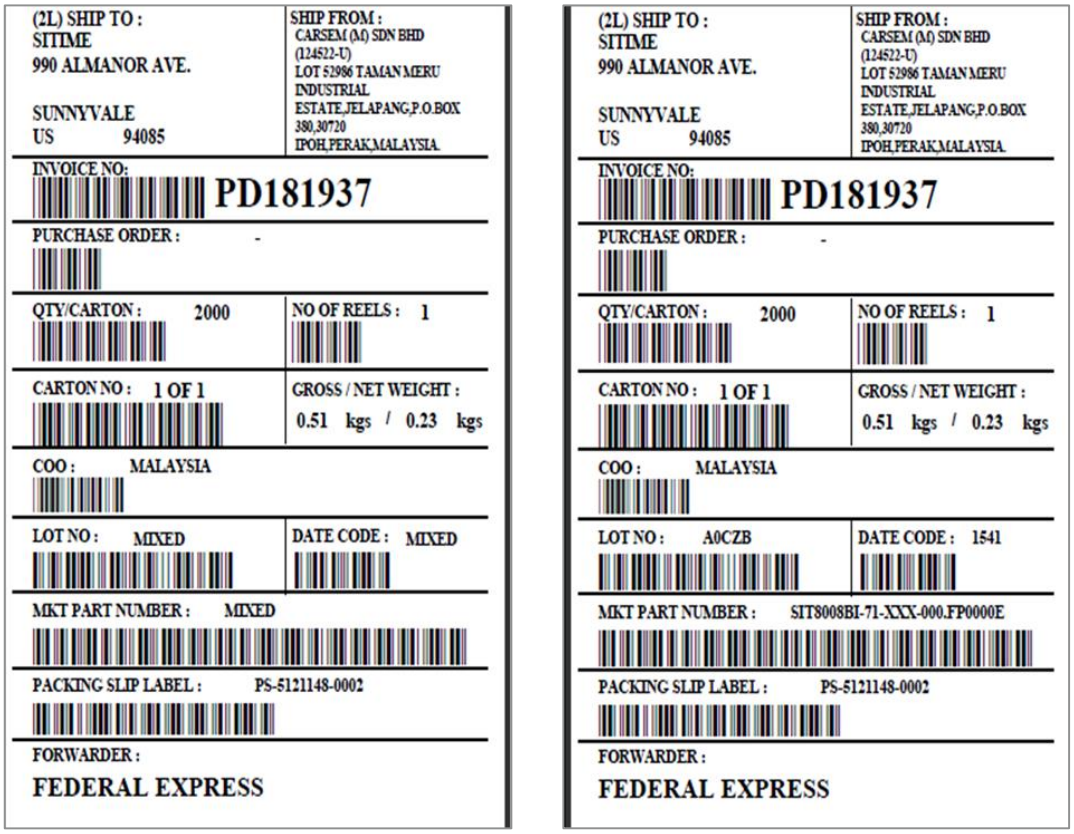


Figure 18: Outer Box/Carton Label

Where,

- Label size will be 4.0” x 6.0”
- Label will contain the following information:
  - i. Ship to
  - ii. Ship from
  - iii. Invoice no – **optional field (vendors internal reference)**
  - iv. End customer PO number
  - v. Total Box Quantity
  - vi. Number of reels
  - vii. Number of Carton (s)
  - viii. Gross and Net Weight
  - ix. Country of Origin (COO)
  - x. Lot Number
  - xi. Date Code
  - xii. Marketing Part Number
  - xiii. Packing Slip Label No
  - xiv. Forwarder Information

Note: When there is more than one marketing part number or more than one date code or more than one lot code, these fields will be indicated as “MIXED” on the label.

10 Additional Questions?

If you have any questions about the information contained in this manufacturing note or other manufacturing questions, please contact your sales representative.

Table 14: Revision History

Version	Release Date	Change Summary
A23	1-Dec-2020	Reformatted, Table of Contents added, grammatical and other edits for consistency and clarification Figure 8 Tape and Reel Dimension (for POD 36 and POD 38 rows)
A24	23-Jun-2021	Added Note 2 to Max. Number of Reflow Cycles
A25	30-Oct-2021	Update sec 7.2. “SiTime recommends not using cleaning equipment, including baths, operating at ultrasonic frequencies.”
A26	4-Nov-2021	Updated wording in sec 7.2.
A27	9-Dec-2021	Typo correction: “glop-top” to “glob-top”
A28	10-Feb-2022	Packaging Method 8 mm Tape & Reel excluded for 2.7 x 2.4 Package Size
A29	22-Mar-2022	Updated sec 2.1 “Added X, Y, Z, V, T character used for marking of Conditional Released parts where full qualification is not completed.”
A30	24-Jun-2022	Table 7 updated
A31	12-Jul-2022	1) Changes made for POD-038-PQFD-006-C03225 - Tape Size 12 to 8 2) Add in 9.0 x9.0 Carrier tape information for 3000, 1000 & 250 Reel Quantity
A32	6-Oct-2022	Updated section 2 to include QFN 2.0x1.2 Marking
A33	28-Nov-2022	Updated section 2 to include Ceramic Package 7.0x5.0 Marking

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