Vertex Channel Emulator

The Vertex® Channel Emulator is an advanced platform that replicates the comprehensive noise and spatial conditions of even the most complex wireless channels. Its cutting edge capabilities enable users to emulate a real-world RF environment in the lab, making it possible to isolate and identify performance issues early in the development cycle.

Vertex is backed by a long history of channel emulation leadership and industry-recognized expertise. Incorporating a modular RF front end with a powerful signal processing core, the Vertex Channel Emulator achieves an unprecedented level of scalability and flexibility, enabling it to efficiently address a broad range of applications from low channel density like SISO or 2x2 MIMO to high channel density required for 5G scenarios, such as MIMO beamforming, MIMO OTA, carrier aggregation, and massive MIMO.

Easy to set up and operate, Vertex includes VIAVI's industry-recognized user-friendly graphical user interface that allows measurements to be set up and performed quickly and accurately.



Vertex Channel Emulator

Applications

- Scalable from basic SISO to high channel density applications
  - MIMO beamforming
  - MIMO OTA
  - Carrier aggregation
  - Massive MIMO
- Wi-Fi 7/8, Wi-Fi 6/6e, Wi-Fi 5, Wi-Fi 4, including MLO
- Device conformance and performance verification
- Virtual drive testing
- Mesh networks
- Satellite (NTN) and aeronautical applications

The world's most scalable channel emulation platform, VIAVI's Vertex Channel Emulator is an advanced test and measurement system that accurately simulates the complex effects of signal fading on wireless transmissions.

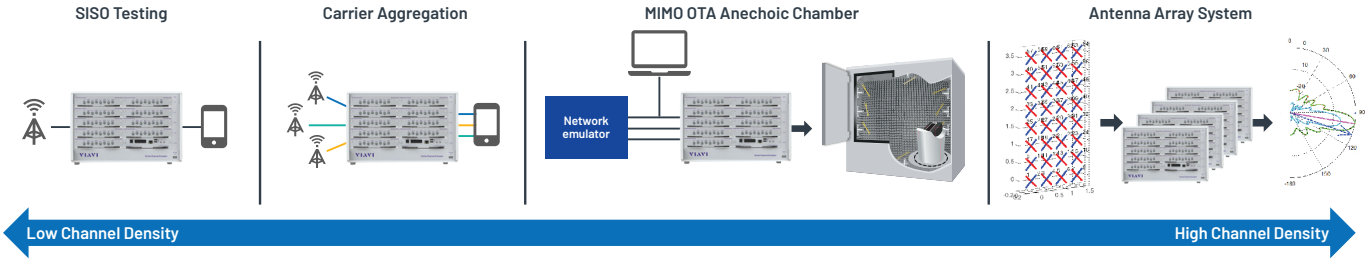
The system enables the test and evaluation of a broad range of applications with a variety of channel densities, from basic applications like 2-channel SISO to complex, high channel density applications like MIMO OTA, MIMO beamforming and carrier aggregation needed for 5G test scenarios.

The Vertex platform combines modularity, scalability and ease-of-use into a powerful test and measurement solution that addresses the needs of a constantly evolving wireless market.

Features and Benefits

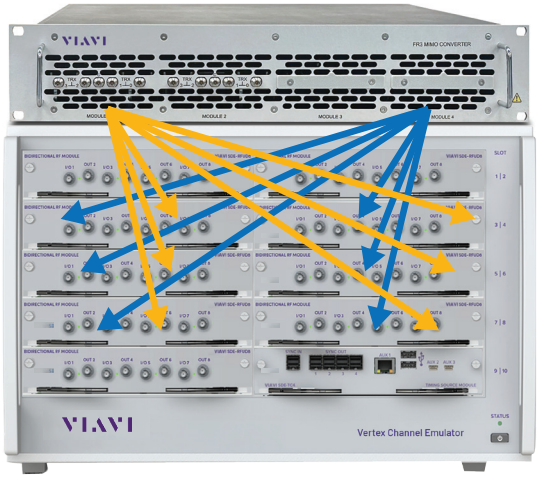
Scalability

The Vertex Channel Emulator is scalable to a broad range of applications. The hardware is capable of supporting as few as two bidirectional RF channels for basic RF testing, and up to 72 ports unidirectional RF channels to support high channel density such as MIMO OTA, all in one single, small form instrument.



