SiT1579

1.2mm² µPower, Low-Jitter, 1Hz – 2.5 MHz Oscillator

Features

- 1 Hz to 2.5 MHz ±50 ppm all-inclusive frequency stability
- Factory programmable output frequency
- World's smallest Oscillator Footprint: 1.2 mm²
  - 1.5 x 0.8 mm CSP
  - No external bypass cap required
- Improved stability reduces system power with fewer network timekeeping updates
- Ultra-low power: 6 µA (100 kHz)
- Supply voltage range: 1.62 V to 3.63 V
- Operating temperature ranges: -20°C to +70°C, -40°C to +85°C
- Pb-free, RoHS and REACH compliant

Applications

- Health and wellness monitors
- Smart pens
- ULP input devices
- Proprietary wireless
- Sensor interface

TempFlat MEMS™

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Electrical Characteristics

Table 1. Electrical Characteristics

Conditions: Min/Max limits are over temperature, V_{DD} = 1.8V ±10%, unless otherwise stated. Typicals are at 25°C and V_{DD} = 1.8V.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Frequency and Stability						
Output Frequency	F_{OUT}	1		2.5 M	Hz	
Initial Frequency Tolerance	F_tol	-10		10	ppm	Includes 2x reflow
Frequency Stability	F_stab	-50		50	ppm	All inclusive of over temperature, referenced to nominal frequency at 25°C, inclusive of V_{DD}, aging, and load
Jitter Performance						
Integrated Phase Jitter	IPJ		2	3.5	ns_{RMS}	F_{OUT} > 1 kHz. Integration bandwidth = 100 Hz to F_{OUT} /2. Inclusive of 50 mV peak-to-peak sinusoidal noise on V_{DD}. Noise frequency 100 Hz to 20 MHz
RMS Period Jitter	PJ		2.2	4.5	ns_{RMS}	Cycles = 10,000, f = 100kHz. Per JEDEC standard 65B, tested at 100kHz. See performance plot for other frequencies.
Supply Voltage and Current Consumption						
Operating Supply Voltage	V_{DD}	1.62		3.63	V	
No Load Supply Current	I_{DD}		3.65	5	µA	F_{OUT} = 1 Hz
			4.5	5.5		F_{OUT} = 33 kHz
			6	7		F_{OUT} = 100 kHz
			13	16		F_{OUT} = 1 MHz
			33	40		F_{OUT} = 2 MHz
Start-up Time at Power-up	t_start		150	300	ms	Measured when supply reaches 90% of final V_{DD} to the first output pulse and within specified min/max frequency limit.
			300 + 2.0 cycles	300 + 2.5 cycles		10 Hz < F_{OUT} ≤ 200 Hz, to first output pulse. Measured when supply reaches 90% of final V_{DD} to the first output pulse and within specified min/max frequency limit.
				500 + 3 cycles		1 Hz ≤ F_{OUT} ≤ 10 Hz, to first output pulse. Measured when supply reaches 90% of final V_{DD} to the first output pulse and within specified min/max frequency limit.
Operating Temperature Range						
Operating Temperature Range	Op_Temp	-20		70	°C	"C" ordering code
		-40		85	°C	"I" ordering code
LVCMOS Output						
Output Rise/Fall Time	t_R, t_F		9	20	ns	20-80%, 15 pF load, V_{DD} = 1.8V +/-10%
Output Clock Duty Cycle	DC	45		55	%	
Output Voltage High	VOH	90%			V_{DD}	I_{OH} = -50 µA, 15 pF load
Output Voltage Low	VOL			10%	V_{DD}	I_{OL} = 50 µA, 15 pF load

Note:

1. Includes initial tolerance, over temp stability, 2x reflow, V_{DD} range, board-level underfill, and 20% load variation. Tested with Agilent 53132A frequency counter. Measured with ≥100 ms gate time for accurate frequency measurement.

