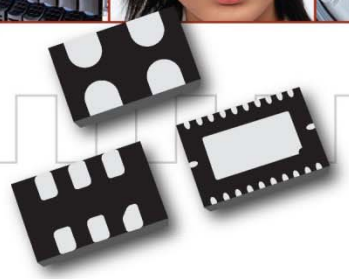
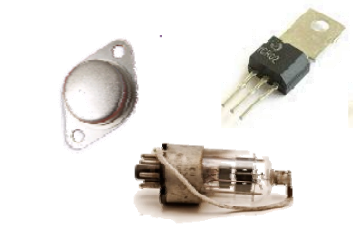
Silicon MEMS Timing Solutions for SSDs

Markus Lutz, Exec VP & CTO



The Smart Timing Choice™

Silicon Always Replaces Incumbent Technology
Silicon MEMS Timing is Replacing Quartz



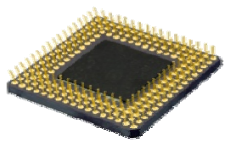
Performance

Features

Availability

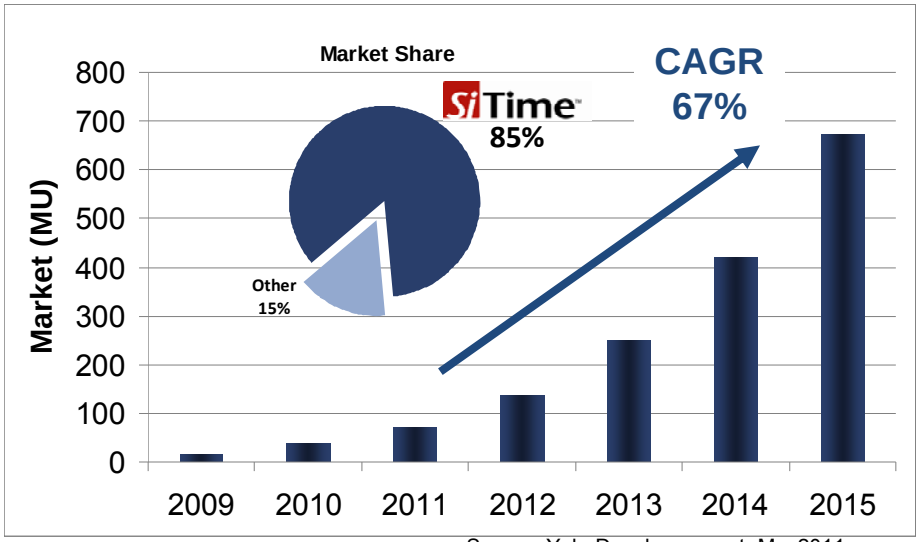
Reliability

Cost



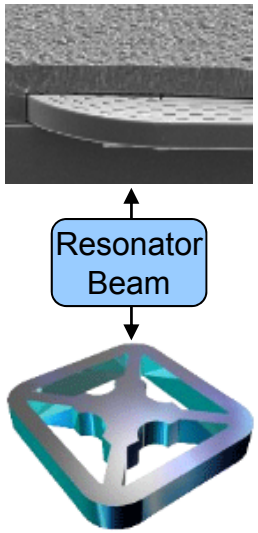
MEMS Timing Devices are Being Rapidly Adopted

