SiT1542 Preliminary

Smallest Footprint (1.2mm^2), Ultra-Low Power 32.768 kHz Oscillator in CSP for Single-Cell Li+ Unregulated Battery Powered Applications

SiTime
The Smart Timing Choice™

Features

- Supply voltage optimized for Li+ battery voltage: 2.7V to 4.3V
- Smallest footprint in chip-scale (CSP): 1.5 x 0.8 mm
- Ultra-low power: 750 nA (typ)
- Oscillator output eliminates external load caps
- NanoDrive™ programmable output swing for lowest power
- Internal filtering eliminates external Vdd bypass cap
- Fixed 32.768 kHz
- <20 PPM initial stability
- <100 PPM stability over -40°C to +85°C
- Pb-free, RoHS and REACH compliant

Applications

- Wireless Mouse or Trackball
- Wireless Keypads
- Pulse-per-Second (pps) Timekeeping
- RTC Reference Clock
- Battery Management Timekeeping

Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Frequency and Stability						
Fixed Output Frequency	Fout		32.768		kHz	
Frequency Stability						
Frequency Stability (1)	F_stab			20	PPM	T_A = 25°C, Vdd: 3.0V – 4.3V
				75		T_A = -10°C to +70°C, Vdd: 3.0V – 4.3V
				100		T_A = -40°C to +85°C, Vdd: 3.0V – 4.3V
				TBD		T_A = -40°C to +85°C, Vdd: 2.7V – 3.0V
25°C Aging		-3		3	PPM	1st Year
Supply Voltage and Current Consumption						
Operating Supply Voltage	Vdd	2.7		4.3	V	T_A = -40°C to +85°C
		2.7		4.5	V	T_A = -10°C to +70°C
Power Supply Reset Voltage	Reset		1.8		V	
Core Operating Current (2, 3)	Idd		0.75		µA	T_A = 25°C, Vdd: 2.7V – 4.3V. No Load
				TBD		T_A = -10°C to +70°C, Vdd max: 4.3V. No Load
				TBD		T_A = -40°C to +85°C, Vdd max: 4.3V. No Load
Output Stage Operating Current (3)	Idd_out		0.165		µA/Vpp	T_A = 25°C, Vdd: 2.7V – 4.3V No Load
$T_{START-UP}$ at Power-up	T_start		150	TBD	ms	T_A = 25°C
Operating Temperature Range						
Commercial Temperature	T_use	-10		70	°C	
Industrial Temperature		-40		85	°C	
Rail-to-Rail Output Option						
Output Rise/Fall Time	tr, tf			200	ns	20-80%, 15 pF Load
Output Clock Duty Cycle	DC	45		55	%	LVCMOS Output
Output Voltage High	VOH	Vdd - 1.54			V	Vdd: 2.7V – 4.3V. I_{OH} = -0.2µA, 15 pF
Output Voltage Low	VOL			50	mV	Vdd: 2.7V – 4.3V. I_{OL} = -0.2µA, 15 pF
NanoDrive™ Programmable, Reduced Swing Output						
Reduced Swing Output	V_sw	0.25		0.80	V	Vdd: 2.7V – 4.3V. For AC-coupled receiver
Output Voltage High Range	VOH	0.50		1.20	V	10 pF, I_{OH} = -0.2µA
Output Voltage Low Range	VOL	0.25		0.80	V	10 pF, I_{OL} = 0.2µA
Output Rise/Fall Time	tr, tf		80	TBD	ns	
Output Clock Duty Cycle	DC	45		55	%	
Jitter Performance (T_A = 25°C, Vdd = 3.0V to 4.3V, unless otherwise stated)						
Period Jitter	T_djitt		45		ns_{RMS}	N = 10,000

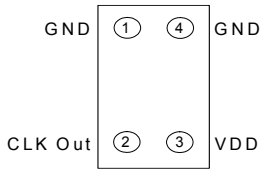
Notes:

1. Stability is specified for two operating voltage ranges. Stability progressively degrades with supply voltage below 3.0V.
2. Core operating current does not include output driver operating current or load current.
3. To derive total operating current (no load), add core operating current + (0.165 µA/V) * (peak-to-peak output Voltage swing).

