SiTime University Turbo Seminar Series

Optimize System Design with Low Power MEMS Oscillators

March 11-12, 2013
Turbo Webinars On the SiTime Web Site

SiTime University

Turbo Webinars

16-minute, highly impactful webinars covering topics that range from timing products to design tips and trends.

Conference Presentations

ISSCC 2012 Tutorial

Getting In Touch with MEMS: The Electromechanical Interface

These slides accompanied the 2012 ISSCC Tutorial. The tutorial is written for practicing IC engineers and students.

Download (1.55 Mb)

MEMS systems include mechanical structures and electronic sensors and drive circuits. Between these is an electromechanical interface, which can be capacitive, piezoresistive, piezoelectric, ferroelectric, electromagnetic, thermal, etc.

www.sitime.com/support/sitime-university
Agenda

• Introduction of the New Low Power MEMS Oscillator Family

• New Features and Enhancements that Enable Better System Designs and Supply Chain Management

• Advantages Over Quartz

• Product Selection Guide
Three Low Power MEMS Oscillators Enhance Industry’s Broadest MEMS Timing Portfolio

New Generation of Low Power Oscillators With Enhanced Features and Performance
Low Power Oscillator Family Highlights

- Wide frequency coverage with 6 decimal places of accuracy
- Excellent total frequency stability as low as ±20 PPM
- Choice of industrial (-40 to 85°C) or commercial (-20 to 70°C)
- Flexible supply voltages, 1.8 V and 2.5 to 3.3 V
- Best power consumption at high frequency
- Rise/fall time control for best EMI
- Industrial standard footprint in 5 package sizes
A Broad Range of Applications

- **SiT1602**
  - 50 Std Freq
  - 3.57 to 77.76 MHz
  - Consumer, Networking

- **SiT8008**
  - Programmable
  - 1 to 110 MHz
  - Computing, Industrial

- **SiT8009**
  - Programmable
  - 115 to 137 MHz
  - High Frequency
Better MEMS Timing Technology
More Features, Enhanced Performance
More Benefits to System ODM/OEM
Higher Performance MEMS Resonator Enhances Oscillator Performance

5 MHz Resonator
For SiT8003/8103
- First generation MEMS
- In production since 2007

48 MHz Resonator
For SiT1602/8008/8009
- Second generation
- In production since 2011
- Enable better phase noise & jitter

- CMOS enhancement enables more features and high performance
  - Improved temperature compensation
  - Improved output driver
  - Improved regulator design
Feature Enhancements and Benefits

- Continuous supply voltage
  - BOM reduction
  - Less inventory

- More rise/fall time control
  - Better jitter
  - Lower EMI

- UP to 10% lower power consumption
  - Industry’s Lowest at high frequencies

- More packages
  - 2016 pkg for 30% space saving
  - SOT23 for best cost

- Other enhancements
  - Faster startup time
  - Better jitter for video
  - Less aging

SoftEdge™ Rise/Fall Time Control to Reduce EMI

- Multiple rise/fall time options are available on any given device
Faster Edge Rates Reduce System Jitter

- Typical rise/fall time
- Good EMI
- Larger jitter due to sensitivity to voltage

- Faster rise/fall time
- *Reduced jitter, less sensitive to voltage*
- Potential EMI Increase can be reduced with good design practice
Continuous Supply Voltage Simplifies Inventory Management

- Example: SiT1602Al-12-xxS-27.000000 where xx = 2.5 to 3.3V
- Result: Single SiTime device replaces 3 quartz oscillators
- Benefits: Fewer parts to manage, more flexibility in meeting demand
Lowest Power Consumption at High Frequency for Greener Electronics

Current Consumption
(125MHz, 3.3V)

SiTime up to 8x lower power consumption

Source: DigiKey product search
More Package Options Increase Design Flexibility

- 36% smaller than 2520 package
- Compatible with quartz
- Available for any combination of freq, voltage and stability

- Industry’s first Leaded package for oscillators
- Most cost effective
- Resistant to PCB flex
- Ideal for high temp apps
MEMS Advantages over Quartz
Flexibility, Reliability, Quality
## Silicon MEMS Delivers More Features and Better Reliability than Quartz

<table>
<thead>
<tr>
<th>Features</th>
<th>SiTime MEMS XO</th>
<th>Quartz XO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core technology</td>
<td>All-Silicon MEMS</td>
<td>Crystals</td>
</tr>
<tr>
<td>Product coverage</td>
<td>Any combination of voltage, frequency, package</td>
<td>Limited options for 1.8V, small package, stability</td>
</tr>
<tr>
<td>Frequency stability over-temp</td>
<td>±20 PPM</td>
<td>±25 PPM</td>
</tr>
<tr>
<td>Lower power consumption at High Frequency</td>
<td>6.4 mA @ 125 MHz</td>
<td>&gt;10 mA @ 125 MHz</td>
</tr>
<tr>
<td>Rise/fall time control</td>
<td>1 – 6 ns</td>
<td>Not Available</td>
</tr>
<tr>
<td>Long term reliability (MTBF)</td>
<td>500 Million Hours</td>
<td>&lt;50 Million Hours</td>
</tr>
</tbody>
</table>
Programmability Enables Optimal Clocks and Fastest Time-to-Market

Configure and request samples from SiTime

Express samples at http://www.sitime.com/support/request-samples
“Reliability is the New Power”