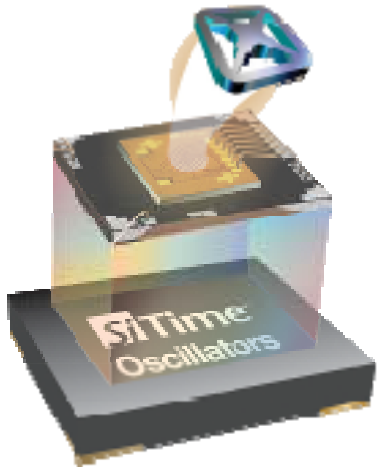
Large, Rapidly Growing Market



Source: Yole Developpement, May2011

100% Silicon Products in Plastic Packages

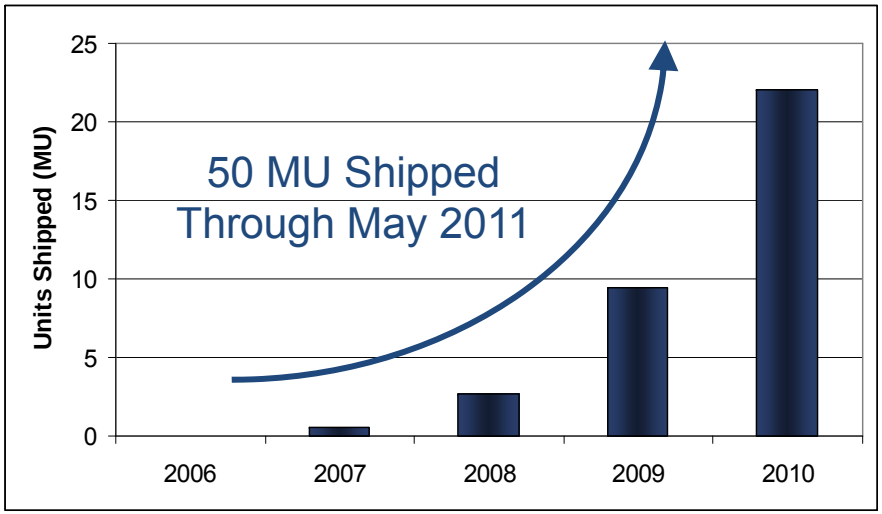




Large Electronics Companies in Many Segments

- 4 of the top 5 Computer makers
- 3 of the top 5 Consumer Electronics companies
- 3 of the top 5 Contract Manufacturers
- 5 of the top 5 ODMs

Unit Shipments are Accelerating



Because of these Value Propositions

	Quartz Oscillator	Silicon MEMS Oscillator	
Performance			Better Stability No Activity Dips
Features			Any Freq, V_{DD}, PPM SS, DCXO, FSXO
Availability			Samples – 1 week Production – 3 weeks
Robustness **Reliability**			50,000 *g* shock 70 *g* vibration, 2 FIT
Cost			Silicon Cost Trajectory

