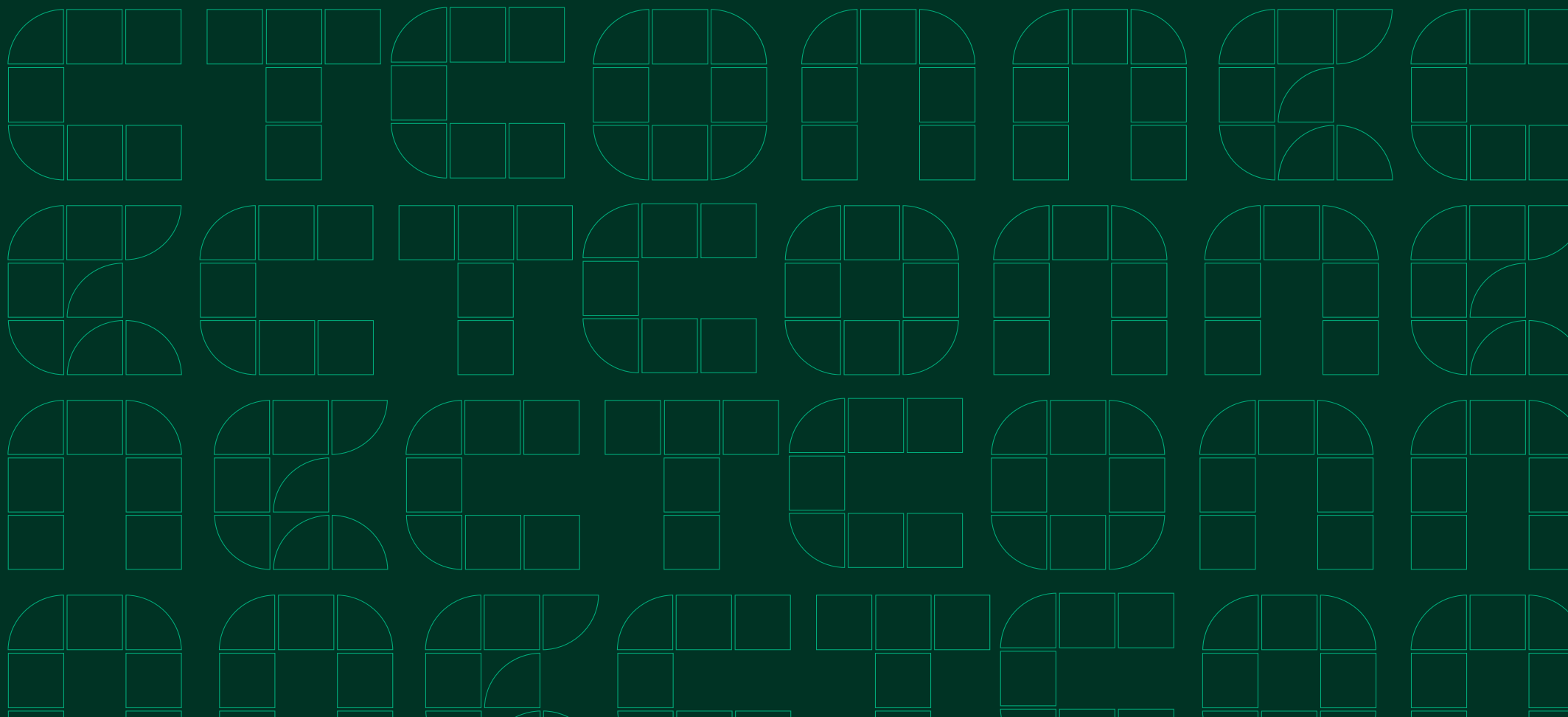


CONNECT

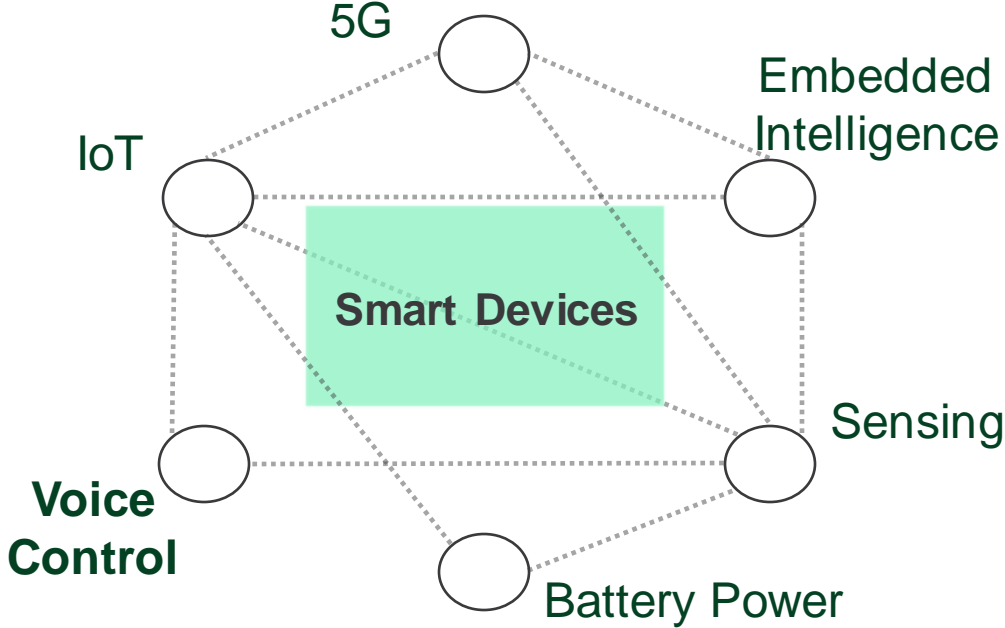


Mastering Audio and Acoustics Testing

Mastering Audio and Acoustics Testing

Min Tang, Offering Manager, SEBU

Overlapping Market Trends - Intensify Pressure on Test



Market Challenges



Test Challenges

Wider Test Coverage	Higher DUT Quality	More Efficient Sustaining	Faster Test Throughput	Compressed Development Schedule	Tighter Regulations	More Insight from Data
Test Budget						

Quiz

How many microphones are there inside your smart phone?



