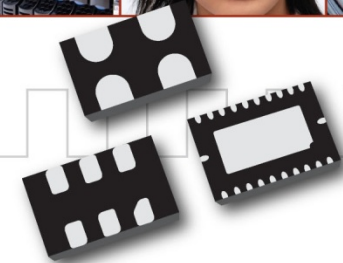




SiTime
Turbo
Webinars

SiTime University Turbo Webinar Series

Silicon MEMS vs. Quartz Supply Chain



August 19-20, 2013

The Smart Timing Choice™

Agenda



- Benefits of a solid supply chain
- How are quartz timing products built?
- How are MEMS oscillators produced?
- A Comparison
- Summary

Benefits of a Solid Supply Chain



Best lead time for samples and production

- Samples available in 48-hours
 - Any frequency
 - Any package
 - Any supply voltage
 - Any frequency stability option
- 4-week production leadtime

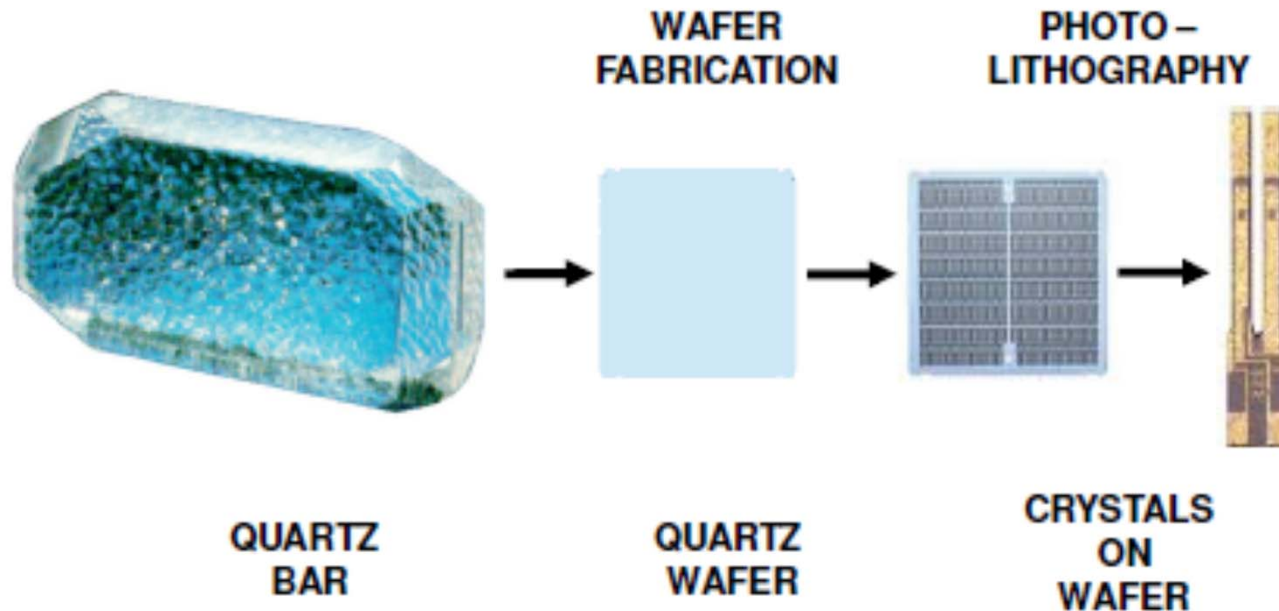
Continuity of Supply

How Do We Do It?