Worse  Better

Applications That Use Silicon MEMS Oscillators

Storage server

FPGA Designs

EPON/GPON Gateway

Computer server

10G Switch

Ethernet Switch

Tablet / Ebook

Notebook

Pico projector

SSD

Set-top box

Base-station

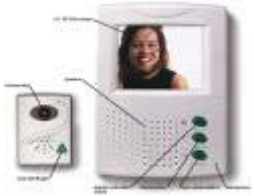
MFP

Infotainment System

VoIP phone

DVR / CCTV / IPCam

DSC



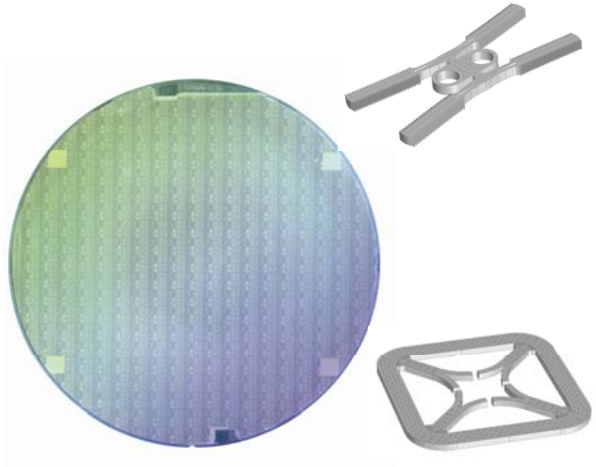
Intercom

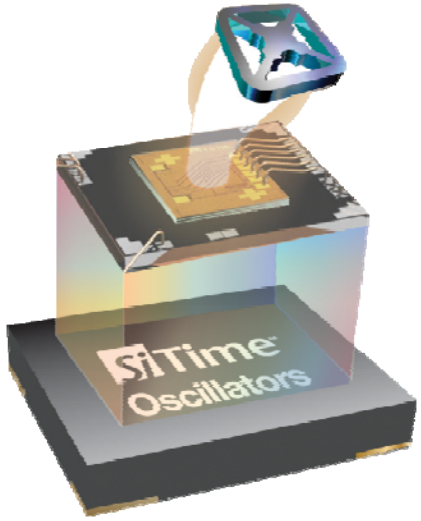
Automotive blackbox

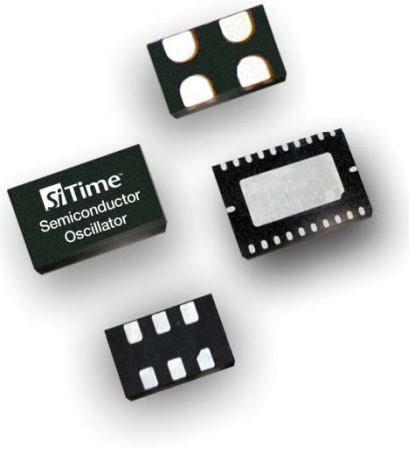
Smart meter

Video Phone

Silicon MEMS Timing Components are Available in these Devices







MEMS Resonators

- For time keeping & reference
- Available as Silicon die
- Co-packaged with SoC in plastic packages