AUDIO & ACOUSTIC TEST

Test Increasingly Complex Sets of Audio Devices

The worldwide **growth** in audio and acoustic testing is being fueled by:

- Rapid growth of IoT devices supporting **voice control** functionality
- Higher consumer expectations in **audio quality** set by popular premium products
- The availability of **high-quality digital microphone** technology at an acceptable cost-of-goods for consumer electronics market.

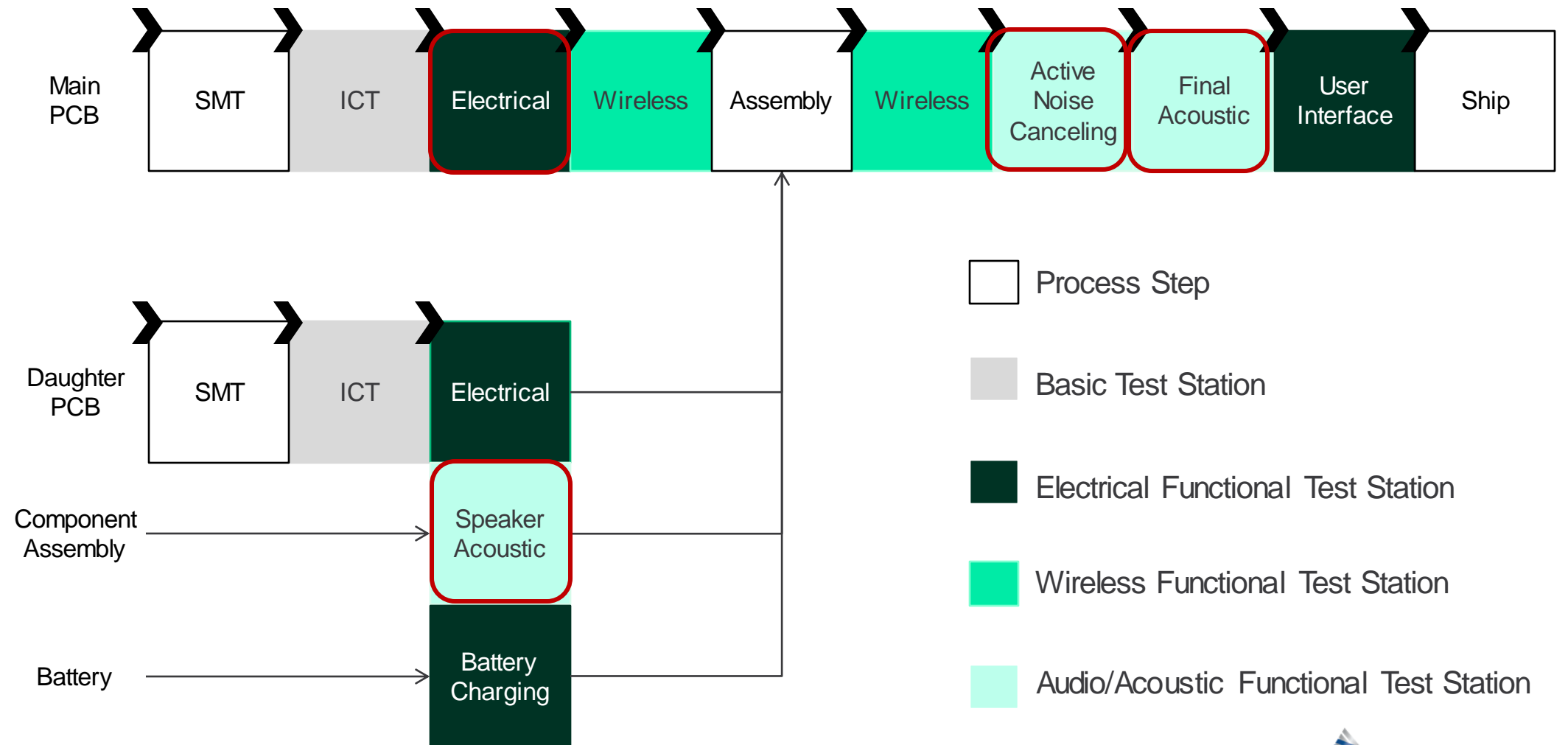
Quiz

What's the difference between Audio Test and Acoustic Test?