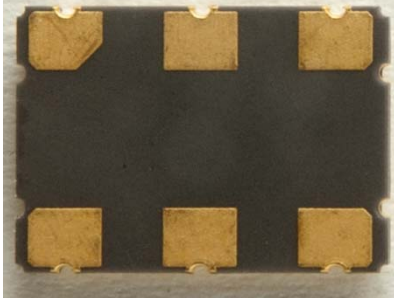
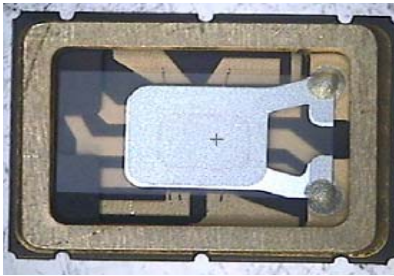
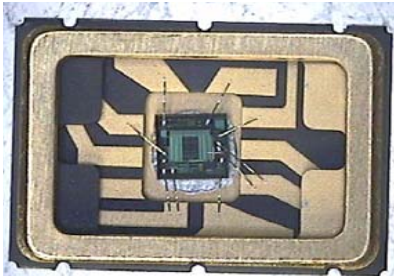
- Standard silicon wafer production
- Standard plastic packaging
- Oscillators come out of assembly as blanks
 - Easiest way to hold wafer inventory prior to assembly and test
 - 4-weeks lead time from wafer-to-finished product