Modularity

Separate RF modules are optimized for unidirectional or bi-directional applications and support a variety of different frequency bands. This allows the Vertex Channel Emulator to be configured for specific test needs using minimal hardware. Field-replaceable RF and DSP modules facilitate upgrades and enhance serviceability. Each RF module has an independent Local Oscillator (LO), allowing the Vertex Channel Emulator to support multiple carrier frequencies in the same instrument. The optional FR3 MIMO Converter can also be added to extend the frequency coverage up to 23.5 GHz, all controlled from a single GUI.



Vertex and FR3 MIMO Converter

High Channel Density in a Compact Space

The Vertex Channel Emulator system supports up to 72 ports and 256 digital links in one 6U rack height. It enables more efficient use of hardware for tests that require higher RF channel counts.

Comprehensive Channel Modeling Support

The built-in Vertex propagation library offers a vast selection of standard channel models, while making it easy to edit and save changes to both the standard as well as user-defined models. Classical and 2D/3D geometrical channel models are supported and the independent channel modeling feature allows one Vertex to support up to 16 nodes for mesh network applications. Optional VIAVI Raytracing can also be added to emulate even higher fidelity site-specific scenarios, including moving object modeling for e.g. integrated sensing and communications (ISAC).

Ease of Use

Complicated test setups are made simpler with an easy-to-use Graphical User Interface (GUI). Intuitively-designed libraries of connection setups make it easy to navigate through complicated configurations by presenting information in a clear way. For debugging purposes, important Information is displayed in real time, including power level tracking of each RF port.

Remote Programming Interface (RPI)

Remote programming is supported through TCP/IP with both telnet or SSH protocol. The RPI commands provide seamless backward compatibly to the VIAVI VR5 HD channel emulator.

Live Streaming Dynamic Environment Emulation (LSDEE)

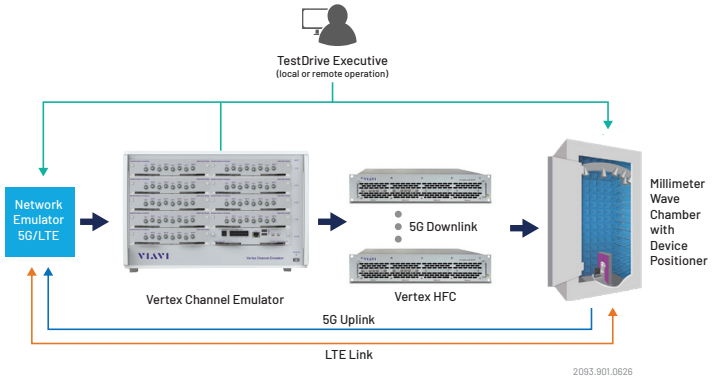
Live Streaming Dynamic Environment Emulation is an advanced feature in addition to the Vertex Channel Emulator RPI. It provides a very high-speed control mechanism for an extensive set of emulation parameters.

Unlike traditional DEE, which allows a user to create predefined scenarios for modifying channel parameters during a test run, there is no requirement to predefine or pre-compile channel emulation states or inter-state durations. LSDEE reduces processing time and monitors device behavior to make real-time scenario adjustments. This is extremely beneficial for high-speed scenarios where manual intervention can interfere with time-sensitive environmental changes. The same set of emulation parameters can be supported as with traditional DEE.