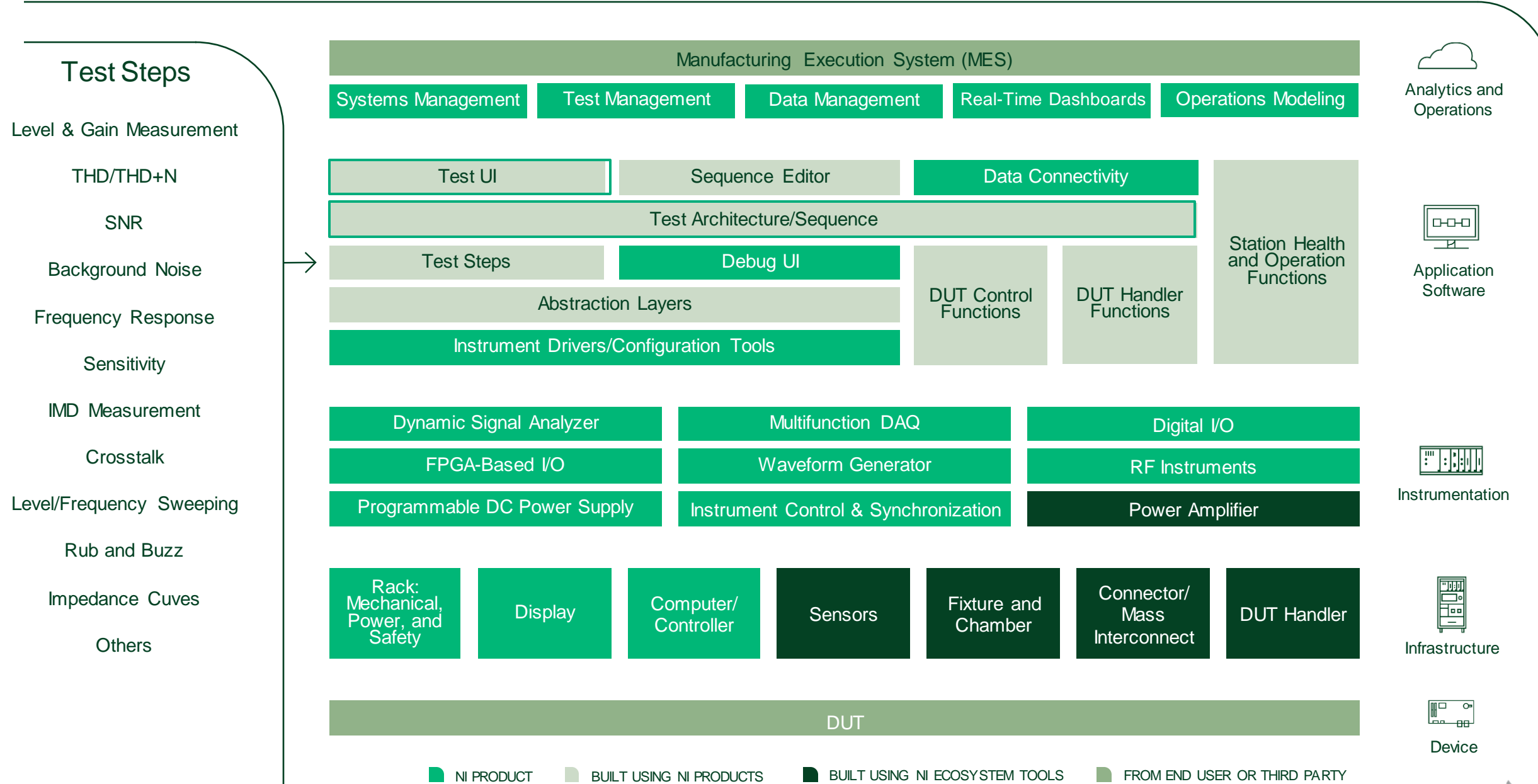


EXAMPLE OF DISTRIBUTED PRODUCTION LINE FOR WIRELESS HEADPHONES

NI Provides Solutions for Each Station in your Line



Components for Audio & Acoustic Functional Test



New Features in Audio and Acoustic Test Software

Test Sequence Templates



Microphone Test Sequence Templates

Sequence Template	Stimulus Signal	Supported Test Items
Microphone Chirp	Chirp	<ul style="list-style-type: none"> • Frequency Response • THD • Sensitivity
Microphone Single Tone	Single tone	<ul style="list-style-type: none"> • Level & Gain • THD • THD + N • Sensitivity
Microphone Stepped Frequency	Stepped frequency	<ul style="list-style-type: none"> • Frequency Response • THD • THD + N • Sensitivity
Microphone Stepped Level	Stepped Level	<ul style="list-style-type: none"> • THD • THD + N • Sensitivity
Microphone Noise Floor	No signal input	Noise Floor

* Supports both Analog and Digital (PDM and I2S) Microphones



Speaker Test Sequence Templates

Sequence Template	Stimulus Signal	Supported Test Items
Speaker Chirp Signal	Continuous frequency sweep	<ul style="list-style-type: none"> • Frequency Response • THD • Rub & Buzz
Speaker Crosstalk	Single tone * One channel idle; one channel with stimulus	Crosstalk
Speaker Impedance	Continuous frequency sweep	Impedance
Speaker Multi Tone	Multitone	IMD
Speaker Polarity	Custom chirp signal	Polarity
Speaker Single Tone	Single tone	<ul style="list-style-type: none"> • THD • THD + N • Rub & Buzz • Signal-to-Noise Ratio (SNR) • Sensitivity
Speaker Stepped Frequency	Stepped frequency sweep	<ul style="list-style-type: none"> • Frequency Response • THD • THD + N • Rub & Buzz
Speaker Stepped Level	Stepped frequency sweep	<ul style="list-style-type: none"> • THD • THD + N

