SiT2024B

Automotive AEC-Q100 SOT23 Oscillator

Features

- AEC-Q100 with extended temperature range (-55°C to 125°C)
- Frequencies between 1 MHz and 110 MHz accurate to 6 decimal places
- Supply voltage of 1.8V or 2.25V to 3.63V
- Excellent total frequency stability as low as ±20 ppm
- Industry best G-sensitivity of 0.1 PPB/G
- Low power consumption of 3.8 mA typical at 1.8V
- LVCMOS/LVTTL compatible output
- 5-pin SOT23-5 package: 2.9 x 2.8 mm x mm
- RoHS and REACH compliant, Pb-free, Halogen-free and Antimony-free

Applications

- Automotive, extreme temperature and other high-rel electronics
- Infotainment systems, collision detection devices, and in-vehicle networking
- Powertrain control

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	1	–	110	MHz	Refer to Table 13 and Table 14 for a list supported frequencies
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 (15 pF ± 10%).
		-25	–	+25	ppm	
		-30	–	+30	ppm	
		-50	–	+50	ppm	
Operating Temperature Range						
Operating Temperature Range (ambient)	T_use	-40	–	+85	°C	Industrial, AEC-Q100 Grade 3
		-40	–	+105	°C	Extended Industrial, AEC-Q100 Grade 2
		-40	–	+125	°C	Automotive, AEC-Q100 Grade 1
		-55	–	+125	°C	Extended Temperature, AEC-Q100
Supply Voltage and Current Consumption						
Supply Voltage	Vdd	1.62	1.8	1.98	V	All voltages between 2.25V and 3.63V including 2.5V, 2.8V, 3.0V and 3.3V are supported.
		2.25	–	3.63	V	
Current Consumption	Idd	–	4.0	4.8	mA	No load condition, f = 20 MHz, Vdd = 2.25V to 3.63V
		–	3.8	4.5	mA	No load condition, f = 20 MHz, Vdd = 1.8V
LVCMOS Output Characteristics						
Duty Cycle	DC	45	–	55	%	All Vdds
Rise/Fall Time	Tr, Tf	–	1.5	3	ns	Vdd = 2.25V - 3.63V, 20% - 80%
		–	1.3	2.5	ns	Vdd = 1.8V, 20% - 80%
Output High Voltage	VOH	90%	–	–	Vdd	IOH = -4 mA (Vdd = 3.0V or 3.3V) IOH = -3 mA (Vdd = 2.8V and Vdd = 2.5V) IOH = -2 mA (Vdd = 1.8V)
Output Low Voltage	VOL	–	–	10%	Vdd	IOL = 4 mA (Vdd = 3.0V or 3.3V) IOL = 3 mA (Vdd = 2.8V and Vdd = 2.5V) IOL = 2 mA (Vdd = 1.8V)
Input Characteristics						
Input High Voltage	VIH	70%	–	–	Vdd	Pin 1, OE
Input Low Voltage	VIL	–	–	30%	Vdd	Pin 1, OE
Input Pull-up Impedence	Z_in	–	100	–	kΩ	Pin 1, OE logic high or logic low
Startup and Resume Timing						
Startup Time	T_start	–	–	10	ms	Measured from the time Vdd reaches its rated minimum value
Enable/Disable Time	T_oe	–	–	130	ns	f = 110 MHz. For other frequencies, T_oe = 100 ns + 3 * cycles
Jitter						
RMS Period Jitter	T_jitt	–	1.6	2.5	ps	f = 75 MHz, 2.25V to 3.63V
		–	1.9	3.0	ps	f = 75 MHz, 1.8V
RMS Phase Jitter (random)	T_phj	–	0.5	–	ps	f = 75 MHz, Integration bandwidth = 900 kHz to 7.5 MHz
		–	1.3	–	ps	f = 75 MHz, Integration bandwidth = 12 kHz to 20 MHz

Table 2. Pin Description

Pin	Symbol	Functionality	
1	GND	Power	Electrical ground
2	NC	No Connect	No connect
3	OE/NC	Output Enable	H[1]: specified frequency output L: output is high impedance. Only output driver is disabled.
		No Connect	Any voltage between 0 and Vdd or Open[1]: Specified frequency output. Pin 3 has no function.
4	VDD	Power	Power supply voltage[2]
5	OUT	Output	Oscillator output

Top View

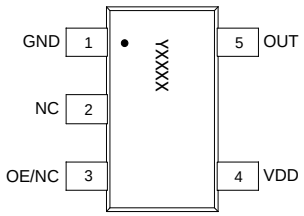


Figure 1. Pin Assignments

Notes:

1. In OE or ST mode, a pull-up resistor of 10 kΩ or less is recommended if pin 3 is not externally driven. If pin 3 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)	θJC, Bottom (°C/W)
SOT23-5	421	175

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
85°C	95°C
105°C	115°C
125°C	135°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]

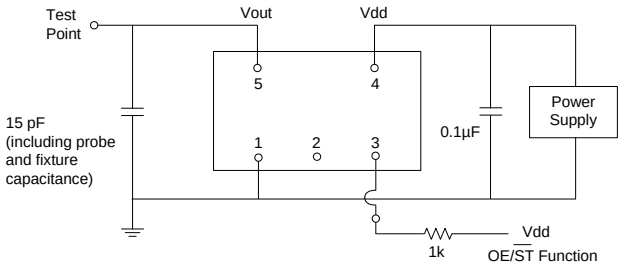


Figure 2. Test Circuit

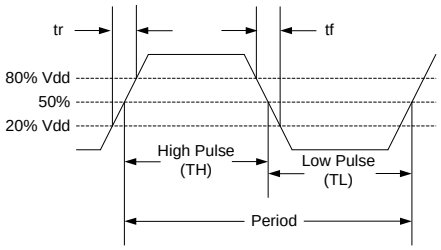
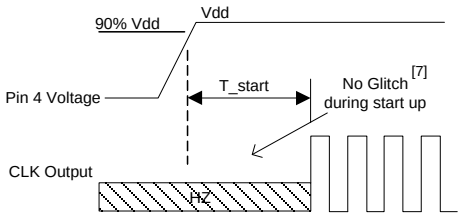


Figure 3. Waveform

Note:

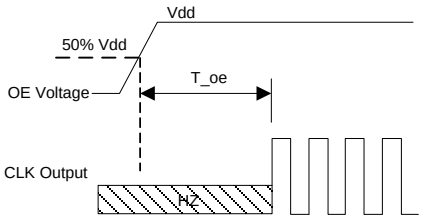
6. Duty Cycle is computed as Duty Cycle = TH/Period.

Timing Diagrams



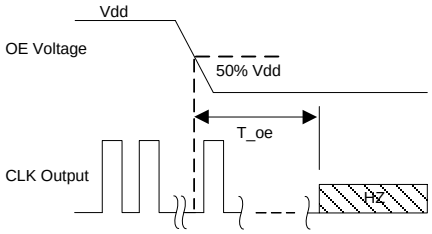
T_start: Time to start from power-off

Figure 4. Startup Timing (OE Mode)



T_oe: Time to re-enable the clock output

Figure 5. OE Enable Timing (OE Mode Only)



T_oe: Time to put the output in High Z mode

Figure 6. OE Disable Timing (OE Mode Only)

Note:

7. SiT2024 has “no runt” pulses and “no glitch” output during startup or resume.

Performance Plots[8]

