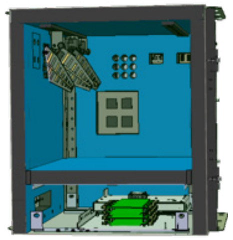
DATASHEET

OCTOBOX® **Pal-6E, and STApal-6E datasheet**

Spirent's Wi-Fi 6E testbeds incorporate RF chambers and instruments controlled by an integrated server with a browser-based UI and a complete API for test automation. The OCTOBOX Pals function as Wi-Fi 6E traffic endpoints or OCTOBOX synchroSniffer® probes for performance testing and expert analysis of Wi-Fi devices and systems. This document describes the OCTOBOX Pal-6E®, and OCTOBOX STApal-6E™ subsystems shown below and the OCTOBOX personal testbeds that incorporate them.

Wi-Fi 6E and legacy Wi-Fi Qualcomm Hawkeye chipset QCN5054/ QCN5024 + Pine	*OCTOBOX Pal-6E*	
Wi-Fi 6 and legacy Wi-Fi Intel AX210 STA chipset Linux host per STApal-6E for max performance	*OCTOBOX STApal-6E*	
OCTOBOX chamber with built-in instruments for ease of integration Built-in Pal-6E or 4 STApal-6Es	*OCTOBOX smartBox™* *OCTOBOX smartBox-STA*	
OCTOBOX chamber with 16 STApal-6Es and a Pal-6E 16 OFDMA endpoints; 20 sniffer probes 576 virtual stations (vSTAs)	*OCTOBOX palBox™*	

Features

- 802.11ax up to 8x8 MIMO-OTA transmission
- 2.4 and 5 GHz 802.11a/b/g/n/ac/ax radios
- Pal-6E and STApal-6E support 6GHz Wi-Fi 6E
- palBox-6E with up to 16 OFDMA STAs and 576 vSTAs; radios configurable for sniffing
- OCTOBOX Wireshark synchroSniffer™ with sniffer probes on 4 Pal-6E and 16 STApal-6E radios
- smartBox and smartBox-STA housing real devices with integrated Pal instruments
- multiperf® multi-point to multipoint traffic with managed traffic endpoints
- Complete isolation from outside interference
- REST API for test automation Benefits
- Verify 6GHz using the Pal-6E
- Quickly and easily verify emerging 802.11ax and legacy Wi-Fi devices in the ideal MIMO-OTA environment that supports MU-MIMO
- Use multipoint-multipoint traffic while automatically recovering from dropped links during long test sequences
- Test OFDMA and MU-MIMO simultaneously using a compact OCTOBOX personal testbed
- Use one or more palBoxes to scale to dozens of OFDMA stations in the testbed
- Use a smartBox to combine off-the-shelf devices with the built-in Pals
- Perform root cause analysis of issues using built-in multi-probe synchroSniffing

Benefits

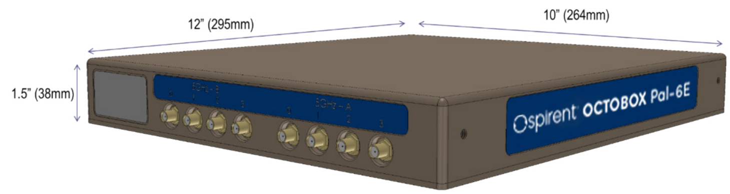
- Verify 6GHz using the Pal-6E
- Quickly and easily verify emerging 802.11ax and legacy Wi-Fi devices in the ideal MIMO-OTA environment that supports MU-MIMO
- Use multipoint-multipoint traffic while automatically recovering from dropped links during long test sequences
- Test OFDMA and MU-MIMO simultaneously using a compact OCTOBOX personal testbed
- Use one or more palBoxes to scale to dozens of OFDMA stations in the testbed
- Use a smartBox to combine off-the-shelf devices with the built-in Pals
- Perform root cause analysis of issues using built-in multi-probe OCTOBOX synchroSniffing
- Pal-6E and STApal-6E can both function as traffic endpoints or synchroSniffer probes. Pal-6E also implements 576 vSTAs. Both Pal-6E and STApal-6Es come stand-alone or built into an OCTOBOX chamber, making that chamber a smartBox. The STApal-6E open and Pal-6E open form factors can be used with an antenna system for testing in open air or in a walk-in test chamber.
- Pal-6E, and STApal-6E support all the Wi-Fi protocols: IEEE 802.11a/b/g/n/ac/ax. Pal-6E and the STApal-6E support also the new Wi-Fi 6E 6 GHz frequency band. Pal-6E supports STA (station) and AP (access point) modes. STApal-6E is an OFDMA capabile STA.

Parallel throughput and synchroSniffing

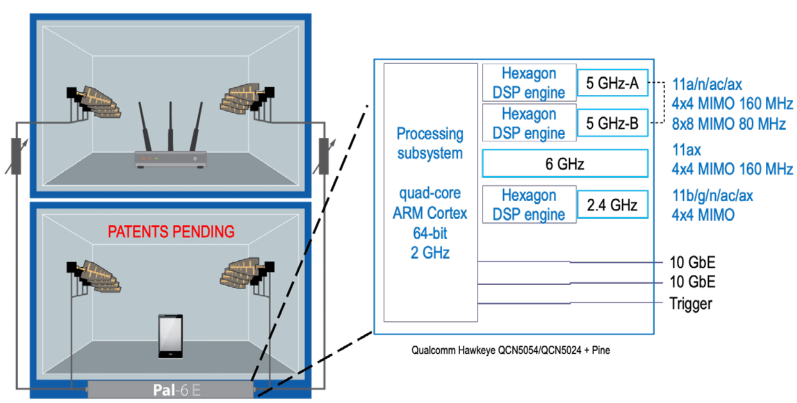
Based on the latest 6 GHz capable 802.11ax chipset and with fine controls at the firmware and driver level, Pal-6E can function as an off-the-shelf device or as a precision test instrument. For example, to test band steering, Pal-6E can function at a set data rate, bandwidth and number of streams (Nss). To test receiver sensitivity, Pal-6E can operate at a fixed modulation coding scheme (MCS).

Pal-6E features four 802.11ax radios. The two 5 GHz radios support up to 8x8 MIMO in channels of up to 80 MHz, or 4x4 MIMO in 80+80 or 160 MHz channels. The single 6 GHz radio support up to 4x4 MIMO channels of up to 160 MHz in 6 GHz band.

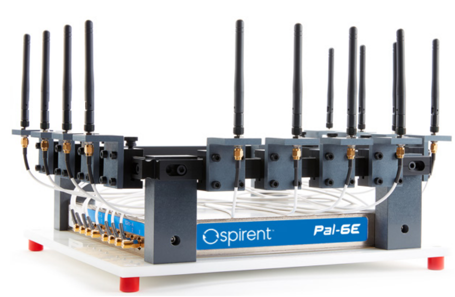
Pal-6E features two 10 GbE ports, one for traffic and the other for streaming plot statistics and PCAP captures.



Pal-6E open module



Pal-6E built into the smartBox; block diagram



Pal-6E open with the antenna subsystem

Pal-6E, and STApal-6E can function as real-time analyzers to show adaptation behavior of modern Wi-Fi systems. They can monitor and plot RSSI, data rate, number of spatial streams, channel width and other physical layer information.

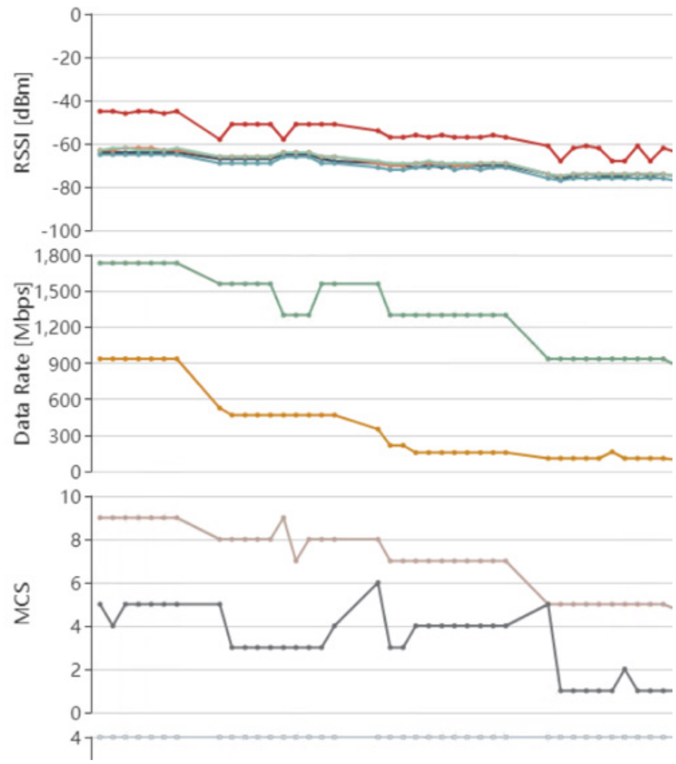
Access Point Testing

To test access point (AP) performance or to emulate a realistic network with multi-station traffic, Pal-6E can emulate up to 576 vSTAs.

STApal-6Es with their own Linux host, offer maximum OFDMA performance on each radio.

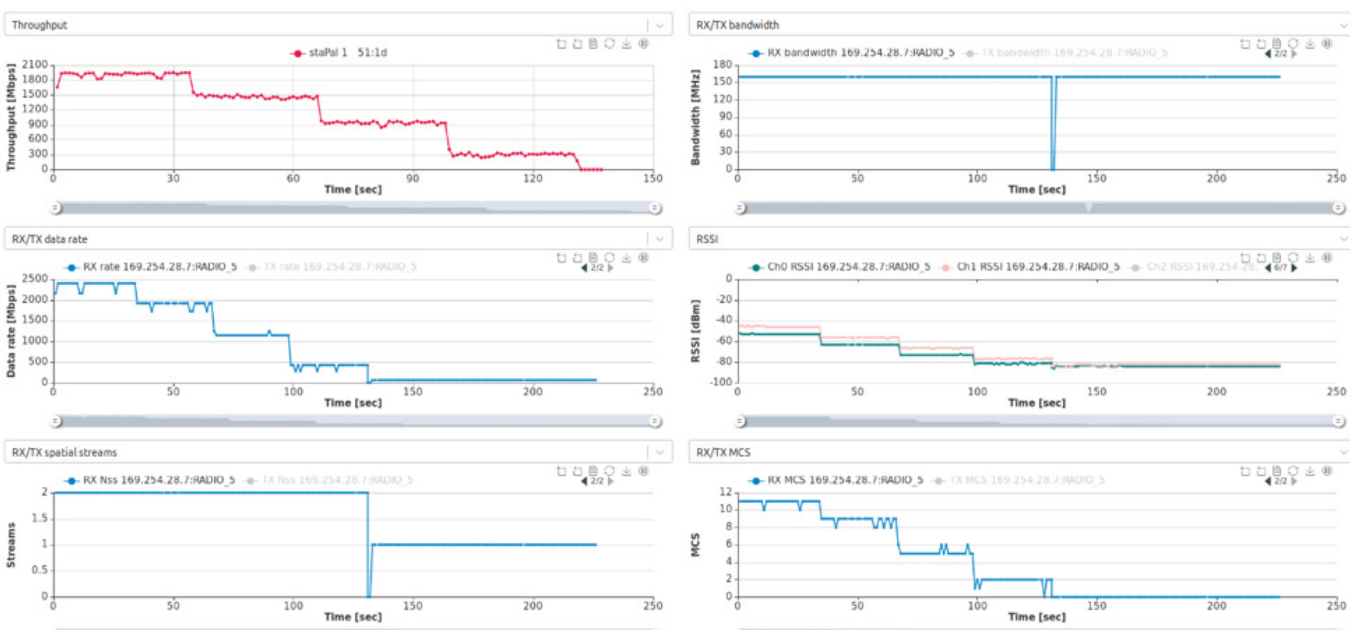
Because OFDMA testing requires multiple station devices to show the expected airlink efficiency, STApal-6E comes packaged as a set of 4 or 16. The smartBox-STA has 4 STApal-6Es while the palBox has 16 plus a Pal-6E.