Table 2. Pin Configuration

Pin	Symbol	I/O	Functionality
1	NC	Internal Test	No Connect. Leave floating. Pin 1 is for internal testing and is designed to be left floating.
2	CLK Out	OUT	Oscillator clock output.
3	V_{DD}	Power Supply	Operates from nominal supply voltages between 1.8V and 3.3V. Under normal operating conditions, V_{DD} does not require external bypass/decoupling capacitor(s). SiT1579 includes on-chip V_{DD} filtering.
4	GND	Power Supply Ground	Connect to ground.

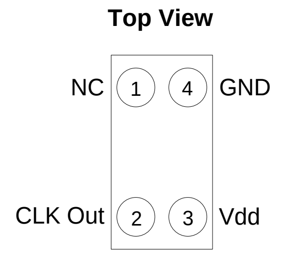


Figure 1. Pin Assignment

Table 3. Absolute Maximum Ratings

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.

Parameters	Test Conditions	Value	Unit
Continuous Power Supply Voltage Range (V_{DD})		-0.5 to 4.0	V
Continuous Maximum Operating Temperature Range		105	°C
Short Duration Maximum Operating Temperature Range	≤ 30 minutes	125	°C
Human Body Model (HBM) ESD Protection	JESD22-A114	2000	V
Charge-Device Model (CDM) ESD Protection	JESD22-C101	750	V
Machine Model (MM) ESD Protection	JESD22-A115	300	V
Latch-up Tolerance	JESD78 Compliant		
Mechanical Shock Resistance	Mil 883, Method 2002	20,000	*g*
Mechanical Vibration Resistance	Mil 883, Method 2007	70	*g*
1508 CSP Junction Temperature		150	°C
Storage Temperature		-65 to 150	°C

System Block Diagram

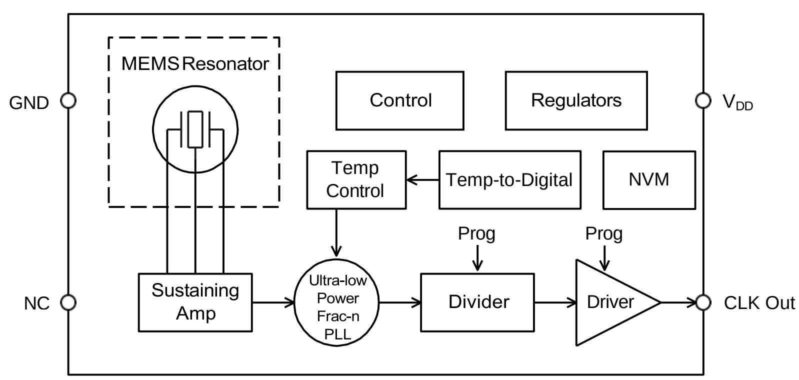


Figure 2. SiT1579 Block Diagram

Description

SiT1579 is an ultra-small and ultra-low power Factory programmable oscillator with an output frequency range between 1 Hz to 2.5 MHz. SiTime's silicon MEMS technology enables the first programmable, µPower oscillator in the world's smallest footprint and chip-scale packaging (CSP). Typical supply current is only 6 µA (100 kHz).

SiTime's MEMS oscillator consists of a MEMS resonator and a programmable analog circuit. SiT1579 MEMS resonator is built with SiTime's unique MEMS First™ process. A key manufacturing step is EpiSeal™ during which the MEMS resonator is annealed with temperatures over 1000°C. EpiSeal creates an extremely strong, clean, vacuum chamber that encapsulates the MEMS resonator and ensures the best performance and reliability. During EpiSeal, a poly silicon cap is grown on top of the resonator cavity, which eliminates the need for additional cap wafers or other exotic packaging. As a result, SiTime's MEMS resonator die can be used like any other semiconductor die. One unique result of SiTime's MEMS First and EpiSeal manufacturing processes is the capability to integrate SiTime's MEMS die with a SOC, ASIC, microprocessor or analog die within a package to eliminate external timing components and provide a highly integrated, smaller, cheaper solution to the customer.

