

## Features

- Any frequency between 1 MHz and 220 MHz accurate to 6 decimal places
- LVPECL and LVDS output signaling types
- 0.6ps RMS phase jitter (random) over 12 kHz to 20 MHz bandwidth
- Frequency stability as low as  $\pm 5$  ppm. Contact SiTime for tighter stability options
- Industrial and extended commercial temperature ranges
- Industry-standard packages: 3.2 x 2.5, 5.0 x 3.2 and 7.0 x 5.0 mm
- For frequencies higher than 220 MHz, refer to SiT5022 datasheet

## Applications

- SATA, SAS, 10GB Ethernet, Fibre Channel, PCI-Express
- Networking, broadband, instrumentation

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## Electrical Characteristics

| Parameter and Conditions                                  | Symbol                          | Min.                       | Typ. | Max.                 | Unit            | Condition  |
|---|---------------------------------|----------------------------|------|----------------------|-----------------|--|
| <b>LVPECL and LVDS, Common Electrical Characteristics</b> |                                 |                            |      |                      |                 |  |
| Supply Voltage  | V <sub>dd</sub>                 | 2.97                       | 3.3  | 3.63                 | V               |  |
|   |                                 | 2.25                       | 2.5  | 2.75                 | V               |  |
|   |                                 | 2.25                       | –    | 3.63                 | V               | Termination schemes in Figures 1 and 2 - XX ordering code  |
| Output Frequency Range                                    | f                               | 1                          | –    | 220                  | MHz             |  |
| Initial Tolerance   | F <sub>init</sub>               | -2                         | –    | 2                    | ppm             | At 25°C after two reflows  |
| Stability Over Temperature                                | F <sub>stab</sub>               | -5                         | –    | +5                   | ppm             | Over operating temperature range at rated nominal power supply voltage and load.<br><b>Contact SiTime for tighter stability options.</b> |
| Supply Voltage  | F <sub>vdd</sub>                | –                          | 50   | –                    | ppb             | $\pm 10\%$ V <sub>dd</sub>   |
| Output Load   | F <sub>load</sub>               | –                          | 0.1  | –                    | ppm             | 15 pF $\pm 10\%$ of load   |
| First Year Aging  | F <sub>aging1</sub>             | -2.5                       | –    | +2.5                 | ppm             | 25°C   |
| 10-year Aging   | F <sub>aging10</sub>            | -5                         | –    | +5                   | ppm             | 25°C   |
| Operating Temperature Range                               | T <sub>use</sub>                | -40                        | –    | +85                  | °C              | Industrial   |
|   |                                 | -20                        | –    | +70                  | °C              | Extended Commercial  |
| Pull Range  | PR                              | $\pm 12.5, \pm 25, \pm 50$ |      |                      | ppm             |  |
| Upper Control Voltage                                     | VC <sub>U</sub>                 | V <sub>dd</sub> -0.1       | –    | –                    | V               | All V <sub>dds</sub> . Voltage at which maximum deviation is guaranteed.   |
| Control Voltage Range                                     | VC <sub>L</sub>                 | –                          | –    | 0.1                  | V               |  |
| Control Voltage Input Impedance                           | Z <sub>vc</sub>                 | 100                        | –    | –                    | k $\Omega$      |  |
| Frequency Change Polarity                                 | –                               | Positive slope             |      |                      | –               |  |
| Control Voltage -3dB Bandwidth                            | V <sub>BW</sub>                 | –                          | –    | 8                    | kHz             |  |
| Input Voltage High  | V <sub>IH</sub>                 | 70%                        | –    | –                    | V <sub>dd</sub> | Pin 1, OE or $\overline{ST}$   |
| Input Voltage Low   | V <sub>IL</sub>                 | –                          | –    | 30%                  | V <sub>dd</sub> | Pin 1, OE or $\overline{ST}$   |
| Input Pull-up Impedance                                   | Z <sub>in</sub>                 | –                          | 100  | 250                  | k $\Omega$      | Pin 1, OE logic high or logic low, or $\overline{ST}$ logic high   |
|   |                                 | 2                          | –    | –                    | M $\Omega$      | Pin 1, $\overline{ST}$ logic low   |
| Start-up Time   | T <sub>start</sub>              | –                          | 6    | 10                   | ms              | Measured from the time V <sub>dd</sub> reaches its rated minimum value.  |
| Resume Time   | T <sub>resume</sub>             | –                          | 6    | 10                   | ms              | In Standby mode, measured from the time $\overline{ST}$ pin crosses  |
| Duty Cycle  | DC                              | 45                         | –    | 55                   | %               | Contact SiTime for tighter duty cycle  |
| <b>LVPECL, DC and AC Characteristics</b>                  |                                 |                            |      |                      |                 |  |
| Current Consumption                                       | I <sub>dd</sub>                 | –                          | 61   | 69                   | mA              | Excluding Load Termination Current, V <sub>dd</sub> = 3.3V or 2.5V   |
| OE Disable Supply Current                                 | I <sub>OE</sub>                 | –                          | –    | 35                   | mA              | OE = Low   |
| Output Disable Leakage Current                            | I <sub>leak</sub>               | –                          | –    | 1                    | $\mu$ A         | OE = Low   |
| Standby Current   | I <sub>std</sub>                | –                          | –    | 100                  | $\mu$ A         | $\overline{ST}$ = Low, for all V <sub>dds</sub>  |
| Maximum Output Current                                    | I <sub>driver</sub>             | –                          | –    | 30                   | mA              | Maximum average current drawn from OUT+ or OUT-  |
| Output High Voltage                                       | VOH                             | V <sub>dd</sub> -1.1       | –    | V <sub>dd</sub> -0.7 | V               | See Figure 1(a)  |
| Output Low Voltage  | VOL                             | V <sub>dd</sub> -1.9       | –    | V <sub>dd</sub> -1.5 | V               | See Figure 1(a)  |
| Output Differential Voltage Swing                         | V <sub>Swing</sub>              | 1.2                        | 1.6  | 2.0                  | V               | See Figure 1(b)  |
| Rise/Fall Time  | T <sub>r</sub> , T <sub>f</sub> | –                          | 300  | 500                  | ps              | 20% to 80%, see Figure 1(a)  |
| OE Enable/Disable Time                                    | T <sub>oe</sub>                 | –                          | –    | 115                  | ns              | f = 212.5 MHz - For other frequencies, T <sub>oe</sub> = 100ns + 3 period  |
| RMS Period Jitter   | T <sub>jitt</sub>               | –                          | 1.2  | 1.7                  | ps              | f = 100 MHz, V <sub>DD</sub> = 3.3V or 2.5V  |
|   |                                 | –                          | 1.2  | 1.7                  | ps              | f = 156.25 MHz, V <sub>DD</sub> = 3.3V or 2.5V   |
|   |                                 | –                          | 1.2  | 1.7                  | ps              | f = 212.5 MHz, V <sub>DD</sub> = 3.3V or 2.5V  |
| RMS Phase Jitter (random)                                 | T <sub>phj</sub>                | –                          | 0.6  | 0.85                 | ps              | f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all V <sub>dds</sub>   |