STApal-6E is based on a STA chipset and supports UL and DL OFDMA. It can function as an OFDMA station or as a synchroSniffer probe and report statistics and performance analysis metrics.



Station Testing

The Pal-6E radios can be configured as APs so they can be traffic partners to the station under test. The radios can also be used as sniffers, inline sniffers or expert analyzers. Station tests include throughput vs. range vs. orientation, RX sensitivity, data rate adaptation performance, roaming, and more.



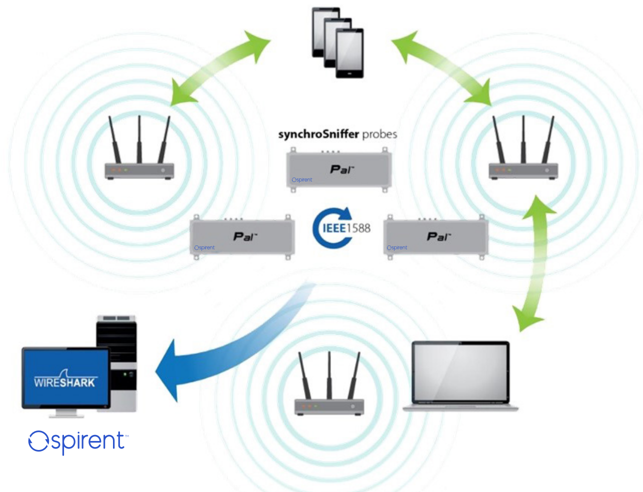
OCTOBOX software shows throughput, statistics and performance analysis plots

OCTOBOX synchroSniffer™

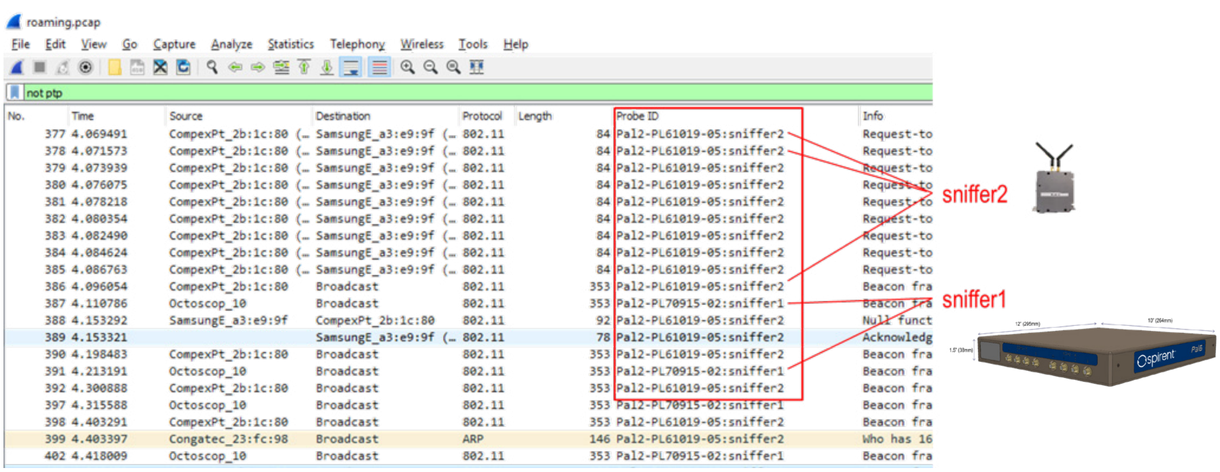
Pal-6E, and STApal-6E can capture and stream packets in PCAP format to Wireshark in real-time. All the Pal radios are synchronized via the Network Time Protocol (NTP) or Precision Time Protocol (PTP).

The captures from each radio in the OCTOBOX testbed are combined by the synchroSniffer engine running on the server into a common PCAP stream viewable in the OCTOBOX-customized Wireshark for easy analysis. In this custom Wireshark application, you can identify captures by probe (i.e. Pal radio).

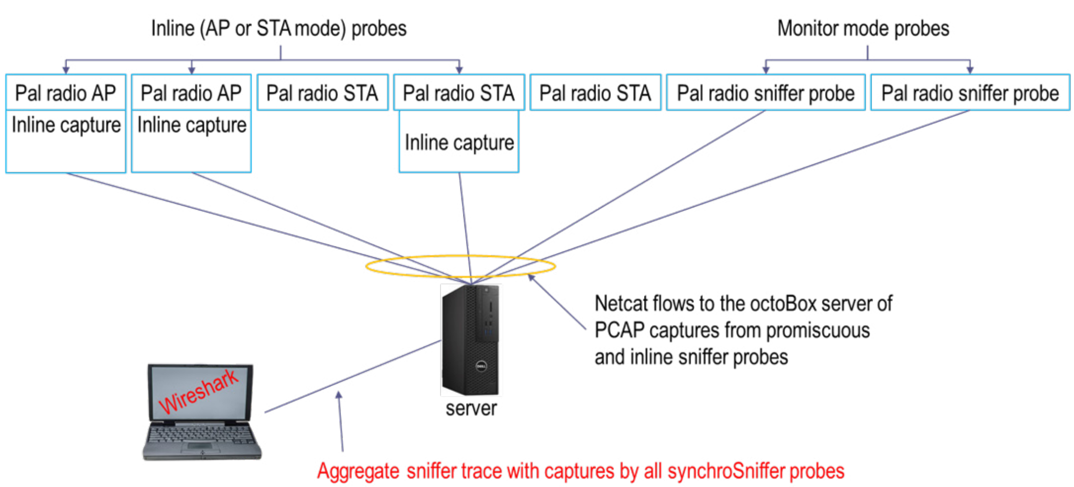
Such an aggregate multiprobe view helps analyze complex band steering, roaming and mesh behavior in the presence of motion, interference, path loss, multipath and DUT orientation. synchroSniffing is required for OFDMA – to simultaneously capture traffic on multiple AIDs (association IDs) that are assigned to different RUs (resource units).



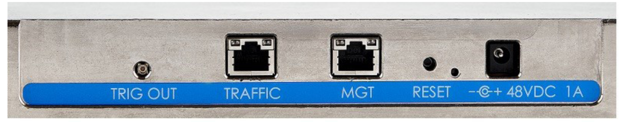
synchroSniffer capability is particularly helpful when testing OFDMA links with multiple stations operating on different resource units (RUs) because a single sniffer can only monitor a single AID. For an OFDMA link with 4 stations, you may need 4 sniffer probes, one on each station. The palBox can assign a STApal-6E sniffer to each STApal-6E endpoint. The sniffer captures from each Pal are aggregated via the synchroSniffer engine for powerful performance analysis of the entire complex OFDMA link. In addition to conventional monitor mode sniffing, Pal-6E radios can also work as in-line sniffer probes when configured as an AP or a STA. Thus, Pal-6E radios can be synchroSniffer probes in two modes: monitor (capture all packets), inline AP/STA (capture packets addressed to the AP/STA).



No.	Time	Source	Destination	Protocol	Length	Probe ID	Info
377	4.069491	CompexPt_2b:1c:80 (…	SamsungE_a3:e9:9f (…	802.11	84	Pal2-PL61019-05:sniffer2	Request-to
378	4.071573	CompexPt_2b:1c:80 (…	SamsungE_a3:e9:9f (…	802.11	84	Pal2-PL61019-05:sniffer2	Request-to
379	4.073939	CompexPt_2b:1c:80 (…	SamsungE_a3:e9:9f (…	802.11	84	Pal2-PL61019-05:sniffer2	Request-to
380	4.076075	CompexPt_2b:1c:80 (…	SamsungE_a3:e9:9f (…	802.11	84	Pal2-PL61019-05:sniffer2	Request-to
381	4.078218	CompexPt_2b:1c:80 (…	SamsungE_a3:e9:9f (…	802.11	84	Pal2-PL61019-05:sniffer2	Request-to
382	4.080354	CompexPt_2b:1c:80 (…	SamsungE_a3:e9:9f (…	802.11	84	Pal2-PL61019-05:sniffer2	Request-to
383	4.082490	CompexPt_2b:1c:80 (…	SamsungE_a3:e9:9f (…	802.11	84	Pal2-PL61019-05:sniffer2	Request-to
384	4.084624	CompexPt_2b:1c:80 (…	SamsungE_a3:e9:9f (…	802.11	84	Pal2-PL61019-05:sniffer2	Request-to
385	4.086763	CompexPt_2b:1c:80 (…	SamsungE_a3:e9:9f (…	802.11	84	Pal2-PL61019-05:sniffer2	Request-to
386	4.096054	CompexPt_2b:1c:80	Broadcast	802.11	353	Pal2-PL61019-05:sniffer2	Beacon fra
387	4.110786	Octoscop_10	Broadcast	802.11	353	Pal2-PL70915-02:sniffer1	Beacon fra
388	4.153292	SamsungE_a3:e9:9f	CompexPt_2b:1c:80	802.11	92	Pal2-PL61019-05:sniffer2	Null funct
389	4.153321		SamsungE_a3:e9:9f (…	802.11	78	Pal2-PL61019-05:sniffer2	Acknowledg
390	4.198483	CompexPt_2b:1c:80	Broadcast	802.11	353	Pal2-PL61019-05:sniffer2	Beacon fra
391	4.213191	Octoscop_10	Broadcast	802.11	353	Pal2-PL70915-02:sniffer1	Beacon fra
392	4.300888	CompexPt_2b:1c:80	Broadcast	802.11	353	Pal2-PL61019-05:sniffer2	Beacon fra
397	4.315588	Octoscop_10	Broadcast	802.11	353	Pal2-PL70915-02:sniffer1	Beacon fra
398	4.403291	CompexPt_2b:1c:80	Broadcast	802.11	353	Pal2-PL61019-05:sniffer2	Beacon fra
399	4.403397	Congatec_23:fc:98	Broadcast	ARP	146	Pal2-PL61019-05:sniffer2	Who has 16
402	4.418009	Octoscop_10	Broadcast	802.11	353	Pal2-PL70915-02:sniffer1	Beacon fra