Key Test Applications

MIMO OTA

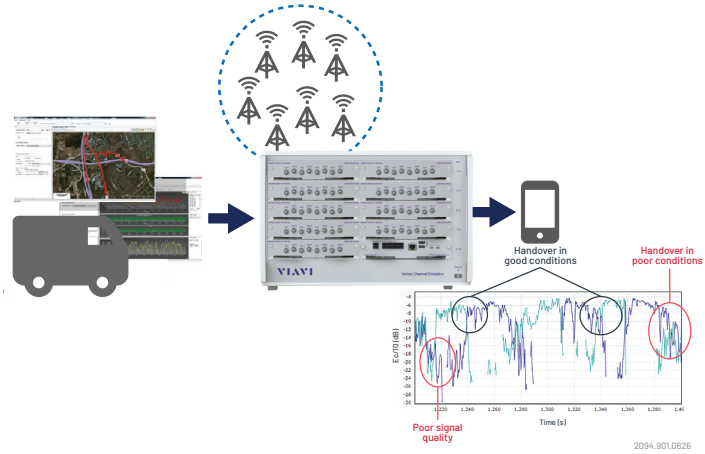
MIMO OTA applications require high channel density, based on the number of probes used in the test setup. The Vertex Channel Emulator can be used in both anechoic and reverberation chamber test setups and can switch between chamber types in minimal time. For anechoic chambers, Vertex supports up to 32 RF probes and two carriers with 16 dual polarized probes or 8 dual polarized probes on one instrument. For reverberation chambers, up to four carriers can be aggregated on one instrument.



Virtual Drive Testing

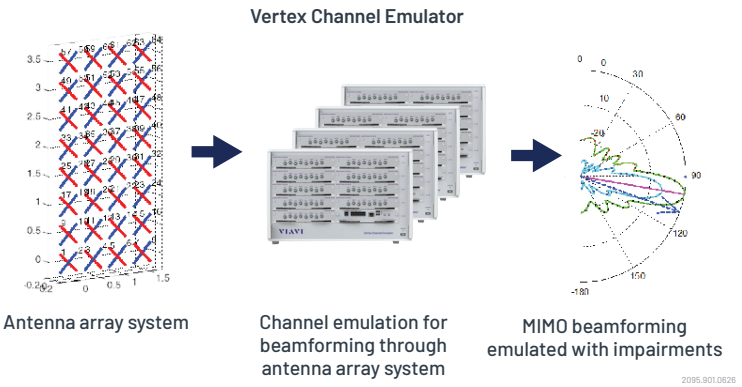
Supporting up to sixteen SISO cells or eight 2x2 MIMO cells on one instrument, Vertex accurately reproduces real network propagation conditions in the lab.

The ability to emulate a high number of cells, combined with VIAVI's Live2Lab® Virtual Drive Test-Conversion Tool (Live2Lab VDT-CT) software, makes the laborious process of drive testing easy and repeatable. Live2Lab VDT-CT can convert a large variety of log file types (QXDM, Accuver, etc.) into reproducible drive route simulations in a lab environment. Additionally, Vertex allows easy debugging of power level issues by allowing users to dynamically monitor the power level on each port.



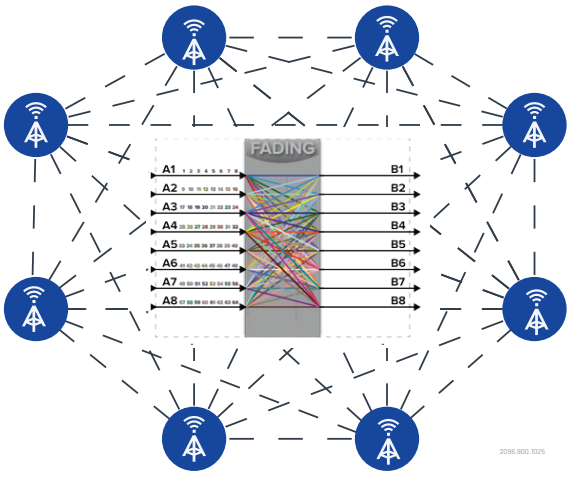
AAS, Massive MIMO and MIMO Beamforming

Up to 4 Vertex instruments can be integrated into one system with the Vertex Baseband Synchronizer (VBS). With the VBS, the Vertex units in a system can work standalone or all together as a complete solution for massive MIMO applications with real-time or IQ playback fading.