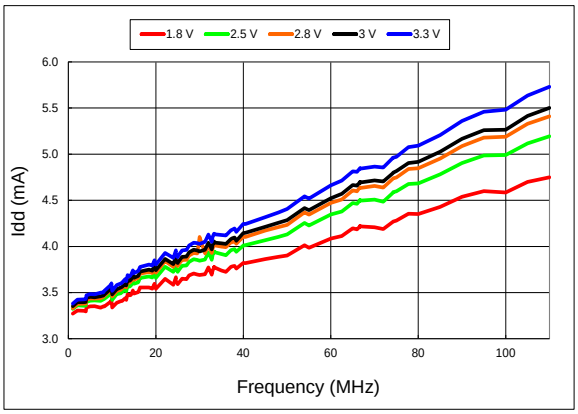


Figure 7. Idd vs Frequency

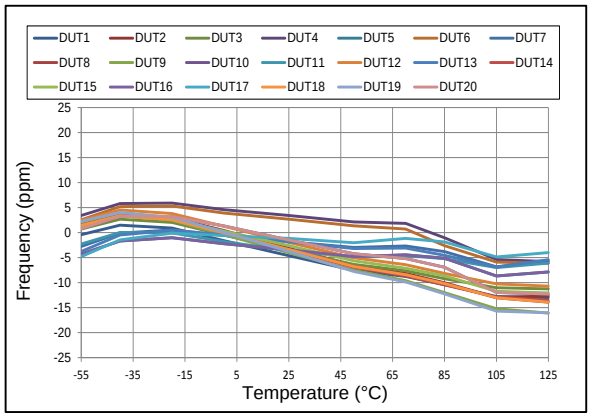


Figure 8. Frequency vs Temperature

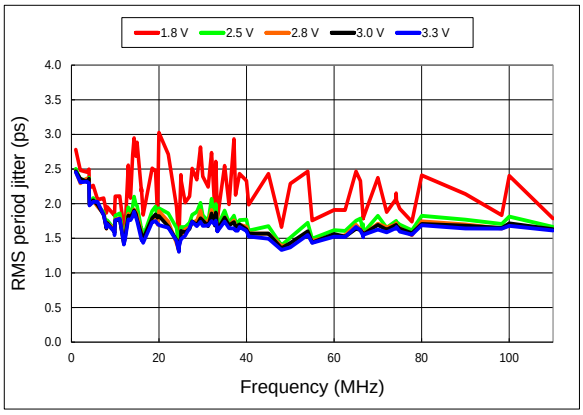


Figure 9. RMS Period Jitter vs Frequency

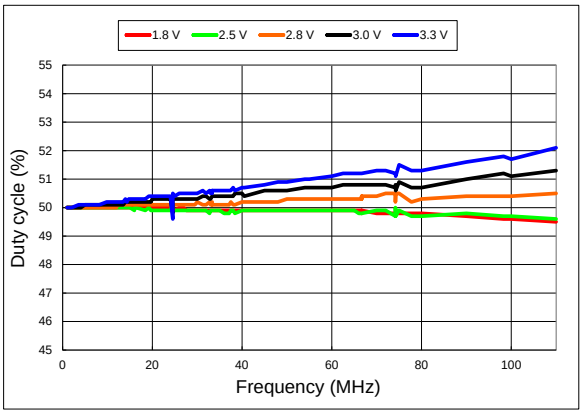


Figure 10. Duty Cycle vs Frequency

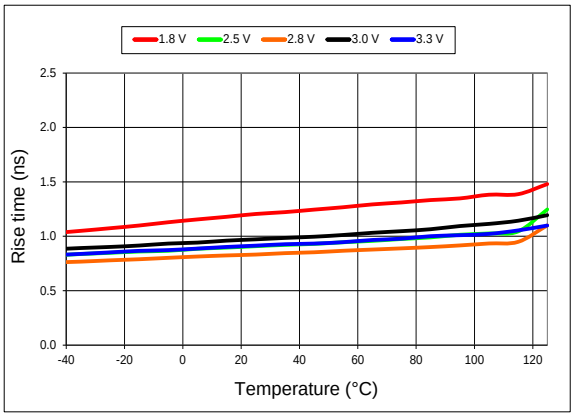


Figure 11. 20%-80% Rise Time vs Temperature

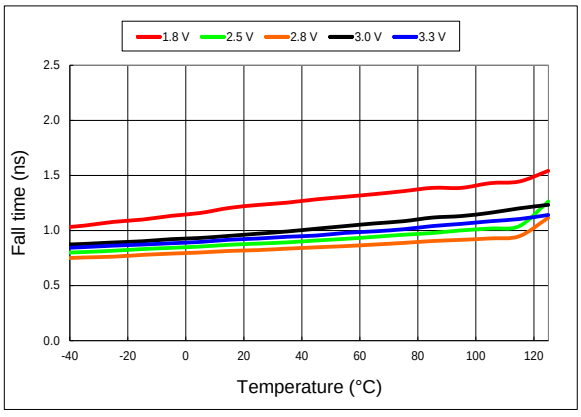


Figure 12. 20%-80% Fall Time vs Temperature

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

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

Rise/Fall Time Typ (ns)					
Drive Strength \ C_{LOAD}	5 pF	15 pF	30 pF	45 pF	60 pF
L	6.16	11.61	22.00	31.27	39.91
A	3.19	6.35	11.00	16.01	21.52
R	2.11	4.31	7.65	10.77	14.47
B	1.65	3.23	5.79	8.18	11.08
T	0.93	1.91	3.32	4.66	6.48
E	0.78	1.66	2.94	4.09	5.74
U	0.70	1.48	2.64	3.68	5.09
F or "-": default	0.65	1.30	2.40	3.35	4.56

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

Rise/Fall Time Typ (ns)					
Drive Strength \ C_{LOAD}	5 pF	15 pF	30 pF	45 pF	60 pF
L	4.13	8.25	12.82	21.45	27.79
A	2.11	4.27	7.64	11.20	14.49
R	1.45	2.81	5.16	7.65	9.88
B	1.09	2.20	3.88	5.86	7.57
T	0.62	1.28	2.27	3.51	4.45
E or "-": default	0.54	1.00	2.01	3.10	4.01
U	0.43	0.96	1.81	2.79	3.65
F	0.34	0.88	1.64	2.54	3.32