OCTOBOX multiPerf® Managed Traffic Endpoints



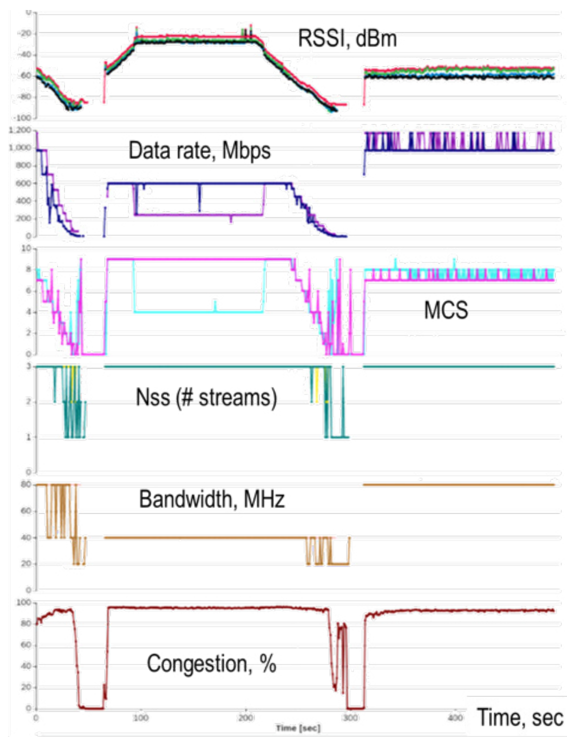
Spirent's multiPerf traffic tool:

- Supports multipoint-to-multipoint traffic
- Automatically recovers from disconnections that are common when testing the dynamic range to a point of disassociation due to low signal level; restarts traffic after reconnection
- Supports iperf2, iperf3, and ping
- Synchronized endpoints for on-way delay measurements and for correlating sniffer captures to the Deep Performance Metrics plots
- Supports bridging traffic for video, audio and other application layer metrics

Each multiPerf traffic endpoint is controlled and monitored via an out-of-band management link. Both traffic and management Ethernet networks in the OCTOBOX testbeds are 10 Gbps and have enough capacity to support multipoint traffic, sniffer captures and status reporting.

All Pal test instruments can be set as a mulitPerf endpoint. multiPerf can also be installed on Windows, Linux, Android, iOS and MacOS devices.

OCTOBOX Deep Performance Metrics plots

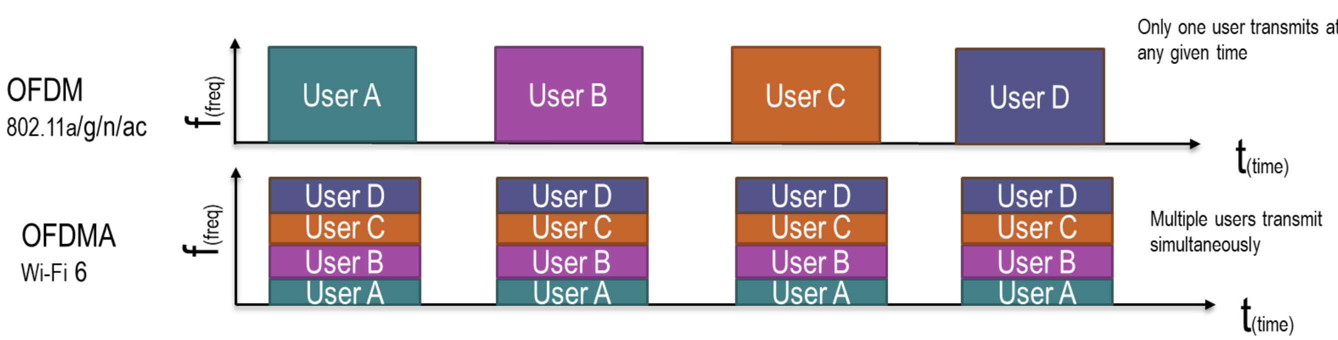


For non-OFDMA links under test, statistics are plotted as single plots for the entire channel. For example, the RSSI, data rate, MCS, Nss (# of streams), bandwidth and other statistics reported by a Pal receiver are plotted as shown on the right. These legacy statistics are produced by each Pal receiver as follows:

1. Open each received packet
2. Extract each statistic from the packet header
3. Discard the packet
4. For each 1 second reporting interval compute the average or the Mode of all the packets received in that interval and plot this value as one point for the interval

Mode (the most common value) is used for discrete plots, such as data rate, Bandwidth, MCS and Nss. Average is used for averageable quantities, such as throughput, RSSI and Congestion.

For OFDMA, RUs (resource units) are assigned to each user dynamically packet by packet so that multiple users can share the frequency band, as shown below.



In the above example, 4 users, A, B, C and D, are transmitting simultaneously in the same OFDMA packet (i.e. time slot) thereby sharing the bandwidth of the channel. The maximum number of RUs per OFDMA packet is 37 in the 80 MHz band and 74 in the 160 MHz band.

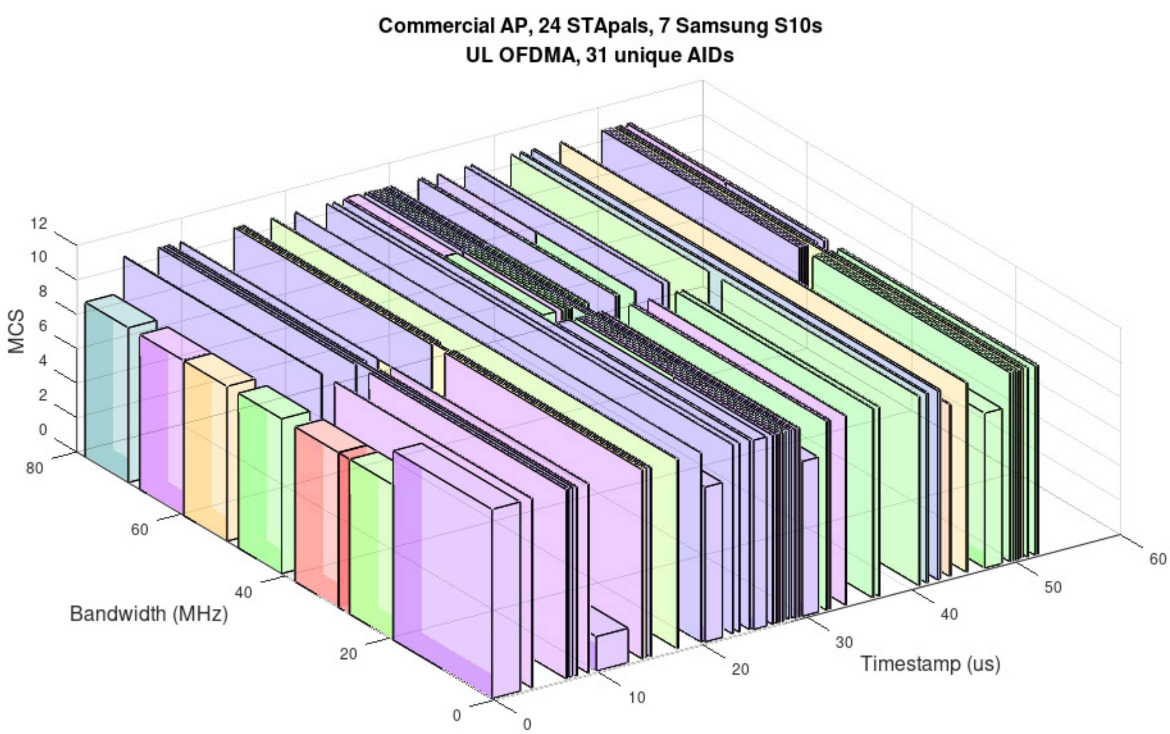
Each user is allocated an AID (association ID) and each AID is allocated an RU (aka frequency slot). The RU allocation to AIDs (users) can change dynamically packet to packet. As the AP scheduler allocates bandwidth to multiple OFDMA STAs, each STA occupies a portion of the spectrum in the operating Wi-Fi channel. For OFDMA, with simultaneous STAs sharing the band, each plot, for example RSSI, now has a 3rd dimension – RU/AID.

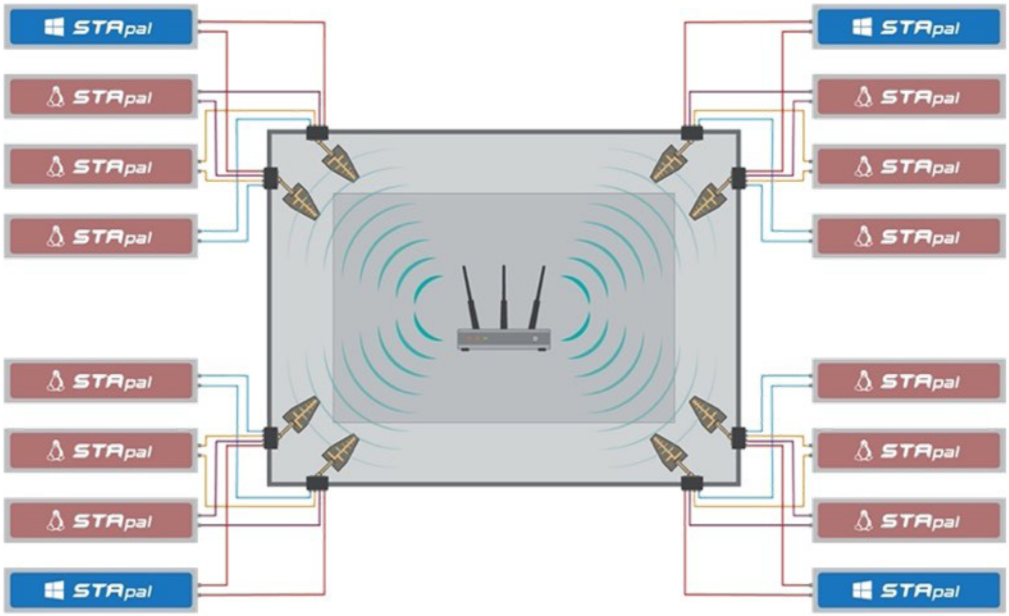
For OFDMA, since the RU/AID allocation changes from packet to packet, we need to show packet by packet plots. These packet by packet graphs are called Deep Performance Metrics plots and are produced by dedicated synchroSniffer probes.

Each synchroSniffer probe can be assigned to log performance analysis metrics for a single device in the testbed. For example, if STApal2 is a sniffer, it can create Deep Performance Metrics plots for STApal1, STApal3 or STApal4 since all four STApal-6Es are on the same pair of antennas and receive the same signal. As a sniffer probe, a STApal-6E can capture up and downlink traffic (UL/DL) for its assigned MAC address and report its PCAP captures into the synchroSniffer trace.