- Parts are programmed at production test
 - Easiest way to inventory packaged product
 - 1-2 week volume lead time

Quartz Resonator Construction



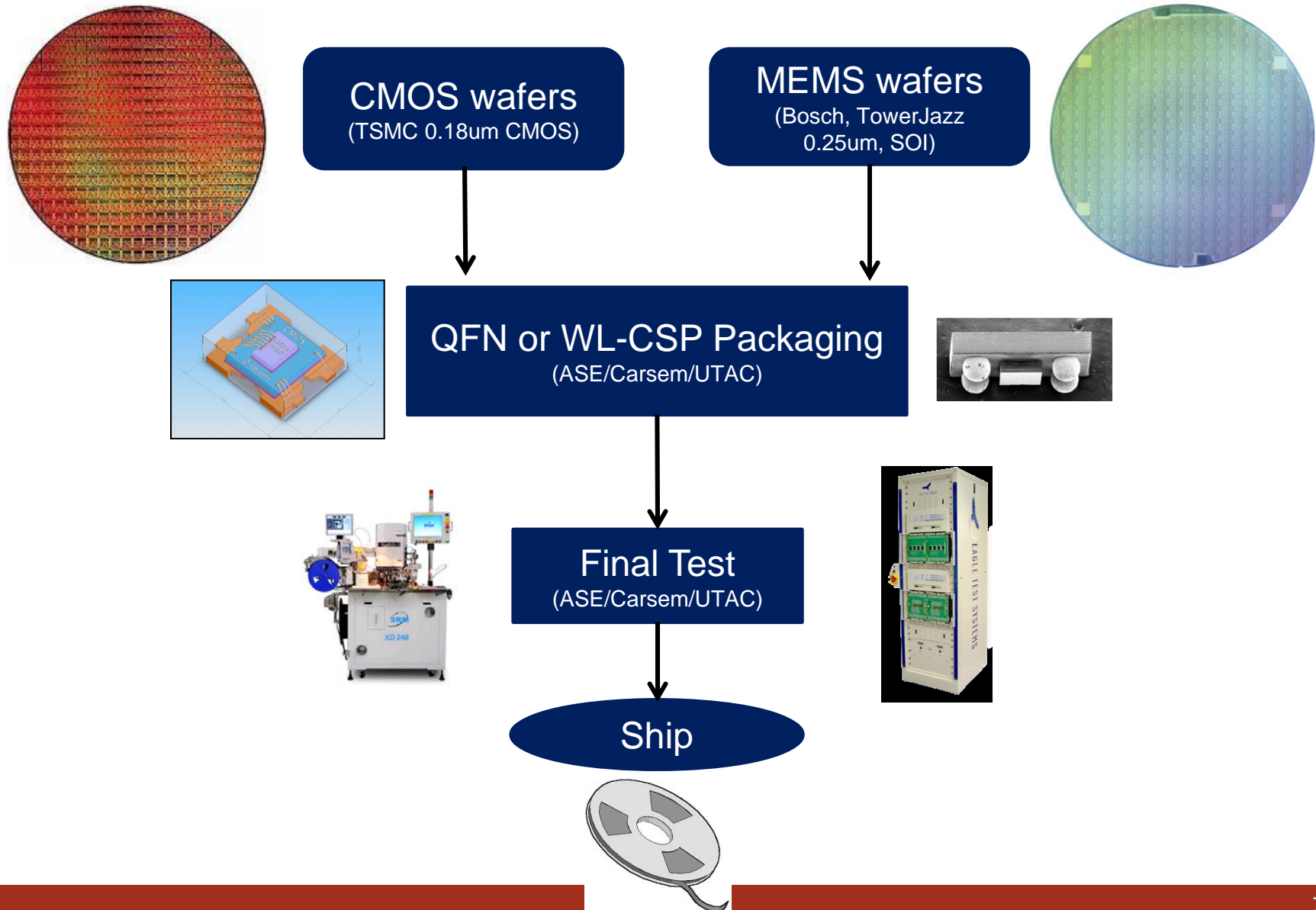
- Photolithography used to apply material to quartz and etch out resonator structure
- Cr-Au plating applied on top of quartz resonator
- Frequency adjustments by laser trimming