Frequency Stability

The SiT1579 oscillator is Factory trimmed to 32.768 kHz at room temperature. The result is a very accurate oscillator at room temperature and over temperature. Unlike quartz crystals that have a classic tuning fork parabola temperature curve with a 25°C turnover point with a 0.04 to 0.06 ppm/°C2 temperature coefficient (TCF), the SiT1579 temperature coefficient is calibrated at room temperature and corrected over temperature with an active temperature correction circuit. The result is <±50 ppm frequency variation over the -40°C to +85°C temperature range.

When measuring the SiT1579 output frequency with a frequency counter, it is important to make sure the counter's gate time is >100 ms. Shorter gate times may lead to inaccurate measurements.

Typical Operating Curves

(T_A = 25°C, V_{DD} = 1.8V, supply current plots are no load, unless otherwise stated)

Figure 3. LVCMOS Output Swing (V_{DD} = 1.8V)

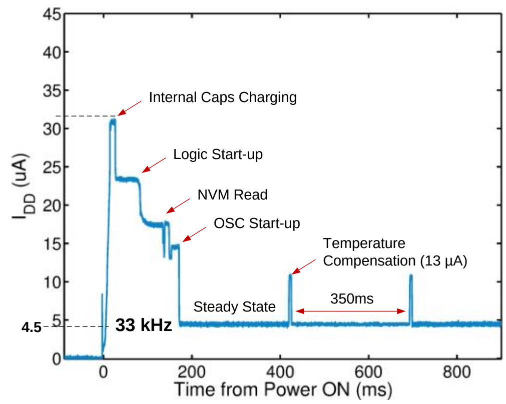


Figure 4. Start-up and Steady-State Current Profile

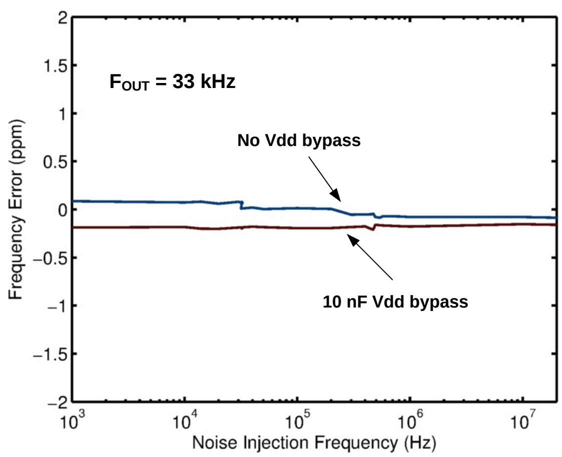


Figure 5. Power Supply Noise Rejection

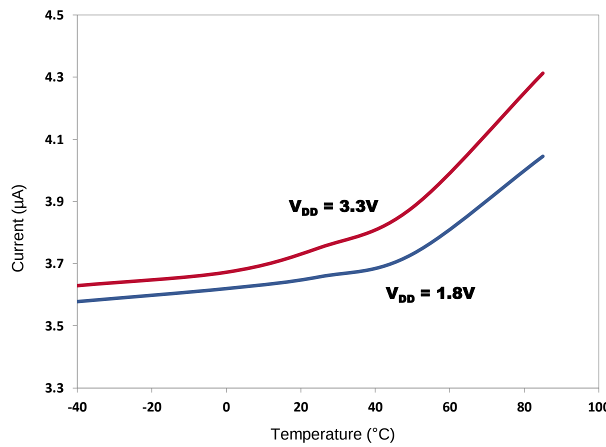


Figure 6. Supply Current vs Temperature (F_{OUT} = 1 Hz)