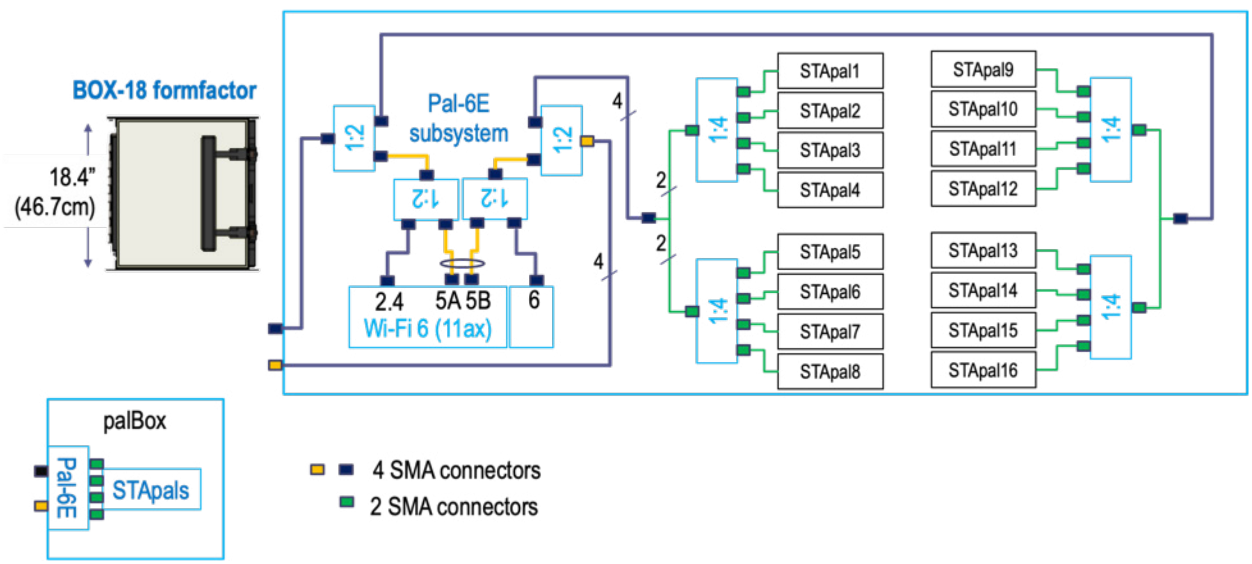
In the DUT chamber, four pairs of antennas are arranged in a spatially diverse way, i.e. mounted in the corners of the chamber in order to enable MU-MIMO beamforming plus OFDMA testing.

At each pair of antennas, you have 1 Windows and 3 Linux STApal-6Es from a palBox. You have an option to configure any of the Linux STApal-6Es either as a sniffer probe or as a traffic endpoint. The Windows STApal-6Es can only be traffic endpoints. Windows STApal-6Es are included in the palBox because throughput performance is driver-dependent and is different in the Windows environment vs. the Linux environment. So, testing with both drivers is desirable to determine real-world expectations.





The palBox also incorporates a Pal-6E subsystem that connects to the same 8 antennas as the STApal-6Es. The figure below shows a detailed block diagram of the palBox and its symbol as used in the OCTOBOX testbed diagrams.



If you are testing with a reasonable number of OFDMA STAs and need dedicated synchroSniffer probes, you can use multiple palBoxes in a testbed. Here's a photo of a testbed with 2 palBoxes on the bottom. This photo shows the palBoxes with their doors open.

In addition to 16 OFDMA STApals, each palBox incorporates a Pal-6E subsystem that can be used to emulate up to 576 vSTAs for testing an access point under a heavy load.

With a palBox, you can generate OFDMA and MU-MIMO traffic simultaneously, plus traffic load from up to 96 virtual stations – a lot of parallel traffic and analysis power in a small space.

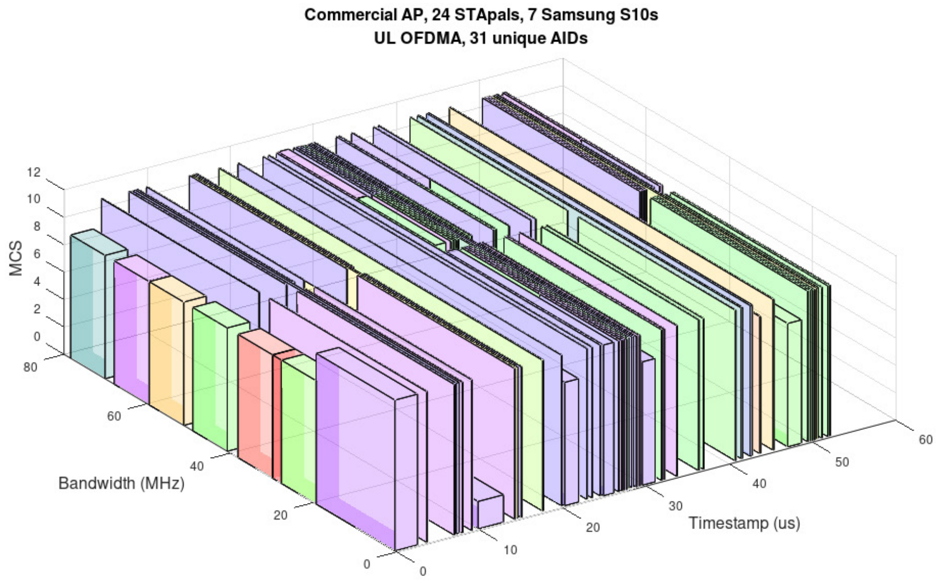
OFDMA Sniffing and Expert Analysis

OFDMA sniffing requires a multi-probe mechanism such as the OCTOBOX synchroSniffer to capture traffic on multiple AIDs simultaneously. OCTOBOX OFDMA Deep Performance Metrics plots are produced by dedicating a STApal-6E to each device in the testbed. For a STA DUT that uses the Pal-6E as a golden AP, inline sniffer traces from the Pal-6E AP are also available in the synchroSniffer trace.

With such complete OFDMA and MU-MIMO captures gathered by multiple probes and aggregated by the synchroSniffer engine, insightful visualization of OFDMA performance can be produced.

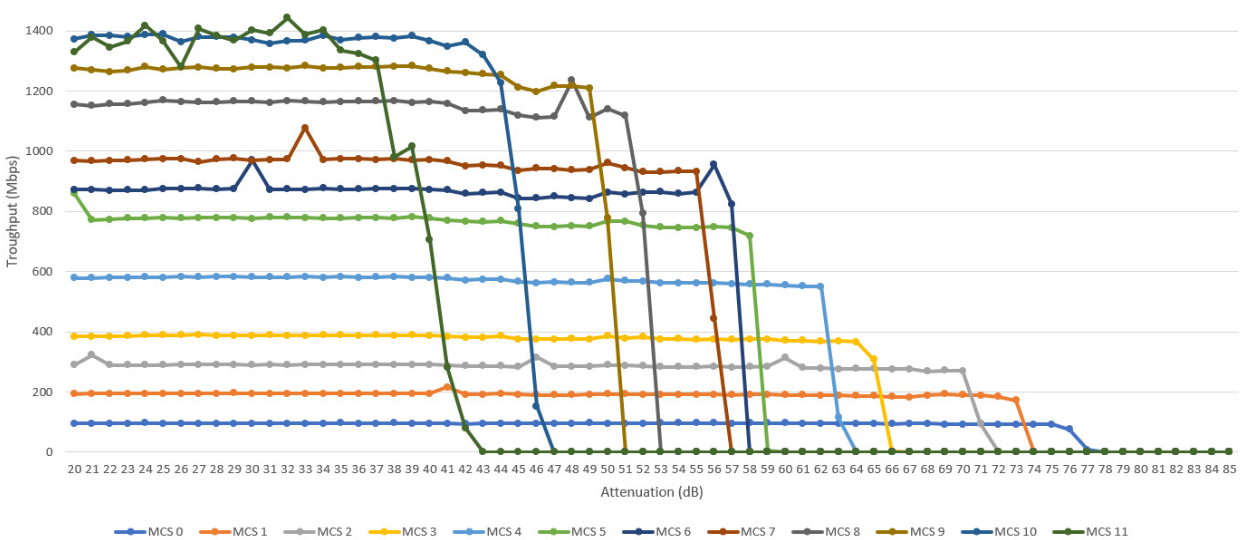
Deep Performance Metrics plots include basic per RU per packet metrics such as RSSI, Nss, bandwidth, data rate and MCS, and other plots.

MCS, RSSI, N per RU/AID allocation:



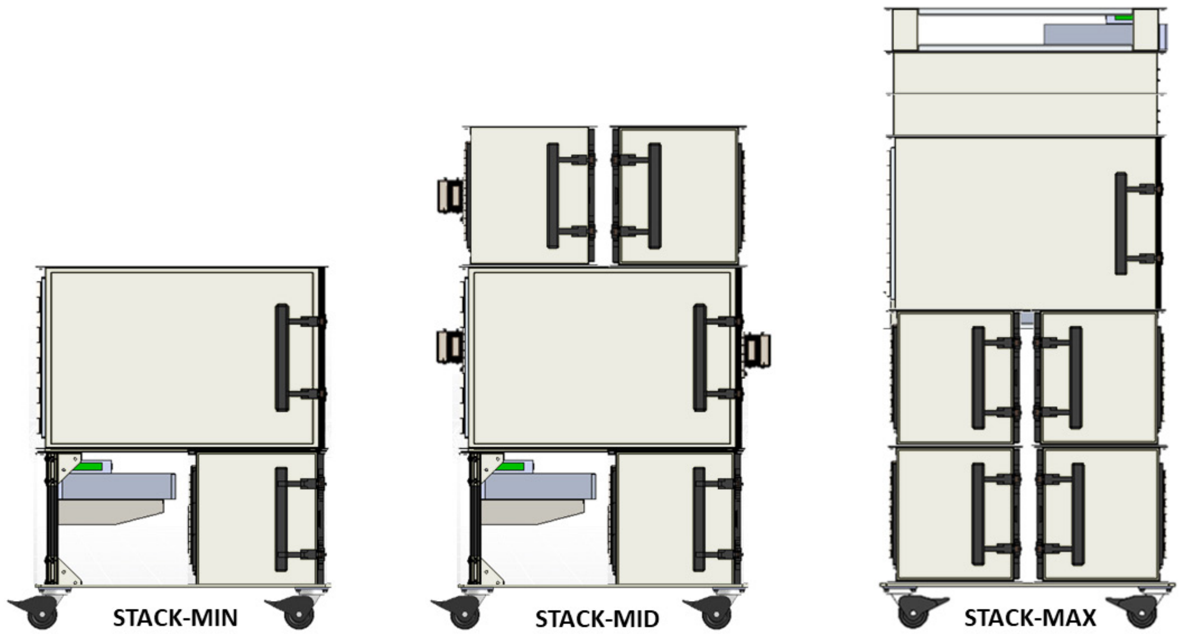
Using Pal-6E as a Test Instrument

When debugging early stage devices with rate adaptation issues, it is necessary to force DUT operation at some fixed parameters including fixed MCS, fixed Nss, etc. Here's an example of a test with a Pal-6E using fixed MCS one by one and observing throughput operation for each MCS setting vs. attenuation. The ideal rate adaptation would result in a throughput plot at the top perimeter of this waterfall curve.