Construction of Quartz Oscillator



- CMOS die attach and wire bonding
- Quartz blank attached by conductive glue
 - Out gassing of glue - causes drift and aging
 - Dispensed amount influences mechanical parameters of resonator
 - Moving metal electrodes - cause drift
- Finished Package Assembly Process
 - Metal lid sealing by seal glass (out gassing) or welding (expensive)
 - Hermetic sealing is required to prevent oxidation and mass loading – drift
 - Laser marking
- Concentrated supply of raw material
 - 80% of quartz raw material is produced in Japan
 - Two ceramic package vendors control the market (Kyocera 80%, Sumitomo 20%)

SiTime MEMS Oscillator Construction- Production Flow



Comparison of Manufacturing Fabs



Quartz: dicing and grinding



Quartz: manual assembly



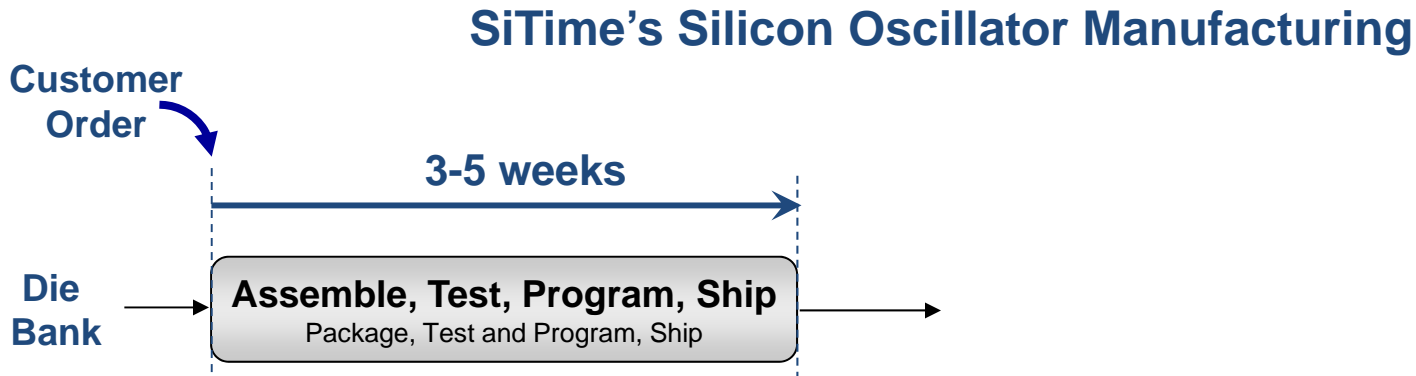
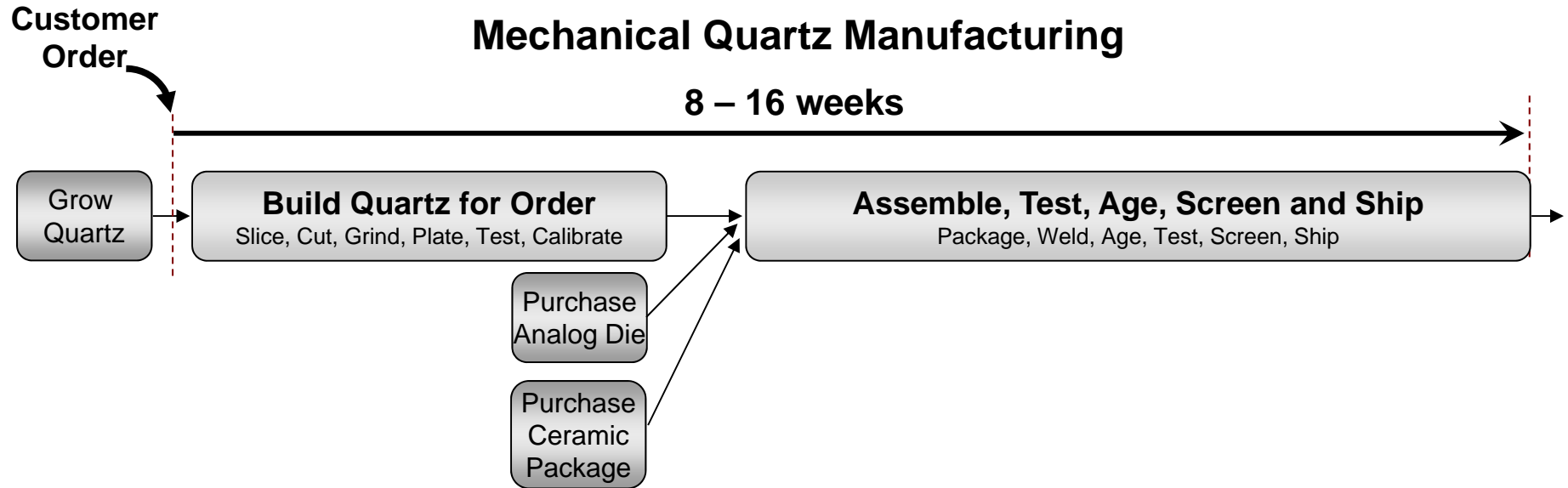
MEMS: Modern 200mm Wafer Fab