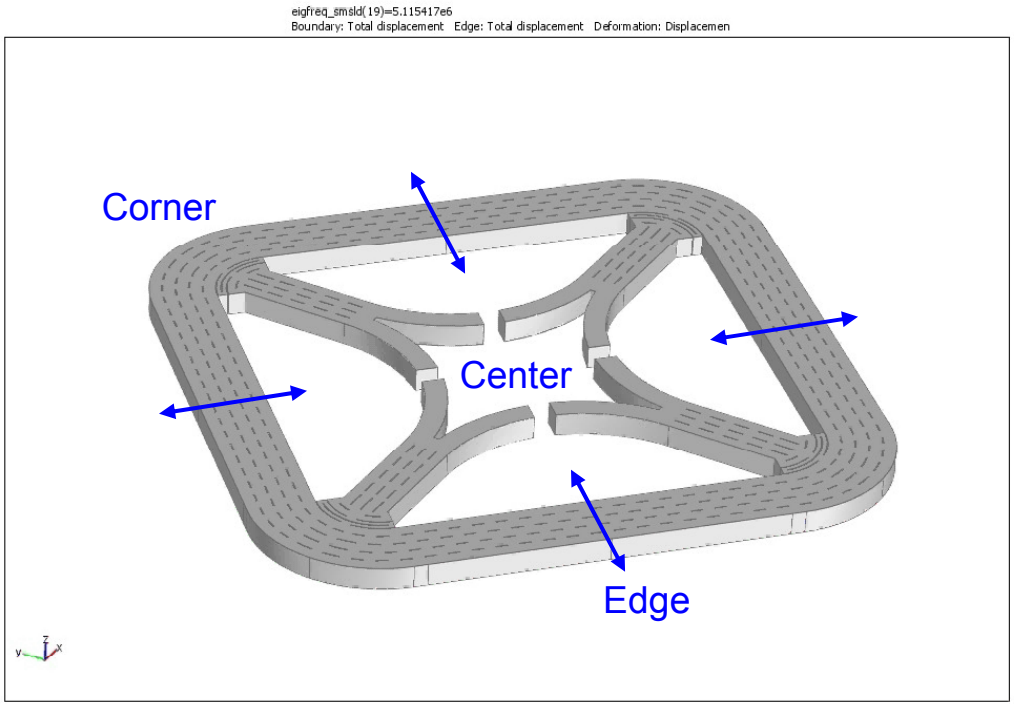
Oscillators

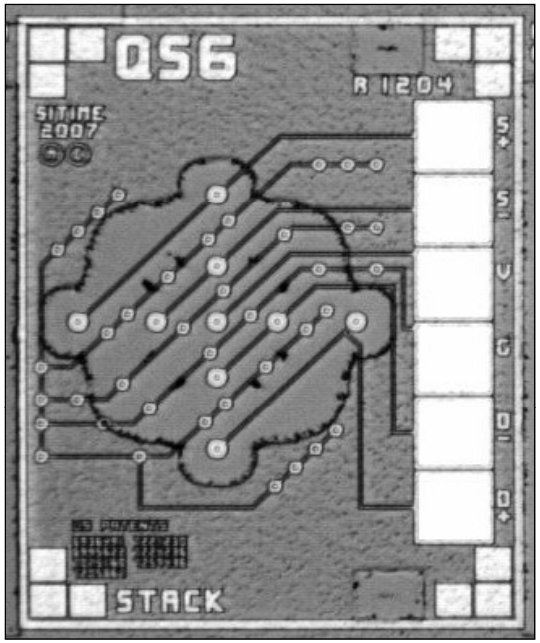
- Replace quartz with no design changes
- Single output devices
- XO, VCXO, TCXO, OCXO