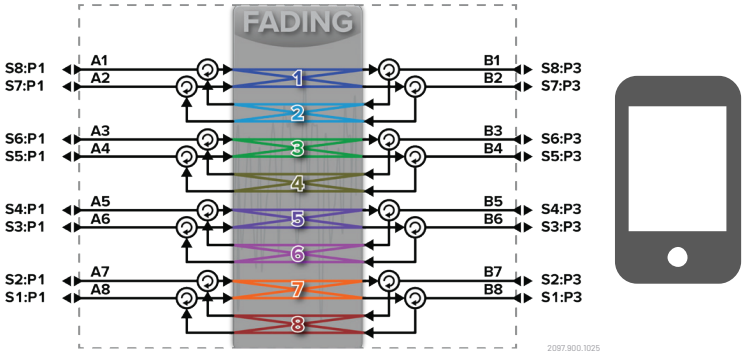
Mesh Networks

Mesh network applications require each node to independently communicate with each other. From a channel emulation perspective, this implies that each radio link needs to be emulated with a different fading profile simultaneously, placing heavy demand on the number of RF antenna ports required in addition to the processor load. Vertex supports up to 16x16 independent channel models on a single instrument, providing the capability to test up to a sixteen node mesh network.



Carrier Aggregation

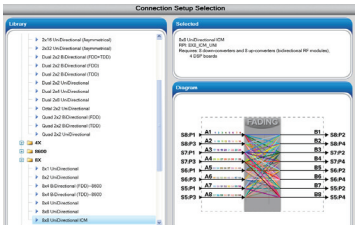
Supporting up to eight 2x2 bi-directional carriers on one instrument, Vertex can be used for carrier aggregation scenarios. Each radio link can be independently modeled, simulating channel conditions to represent multiple carriers on the same eNB and gNB or from different eNB and gNB's. The same setup can also be used for simulating channel conditions that trigger handovers and on Coordinated Multipoint (CoMP) applications as well.



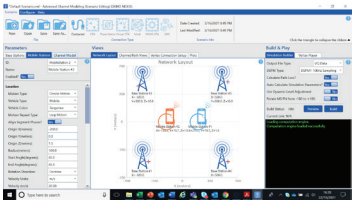
Graphical User Interface



For users familiar with VIAVI's VR5 HD Channel Emulator, the Vertex Channel Emulator presents a seamless transition, as it has been developed with the same GUI features. The Vertex GUI is very easy to use and presents clear and concise information even for the first-time user. The GUI can be accessed using a cable hooked up to the Vertex display port or through the controller laptop. Connection setup and RF parameters for channel modeling can be easily configured to run in real-time mode. A comprehensive set of ready-to-run standard models is provided, making it easy to select and play. Setup of most test cases is a matter of using a few mouse clicks and drop down menus.



The GUI provides an easy-to-read display for high channel density features that can be complicated to set up. For example, the connection setup for an 8x8 MIMO application, or 64 radio links, can be easily viewed using the pre-loaded option from the Connection Setup library.



Conducted, eNB, gNB OTA environment builder, Phase Matrix massive MIMO environment builder, Virtual OTA (Wireless cables), MESH environment builder, FR2 MIMO OTA environment builder (TS38.151) and Satellite-Aeronautical environment builder.



Configuring the MIMO correlation matrix is easy and convenient to do on the Vertex GUI. Complicated matrices such as a 2x8 configurations can be created using spreadsheet-type entries, rather than spending the time writing elaborate test scripts for creating the correlation matrices.



The Vertex GUI displays real-time information regarding channel power with respect to fading. This instantaneous display enables quick detection of deviations from expected behavior and the ability to efficiently debug problems.



The cable connection diagram built-in to the Vertex GUI presents the actual cabling connections that need to be made. This feature makes it easy to cable complicated connection setups and minimizes cabling error. The image shown is the cabling setup for an 8x8 unidirectional configuration.

Additionally, the built-in temporal player feature facilitates real-time tracking of power levels at each port. This is especially useful for handover scenarios, which are based on power levels between the serving cells.