Supply Chain Comparison

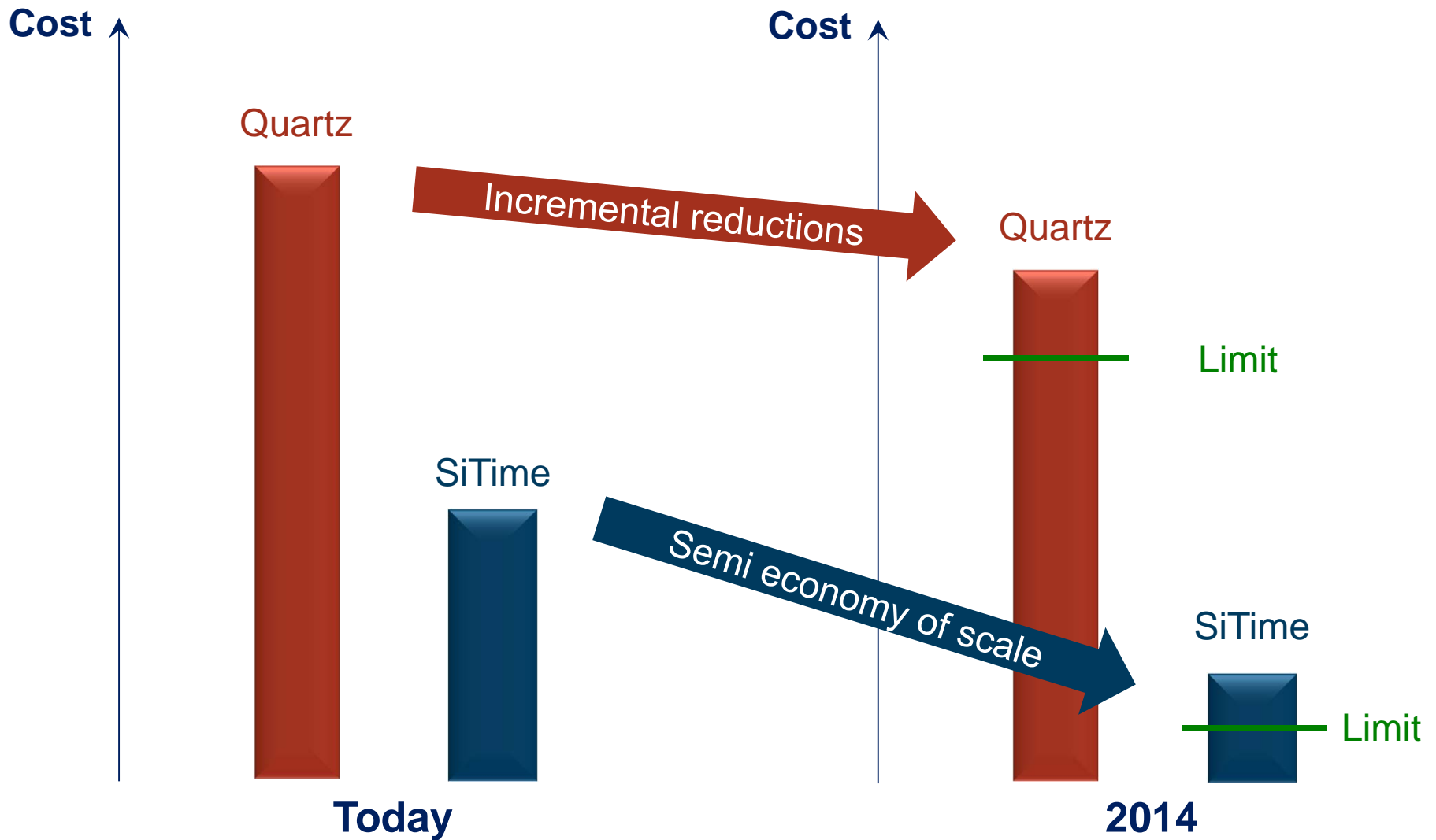


	MEMS	Quartz Oscillators
Processes	<ul style="list-style-type: none"> - Standard CMOS tools and processes - High volume batch processing 	<ul style="list-style-type: none"> - Proprietary processes - Serial, single part processes
Fabs/ Foundries	<ul style="list-style-type: none"> - Modern, standard - Highly controlled - Ultra clean 	<ul style="list-style-type: none"> - Specialized, unique quartz fabs
Scalability	<ul style="list-style-type: none"> - No capacity limit - Multiple sources to increase capacity 	<ul style="list-style-type: none"> - New lines required for any increase in capacity - Slow to ramp and react
Quality control	<ul style="list-style-type: none"> - CMOS standard - 6 sigma, SPC, JEDEC - Single customer qualification for many freqs 	<ul style="list-style-type: none"> - Every part & freq requires customer qualification - High customer audit effort
Cost	<ul style="list-style-type: none"> -Low cost foundry -Batch processes 	<ul style="list-style-type: none"> - Custom tooling - Strongly dependent on utilization

Quartz vs. MEMS: Manufacturing



SiTime – Sustainable Cost Advantage



Summary



- MEMS has a simpler structure and manufacturing process
- Being programmable, MEMS have better lead time for samples and production
- Utilizing proven semiconductor processes, MEMS can ramp to volume from zero to millions quickly
- With standard processes available from multiple sources, MEMS is lower risk to supply
- MEMS structures and processes have proven themselves in accelerometers, gyroscopes and sensors shipping in billions every year

Contact Information



- **For Questions, contact SiTime Technical Support**
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