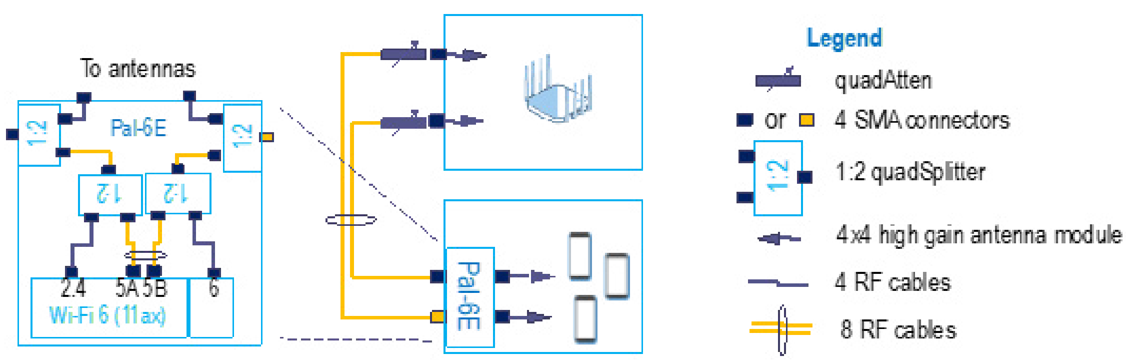


OCTOBOX Personal Testbeds

OCTOBOX STACK-MIN, OCTOBOX STACK-MID and OCTOBOX STACK-MAX testbeds are recommended configurations.



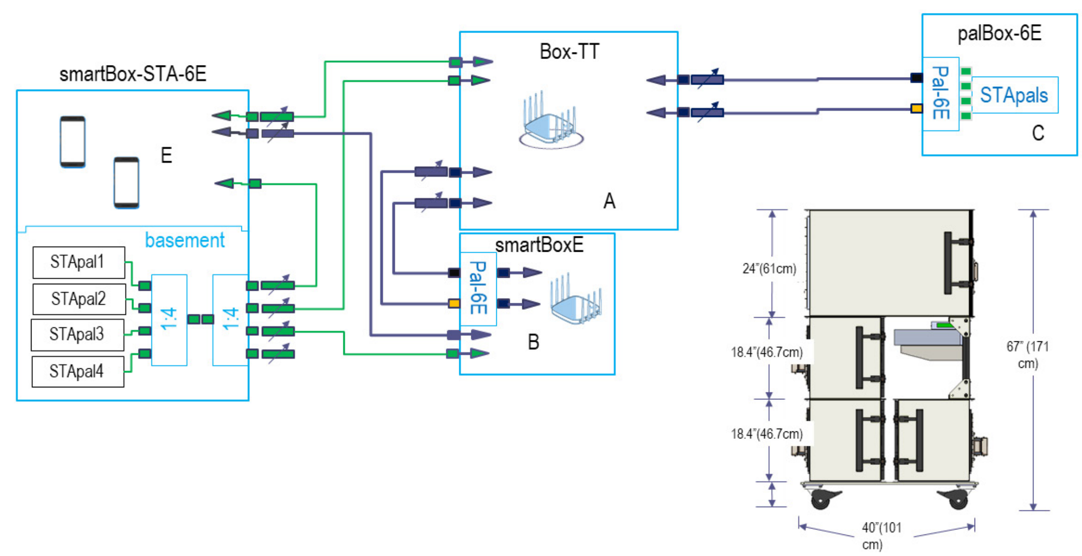
A block diagram of the simplest Pal-6E based testbed, STACK-MIN, is shown below. Replace the smartBox with a palBox for OFDMA capabilities.



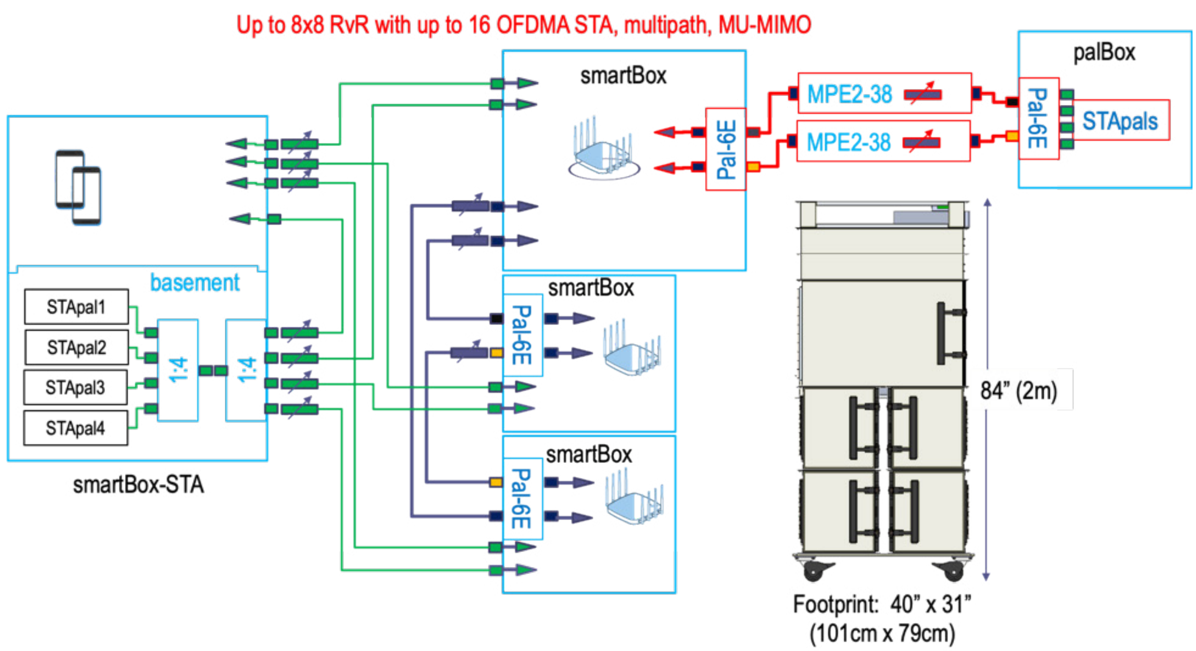
The OCTOBOX STACK-MIN testbed is capable of the following tests:

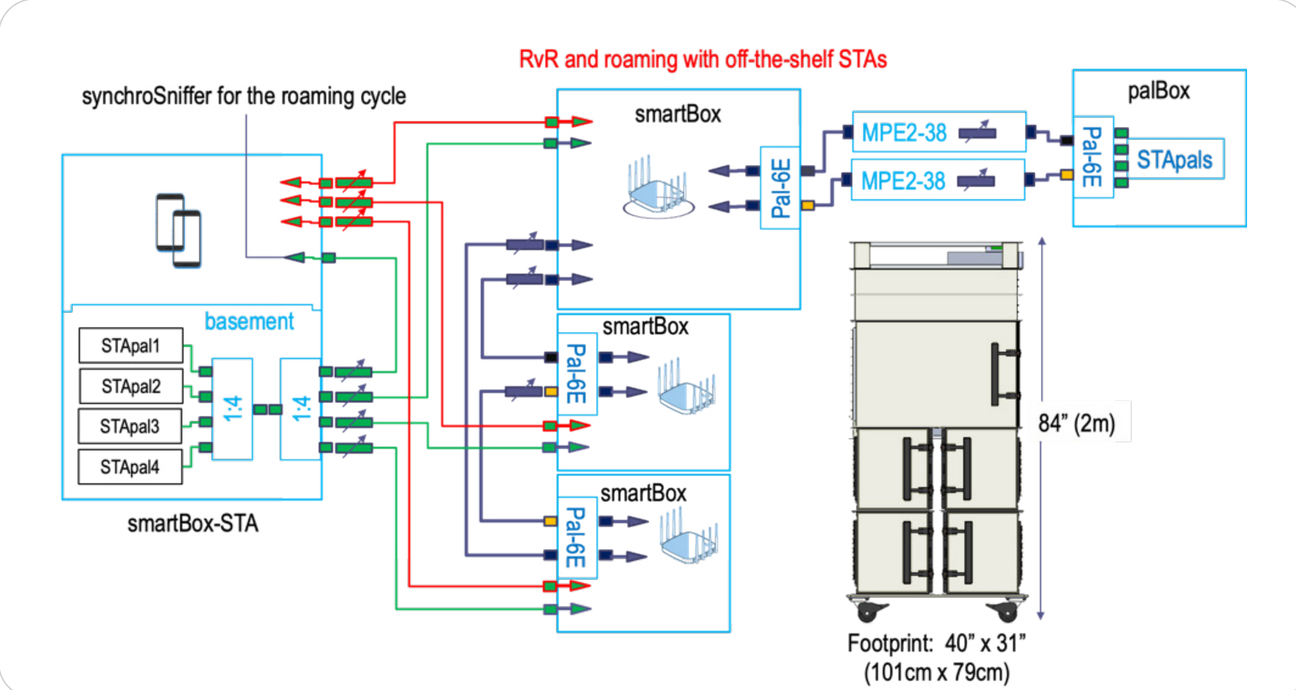
- RvR, RvR with rotation, RvRvO or RvOvR if a turntable is included
- Band steering
- Packet capture
- OFDMA testing with 16 STApal-6Es using a palBox