Pin Configuration

Pin	Symbol	I/O	Functionality
1, 4	GND	Power Supply Ground	Connect to ground. Acceptable to connect pin 1 and 4 together.
2	CLK Out	OUT	Oscillator clock output. The CLK can drive into a Ref CLK input or into an ASIC or chip-set's 32 kHz XTAL input. When driving into an ASIC or chip-set oscillator input (X IN and X Out), the CLK Out is typically connected directly to the XTAL IN pin. No need for load capacitors. The output driver is intended to be insensitive to capacitive loading.
3	Vdd	Power Supply	Connect to power supply 2.7V ≤ Vdd ≤ 4.5V. Under normal operating conditions, Vdd does not require external bypass/decoupling capacitor(s).

CSP Package (Top View)



System Block Diagram

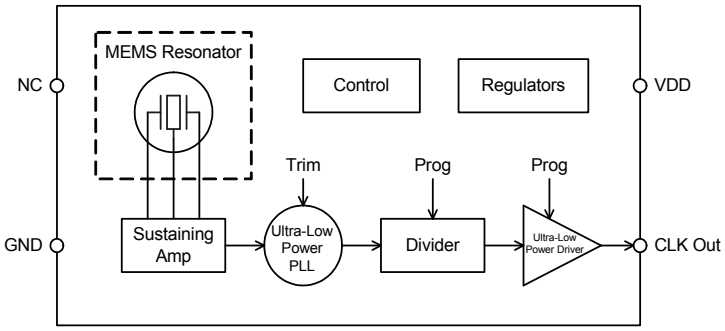


Figure 1.

Absolute Maximum

Attempted operation outside the absolute maximum ratings of the part 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	Symbol	Test Condition	Value	Unit
Power Supply Voltage Range (Vdd)	Vdd		-0.5 to 4.7	V
ESD Protection		HBM 100pF, 1.5kΩ	2000	V
ESD Protection		CDM, 25°C	750	V
ESD Protection		MM, 25°C	200	V
Latch-up Tolerance			JESD78 Compliant	
Mechanical Shock Resistance	ΔF/F	Mil 883, Method 2002	50,000	g
Mechanical Vibration Resistance	ΔF/F	Mil 883, Method 2005	70	g
CSP Junction Temperature			TBD	
Storage Temperature			-65°C to 150°C	

Thermal Consideration

Package	θJA, 4 Layer Board (°C/W)	θJA, 2 Layer Board (°C/W)	θJC, Bottom (°C/W)
1508 CSP	TBD		

Description

The SiT1542 is the is the world's smallest, lowest power 32 kHz oscillator optimized for unregulated Li+ battery powered applications where the supply voltage must track the Li+ battery voltage from 4.3V down to 2.7V. SiTime's silicon MEMS technology enables the smallest footprint and chip-scale packaging. This device reduces the 32 kHz footprint by as much as 85% compared to existing 2.0 x 1.2 mm SMD XTAL packages. Unlike XTALs, the SiT1542 oscillator output enables greater component placement flexibility and eliminates external load capacitors, thus saving additional component count and board space. And unlike standard oscillators, the SiT1542 features NanoDrive™, a factory programmable output that reduces the voltage swing to minimize power. For low-voltage, regulated applications, consider the SiT1532 which operates down to 1.2V

Frequency Stability

The SiT1542 is factory calibrated (trimmed) to guarantee frequency stability to be less than 20 PPM at room temperature and less than 100 PPM over the full -40°C to +85°C temperature range. Unlike quartz crystals that have a classic tuning fork parabola temperature curve with a 25°C turnover point, the SiT1542 temperature coefficient is extremely flat across temperature. The devices maintain less than 100 PPM frequency stability over the full operating temperature range.

Power Supply Noise Immunity

In addition to eliminating external output load capacitors common with standard XTALs, the SiT1542 includes special internal power supply filtering and thus, eliminates the need for an external Vdd bypass-decoupling capacitor. This feature further simplifies the design and keeps the footprint as small as possible. Internal power supply filtering is designed to reject up to ±50 mVpp magnitude and frequency components through 5 MHz.