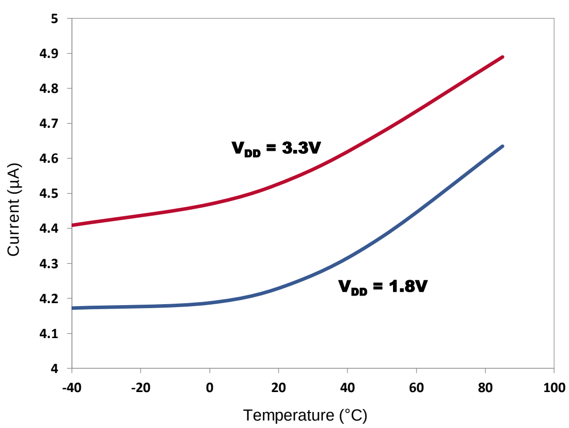


Figure 7. Supply Current vs Temperature (F_{OUT} = 100 Hz)

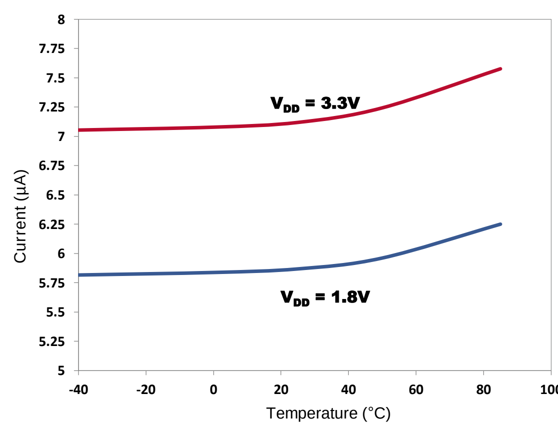


Figure 8. Supply Current vs Temperature (F_{OUT} = 100 kHz)

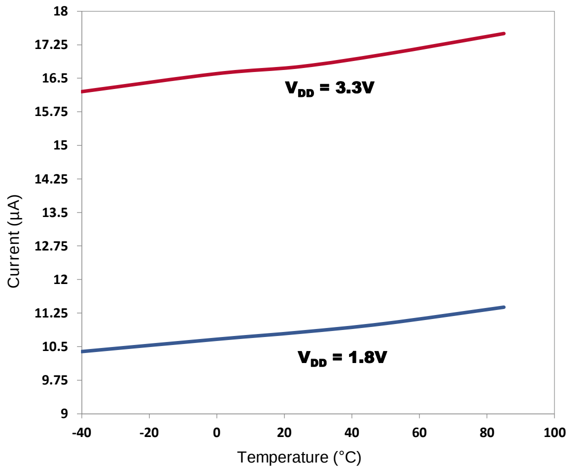


Figure 9. Supply Current vs Temperature (F_{OUT} = 500 kHz)

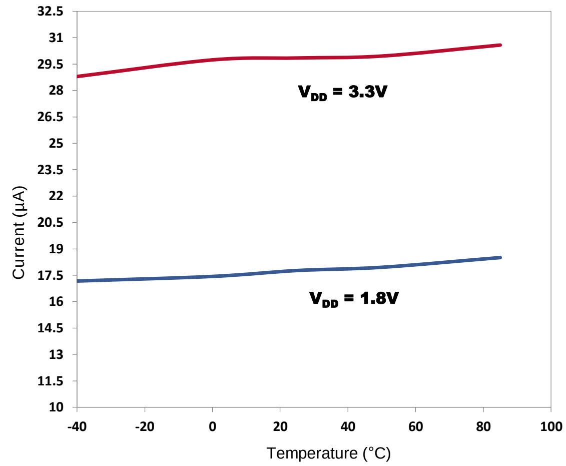


Figure 10. Supply Current vs Temperature (F_{OUT} = 1 MHz)