## Electrical Characteristics (continued)

| Parameter and Conditions               | Symbol                          | Min.  | Typ. | Max.  | Unit | Condition  |
|--|---------------------------------|-------|------|-------|------|--|
| <b>LVDS, DC and AC Characteristics</b> |                                 |       |      |       |      |  |
| Current Consumption                    | I <sub>dd</sub>                 | –     | 47   | 55    | mA   | Excluding Load Termination Current, V <sub>dd</sub> = 3.3V or 2.5V             |
| OE Disable Supply Current              | I <sub>OE</sub>                 | –     | –    | 35    | mA   | OE = Low   |
| Differential Output Voltage            | VOD                             | 250   | 350  | 450   | mV   | See Figure 2   |
| Output Disable Leakage Current         | I <sub>leak</sub>               | –     | –    | 1     | μA   | OE = Low   |
| Standby Current                        | I <sub>std</sub>                | –     | –    | 100   | μA   | $\overline{ST}$ = Low, for all V <sub>dds</sub>                                |
| VOD Magnitude Change                   | ΔVOD                            | –     | –    | 50    | mV   | See Figure 2   |
| Offset Voltage                         | VOS                             | 1.125 | 1.2  | 1.375 | V    | See Figure 2   |
| VOS Magnitude Change                   | ΔVOS                            | –     | –    | 50    | mV   | See Figure 2   |
| Rise/Fall Time                         | T <sub>r</sub> , T <sub>f</sub> | –     | 495  | 600   | ps   | 20% to 80%, see Figure 2   |
| OE Enable/Disable Time                 | T <sub>oe</sub>                 | –     | –    | 115   | ns   | f = 212.5 MHz - For other frequencies, T <sub>oe</sub> = 100ns + 3 period      |
| RMS Period Jitter                      | T <sub>jitt</sub>               | –     | 1.2  | 1.7   | ps   | f = 100 MHz, VDD = 3.3V or 2.5V  |
|  |                                 | –     | 1.2  | 1.7   | ps   | f = 156.25 MHz, VDD = 3.3V or 2.5V   |
|  |                                 | –     | 1.2  | 1.7   | ps   | f = 212.5 MHz, VDD = 3.3V or 2.5V  |
| RMS Phase Jitter (random)              | T <sub>phj</sub>                | –     | 0.6  | 0.85  | ps   | f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all V <sub>dds</sub> |

