# Welcome!
# Texas Instruments New Product Update

- This webinar will be recorded and available at www.ti.com/npu
- Phone lines are muted
- Please post questions in the chat or contact your TI sales contact or field applications engineer

# TI'S LMK6 BAW OSCILLATOR FAMILY: INDUSTRY'S FIRST SILICON-BASED BAW OSCILLATOR

## New Product Update

Kia Rahbar – Clocks & Timing Product Marketing Engineer

# Agenda

- BAW resonator technology overview
- BAW oscillator key features
- TI Oscillator Roadmap
- BAW oscillator comparison to quartz, mems, and crystals
- BAW oscillator markets and use cases

Please feel free to “chat”  Purnachandar Poshala who is available to answer any questions you have throughout this presentation.

# BAW Resonator Technology

# BAW resonator technology

## TI Bulk Acoustic Wave (BAW) resonator

- Micro-resonator technology that enables integration with another IC
  - Thin layer of piezoelectric film sandwiched between metal films and other layers that confine the mechanical energy.
- Categorized as Piezo-MEMS. Shares commonalities with both Quartz and MEMS technologies:
  - Can think of BAW as a miniature quartz crystal – utilizes piezoelectric transduction to generate vibration
  - Also categorized as MEMS technology – batch fabrication using semiconductor compatible process
  - Differentiation: 50x - 100x higher frequencies than quartz and other commercialized MEMS resonators
- BAW technology isn't new but TI is the first to commercialize it for clocking purposes:
  - Successful integration as VCO & reference resonator for oscillator
  - Design controls fine tuning of process if needed with capability to adjust resonator frequency, impedance, quality factor, size, etc. to optimize for specific device architecture and application
  - Millions of ICs have already been shipped with no reliability issue
- Key performance spec: **Exceptional Jitter**!

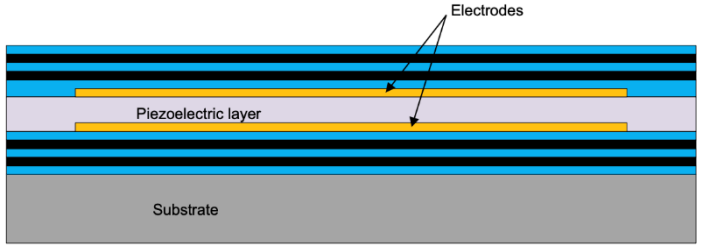
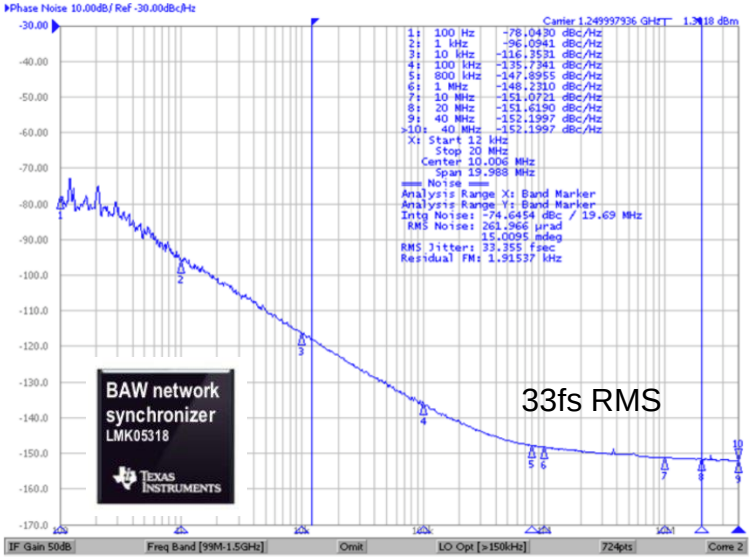



**Figure 2. Basic structure of a Bulk Acoustic Wave (BAW) resonator.**



# BAW Oscillator Key Features and Roadmap

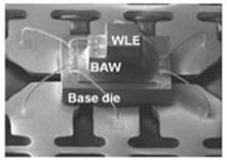
# TI’s BAW oscillator

## Ultra-low **jitter performance**


**LVDS/LVPECL/HCSL:**
100 fs RMS jitter at 156.25 MHz
**LVCMOS:**
200 fs RMS jitter at 25 MHz

TI oscillator portfolio integrates **Bulk Acoustic Wave (BAW) resonator** technology to enable ultra low jitter performance