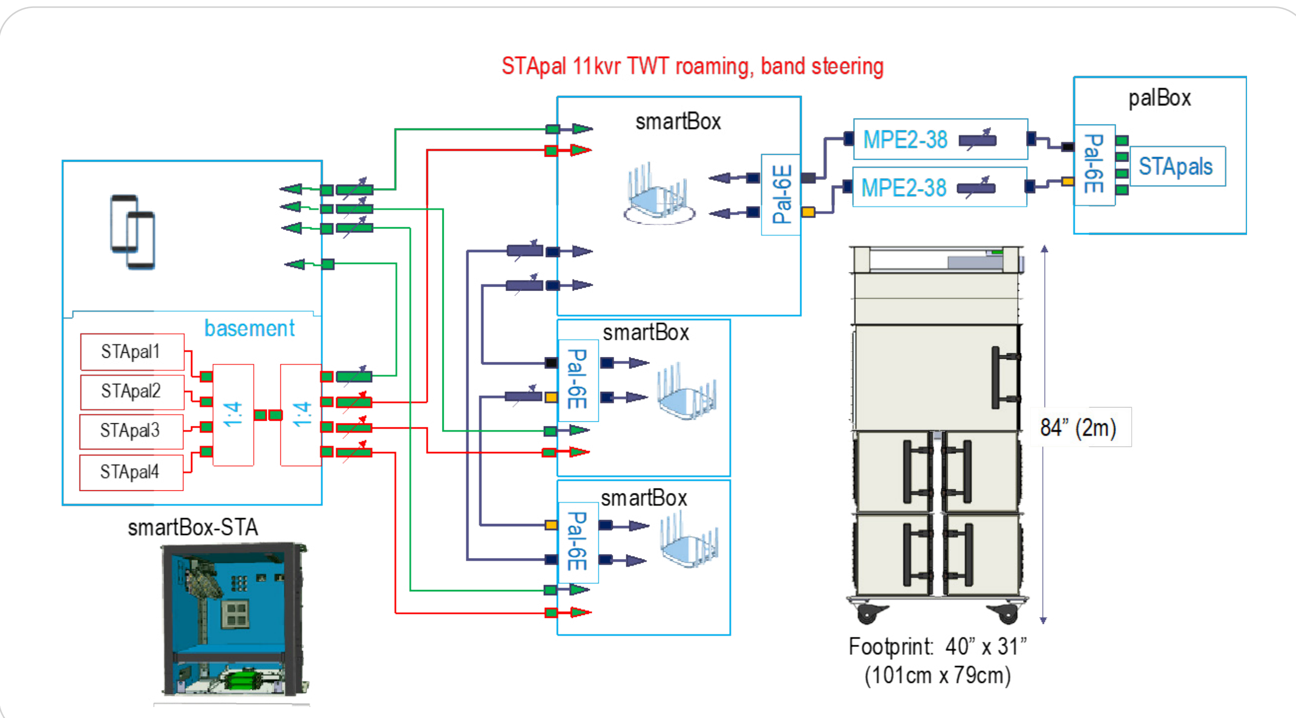
OCTOBOX STACK-MID is designed for communications service provider (CSP) to test and optimize home-focused Wi-Fi devices and solutions. A subset of Spirent's fully-featured OCTOBOX STACK-MAX testbed, OCTOBOX STACK-MID supports testing of all features and standards vital to home Wi-Fi devices, including the latest Broadband Forum TR-398 Issue 2 test cases for home router performance. Spirent's OCTOBOX STACK-MID enables CSPs to test the latest Wi-Fi solutions for the home user, including the most recent technologies such as Wi-Fi 6, Wi-Fi 6E, MU-MIMO and OFDMA. When combined with the OCTOBOX Tracker field-to-lab replay solution, the testbed can also be used in the optimization of mesh networks, while features such as roaming, access point (AP) steering, band steering, and load balancing are also easy to test and optimize. Realistic deployment scenarios can be recorded in the field and replicated inside the testbed.

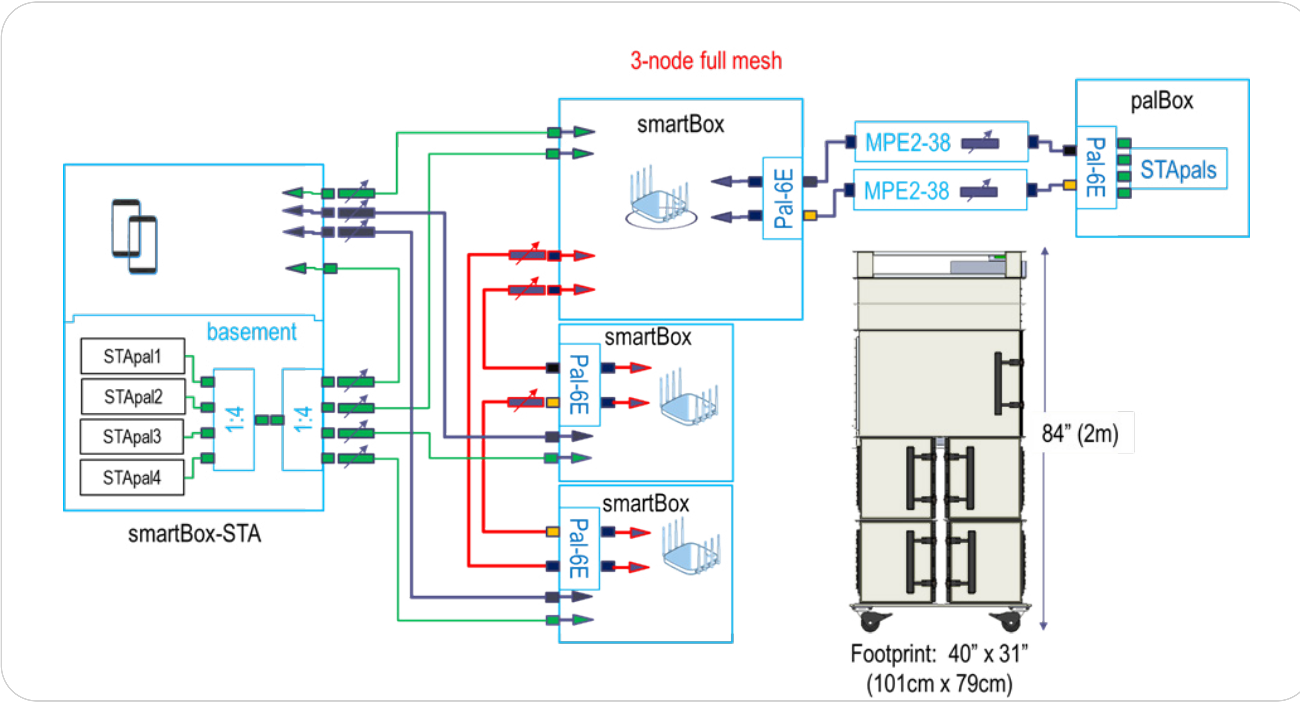


The following 6 block diagrams show the different RF paths in the STACK-MAX and the functions they perform. The paths are highlighted in red and the functions are stated in red font.

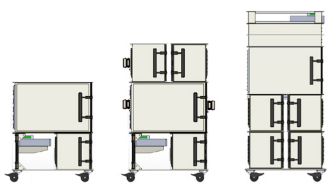



RvR and roaming with off-the-shelf STAs
synchroSniffer for the roaming cycle
smartBox
Pal-6E
MPE2-38
MPE2-38
palBox
Pal-6E
STApals
basement
STApal1
STApal2
STApal3
STApal4
1:4
1:4
smartBox-STA
smartBox
Pal-6E
smartBox
Pal-6E
84" (2m)
Footprint: 40" x 31"
(101cm x 79cm)


STApal 11kvr TWT roaming, band steering
smartBox
Pal-6E
MPE2-38
MPE2-38
palBox
Pal-6E
STApals
basement
STApal1
STApal2
STApal3
STApal4
1:4
1:4
smartBox-STA
smartBox
Pal-6E
smartBox
Pal-6E
84" (2m)
Footprint: 40" x 31"
(101cm x 79cm)

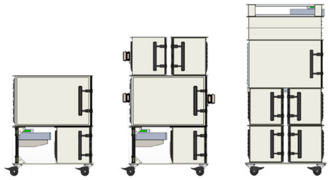


Testbed features and comparison

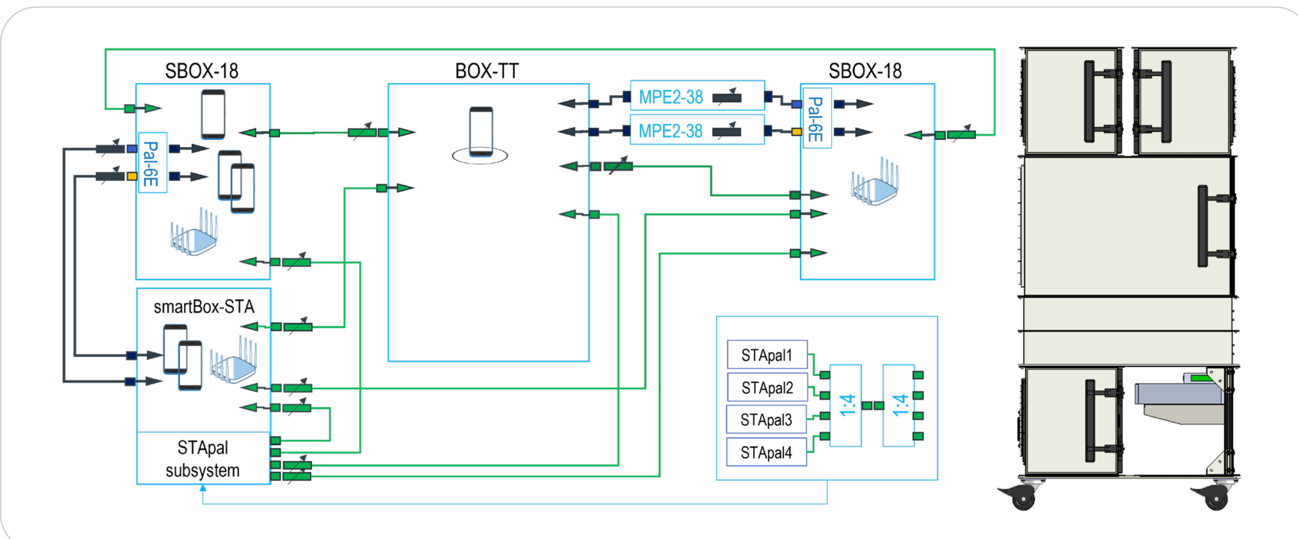


	STACK-			Notes
	MIN	MID	MAX	
TR-398	•	•	•	Automated certification to the Broadband Forum TR-398 performance test standard. Full coverage on STACK-MAX and STACK-MID.
RvR	•	•	•	Rate vs range test
RvRvO, RvOvR, RvRwR	•	•	•	Orientation or rotation tests require a turntable
Quad-band throughput	•	•	•	Aggregate throughput on up to 3 channels
Band Steering	•	•	•	
Roaming		•	•	
Mesh		•	•	
8x8 MIMO OTA	•	•	•	
8x8 with multipath			•	
160 MHz MIMO OTA	•	•	•	
MU-MIMO OTA	•	•	•	Beamforming based multi-user MIMO
DFS	•	•	•	
ACS	•	•	•	
Traffic replay	•	•	•	
Inline sniffing	•	•	•	synchroSniffer probe while in STA or AP mode, reporting packets targeted for the STA or AP
synchroSniffer probes	16	23	31	palBox in STACK-MAX has 16 STApal-6Es and a Pal-6E subsystem. Twelve out of the sixteen STApal-6Es have a 2x2 STA radio capable of sniffing on either 2.4, 5 or 6 GHz band

Testbed features and comparison (con'td)



Total number of stations per band				
2.4 GHz	17	22	24	Pal-6E has one 2.4 GHz, two 5 GHz, and one 6 GHz radio. The two 5 GHz radios can be run separately or combined as a single 8x8 80MHz radio or a 4x4 160 MHz radio.
5 GHz	18	24	28	
6 GHz	17	22	24	
OFDMA-capable STAs	16	20	20	OFDMA multiperf endpoints
vSTA				
2.4 GHz	240	480	960	Each vSTA can run its own traffic using the OCTOBOX multiPerf mp2mp traffic; bridge via vSTAs to set up application layer traffic, e.g. voice/video streams
5 GHz	256	512	1024	
6 GHz	80	160	320	
Total	576	1152	2304	



STACK-STA is a fully featured testbed optimized for testing Wi-Fi stations. The testbed can be used to test any device, including OFDMA and up to 8x8 capable MIMO.