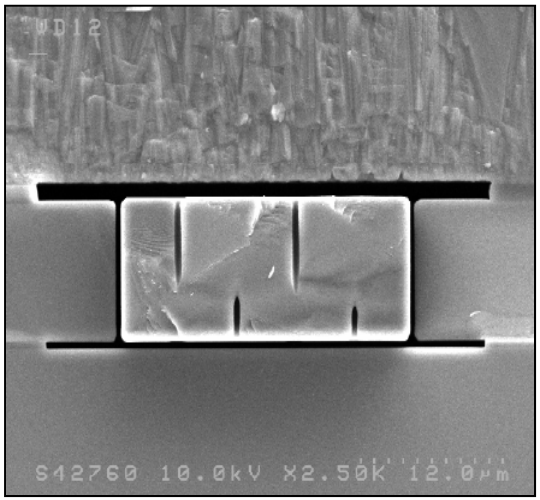
Clock Generators

- Small size, highly integrated
- 3 PLLs, 6 outputs
- Full-featured

Operation of a MEMS Resonator

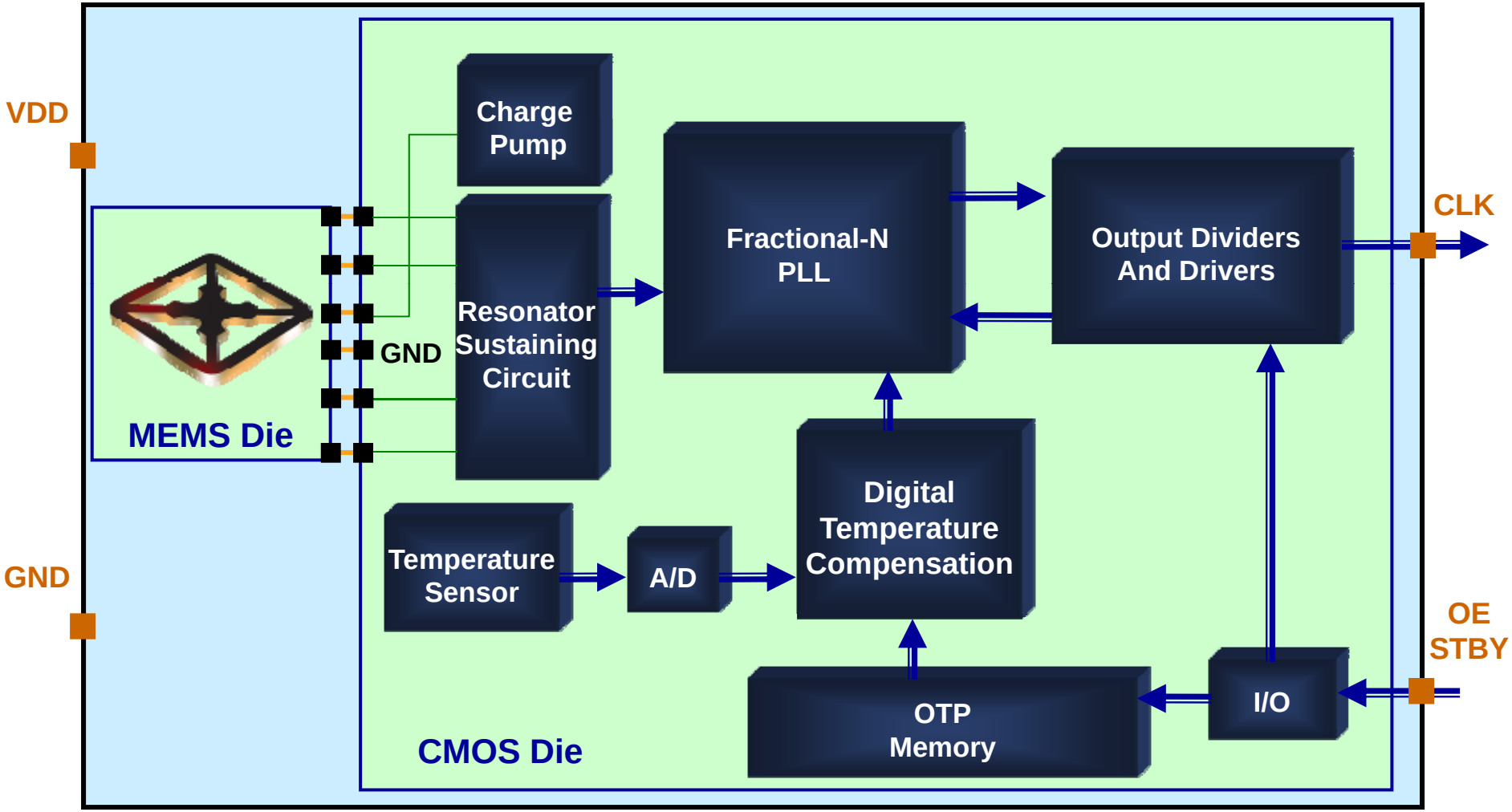






- Like a 2D bell – held in the center with its outer edges ringing
- Quad with center anchor and motionless corners
- Four resonant beams with eight capacitive electrodes