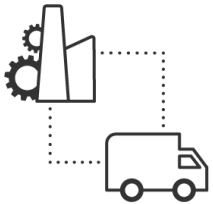
## **Better reliability** improves system level performance




- Vibration (1 ppb/g typical) and shock immunity
- Temperature stability (± 20ppm)
- Higher MTBF

**Superior reliability** provides significant advantages compared to crystal oscillators

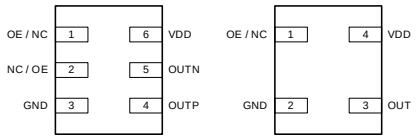
## We own the **supply chain**



TI owns **fabrication, assembly and packaging** in WW

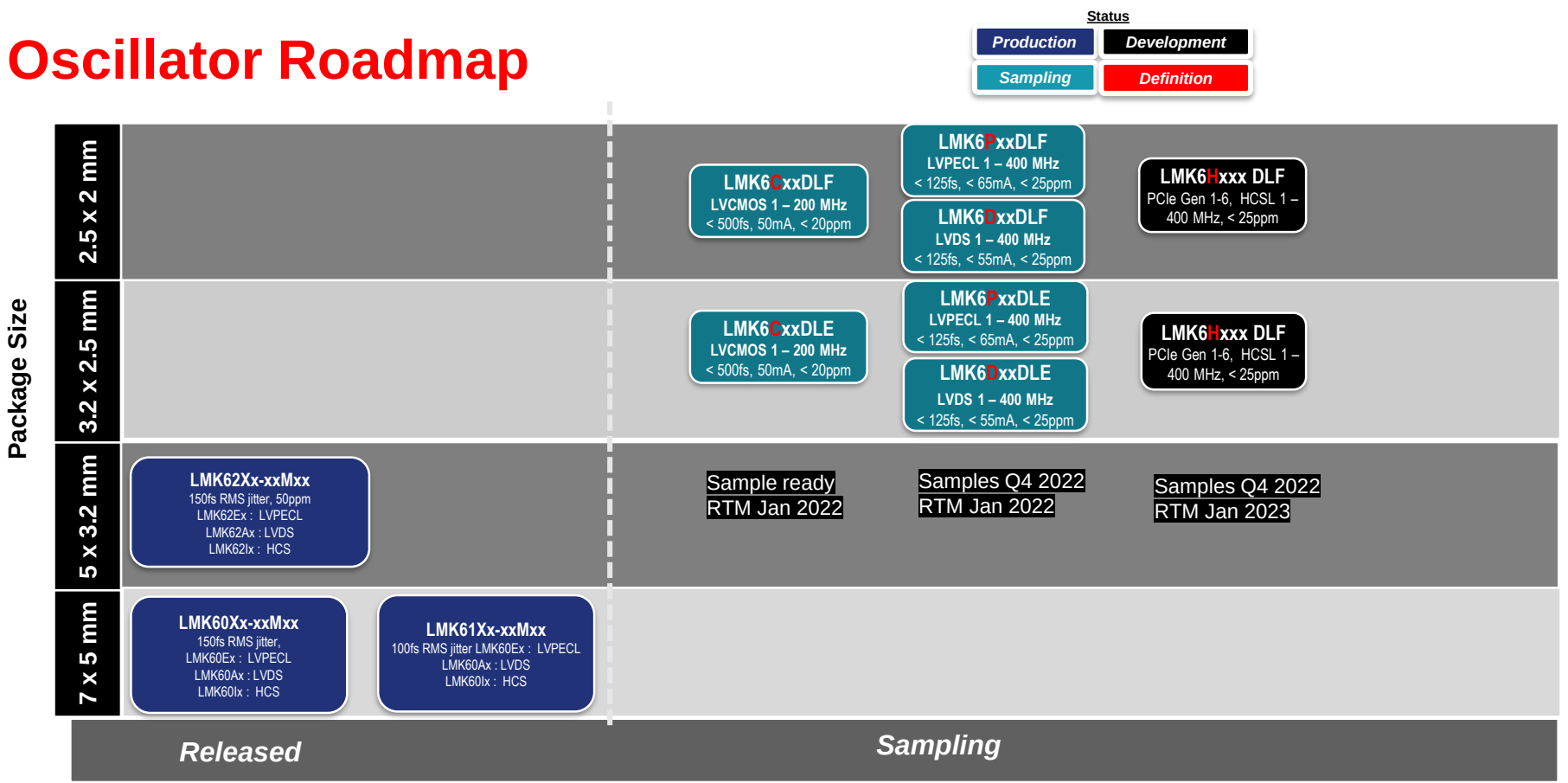
- No supply constraints due to dependability on external vendor
- Quickly support samples and mass production with single IC for all variants (frequency, output type, voltage, etc.)