## Pin Description

| Pin | Map                    | Functionality |   |
|-----|------------------------|---------------|---|
| 1   | VC/OE/ $\overline{ST}$ | V Control     | Voltage control   |
|     |                        | Output Enable | H or Open: specified frequency output<br>L: output is high impedance  |
|     |                        | Standby       | H or Open: specified frequency output<br>L: Device goes to sleep mode. Supply current reduces to I <sub>std</sub> . |
| 2   | NC                     | NA            | No Connect; Leave it floating or connect to GND for better heat dissipation   |
| 3   | GND                    | Power         | VDD Power Supply Ground   |
| 4   | OUT+                   | Output        | Oscillator output   |
| 5   | OUT-                   | Output        | Complementary oscillator output   |
| 6   | VDD                    | Power         | Power supply voltage  |



## Absolute Maximum

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 (HBM)  | –    | 2000 | V    |
| Soldering Temperature (follow standard Pb free soldering guidelines) | –    | 260  | °C   |

## Thermal Consideration

| Package     | θJA, 4 Layer Board (°C/W) | θJC, Bottom (°C/W) |
|-------------|---------------------------|--------------------|
| 7050, 6-pin | 142                       | 27                 |
| 5032, 6-pin | 97                        | 20                 |
| 3225, 6-pin | 109                       | 20                 |

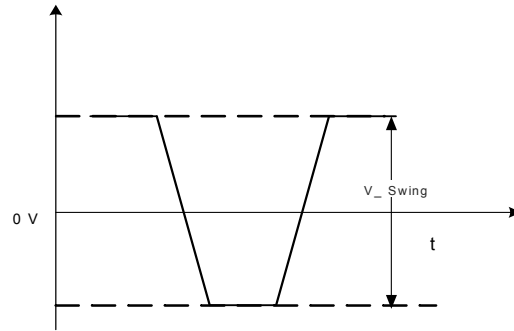
## Environmental Compliance

| 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              |

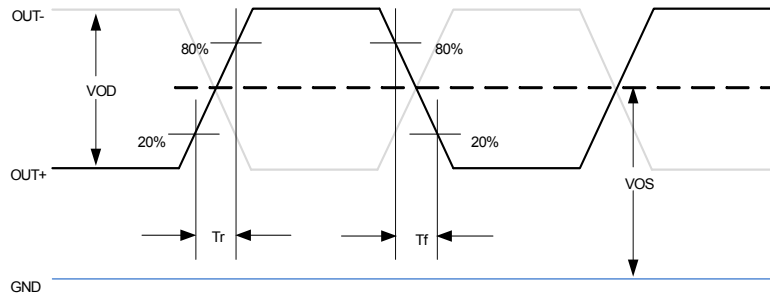
**Waveform Diagrams**



**Figure 1(a). LVPECL Voltage Levels per Differential Pin (OUT+/OUT-)**



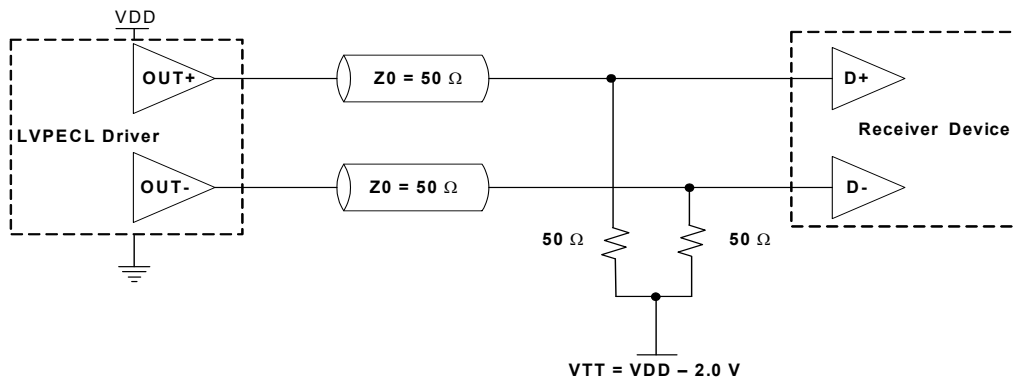
**Figure 1(b). LVPECL Voltage Levels Across Differential Pair**