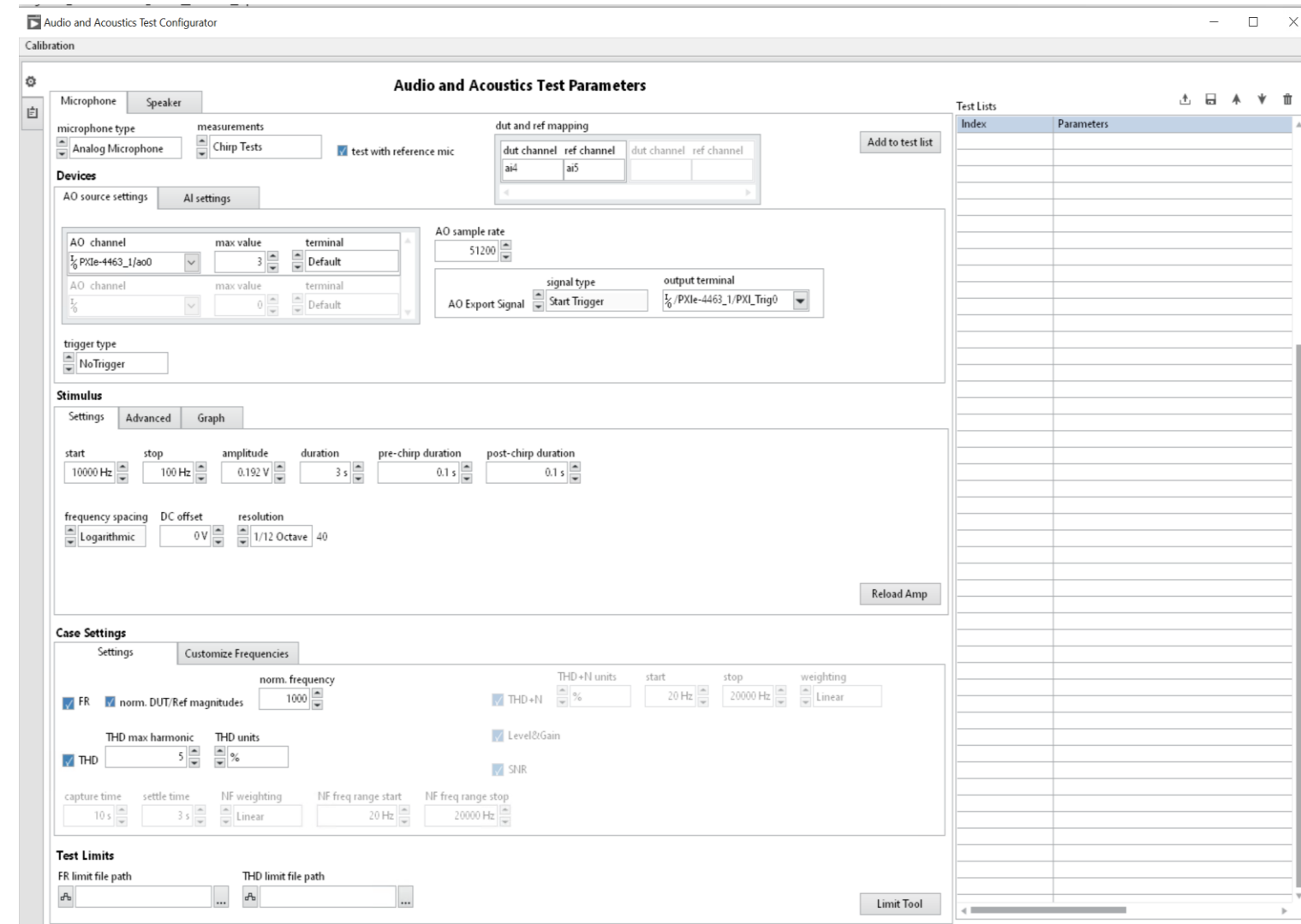
Audio and Acoustics Test Software 23.3

- Ready-to-use test sequence templates and test IP
- Support for both analog and digital audio
- Support for both LabVIEW and C# (New)
- Open modular approach, easy to customize and migrate with existing software architecture
- **Utilities**
 - Audio and Acoustics Test Configurator (New)
 - Calibration exe (New)
 - Interactive Limit setting Tool



New Feature in Audio and Acoustics Test Configurator

- One-stop parameter configuration, test execution, and test monitoring
- Streamline the workflow for test automation, graphical tool to run and debug customized test steps
 - Config stimulus signals and test cases to customize test steps
 - Provide templates/examples (test sequences) for most of common test cases for speaker and microphone
 - Real time data visualization for test results, snaps ready for review
 - Test report generation
- Easy to load data from calibration files or TEDS



Audio and Acoustics Test Configurator

Calibration

Audio and Acoustics Test Parameters

Microphone Speaker

measurements: Chirp Tests Add to test list

Devices

AO source settings AI settings

AI settings: AI channel: cDAQ2Mod4/ao0, channel type: SPL (Pa), max value: 130, sensitivity: 50.53 mV/Pa, coupling: AC, excitation: Min, terminal: Default, AI sample rate: 102.4k

resistor acquisition: AI channel: cDAQ2/ao, channel type: SPL (Pa), max value: 130, sensitivity: 52.18 mV/Pa, coupling: AC, excitation: Min, terminal: Default

trigger type: DigitalStart, AI trigger source: cDAQ2/ao/StartTrigger, edge: Rising Load Sensitivity

Stimulus

Settings Advanced Graph

start: 10000 Hz, stop: 100 Hz, amplitude: 0.3 V, duration: 3 s, pre-chirp duration: 0.1 s, post-chirp duration: 0.1 s

frequency spacing: Logarithmic, resolution: 1/24 Octave, DC offset: 0 V

Case Settings

Settings Customized Frequency

amplifier calibration file: ..., THD +N units: dB, start: 10000 Hz, stop: 100 Hz, weighting: A-weighting

THD max harmonic: 5, THD units: %

Rub max harmonic: 15

impedance resistor: 0 ohms

Test Limits

THD limit file path: C:\Users\Public\Documents\..., FR limit file path: C:\Users\Public\Documents\..., Rub&Buzz limit file path: C:\Users\Public\Documents\..., Limit Tool