Additional features include:

- Supports rate vs range testing with any off-the-shelf AP or a built in Pal-6E test instrument.
- Includes built-in instruments to test station's OFDMA capabilities. The four built-in STApals are used to load the AP thus forcing it to use OFDMA.
- Supports beamforming, allowing the built in STApal instruments and/or off-the-shelf stations to be used in a MU-MIMO test.
- Supports tests involving overlapping BSS, roaming and BSS coloring. Pal-6E instrumentation or off-the-shelf APs can be used in a test scenario.
- The built in Pal instrumentation can be used for synchroSniffing enabling PCAP based analysis.

OCTOBOX Pal-6E Open and OCTOBOX STApal-6E Open

Use the OCTOBOX Pal-6E open or OCTOBOX STApal-6E open in a walk-in isolation chamber or in an open-air test environment, such as a test house.

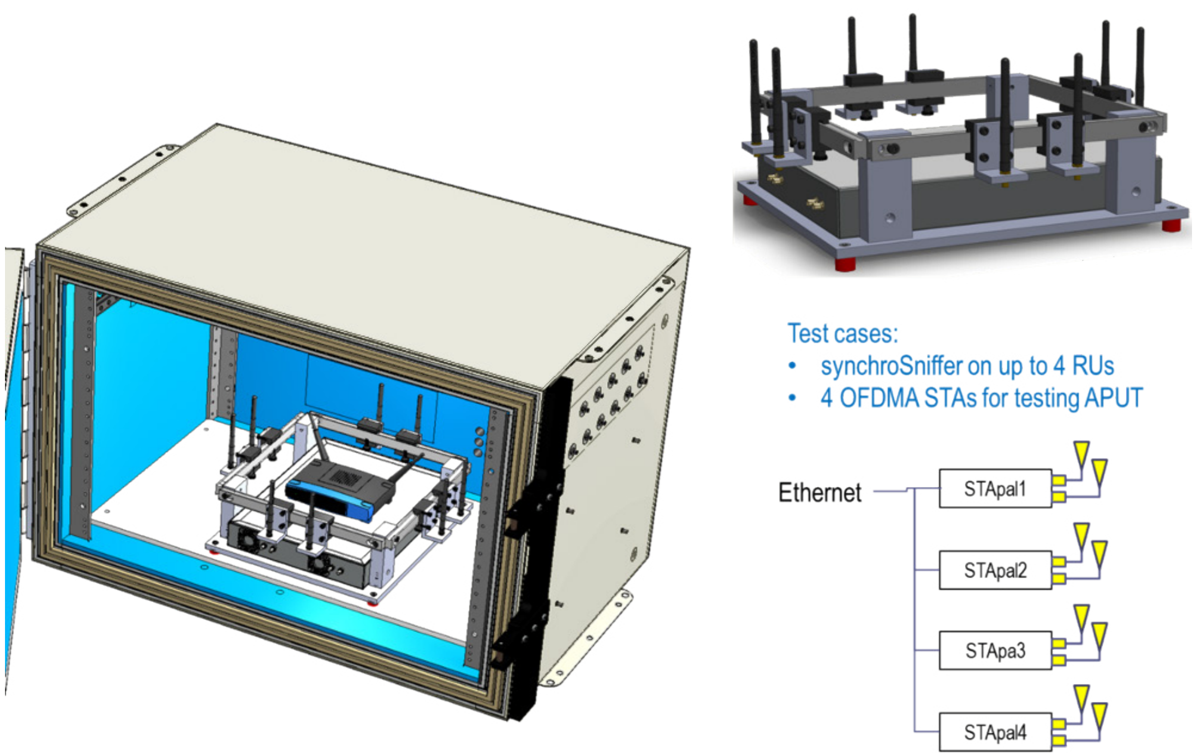
All the RF connectors for the Wi-Fi 6E radios and interference can be directly connected to the antennas. The open antenna subsystem supports all Spirent's antenna carriers, including high gain antennas and dipole antennas for open air testing.

Open antenna system can be configured with any of the OCTOBOX antennas

Both Pal-6E open and STApal-6E open can also be placed inside an OCTOBOX chamber as a portable synchroSniffer or as traffic endpoints.

Pal-6E open photo showing all the RF ports

STApal-6E open contains 4 STApal-6Es as shown.



STApal-6E open with the antenna system shown inside and outside of the OCTOBOX chamber

Pal-6E and STApal-6E Specifications

Wi-Fi	Pal-6/6E	STApal, and STApal-6E
Channels	2.4 GHz, 5 GHz and 6 GHz (Pal-6E only); quad-band	2.4 GHz, 5 GHz and 6 GHz (STApal-6E only)
Bandwidth	20, 40, 80, 80+80, 160 MHz	20, 40, 80, 160 MHz and subchannel RUs
Standards	801.11a, 802.11b, 802.11g, 802.11n, 802.11ac (wave 2), 802.11ax	801.11a, 802.11b, 802.11g, 802.11n, 802.11ac (wave 2), 802.11ax
Virtual stations	64 per-radio	
Traffic replay	From PCAP file	
Monitor	Detailed statistics from the Wi-Fi chipset	RSSI, MCS, Nss, bandwidth plus per packet Deep Performance Metrics plots from the synchroSniffer
Sniffer	synchroSniffer Wireshark captures	synchroSniffer Wireshark captures
802.11ax PHY	DL/UP OFDMA in AP mode DL MU-MIMO in AP mode and beamforming	DL/UL OFDMA in STA mode DL MU-MIMO
802.11ax MAC	• Trigger frame support • Non-trigger based and trigger-based sounding for beamforming • Multi-user RTS and CTS • Buffer status report • UL-OFDMA Random Access • Multiple BSSID • Bandwidth query report	• Trigger frame support • Non-trigger based and trigger-based sounding for beamforming • UL-OFDMA Random Access
General	**Pal-6/6E**	
Traffic endpoints	multiPerf®, iperf3, iperf2, ping	
	Trigger out connector for triggering external RF instruments	
Management	10 Gbps Ethernet	
Power	Power adapter	
Dimensions	23” x 10.4” x 1.4” (58 √ 26 √ 3.5cm)	
TX power	MCS, # streams, frequency and channel width dependent (see below)	
Processor subsystem	quad-core, ARM Cortex 64-bit, 2 GHz	

Pal-6/6E, STApal, STApal-6E Real-Time Radio Status

STA	AP	MON	Pal-6/6E	STApal, and STApal-6E
√	√	√	Offline	Offline
√	√	√	Monitor	Monitor
√			Scanning <CH #>	Scanning <CH #>
√	√		PHY mode <HT20, OFDMA, HE40, etc.>	PHY mode <HT20, OFDMA, HE40, etc.>
√	√	√	Channel primary and secondary	Channel primary and secondary channels
√			Bandwidth	Bandwidth
	√		Associated STAs <#> hover over to show list of STAs	
√			MAC address	MAC address
√	√		BSSIDs <list>	BSSIDs <list>
	√		SSID	

Pal-6E Tx Power and Rx Sensitivity

RF Performance for 6GHz

	Data Rate	Tx Power (Per Chain)	Tx Power (4 Chains)	Tolerance
6GHz 802.11a	6Mbps	20dBm	26dBm	±2db
	9Mbps	20dBm	26dBm	±2db
	12Mbps	20dBm	26dBm	±2db
	18Mbps	20dBm	26dBm	±2db
	24Mbps	20dBm	26dBm	±2db
	36Mbps	20dBm	26dBm	±2db
	48Mbps	20dBm	26dBm	±2db
	54Mbps	20dBm	26dBm	±2db
6GHz 802.11n/ac VHT20	MCS 0	20dBm	26dBm	±2db
	MCS 1	20dBm	26dBm	±2db
	MCS 2	20dBm	26dBm	±2db
	MCS 3	20dBm	26dBm	±2db
	MCS 4	20dBm	26dBm	±2db
	MCS 5	20dBm	26dBm	±2db
	MCS 6	20dBm	26dBm	±2db
	MCS 7	20dBm	26dBm	±2db
	MCS 8	16dBm	22dBm	±2db
6GHz 802.11n/ac VHT40	MCS 0	20dBm	26dBm	±2db
	MCS 1	20dBm	26dBm	±2db
	MCS 2	20dBm	26dBm	±2db
	MCS 3	20dBm	26dBm	±2db
	MCS 4	20dBm	26dBm	±2db
	MCS 5	20dBm	26dBm	±2db
	MCS 6	20dBm	26dBm	±2db
	MCS 7	20dBm	26dBm	±2db
	MCS 8	16dBm	22dBm	±2db
	MCS 9	16dBm	22dBm	±2db
6GHz 802.11ac VHT80	MCS 0	20dBm	26dBm	±2db
	MCS 1	20dBm	26dBm	±2db
	MCS 2	20dBm	26dBm	±2db
	MCS 3	20dBm	26dBm	±2db
	MCS 4	20dBm	26dBm	±2db
	MCS 5	20dBm	26dBm	±2db
	MCS 6	20dBm	26dBm	±2db
	MCS 7	20dBm	26dBm	±2db
	MCS 8	16dBm	22dBm	±2db
	MCS 9	16dBm	22dB	±2dB

	Data Rate	Rx Specifications Sensitivity	Tolerance
6GHz 802.11a	6Mbps	TBD	±2dB
	9Mbps	TBD	±2dB
	12Mbps	TBD	±2dB
	18Mbps	TBD	±2dB
	24Mbps	TBD	±2dB
	36Mbps	TBD	±2dB
	48Mbps	TBD	±2dB
	54Mbps	TBD	±2dB
6GHz 802.11n/ac VHT20	MCS 0	TBD	±2dB
	MCS 1	TBD	±2dB
	MCS 2	TBD	±2dB
	MCS 3	TBD	±2dB
	MCS 4	TBD	±2dB
	MCS 5	TBD	±2dB
	MCS 6	TBD	±2dB
	MCS 7	TBD	±2dB
	MCS 8	TBD	±2dB
6GHz 802.11n/ac VHT40	MCS 0	TBD	±2dB
	MCS 1	TBD	±2dB
	MCS 2	TBD	±2dB
	MCS 3	TBD	±2dB
	MCS 4	TBD	±2dB
	MCS 5	TBD	±2dB
	MCS 6	TBD	±2dB
	MCS 7	TBD	±2dB
	MCS 8	TBD	±2dB
	MCS 9	TBD	±2dB
6GHz 802.11ac VHT80	MCS 0	TBD	±2dB
	MCS 1	TBD	±2dB
	MCS 2	TBD	±2dB
	MCS 3	TBD	±2dB
	MCS 4	TBD	±2dB
	MCS 5	TBD	±2dB
	MCS 6	TBD	±2dB
	MCS 7	TBD	±2dB
	MCS 8	TBD	±2dB
	MCS 9	TBD	±2dB

Pal-6E Tx Power and Rx Sensitivity

RF Performance for 6GHz (cont'd)