## **Drop-in replacement**




Flexibility for **any frequency** (1-400MHz)**, drop-in** replacement on 3.2*2.5 and 2.5*2.0mm with standard package

# Oscillator Roadmap

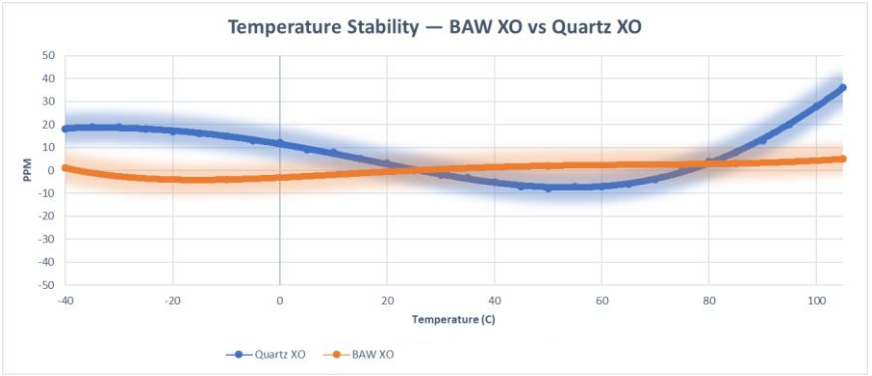


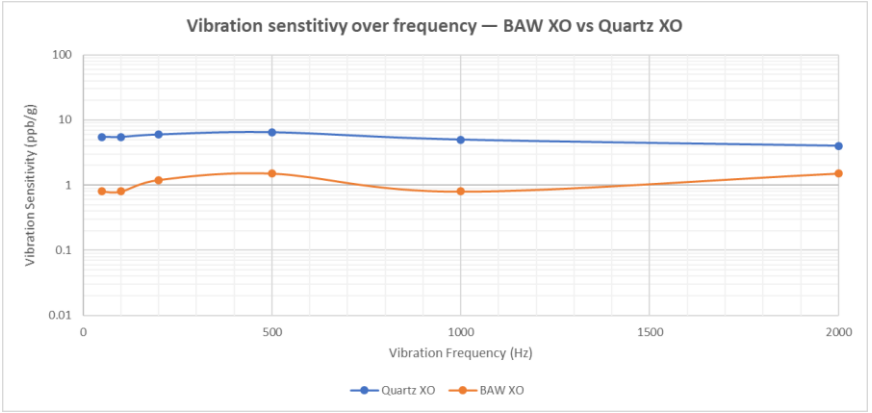
# BAW Oscillator Compared to Other Oscillators

# BAW oscillator compared to Quartz

## Pin to pin compatible to replace Quartz based oscillators with added benefits

- Flexible – single IC (BAW + base die) provides <u>any</u> output frequency.
  - Alleviates supply constraints
- BAW oscillator has significantly better temperature stability
  - < ±10 ppm over -40 – 105C temperature range
  - Quartz based solution (without integrating temperature compensation circuitry) grow significantly past ~80C.
- Mechanical robustness
  - Passes MIL-STD-F Method 2007 and MIL-STD-F Method 2002
  - ~1 ppb/g over typical tested range (50 Hz – 2 kHz), Quartz can be anywhere from a few ppb/g to 10s of ppb/g
  - Not susceptible to activity DIP
- Integrated LDO
  - Provides supply noise immunity, eliminating the need for external LDO or DC/DC