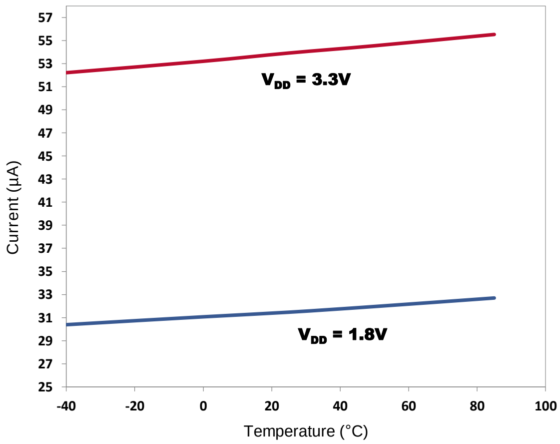


Figure 11. Supply Current vs Temperature (F_{OUT} = 1.85 MHz)

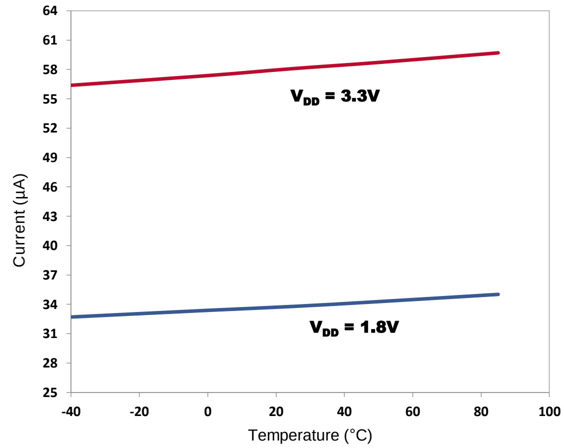
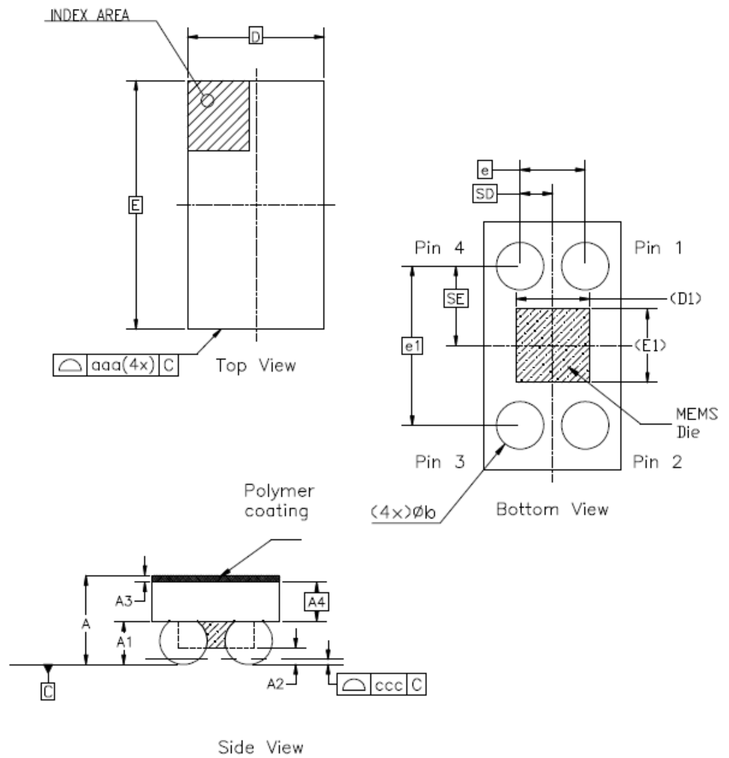


Figure 12. Supply Current vs Temperature (F_{OUT} = 2 MHz)

Dimensions and Patterns

Package Size – Dimensions (Unit: mm)