Output Voltage

For low-power applications that drive directly into a chip-set's XTAL input, the reduced swing output is ideal. SiTime's unique NanoDrive™, factory-programmable output stage is optimized for low voltage swing to minimize power and maintain compatibility with the downstream oscillator input. The SiT1542 output swing is factory programmed between 250 mVpp and 800 mVpp. V_{OH} programming range is between 500 mV and 1.2V in 100 mV increments. Similarly, V_{OL} programming range is between 250 mV and 800 mV. Contact SiTime for programming support.

Calculating Load Current

No Load Supply Current

When calculating no-load power for the SiT1542, the core and output driver components need to be added. Since the output voltage swing can be programmed for reduced swing between 250 mV and 800 mV for ultra-low power applications, the output driver current is variable. Therefore, no-load operating supply current is broken into two sections; core and output driver. The equation is as follows:

Supply Current (no load) = I_{dd} Core + (165nA/V)($Vout_{pp}$)

***Example 1*: Full-swing LVCMOS**

- Vdd = 3.3V
- Idd Core = 750nA
- $Vout_{pp}$ = 2.1V (max output of device)

Supply Current = 750nA + (165nA/V)(2.1V) = 1047nA

***Example 2*: NanoDrive™ Reduced Swing**

- Vdd = 3.3V
- Idd Core = 750nA
- $Vout_{pp}$ (Programmable) = V_{OH} – V_{OL} = 1.1V - 0.6V = 0.5V

Supply Current = 750nA + (165nA/V)(0.5V) = 832nA

Total Supply Current with Load

To calculate the total supply current, including the load, follow the equation listed below. Note the greater than 40% reduction in power with NanoDrive™.

* Total Current = Idd Core + Idd Output Driver (165nA/V*$Vout_{pp}$) + Load Current (C*V*F)

***Example 1*: Full-swing LVCMOS**

- Vdd = 3.3V
- $Vout_{pp}$ = 2.1V (max output of device)
- Idd Core = 750nA
- Load Capacitance = 10pF
- Idd Output Driver: (165nA/V)(2.1V) = 347nA
- Load Current: (10pF)(2.1V)(32.768kHz) = 688nA

Total Current = 750nA + 347nA + 688nA = 1785nA

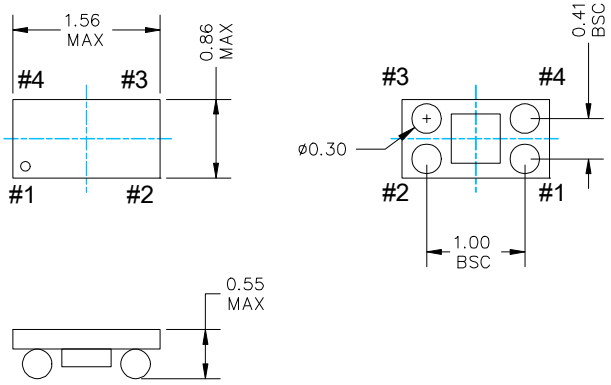
***Example 2*: NanoDrive™ Reduced Swing**

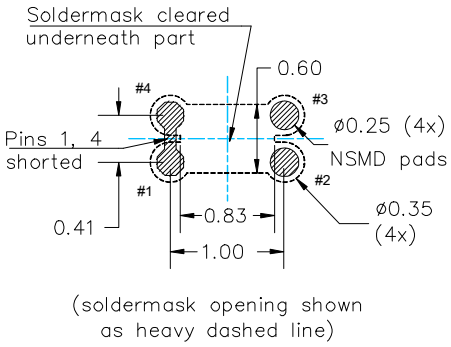
- Vdd = 3.3V
- Idd Core = 750nA
- Load Capacitance = 10pF
- $Vout_{pp}$ (Programmable): V_{OH} – V_{OL} = 1.1V - 0.6V = 0.5V
- Idd Output Driver: (165nA/V)(0.5V) = 83nA
- Load Current: (10pF)(0.5V)(32.768kHz) = 164nA