Technical Specifications

RF Configuration	Single Instrument • 4x4 Bidirectional • 16x16 Unidirectional • Up to 8x8 Bidirectional Multi-instrument • Up to 64x8 Bidirectional (TDD and FDD)
RF Inputs	Single Instrument • Up to 32 Multi-instrument • Up to 128
RF Outputs	Single Instrument • Up to 32 Multi-instrument • Up to 128
Digital Channels	Single Instrument • Up to 256 (Digital channel density = 16x16) Multi-instrument • Up to 1024
Bandwidth	40 MHz, 100 MHz, 200 MHz, 400 MHz, 600 MHz*, 800 MHz*, 1000 MHz*, 1200 MHz* *By stitching multiple channels
Frequency Range	100 MHz to 7.325 GHz Extensible to 23.5 GHz with the optional FR3 MIMO Converter
RF Input	• Input level range: -50 to +15 dBm • Level resolution: 0.1 dB • Damage level: +33 dBm (Peak)
RF Output Level	• Min/max range: -110 to -10 dBm (RMS) • Resolution: 0.1 dB
Input and Output Power Meters	• Modes — Continuous — RF burst-triggering for gated input signals
Residual EVM, typical (5G NR 100 MHz)	• <-43 dB: 100 MHz to 1.5 GHz • <-40 dB: 1.5 GHz to 5 GHz • < -37 dB: 5 GHz to 7.325 GHz (<-43 dB with optional FR3 MIMO Converter)
Residual Noise	Better than -165 dBm/Hz at a set output level of -45 dBm
RF Port VSWR	1.5:1
Independent Paths	Up to 24 paths per digital channel
Delay	0 to 1 s at bandwidths >=100 MHz; 0 to 2 s at bandwidths =40 MHz; 0.1 vns resolution
Relative Path Loss	0 to 40 dB
Dynamic Channel Parameters	• Sliding delay (moving propagation) • Birth-death delay • 3GPP High-Speed Train (HST) profiles log normal (shadow fading)
Insertion Delay	Minimum 2.65 µs. value increases with topology and number of Vertex units

*Later SW versions

Technical Specifications continued

Dynamic Environment Emulation (DEE) and Live Streaming DEE (LSDEE)	• Controllable parameters: — State duration, channel output level, AWGN on/off, C/N, path on/off, relative power and delay, LOS AoA, K factor, frequency shift, Doppler velocity, MIMO branch phase, power imbalance, and correlation, link phase and loss, bulk delay, path phase, geometrical characters, port Doppler — Channel model update rate: 100 times per second — Start method: Triggered, free play — Play method: Run for N loops, wrap around — Smoothing supported
Standards-based Models	LTE, Wi-Fi (802.11a/b/g, 802.11n, 802.11 ac, 802.11 ax), IMT-A, WiMAX, UMTS, CDMA2000®, HSPA, GSM, SCM/SCME (ITU-R M.2135), WINNER, Butler, 5G TDL and CDL, D2D
Custom Models	Easy-to-use interface allows the user to create custom channel models or edit any of the standard channel models in the library Optional VIAVI Raytracing software can be integrated to emulate higher fidelity site-specific scenarios, including moving object modeling for integrated sensing and communications (ISAC)
Fading Mode	Classical, GCM, 3D GCM, MIMO OTA
Real-time Fading	• Types: Rayleigh, Rician, pure Doppler, frequency shift, phase shift, Log normal (Shadow) fading • Fading Doppler: Up to 12 kHz • Doppler frequency shift: -2 MHz to 2 MHz • Relative phase: 0-360°, 0.1° resolution • Rician K factor: -30 to +30 dB • Level crossing rate (LCR) accuracy: < ±2.5% deviation from theoretical LCR curve of the simulated vehicle velocity • Fading power spectrum: classical 6dB, flat, classical 3 dB, rounded, rounded 12 dB, bell • Correlation: programmable complex correlation between paths
IQ-playback Fading	Supports IQ playback fading
AWGN	• C/N Ratio: -40 to +40 dB • Accuracy: ±0.1 dB • Bandwidth: up to 400 MHz • Settable modes: C/N, Eb/No, N
Control Interface	• PC-based graphical user interface • Remote programming through ethernet
10 MHz Internal Reference Accuracy	1 ppm
Non-contiguous Carrier Aggregation	Single Instrument • Up to 16 independent carriers Multi-instrument • Up to 64 independent carriers
Mesh Capacity	Single Instrument • Up to 16 nodes with up to 2 sec independent delay

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