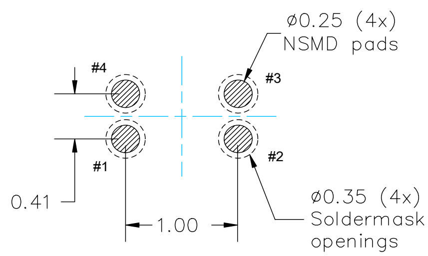
Dimension Table (mm)					
Item		SYMBOL	MINIMUM	NOMINAL	MAXIMUM
Total Thickness		A	0.48	0.54	0.60
Stand Off		A1	0.22		0.28
MEMS Clearance		A2	0.027		0.113
Film Thickness		A3	0.036	0.040	0.044
Wafer Thickness		A4	0.225	0.250	0.275
Ball Diameter		b	0.30	0.315	0.33
Ball Pitch	X	e	0.41 BSC		
	Y	e1	1.00 BSC		
MEMS	X	D1	0.46 REF		
	Y	E1	0.46 REF		
Body Size	X	D	0.84 BSC		
	Y	E	1.54 BSC		
Ball To Center	X	SD	0.205 BSC		
	Y	SE	0.500 BSC		
Package Edge Tolerance		aaa	0.040		
Coplanarity		ccc	0.075		

4 LD – 1.5 x 0.8 x 0.55 mm

Package Outline

POD-35 Rev A

Recommended Land Pattern (Unit: mm)



(soldermask openings shown with dashed line around NSMD pad)

Recommended 4-mil (0.1mm) stencil thickness

Manufacturing Guidelines

1) No Ultrasonic or Megasonic cleaning: Do not subject SiT1579 to an ultrasonic or megasonic cleaning environment. Permanent damage or long term reliability issues may occur.
2) Applying board-level underfill and overmold is acceptable and will not impact the reliability of the device.
3) Reflow profile, per JESD22-A113D.
4) The SiT1579 CSP includes a protective, opaque polymer top-coat. If the SiT1579 will see intense light, especially in the 1.0-1.2µm IR spectrum, we recommend a protective “glob-top” epoxy or other cover to keep the light from negatively impacting the frequency stability.
5) For additional manufacturing guidelines and marking/tape-reel instructions, refer to SiTime Manufacturing Notes.

Ordering Information

SiT1579AI-J3-XXE-XXXX.XXXXXXQ

Part Family
"SiT1579"

Revision Letter
"A": is the revision

Temperature Range
"C": Extended Commercial, -20 to 70ºC
"I": Industrial, -40 to 85ºC

Package Size
"J": 1.5 mm x 0.8 mm CSP

All-Inclusive Over Temp Stability
"3": ±50 ppm

Supply Voltage
XX = 1.8V – 3.3V
1.8V = 18
2.0V = 20
2.5V = 25
3.0V = 30
3.3V = 33

Output Frequency
Continuous frequency options from 1 Hz to 2.5 MHz

Enter your desired frequency as shown below:
2500.000000 = 2.5 MHz
2000.000000 = 2.0 MHz
1850.000000 = 1.85 MHz
0512.288000 = 512.288 kHz
0010.000000 = 10.0 kHz
0004.096000 = 4.0960 kHz
0000.100256 = 100.256 Hz
0000.010000 = 10.0 Hz
0000.001000 = 1.0 Hz
0000.001100 = 1.10 Hz
0000.005123 = 5.123 Hz

Packaging
"S": 8 mm Tape & Reel, 10ku reel
"Q": 8 mm Tape & Reel, 5ku reel
"E": 8 mm Tape & Reel, 1ku reel
Samples in cut Tape

Table 4. Revision History

Version	Release Date	Change Summary
0.9	05/09/2017	Initial Preliminary Datasheet Release
0.95	06/12/2017	Updated start-up time typical value
1.0	08/03/2017	Final Release Increased maximum output frequency option Added additional typical operating curves Updated typical No Load Supply Current (Table 1)
1.1	01/22/2018	Updated the maximum frequency from 2.0 MHz to 2.5 MHz

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