SiT1581

1.2 mm² µPower, Low-Jitter, 1 Hz – 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 mm x 0.8 mm CSP
- Ultra-low power: 4.5 µA (32.768 kHz)
- Supply voltage range: 1.62 V to 1.98 V
- Operating temperature ranges: -20°C to +70°C, -40°C to +85°C
- Pb-free, RoHS and REACH compliant
- Hermetically sealed against gas intrusion to exceed test conditions described in MIL-STD-883G Method 1014.12

Applications

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

TempFlat MEMS

AstroMEMS™

INSTANT SAMPLES | SEARCH INVENTORY | GREEN SOLUTIONS | LIFETIME WARRANTY

Electrical Characteristics

Table 1. Electrical Characteristics

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

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Frequency and Stability						
Output Frequency	F_{OUT}	1		2.5 M	Hz	
Initial Frequency Tolerance	F_tol	-5		5	ppm	Includes 2x reflow, at 25°C
Frequency Stability[1]	F_stab	-50		50	ppm	All-inclusive including initial tolerance, temperature, V_{DD}, aging, board-level underfill, and 20% load variation.
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		2.5	4	ns_{RMS}	Cycles = 10,000, f = 32.768 kHz. Per JEDEC standard 65B
Supply Voltage and Current Consumption						
Operating Supply Voltage	V_{DD}	1.62		1.98	V	Ordering Code "18"
		2.97	3.3	3.63		F_{OUT} = 32.768 kHz, Ordering Code "33"
		1.62		3.63		F_{OUT} = 32.768 kHz, Ordering Code "YY"
No Load Supply Current	I_{DD}		3.65	5	µA	F_{OUT} = 1 Hz
			4.5	5.5		F_{OUT} = 32.768 kHz @Vdd = 18 (Ordering Code)
			4.6	5.8		F_{OUT} = 32.768 kHz @Vdd = 33 or @Vdd=YY (Ordering Code)
			6	7		F_{OUT} = 100 kHz
			8.5	10.5		F_{OUT} = 500 kHz
			13	16		F_{OUT} = 1 MHz
			30	34.5		F_{OUT} = 2.5 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

Table 1. Electrical Characteristics (continuous)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
LVCMOS Output						
Output Rise/Fall Time	t_R, t_F		9	20	ns	10-90%, 15 pF load @Vdd=18 or @Vdd=YY (Ordering Code)
			4.5	10		10-90%, 15 pF load @Vdd=33 (Ordering Code)
Output Clock Duty Cycle	DC	45		55	%	
Output Voltage High	VOH	90%			V_{DD}	I_{OH} = -1 µA, 15 pF load
Output Voltage Low	VOL			10%	V_{DD}	I_{OL} = 1 µA, 15 pF load

Note:

1. 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	Device supply voltage. Under normal operating conditions, V_{DD} does not require external bypass/decoupling capacitor(s). SiT1581 includes on-chip V_{DD} filtering.
4	GND	Power Supply Ground	Connect to ground.

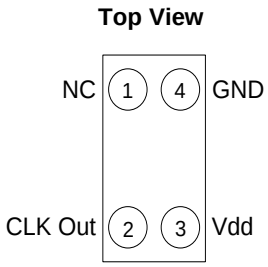


Figure 1. Pin Assignment

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

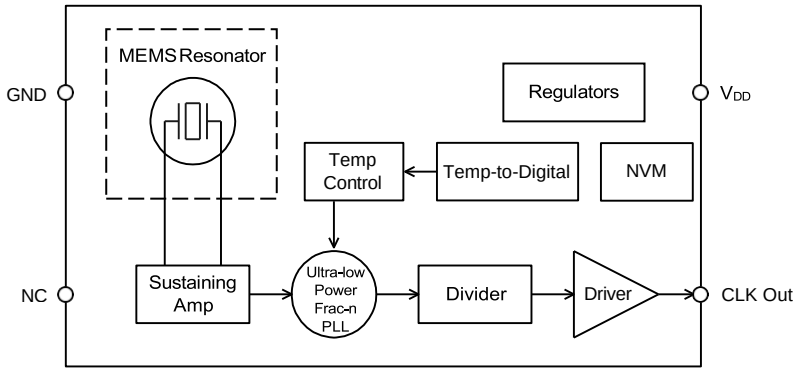


Figure 2. SiT1581 Block Diagram

Description

SiT1581 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 4.5 µA (32.768 kHz).

SiTime's MEMS oscillator consists of a MEMS resonator and a programmable IC. SiT1581 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.

Frequency Stability

The SiT1581 oscillator is factory trimmed to target frequency 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 SiT1581 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 SiT1581 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.

The SiT1581 is designed to be robust and maintain frequency accuracy even in the presence of the smallest molecular gases that may be encountered either in manufacturing, qualification stress or general usage. In such cases, the SiT1581 is designed to withstand external influences and stay within the ±50 ppm all-inclusive frequency stability.