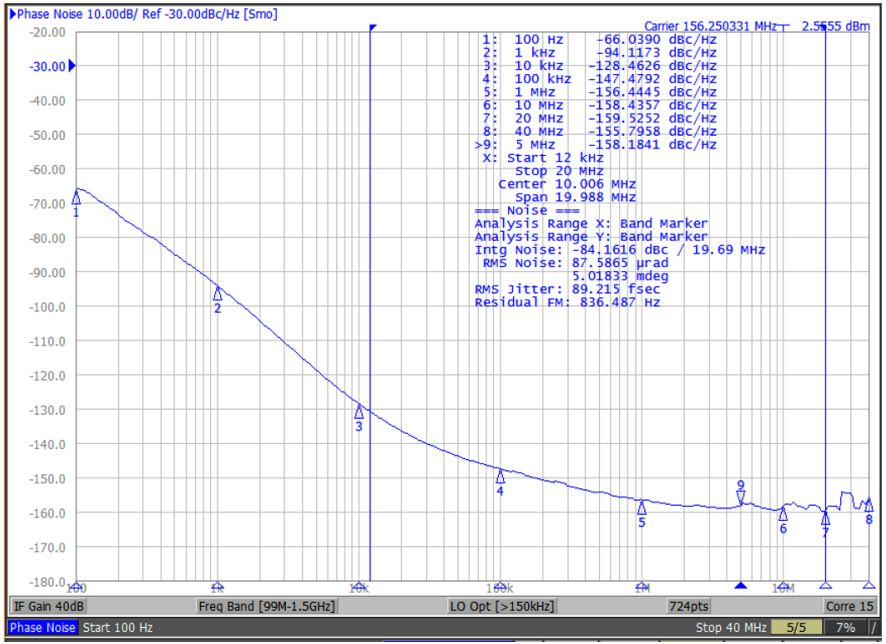
# BAW oscillator compared to other MEMS

**Pin to pin compatible to replace other MEMS based oscillators with added benefits**

- Many similarities:
  - Batch fabrication like semiconductor process
  - Single chip solution to support whole product family at any frequency (Quartz SPXO requires different crystal / overtone for different frequencies)
  - Mechanical robustness and better reliability

- **Key differentiator: Superior jitter** (12 kHz – 20 MHz BW)
  - Typical BAW oscillator **~100 fs** with max 125 fs (supported on final silicon revision)
  - Other fractional MEMS solutions **~250+ fs**

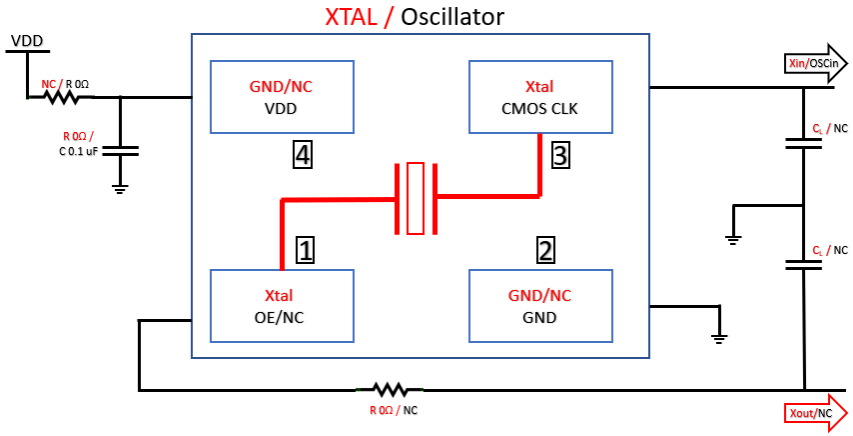
- Does NOT require vacuum hermetic sealed package
  - No impact if exposed to helium gas



# BAW Oscillator to replace Crystals

## Oscillators are much easier to design!

- Benefits of using an oscillator vs a crystal include:
  - No external components required to make sure of oscillation (drive level) and correct stability (load capacitance)
  - No layout concerns which may impact stability (stray capacitance)
  - Vibration, shock, aging effects measured and specified (unknown on crystals)
  - One product supports all frequencies
  - Small package matching crystal size
- Must route a Vdd supply to device pin
  - Receiver needs to support XO signal
- Dual layout recommendations on all crystals to alleviate supply issues