Silicon MEMS Oscillator – Block Diagram

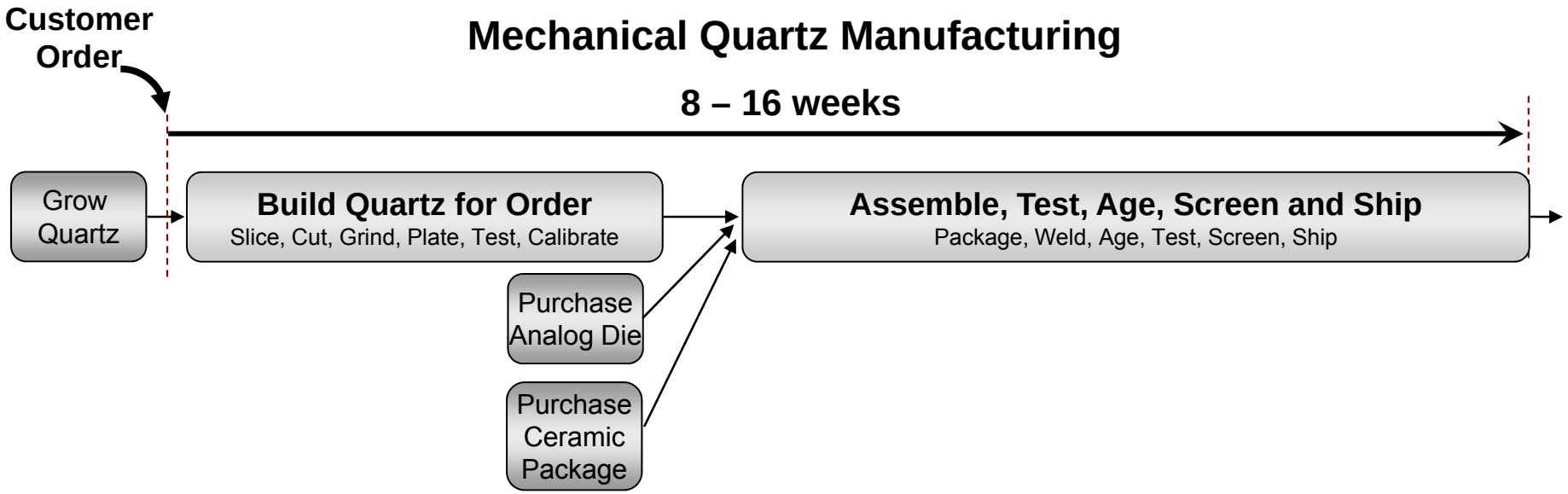


Silicon MEMS Timing Solutions are Very Flexible

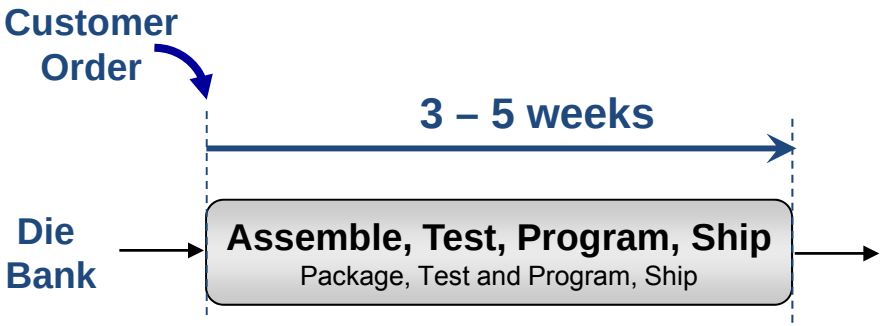
Frequency	200 kHz	6 Decimals of Accuracy							800 MHz
Stability	±0.5	±2.5	±5	±10	±25				±50 PPM
Pull Range	±25	±50	±100	±150	±200	±400	±800		±1600 PPM
Output Type	CMOS		LVPECL			LVDS			HCSL
Spread Spectrum	±0.25%	±0.5%	±1%	±2%	–0.25%	–0.5%	–1%	–2%	–4%
Temperature	Automotive			Industrial					Commercial
Drive Strength	Low				Standard				High