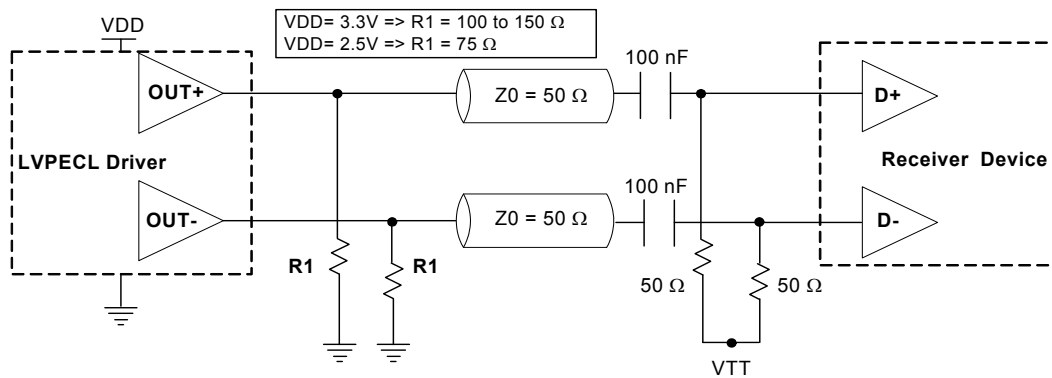
**Figure 2. LVDS Voltage Levels per Differential Pin (OUT+/OUT-)**

**Termination Diagrams**

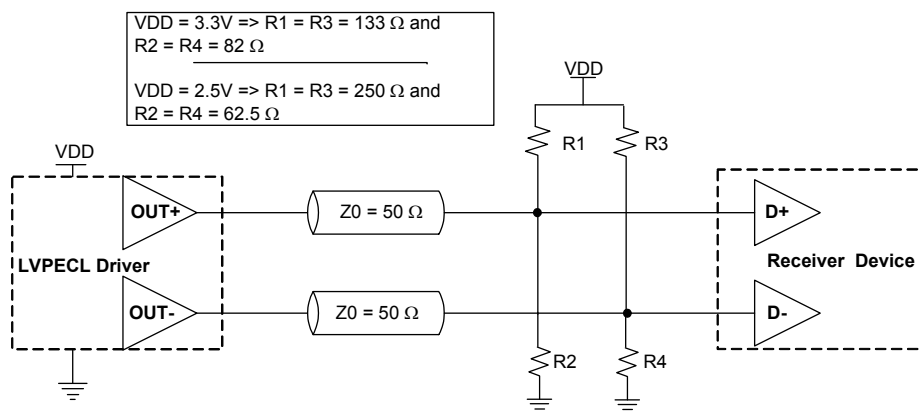
**LVPECL:**



**Figure 3. LVPECL Typical Termination**



**Figure 4. LVPECL AC Coupled Termination**



**Figure 5. LVPECL with Thevenin Typical Termination**

LVDS:

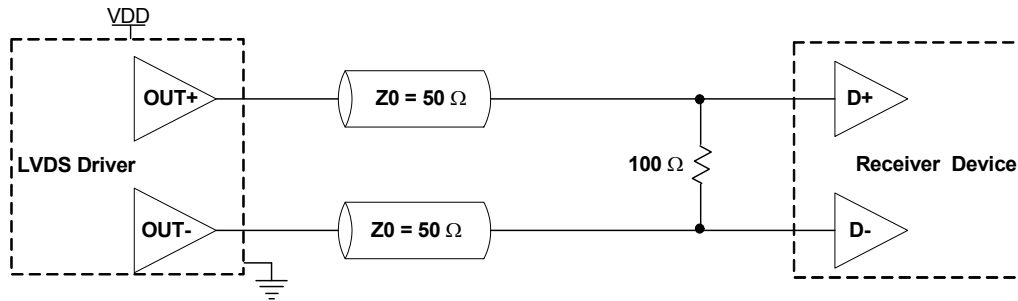


Figure 6. LVDS Single Termination (Load Terminated)

### Dimensions and Patterns

| Package Size – Dimensions (Unit: mm) <sup>[1]</sup> | Recommended Land Pattern (Unit: mm) <sup>[2]</sup> |
|---|--|
| <p><b>3.2 x 2.5x 0.75 mm</b></p>                    |  |
| <p><b>5.0 x 3.2 x 0.75 mm</b></p>                   |  |
| <p><b>7.0 x 5.0x 0.90 mm</b></p>                    |  |

**Notes:**

1. 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.
2. A capacitor of value 0.1  $\mu$ F between Vdd and GND is recommended.