Typical Operating Curves

(T_A = 25°C, V_{DD} = 1.8 V)

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

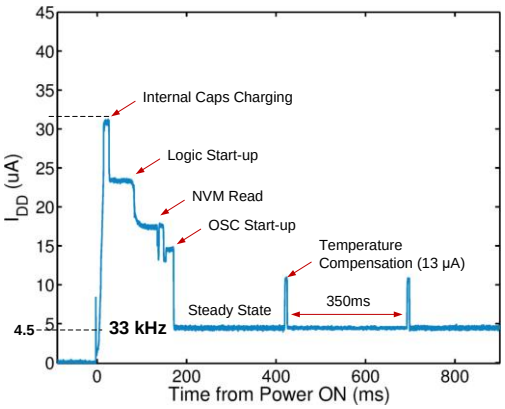
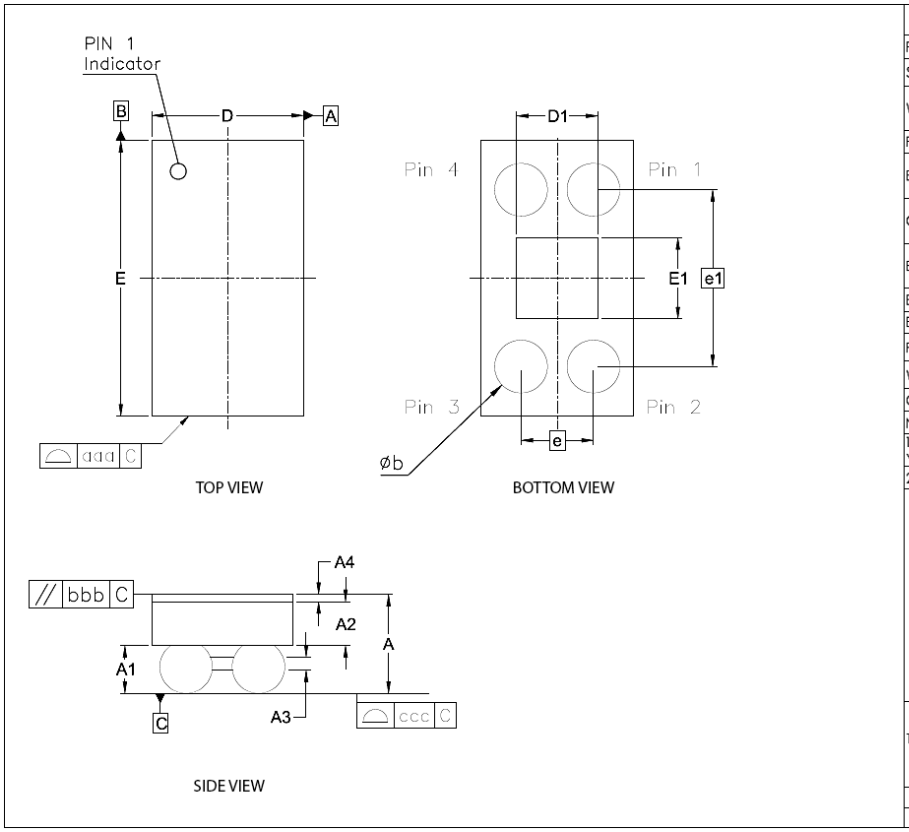


Figure 4. Start-up and Steady-State Current Profile

Dimensions and Patterns

Package Size – Dimensions (Unit: mm)

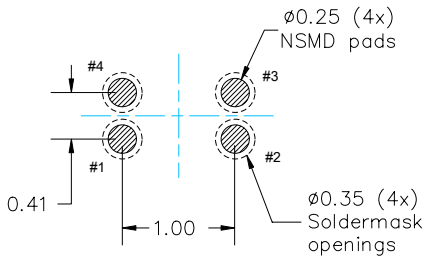


		SYMBOL	MIN	NOM	MAX
PACKAGE THICKNESS		A	0.481	0.540	0.599
STAND OFF		A1	0.220	0.250	0.280
WAFER THICKNESS		A2	0.225	0.250	0.275
		A3	0.101	0.114	0.127
FILM THICKNESS		A4	0.036	0.040	0.044
BODY SIZE	X	D		0.845	
	Y	E		1.545	
CHILD DIE SIZE	X	D1		0.460	
	Y	E1		0.492	
BALL PITCH		e		0.410 BSC	
		e1		1.000 BSC	
BALL SIZE				0.300	
BALL DIAMETER/WIDTH		b	0.285	0.315	0.345
PACKAGE TOLERANCE		aaa		0.030	
WAFER FLATNESS		bbb		0.100	
COPLANARITY		ccc		0.030	

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

TITLE 4L NCSP		SiTime	
		DWG NO.	
		POD-032-NCSP-004-C01508	
0.845x1.545x0.54 mm		REV.	SHEET
DATE	10-MAR-2019	B03	1 OF 2

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 SiT1581 to an ultrasonic or megasonic cleaning environment. Permanent damage or long term reliability issues may occur.

   device.

2) Reflow profile, per JESD22-A113D.
3) The SiT1581 CSP includes a protective, opaque polymer top-coat. If the SiT1581 will see 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.
4) For additional manufacturing guidelines and marking/tape-reel instructions, refer to SiTime Manufacturing Notes.

Ordering Information

SiT1581AI-J3-18E-0032.768000Q

Part Family
"SiT1581"

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

Packaging
"S": 8 mm Tape & Reel, 10 ku reel
"Q": 8 mm Tape & Reel, 5 ku reel
"D": 8 mm Tape & Reel, 3 ku reel
"E": 8 mm Tape & Reel, 1 ku reel
Samples in cut Tape

Output Frequency
Specified in kHz
See examples below:
2500.000000 = 2.5 MHz
0032.768000 = 32.768 kHz
0000.001000 = 1.0 Hz

Supply Voltage
YY = 1.8 V ±10% to 3.3 V ±10% for **Fout = 32.768 kHz ONLY**
18 = 1.8 V
33 = 3.3 V for **Fout = 32.768 kHz ONLY**

Table 4. Revision History

Version	Release Date	Change Summary
Preliminary	25-Jun-2020	Preliminary datasheet. Subject to change
1.01	5-Aug-2020	Final Release
1.1	29-Mar-2021	Added support for 3.3 V (Ordering code = 33) and 1.8 V to 3.3 V (Ordering Code = YY); Updated parameters Table 1 for new voltage settings Updated Ordering Information, added Option “D” for 3ku reels Updated hyperlinks, trademarks, date format and layout formatting

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