Voltage	1.8V	2.5V	2.8V	3.3V
Package	2.5 x 2.0	3.2 x 2.5	5.0 x 3.2	7.0 x 5.0 mm

Silicon MEMS Timing Solutions Offer a Sustainable Lead Time Benefit



SiTime's Silicon Oscillator Manufacturing



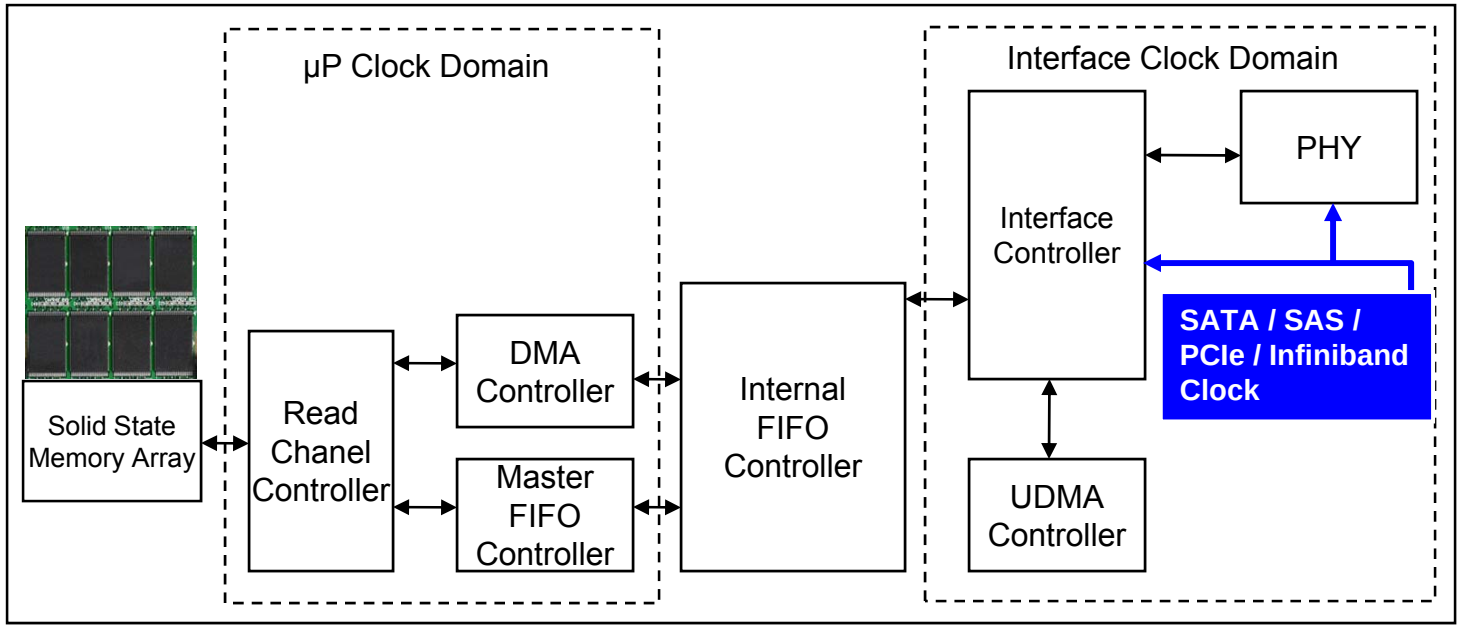
Reduced Inventory Cost
Faster Time to Market
Meet Upsides with Very Short Lead Times
Reduced Risk

Block Diagram and SSD Types

There are 4 major interfaces for SSD

1. SATA, mainly used in consumer SSD
2. SAS, mainly used in enterprise SSD
3. Infiniband, mainly used in enterprise SSD
4. PCIe