### Ordering Information

SiT5021AC-1CE-33VQ123.123456T



**Note:**

3. Contact SiTime for tighter stability options.

### Ordering Codes for Supported Tape & Reel Packing Method

| Device Size  | 12 mm T&R (3ku) | 12 mm T&R (1ku) | 12 mm T&R (250u) | 16 mm T&R (3ku) | 16 mm T&R (1ku) | 16 mm T&R (250u) |
|--------------|-----------------|-----------------|------------------|-----------------|-----------------|------------------|
| 7.0 x 5.0 mm | -               | -               | -                | T               | Y               | X                |
| 5.0 x 3.2 mm | T               | Y               | X                | -               | -               | -                |
| 3.2 x 2.5 mm | T               | Y               | X                | -               | -               | -                |

### Frequencies Not Supported

Range 1: From 209.000001 MHz to 210.999999 MHz

### Revision History

| Version | Release Date | Change Summary  |
|---------|--------------|---|
| 1.2     | 8/20/13      | Original  |
| 1.3     | 12/16/13     | Added input specifications, LVPECL/LVDS waveforms, packaging T&R options  |
| 1.4     | 12/11/14     | Modified Thermal Consideration values and Pin Configuration table (pin 1) and drawing   |
| 1.5     | 11/12/15     | <ul style="list-style-type: none"><li>Revised stability over temperature and first year aging values in the electrical characteristics table</li><li>Revised frequency stability and supply voltage options</li></ul> |

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# Supplemental Information

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

# Silicon MEMS Outperforms Quartz

## 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<sup>[1]</sup>

## 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

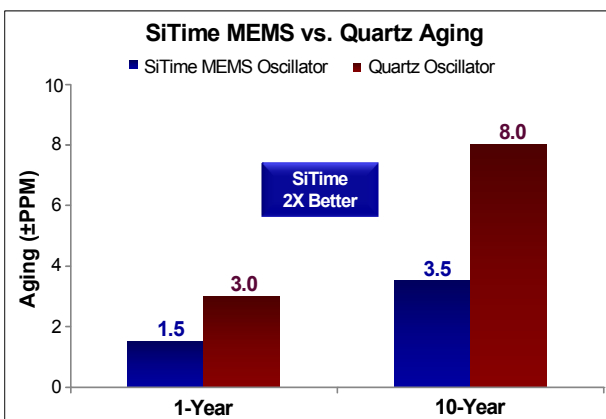


Figure 2. Aging Comparison<sup>[2]</sup>

## 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)<sup>[3]</sup>

## 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
- Best analog CMOS design expertise



Figure 4. Power Supply Noise Rejection<sup>[4]</sup>

## 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<sup>[5]</sup>

## 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<sup>[6]</sup>

### 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:**

  - SiTime, SiT9120AC-1D2-33E156.250000 - MEMS based - 156.25 MHz
  - Epson, EG-2102CA 156.2500M-PHPAL3 - SAW based - 156.25 MHz
  - TXC, BB-156.250MBE-T - 3rd Overtone quartz based - 156.25 MHz
  - Kyocera, KC7050T156.250P30E00 - SAW based - 156.25 MHz
  - Connor Winfield (CW), P123-156.25M - 3rd overtone quartz based - 156.25 MHz
  - SiLabs, Si590AB-BDG - 3rd overtone quartz based - 156.25 MHz
4. 50 mV pk-pk Sinusoidal voltage.
 

**Devices used in this test:**

  - SiTime, SiT8208AI-33-33E-25.000000, MEMS based - 25 MHz
  - NDK, NZ2523SB-25.6M - quartz based - 25.6 MHz
  - Kyocera, KC2016B25MOC1GE00 - quartz based - 25 MHz
  - Epson, SG-310SCF-25M0-MB3 - quartz based - 25 MHz
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 customers. Please contact [productsupport@sitime.com](mailto:productsupport@sitime.com).

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