Test Lists

Index	Parameters
2	[Speaker Chirp Signal-0] FR = TRUE THD = TRUE Rub_Buzz = TRUE CustomizeFRFreqsCounts = 4 CustomizeFRFreq(0) = 100.000000 CustomizeFRFreq(1) = 200.000000 CustomizeFRFreq(2) = 1000.000000 CustomizeFRFreq(3) = 10000.000000 CustomizeTHDFreqsCounts = 4 CustomizeTHDFreq(0) = 100.000000 CustomizeTHDFreq(1) = 400.000000 CustomizeTHDFreq(2) = 5000.000000 CustomizeTHDFreq(3) = 10000.000000 CustomizeRubFreqsCount = 4 CustomizeRubFreq(0) = 200.000000 CustomizeRubFreq(1) = 2000.000000 CustomizeRubFreq(2) = 5000.000000 CustomizeRubFreq(3) = 10000.000000 THDUnits = 2 HarmonicToTestCount = 2 HarmonicToTest(0) = 2 HarmonicToTest(1) = 3 MaxHarmonic = 5 MaxDelay = 1000.000000 MeasureDelaysCount = 0 RubMaxHarmonic = 15 AmplifierCalibrationFile = C:\Users\Public\Documents\National Instruments\Audio and Acoustics\Examples\TestStand 2019 (64-bit)\Mic and Speaker seq THDLimitFile = C:\Users\Public\Documents\National Instruments\Audio and Acoustics\Examples\TestStand 2019 (64-bit)\Mic and Speaker seq FRLimitFile = C:\Users\Public\Documents\National Instruments\Audio and Acoustics\Examples\TestStand 2019 (64-bit)\Mic and Speaker seq ChirpStartFreq = 10000.000000 Amplitude = 0.300000 Duration = 3.000000 Pre-Chirp = 0.100000 Post-Chirp = 0.100000 Resolution = 80 FrequencySpacing = 1 DCOffset = 0.000000 EnableSyncPulse = TRUE Level = 0.300000 SyncDuration = 0.050000 Type = 0 Pre-PulseDuration = 0.000000 AOSettings.Count = 1 AOSettings.AOChannel(0) = cDAQ2Mod4/ao0 AOSettings.Max(0) = 3.000000 AOSettings.OutputTerminal(0) = -1 AOSampleRate = 51200.000000 AOExportTrigger = FALSE AOExportSignalType = 12491 AOExportTerminal = cDAQ2/ao/StartTrigger AOTriggerType = 0 AOStartTriggerTerminal = P3A-4461-P30 Tr

Audio and Acoustics Test Configurator

Calibration

Test UUTs: report path: C:\Users\Public\Documents\National Instruments\Audio and Acoustics\Examples\TestStand 2019 (64-bit)\Mic and Speaker seq LabVIEW version: LabVIEW 2018 (32-bit)

Sequence Report: Analog Mic Chirp Signal - Man (Analog Microphone Test seq)

Step	Description	Settings	Status
1	Load Stimulus signal and...	Parameters: CustomizedFrequencies	Done
2	Calculate Resample I...	Action: Cal Resamp Info vi	Done
3	Get Customized Limits	Action: Customized Mic Test Limit A...	Done
4	Get Limits	Action: Mic Get Link vi	Done
5	End		Done
6	Configure AO Timing	Action: Configure Timing (AO) vi	Done
7	Configure AI Timing	Action: Configure Timing (AI) vi	Done
8	Configure AO Trigger	Action: Configure Trigger (AO, AI) vi	Done
9	AO Export Start Trigger	Action: Export Trigger Signal (AO, AI)...	Done
10	Configure AI Trigger	Action: Configure Trigger (AO, AI) vi	Done
11	Play and Record		Done
12	AO Write Waveform	Action: Write Waveform (AO) vi	Done
13	Start AI Task	Action: Start (AO, AI) vi	Done
14	Start AO Task	Action: Start (AO, AI) vi	Done
15	AI Acquire Waveform	Action: Read Waveform (AI) vi	Done
16	Stop AO Task	Action: Stop (AO, AI) vi	Done
17	Stop AI Task	Action: Stop (AO, AI) vi	Done
18	Analyze		Done
19	Remove Delay	Action: Mic Align Waveforms vi	Done
20	Customized Chirp An...	Parameters: CustomizedFrequencies	Done
21	Chirp Analyze	Action: Mic Chirp Analysis vi	Done
22	End		Done
23	FR Post Processing	Action: Analog Mic FR Post Processi...	Precondition
24	THD Remove Ref Results	Action: Remove Reference Results vi	Precondition
25	THD Units	Locals: THD_Case_Name = StkPara...	Pre Expression
26	Make Sure SN Number ...	Locals: DUTNumber = (Parameters.E...	Pre Expression
27	Get DUT Number	Locals: DUTNumber = (Parameters.E...	Pre Expression
28	Post Result to UI		Precondition
29	Post Magnitude to UI	Call Update Data to UI in <Current FL...	Precondition
30	Post Phase to UI	Call Update Data to UI in <Current FL...	Precondition
31	Post THD to UI	Call Update Data to UI in <Current FL...	Precondition
32	Write Report		Precondition
33	Write Report for each DUT	Locals: Loop_i = 0; Locals: Loop_j < L...	Precondition
34	Convert Phase to gr...	Action: ConvertTo2DArray vi	Additional Results
35	Convert THD to grap...	Action: ConvertTo2DArray vi	Additional Results
36	Convert Magnitudes t...	Action: ConvertTo2DArray vi	Additional Results
37	Write FR Magnitude	Pass/Fail Test: Mic Write Report vi	Precondition
38	Write FR Phase Report	Pass/Fail Test: Mic Write Report vi	Precondition
39	Write THD Report	Pass/Fail Test: Mic Write Report vi	Precondition
40	End		Precondition
41	<End Group>		

Test Results

serial number: 08010009

test list: Speaker Chirp Signal-0

test case: Magnitude(dB)

Real-Time Result Display

Digital Audio Test

NI's Digital Audio Functional Test Solution



Meet your team's goals:

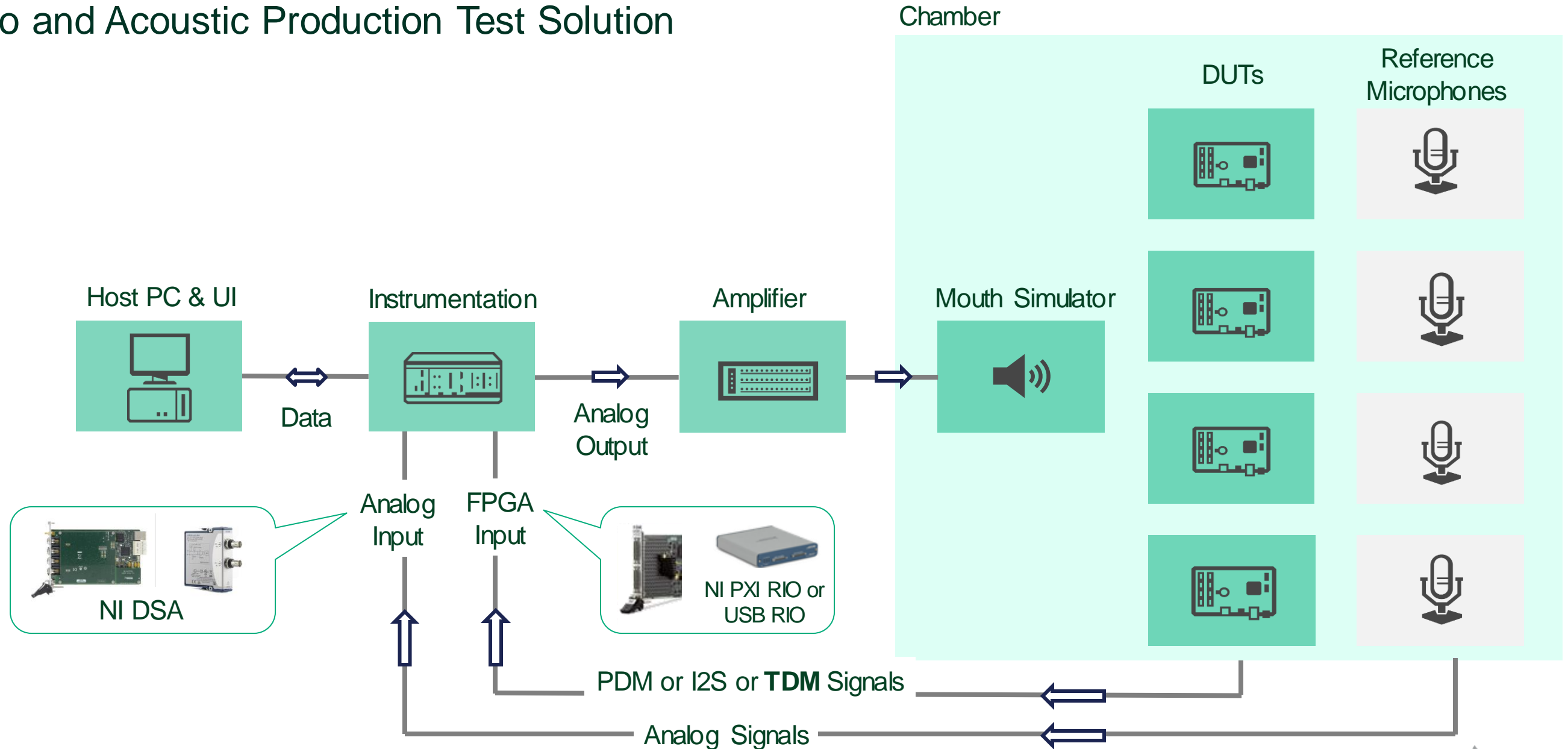
- Reduce engineering effort and risk with benchmarked system level design guide
- Maximize yield with data analytics & systems management configurations.
- Quickly adapt to new requirements with an open, modular architecture
- Free-up budget with lower cost per channel

Meet your technical goals:

- Parallel **FPGA** based PDM & I2S acquisition and generation allows high channel count, multi-up test
-
- **120dB stopband attenuation** optimized for SNR/noise floor test
-
- Higher measurement accuracy with **pure digital decoding**
-
- On-the-fly adjustment of decimation factor and rate

Hardware Setup for a Digital Audio Test

Audio and Acoustic Production Test Solution



Digital Audio Test using FPGA

FPGA PDM Demodulation

HIGHER CHANNEL DENSITY

- Never be limited by I/O channel count, with up to 128 digital lines per card.