Application Block Diagram

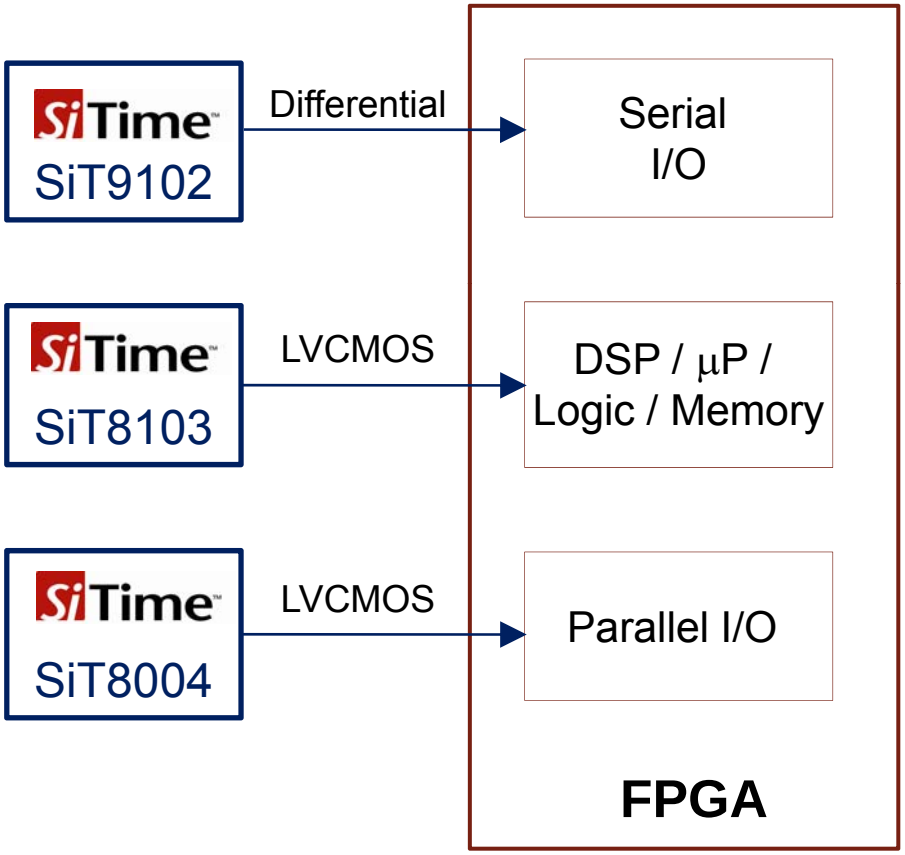


Silicon MEMS Oscillator – Support for Clock Frequencies Used in SSD

	SATA or SAS Clock Frequency (MHz)						PCIe Frequency (MHz)		Infiniband Frequency (MHz)	
	31.25	37.5	50	62.5	75	150	100	200	100	200
SiT8003 (SE)	√	√	√	√	√		√		√	
SiT8004 (SE)						√				
SiT9102 (Diff)						√	√	√	√	√
SiT9001/9003 (SE) (Spread Spectrum)	√	√	√	√	√	√	√	√		
SiT9002 (Diff) Spread Spectrum)	√	√	√	√	√	√	√	√		

- Silicon MEMS oscillators are 100% drop-in replacement for Crystal oscillators

Silicon MEMS Oscillators Provide All Timing Functions for FPGA Designs



Benefits of MEMS Oscillators

- 100% drop in replacement for quartz with NO DESIGN CHANGES
- Samples in 1 week, production in 3 weeks
- Customize SiTime's clock features for best FPGA performance (speed, power, timing margin):
  - Frequencies from 1 to 800 MHz
  - Vdd from 1.8V to 3.3V
  - Spread spectrum, EMI reduction

SiT9102	SiT8103	SiT8004
LVDS, LVPECL,	LVCMOS	LVCMOS
1 – 800 MHz	1 – 110 MHz	125 – 150 MHz
5032, 7050 pkg	2520, 3225, 5032, 7050 pkg	2520, 3225, 5032, 7050 pkg
10 – 50 ppm	20 – 50 ppm	20 – 50 ppm

Silicon MEMS Timing Solutions for SSD

- Silicon MEMS oscillators have the best flexibility, programmability
  - Any frequency up to 800 MHz with 6 decimals of accuracy
  - Programmable signaling levels – LVPECL, LVDS, CML, HCSL, CMOS
  - Any voltage – 1.8V, 2.5V, 3.3V with no restriction on frequencies
  - Stability as good as 10 PPM
  - Easy availability in small packages, 2.5x2.0 mm
  - Thin solutions – 0.25mm to 0.9mm height
- Silicon MEMS oscillators are most reliable timing solution for SSD
  - 2 FIT = 500,000,000 hours MTBF
  - 10 times more reliable than crystal oscillator
- Silicon MEMS oscillators are the most robust timing solution for SSD
  - 50,000 G shock resistance
  - 70 G vibration resistance
- Silicon MEMS Oscillators have the fastest lead time
  - Customized samples in 1 week
  - Production quantities of standard and custom samples in 3-5 weeks
- Many Enterprise SSDs use Silicon MEMS Oscillators today

SiTime Summary

$5B Timing Market
3 Segments – Oscillators, Clock Generators and Resonators

SiTime's Advantage – Siliconizing, Integration
More Features, Higher Performance, Lower Cost

Category Creator, 85% Share
500 Customers in Production

50MU Shipped through May 2011
Accelerating Growth