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

Rise/Fall Time Typ (ns)					
Drive Strength \ C_{LOAD}	5 pF	15 pF	30 pF	45 pF	60 pF
L	3.77	7.54	12.28	19.57	25.27
A	1.94	3.90	7.03	10.24	13.34
R	1.29	2.57	4.72	7.01	9.06
B	0.97	2.00	3.54	5.43	6.93
T	0.55	1.12	2.08	3.22	4.08
E or "-": default	0.44	1.00	1.83	2.82	3.67
U	0.34	0.88	1.64	2.52	3.30
F	0.29	0.81	1.48	2.29	2.99

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

Rise/Fall Time Typ (ns)					
Drive Strength \ C_{LOAD}	5 pF	15 pF	30 pF	45 pF	60 pF
L	3.60	7.21	11.97	18.74	24.30
A	1.84	3.71	6.72	9.86	12.68
R	1.22	2.46	4.54	6.76	8.62
B	0.89	1.92	3.39	5.20	6.64
T or "-": default	0.51	1.00	1.97	3.07	3.90
E	0.38	0.92	1.72	2.71	3.51
U	0.30	0.83	1.55	2.40	3.13
F	0.27	0.76	1.39	2.16	2.85

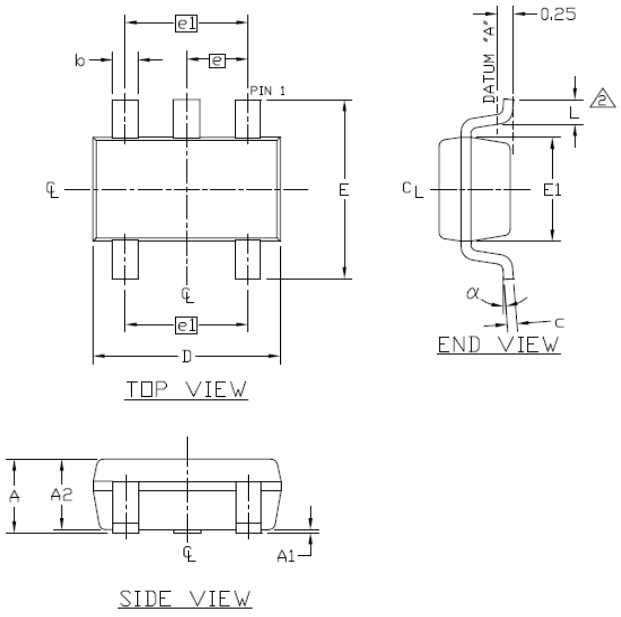
Table 11. Vdd = 3.3V Rise/Fall Times for Specific C_{LOAD}

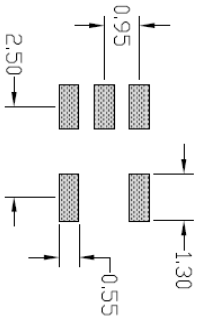
Rise/Fall Time Typ (ns)					
Drive Strength \ C_{LOAD}	5 pF	15 pF	30 pF	45 pF	60 pF
L	3.39	6.88	11.63	17.56	23.59
A	1.74	3.50	6.38	8.98	12.19
R	1.16	2.33	4.29	6.04	8.34
B	0.81	1.82	3.22	4.52	6.33
T or "-": default	0.46	1.00	1.86	2.60	3.84
E	0.33	0.87	1.64	2.30	3.35
U	0.28	0.79	1.46	2.05	2.93
F	0.25	0.72	1.31	1.83	2.61

Dimensions and Patterns

Package Size – Dimensions (Unit: mm)[10]	Recommended Land Pattern (Unit: mm)[11]

2.90 x 2.80 mm SOT23-5





Notes:

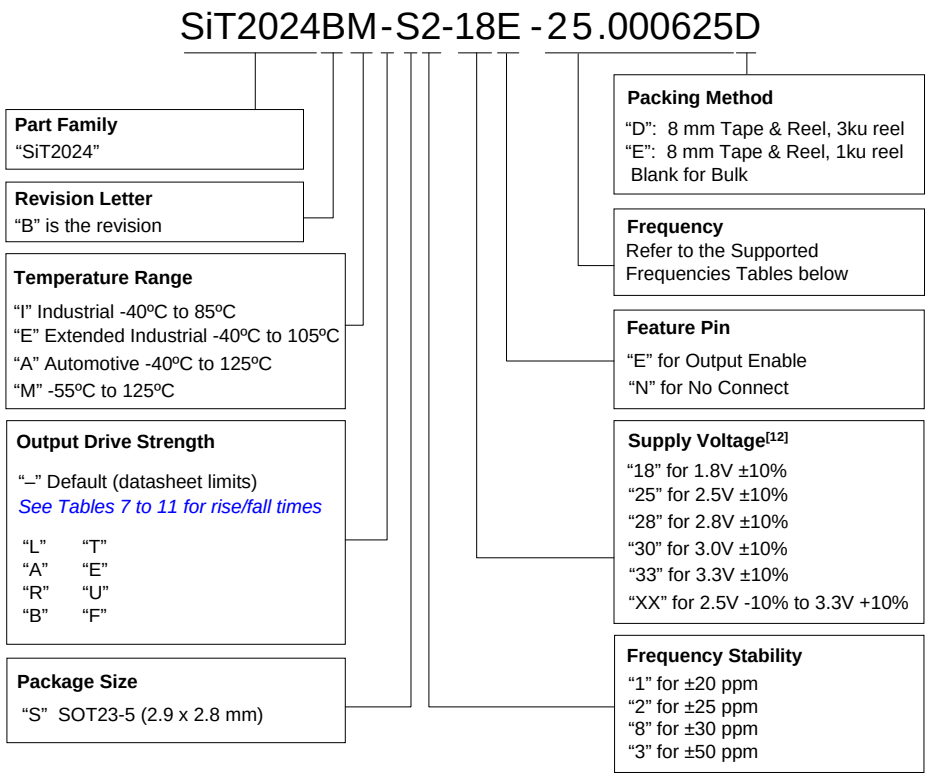
10. Top marking: Y denotes manufacturing origin and XXXX denotes manufacturing lot number. The value of "Y" will depend on the assembly location of the device.
11. A capacitor value of 0.1 µF between Vdd and GND is required

Table 13. Dimension Table

Symbol	Min.	Nom.	Max.
A	0.90	1.27	1.45
A1	0.00	0.07	0.15
A2	0.90	1.20	1.30
b	0.30	0.35	0.50
c	0.14	0.15	0.20
D	2.75	2.90	3.05
E	2.60	2.80	3.00
E1	1.45	1.60	1.75
L	0.30	0.38	0.55
L1	0.25 REF		
e	0.95 BSC.		
e1	1.90 BSC.		
α	0°	–	8°

Ordering Information

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



Note:

12. The voltage portion of the SiT2024 part number consists of two characters that denote the specific supply voltage of the device. The SiT2024 supports either 1.8V ±10% or any voltage between 2.25V and 3.62V. In the 1.8V mode, one can simply insert 18 in the part number. In the 2.5V to 3.3V mode, two digits such as 18, 25 or 33 can be used in the part number to reflect the desired voltage. Alternatively, "XX" can be used to indicate the entire operating voltage range from 2.25V to 3.63V.

Table 14. Supported Frequencies (-40°C to +85°C)[13]

Frequency Range	
Min.	Max.
1.000000 MHz	110.000000 MHz

Table 15. Supported Frequencies (-40°C to +105°C or -40°C to +125°C)[13, 14]

Frequency Range	
Min.	Max.
1.000000 MHz	61.222999 MHz
61.974001 MHz	69.795999 MHz
70.485001 MHz	79.062999 MHz
79.162001 MHz	81.427999 MHz
82.232001 MHz	91.833999 MHz
92.155001 MHz	94.248999 MHz
94.430001 MHz	94.874999 MHz
94.994001 MHz	97.713999 MHz
98.679001 MHz	110.000000 MHz

Table 16. Supported Frequencies (-55°C to +125°C)[13, 14]

Frequency Range	
Min.	Max.
1.000000 MHz	61.222999 MHz
61.974001 MHz	69.239999 MHz
70.827001 MHz	78.714999 MHz
79.561001 MHz	80.159999 MHz
80.174001 MHz	80.779999 MHz
82.632001 MHz	91.833999 MHz
95.474001 MHz	96.191999 MHz
96.209001 MHz	96.935999 MHz
99.158001 MHz	110.000000 MHz

Notes:

13. Any frequency within the min and max values in the above table are supported with 6 decimal places of accuracy.
14. Please contact SiTime for frequencies that are not listed in the tables above.

Table 17. 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	http://www.sitime.com/component/docman/doc_download/243-manufacturing-notes-for-sitime-oscillators
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 18. Revision History

Revision	Release Date	Change Summary
0.1	05/19/2015	Final production release
1.4	03/18/2016	Added support for ±20 ppm frequency stability Revised the dimension table Added the industrial temperature "-40°C to ±85°C" option Revised the supported frequency tables
1.6	12/14/2016	Changed Clock Generator to SOT23 Oscillator Updated logo and company address, other page layout changes

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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