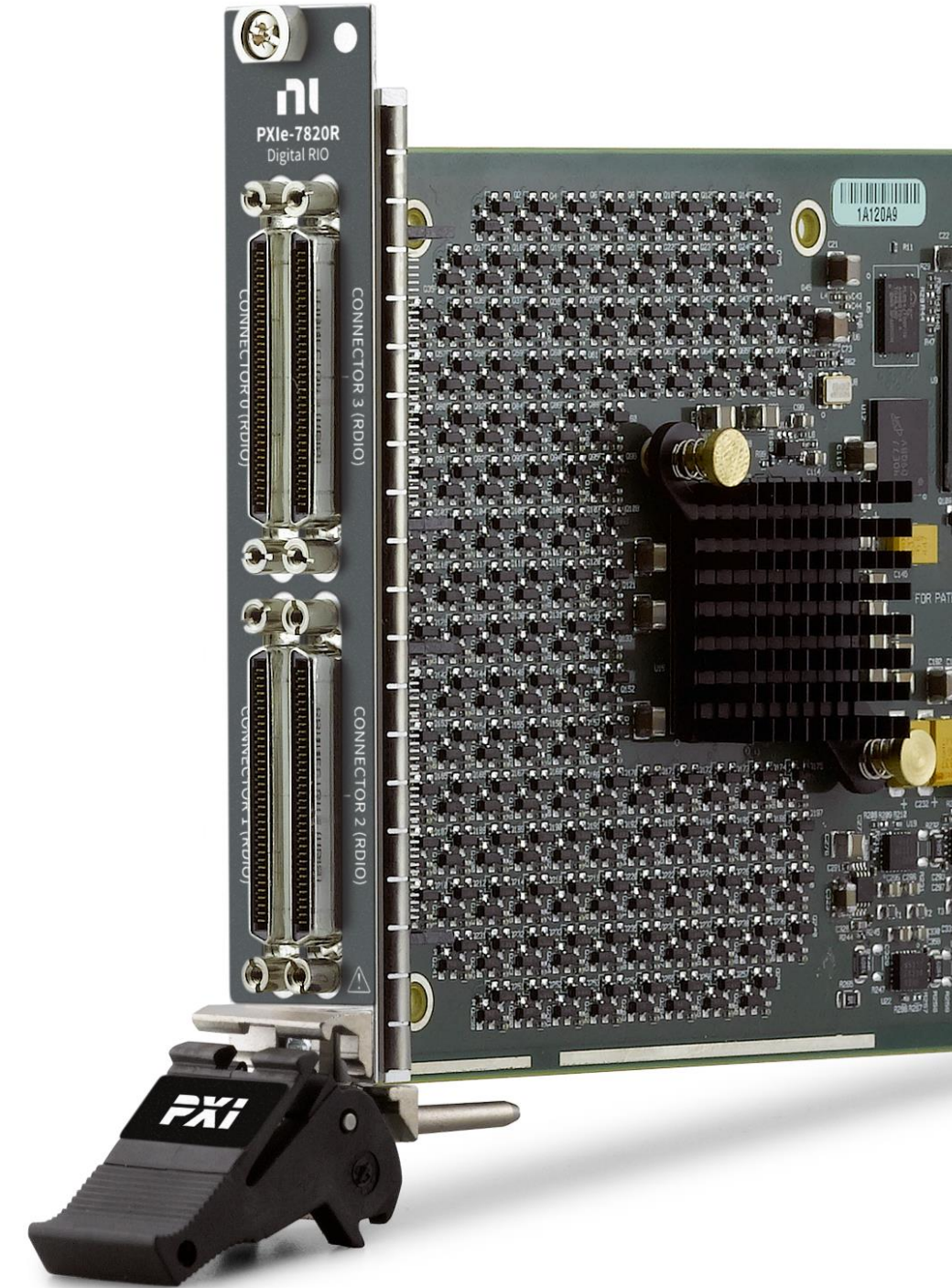
BETTER MEASUREMENT ACCURACY

- Improve measurement accuracy and simplify your signal path with direct digital acquisition (no digital-to-analog converter)

GREATER RESILIENCE TO CHANGE

- Insulate station investment from specification changes by updating test steps with DUT specific parameters such as clock speed and voltage level in software.

RAPID TEST DEVELOPMENT



Digital Audio Solution Details

Production Test - Audio & Acoustic: Digital

PXle 7820/7821

Acquisition		Generation	
32 PDM lines (64 channels)	32 I2S lines (64 channels)	16 PDM lines (32 channels)	16 I2S lines (32 channels)
24 GPIO	16 GPIO	8 GPIO	8 GPIO
W/ triggering	W triggering	W/ triggering	W/ triggering

USB 7845/7846

Acquisition		Generation	
8 PDM lines(16 channels)	8 I2S lines (16 channels)	8 PDM lines(16 channels)	8 I2S lines (16 channels)
8 GPIO	8 GPIO	8 GPIO	8 GPIO
W/O triggering	W/O triggering	W/O triggering	W/O triggering



PXle 7820/7821



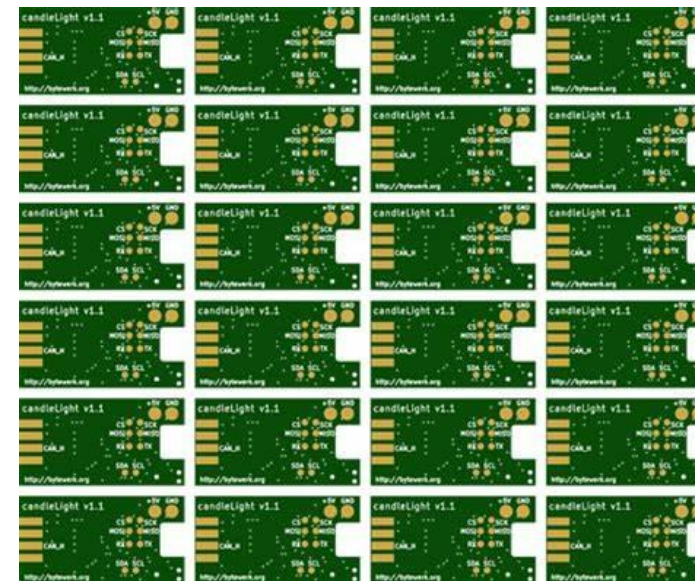
USB 7845/7846

Applications Require High Channel Density

Example 1:
Microphone module Production Test,
16 sites or higher



Example 2:
Panelized PCBA FCT for Wearable device,
AR/VR Device,
Smart Speaker, etc.