For more info, check out “Resilience and Reliability of Silicon MEMS” and “Reliability Calculations of SiTime Oscillators” at [http://www.sitime.com/support/application-notes](http://www.sitime.com/support/application-notes)
Different MEMS Oscillator Family for Different Applications
Product Selection Guideline – Low Power MEMS Oscillators

• SiT1602/8008/8009 are Recommended for all new designs

• SiT8103/8003/8004 are NOT recommended for new designs

• SiT8103/8003/8004 will continue to be available in production volumes

<table>
<thead>
<tr>
<th>Recommended Devices</th>
<th>Mature Devices</th>
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<tbody>
<tr>
<td>SiT1602</td>
<td>SiT8103</td>
</tr>
<tr>
<td>SiT8008</td>
<td>SiT8003</td>
</tr>
<tr>
<td>SiT8009</td>
<td>SiT8004</td>
</tr>
</tbody>
</table>

Different performance spec and frequency ranges for different applications
Product Selection Guide – Low Power vs. Low Jitter Continued..

• Key differences

<table>
<thead>
<tr>
<th></th>
<th>Low Jitter SiT8208/8209</th>
<th>Low Power SiT1602/8008/8009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>1-220 MHz</td>
<td>1 – 137 MHz</td>
</tr>
<tr>
<td>Jitter</td>
<td>0.5 ps</td>
<td>~1.3 ps</td>
</tr>
<tr>
<td>Target applications</td>
<td>Jitter sensitive</td>
<td>Portable device</td>
</tr>
<tr>
<td></td>
<td>Networking &amp; Telecom</td>
<td>Low end networking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Computing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Consumer</td>
</tr>
</tbody>
</table>

• How to select--
  • Go with SiT1602/8008/8009 as the default for most applications
  • Go with SiT8208/8209 for high end applications in networking and telecom where jitter is important

• For more information, visit http://www.sitime.com/support/product-selector
Summary

Lowest Power, Drop-in Replacement
Up to 8x lower than quartz, standard footprints

More Features, Most Flexibility
Rise/fall time control, Continuous voltage, 6 package options

Industry-Best Reliability
FIT Rate: 2, 500M Hours MTBF

Availability: Any Frequency, Supply Voltage, Package
Samples shipped within 48-hours, shortest production leadtime
Contact Information

• For Questions, contact SiTime Technical Support
  Technicalsupport@sitime.com

• For Turbo Webinar pdf Downloads on SiTime’s Web Site
  www.sit ime.com/support/sitime-u/turbo-webinars
  • All new webinars will be posted within 24-hours

• For Low Power Oscillator datasheets and other info, visit
  http://www.sit ime.com/products/low-power-oscillators
SiT1602 Standard Frequency, Low Power MEMS XO

• 50 standard frequencies
• 100% drop-in replacement of quartz
• Package as small as 2016
• Excellent jitter for digital non-RF applications
• Excellent long term jitter (30ps over 10 µs interval) for video
• Faster startup time with gated output

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Frequency Stability</th>
<th>Supply Voltage</th>
<th>Packages</th>
<th>Temp. Range</th>
<th>Active Current (typical)</th>
<th>Startup Time</th>
<th>Output Load</th>
<th>Signaling Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.75 to 77.6 MHz</td>
<td>± 20 PPM</td>
<td>1.8 V</td>
<td>2016</td>
<td>-40 to +85 C</td>
<td>3.4 mA (no load)</td>
<td>5 ms</td>
<td>15pF</td>
<td>LVCMOS</td>
</tr>
<tr>
<td></td>
<td>± 25 PPM</td>
<td>2.5 to 3.3V</td>
<td>2520</td>
<td>-20 to +70 C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>± 50 PPM</td>
<td>3225</td>
<td>3225</td>
<td></td>
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Production Now

4-pin
2016/2520/3225
5032/7050
SiT8008 Programmable, Low Power MEMS XO

- Any frequency between 1 to 110 MHz with 6 decimal places of accuracy
- 100% drop-in replacement of quartz
- Package as small as 2016
- Excellent jitter for digital non-RF applications
- Excellent long term jitter (30ps over 10 µs interval) for video
- Faster startup time with gated output

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<td>± 20 PPM</td>
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<td></td>
<td>± 25 PPM</td>
<td>2.5 to 3.3V</td>
<td>2520</td>
<td>-20 to +70 C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>± 50 PPM</td>
<td>3.2 to 3.3V</td>
<td>3225</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>1.8 V</td>
<td>5032</td>
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<td></td>
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- Production Now

4-pin
2016/2520/3225
5032/7050

IO Pin Configuration:
1. OE/ST
2. GND
3. OUT
4. VDD
SiT8009 High Frequency, Low Power MEMS XO

- Any frequency between 115 to 137 MHz with 6 decimal places of accuracy
- Lowest power consumption for high frequency oscillators
- 100% drop-in replacement of quartz
- Package as small as 2016
- Excellent jitter for Ethernet, PCIe and other digital non-RF applications

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<tr>
<td>115 to 137 MHz</td>
<td>± 20 PPM, ± 25 PPM, ± 50 PPM</td>
<td>1.8 V, 2.5 to 3.3V</td>
<td>2016, 2520, 3225, 5032, 7050</td>
<td>-40 to +85 C, -20 to +70 C</td>
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