Total Current = 750nA + 83nA + 164nA = 997nA

Dimensions and Patterns

Package Size – Dimensions (Unit: mm)	Recommended Land Pattern (Unit: mm)
1.5 x 0.8 mm CSP (contact SiTime for final CSP dimensions)	

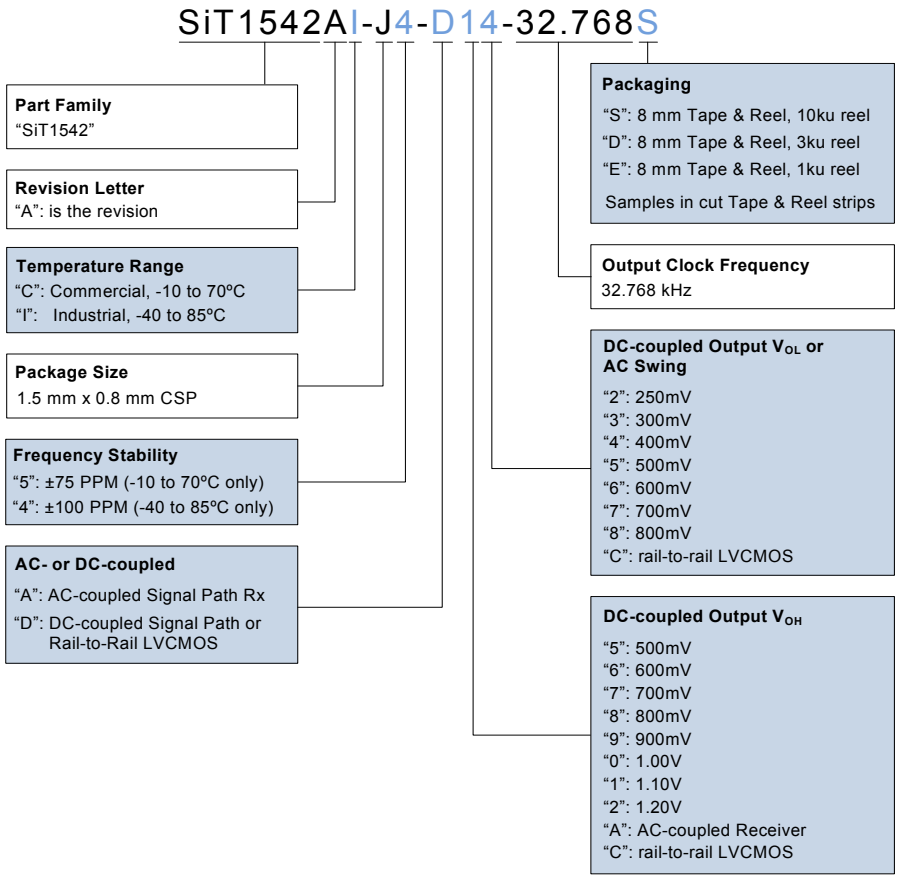




(soldermask opening shown as heavy dashed line)

Ordering Information

Part number characters in blue represent the customer specific options. The other characters in the part number are fixed.



The following examples illustrate how to select the appropriate temp range and output voltage requirements:

***Example 1:* SiT1542AI-J4-D14-32.768**

- Industrial temp & corresponding 100 PPM frequency stability. Note, 100 PPM is only available for the industrial temp range, and 75 PPM is only available for the commercial temp range.
- Output swing requirements:
  a) "D" = DC-coupled receiver
  b) "1" = V_{OH} = 1.1V
  c) "4" = V_{OL} = 0.4V

***Example 2:* SiT1542AC-J5-AA5-32.768**

- Commercial temp & corresponding 75 PPM frequency stability. Note, 100 PPM is only available for the industrial temp range, and 75 PPM is only available for the commercial temp range.
- Output swing requirements:
  a) "A" = AC-coupled receiver
  b) "A" = AC-coupled receiver
  c) "5" = 500mV swing