Digital Audio Acquisition and Generation Toolkit

Key Features

- PDM (pulse-density modulation) acquisition and generation
- Easy-to-use API
 - Similar to DAQmx
- PXI triggering
 - Synchronization between SMU module and PDM acquisition
- Variable clock rate and decimation factor

New Features

- PCM (pulse-code modulation) acquisition and generation APIs
 - I2S, Left-Justified, Right-Justified, TDM (4-Channel, 6-Channel, 8-Channel)
 - Max bit rate 24.576MHz
 - SPDIF (Digital only)
- **'Flexible Block'**
- Increase the maximum total number of timing engines to 4

Demo

Example Test Station

- Configured with a **4-up** architecture
- For **duel digital microphone module** functional test.
- Optimized for both measurement **accuracy** and **throughput**
- At a **lower overall cost** than many other turnkey solutions on the market

Analog reference microphones

Duel digital microphone DUT



Rackmount IPC

PXI DSA Input Card
PXI DSA Output Card
PXI Digital Input FPGA Card

Amplifier leading to mouth simulator



This system was designed in partnership with NI system integration partner **Booster**.



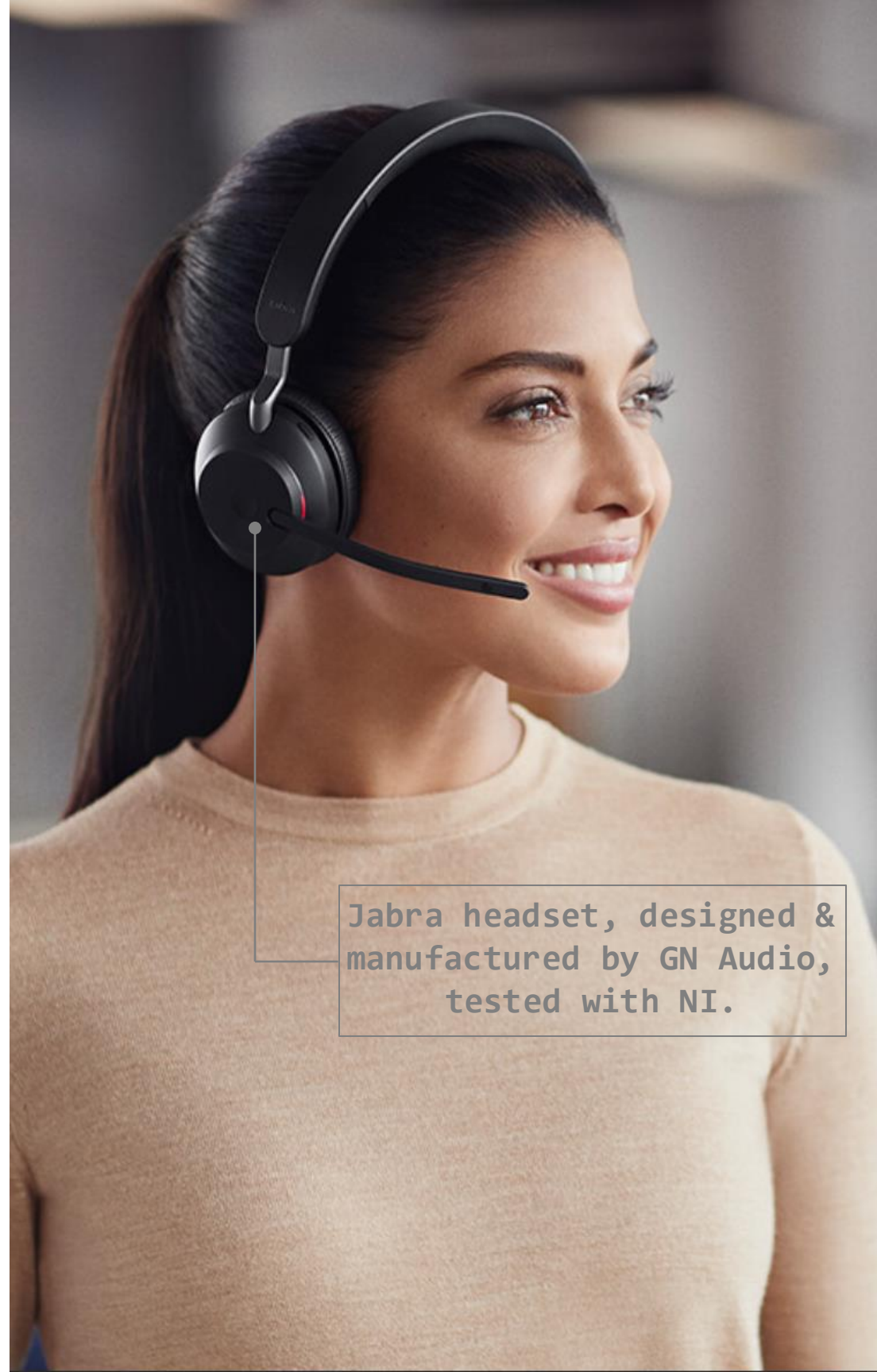
GN Audio Ensure Quality while Speeding Development of Manufacturing Test Systems

Successfully deployed a standardized test platform for more than 80 products and variants, based on NI measurement hardware, NI TestStand, and CATS software from CIM.AS

“We consider NI DAQ hardware the industry standard for production test applications. The close integration with NI software ensures ready access to our coverage requirements.”

Christian Wolf

Global Manufacturing Test Manager,
GN Audio



Jabra headset, designed & manufactured by GN Audio, tested with NI.

2.5X
TEST COVERAGE
INCREASE

2
WEEKS OF TEST
DEV. FOR NPI

6
GLOBAL
MANUFACTURING
SITES

Millions
PRODUCTS TESTED

“Our solution uses LabVIEW and PXI modular instruments, including dynamic signal acquisition, to achieve our test system cost target, meet performance and quality requirements, and improve test throughput by 33 percent.”

Koh Chee Lit

MANUFACTURING TEST, SONY EMCS

Questions?



CONNECT

2024 AUSTIN