# BAW Oscillator Markets and Uses

# BAW Oscillator Markets

Optical Modules

Datacenter & Enterprise Computing

Wired Networking

Building Automation
Medical
Test & Measurement

Factory Automation

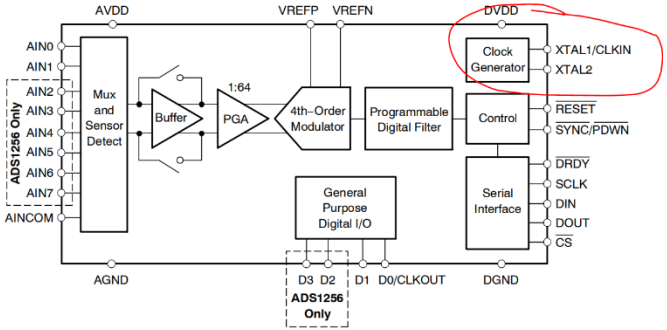
Motor Drives

Wireless Infrastructure

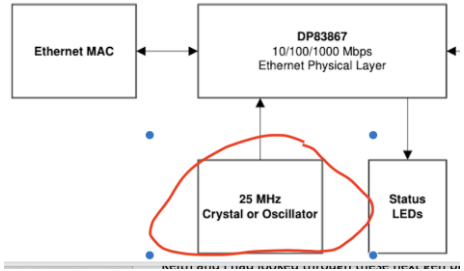
Broadband Fixed Line Access

# BAW Uses

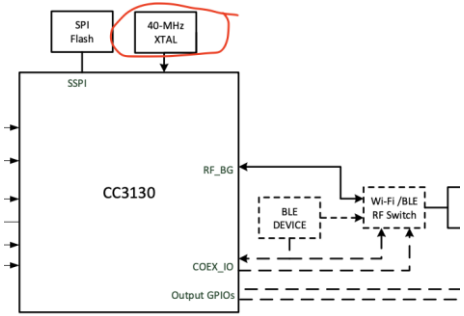
## ADS1256



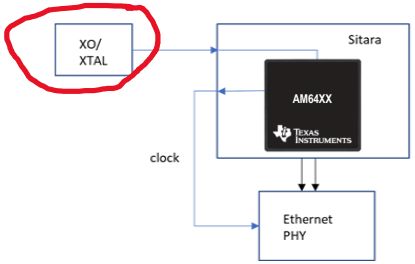

## PHY:DP838xx



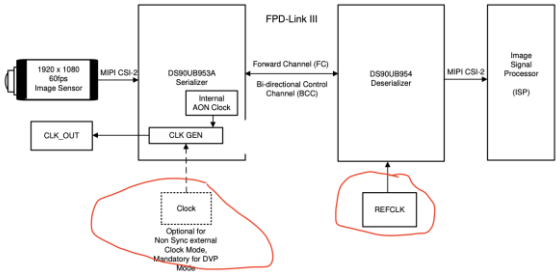

## WIFI:CC313x




## AM64xx




## FDPLINK: DS90UB953A/4



# Getting started

You can start evaluating this device leveraging the following:

| Content type | Content title | Link to content or more details |
|---|---|---|
| Product folder | LMK6C low-jitter, high performance, bulk-acoustic-wave (BAW), fixed frequency oscillator | LMK6C |
| Technical blog content or white paper | • Top 5 things to know about TI BAW resonator technology<br>• BAW Oscillator in Optical Modules<br>• BAW Oscillator in Factory Automation<br>• BAW Oscillator in Grid Infrastructure<br>• BAW Oscillator in Building Automation<br>• BAW Oscillator in Wired Networking<br>• BAW Oscillator in Datacenters | • Top 5 things to know about TI BAW resonator technology<br>• BAW Oscillator in Optical Modules<br>• BAW Oscillator in Factory Automation<br>• BAW Oscillator in Grid Infrastructure<br>• BAW Oscillator in Building Automation<br>• BAW Oscillator in Wired Networking<br>• BAW Oscillator in Datacenters |
| Selection and design tools and models | • Clock Tree Architect | • Clock Tree Architect |
| Development tool or evaluation kit | • LMK6x6EVM User's Guide | • LMK6x6EVM User's Guide |

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