	Data Rate	Tx Power (Per Chain)	Tx Power (4 Chains)	Tolerance
6GHz 802.11ax HE20	MCS 0	20dBm	26dBm	±2dB
	MCS 1	20dBm	26dBm	±2dB
	MCS 2	20dBm	26dBm	±2dB
	MCS 3	20dBm	26dBm	±2dB
	MCS 4	20dBm	26dBm	±2dB
	MCS 5	20dBm	26dBm	±2dB
	MCS 6	20dBm	26dBm	±2dB
	MCS 7	20dBm	26dBm	±2dB
	MCS 8	16dBm	22dBm	±2dB
	MCS 9	16dBm	22dBm	±2dB
	MCS 10	14dBm	20dBm	±2dB
	MCS 11	14dBm	20dBm	±2dB
	MCS 12	13dBm	19dBm	±2dB
	MCS 13	13dBm	19dBm	±2dB
6GHz 802.11ax HE40	MCS 0	20dBm	26dBm	±2dB
	MCS 1	20dBm	26dBm	±2dB
	MCS 2	20dBm	26dBm	±2dB
	MCS 3	20dBm	26dBm	±2dB
	MCS 4	20dBm	26dBm	±2dB
	MCS 5	20dBm	26dBm	±2dB
	MCS 6	20dBm	26dBm	±2dB
	MCS 7	20dBm	26dBm	±2dB
	MCS 8	16dBm	22dBm	±2dB
	MCS 9	16dBm	22dBm	±2dB
	MCS 10	14dBm	20dBm	±2dB
	MCS 11	14dBm	20dBm	±2dB
	MCS 12	13dBm	19dBm	±2dB
	MCS 13	13dBm	19dBm	±2dB
6GHz 802.11ax HE80	MCS 0	20dBm	26dBm	±2dB
	MCS 1	20dBm	26dBm	±2dB
	MCS 2	20dBm	26dBm	±2dB
	MCS 3	20dBm	26dBm	±2dB
	MCS 4	20dBm	26dBm	±2dB
	MCS 5	20dBm	26dBm	±2dB
	MCS 6	20dBm	26dBm	±2dB
	MCS 7	20dBm	26dBm	±2dB
	MCS 8	16dBm	22dBm	±2dB
	MCS 9	16dBm	22dBm	±2dB
	MCS 10	14dBm	20dBm	±2dB
	MCS 11	14dBm	20dBm	±2dB
	MCS 12	13dBm	19dBm	±2dB
	MCS 13	13dBm	19dBm	±2dB

	Data Rate	Rx Specifications Sensitivity	Tolerance
6GHz 802.11ax HE20	MCS0	TBD	±2dB
	MCS 1	TBD	±2dB
	MCS 2	TBD	±2dB
	MCS 3	TBD	±2dB
	MCS 4	TBD	±2dB
	MCS 5	TBD	±2dB
	MCS 6	TBD	±2dB
	MCS 7	TBD	±2dB
	MCS 8	TBD	±2dB
	MCS 9	TBD	±2dB
	MCS 10	TBD	±2dB
	MCS 11	TBD	±2dB
	MCS 12	TBD	±2dB
	MCS 13	TBD	±2dB
6GHz 802.11ax HE40	MCS 0	TBD	±2dB
	MCS 1	TBD	±2dB
	MCS 2	TBD	±2dB
	MCS 3	TBD	±2dB
	MCS 4	TBD	±2dB
	MCS 5	TBD	±2dB
	MCS 6	TBD	±2dB
	MCS 7	TBD	±2dB
	MCS 8	TBD	±2dB
	MCS 9	TBD	±2dB
	MCS 10	TBD	±2dB
	MCS 11	TBD	±2dB
	MCS 12	TBD	±2dB
	MCS 13	TBD	±2dB
6GHz 802.11ax HE80	MCS 0	TBD	±2dB
	MCS 1	TBD	±2dB
	MCS 2	TBD	±2dB
	MCS 3	TBD	±2dB
	MCS 4	TBD	±2dB
	MCS 5	TBD	±2dB
	MCS 6	TBD	±2dB
	MCS 7	TBD	±2dB
	MCS 8	TBD	±2dB
	MCS 9	TBD	±2dB
	MCS 10	TBD	±2dB
	MCS 11	TBD	±2dB
	MCS 12	TBD	±2dB
	MCS 13	TBD	±2dB

Pal-6E Tx Power and Rx Sensitivity

RF Performance for 6GHz (cont'd)								
	Data Rate	Tx Power (Per Chain)	Tx Power (4 Chains)	Tolerance		Data Rate	Rx Specifications Sensitivity	Tolerance
6GHz 802.11ax HE160	MCS 0	19dBm	25dBm	±2dB	6GHz 802.11ax HE160	MCS 0	TBD	±2dB
	MCS 1	19dBm	25dBm	±2dB		MCS 1	TBD	±2dB
	MCS 2	19dBm	25dBm	±2dB		MCS 2	TBD	±2dB
	MCS 3	19dBm	25dBm	±2dB		MCS 3	TBD	±2dB
	MCS 4	18dBm	24dBm	±2dB		MCS 4	TBD	±2dB
	MCS 5	18dBm	24dBm	±2dB		MCS 5	TBD	±2dB
	MCS 6	18dBm	24dBm	±2dB		MCS 6	TBD	±2dB
	MCS 7	18dBm	24dBm	±2dB		MCS 7	TBD	±2dB
	MCS 8	14dBm	20dBm	±2dB		MCS 8	TBD	±2dB
	MCS 9	14dBm	20dBm	±2dB		MCS 9	TBD	±2dB
	MCS 10	10dBm	16dBm	±2dB		MCS 10	TBD	±2dB
	MCS 11	10dBm	16dBm	±2dB		MCS 11	TBD	±2dB
	MCS 12	10dBm	16dBm	±2dB		MCS 12	TBD	±2dB
	MCS 13	10dBm	16dBm	±2dB		MCS 13	TBD	±2dB

Pal-6 / Pal-6E 5GHz (Tx)

Metric	CS	Measured
Tx Power Accuracy (dB)	+/- 1.5 dB CLPC +/- 2.5 dB OLPC	+1.5 dB CLPC +4.0/-1.5 dB OLPC
IEEE Mask-limited Power (VHT80 4x4)	23dBm	23dBm
IEEE Mask -limited Power (VHT80 8x8)	23dBm	23dBm
EVM Limited Power (MU HE80)	14.5dBm@-41dB	16dBm
EVM Limited Power (MU VHT80)	16.5dBm@-38dB	18dBm
EVM Limited Power (SU HE80)	18dBm@-35dB	20dBm
EVM Limited Power (SU VHT80)	19.5dBm@-32dB	22dBm
EVM Limited Power (MU HE 160)	14.5dBm@-41dB	18dBm
EVM Limited Power (SU VHT160)	19.5dBm@-32dB	22dBm
Tx EVM Floor (Header-only)	-41 dB	-41.5 dB

Pal-6 / Pal-6E 5 GHz (Rx)

Metric	CS	Measured
Sensitivity (11a/6Mbps/8x8/1SS)	-98.5 dBm	-100.5dBm
Sensitivity (MCS0/VHT20/1x1/1SS)	-93.5 dBm	-94.0dBm
Sensitivity (MCS0/VHT20/8X8/1SS)	-98.5 dBm	-100.5dBm
Sensitivity (MCS9/VHT80/8x8/4SS)	-67 dBm	-67.5dBm
Sensitivity (MCS9/VHT80/8x8/8SS)	-64 dBm	-64.5dBm
Sensitivity (MCS9/VHT160/4x4/4SS)	-61 dBm	-61.5dBm
Sensitivity (MCS11/HE80/8x8/4SS)	-61 dBm	-62.0dBm
Sensitivity (MCS11/HE80/8x8/8SS)	-58 dBm	-59.0dBm
Sensitivity (MCS11/HE160/4x4/4SS)	-55 dBm	-55.5dBm
Max Rx Signal	-10 dBm	-10dBm
Tx EVM Floor (Header-only)	-41 dB	-41.5 dB

Pal-6 / Pal-6E 2.4 GHz

Metric (room temp)	CS	Measured
Tx Power Accuracy (dB)	+/- 1dB	+/- 1dB
IEEE Mask Limited Power (CCK)	23dBm	24dBm
IEEE Mask Limited Power (VHT40)	23dBm	24dBm
EVM Limited Power (MU HE40)	16dBm@-41dB	20dBm
EVM Limited Power (MU VHT40)	18dBm@-38dB	22dBm
EVM Limited Power (SU HE40)	19.5dBm@-35dB	22dBm
EVM Limited Power (SU VHT40)	21dBm@-32dB	23dBm
Tx EVM Floor (Header-only)	-41dB	-43dB
Sensitivity (11b/1Mbps/4x4/1SS	-103dBm	-106.0dBm
Sensitivity (MCS0/VHT20/1x1/1SS)	-94.5dBm	-95.0dBm
Sensitivity (MCS0/VHT20/4x4/1SS)	-98.5 dBm	-99.5dBm
Sensitivity (MCS9/VHT40/4x4/4SS)	-68.5dBm	-69.0dBm
Sensitivity (MCS11/HE40/4x4/4SS)	-62.5dBm	-63.5dBm
Max Rx Signal	-10dBm	-10dBm

Pal-6 / Pal-6E DL OFDMA

Metric	CS	Measured
Tx Power Accuracy (dB)	**+/- 1.5 dB**	**+/-1.5**
IEEE Mask-limited Power (HE80 8x8)	23 dBm	23dBm
EVM Limited Power (SU HE80 MCS11)	17.5dBm@-35dB	18dBm
EVM Limited Power (SU HE40 MCS11)	18.0dBm@-25dB	20dBm
EVM Limited Power (SU HE20 MCS11)	18.5dBm@-35dB	20dBm
Tx EVM Floor (Header-only)	-41 dB	-41 dB

Pal-6 / Pal-6E System Level Power

Metric	CS Target (W)	Measured
8x8+4x4 – Retail Thermal Max	44.5	
8x8+4x4 – Retail Typical	40.5	39.0
8x8+4x4 – Retail Throughput Max	23.5	18.7
4x4+4x4 – Retail Thermal Max	35.0	
4x4+4x4 – Retail Typical	32.5	30.9
4x4+4x4 – Retail Throughput Max	20.5	15.5
Tx EVM Floor (Header-only)	-41 dB	-41 dB

STApal System Description

	STApal	STApal-6E
Frequency band(s) of operation	2.4 GHz and 5 GHz bands	2.4 GHz, 5 GHz and 6 GHz bands
Operating frequency	2400-2485 MHz 5150-5250 MHz 5250-5350 MHz 5470-5725 MHz 5725-5850MHz	2400-2485 MHz 5150-5250 MHz 5250-5350 MHz 5470-5725 MHz 5725-5895MHz 5925-7125 MHz
Channel spacing / bandwidth	2.4 GHz: 802.11b/g/n: 5 MHz / BT: 1 MHz bandwidth: 20 MHz / 40 MHz 5GHz: 802.11a/n/ac/ax: 20, 40, 80, 160 MHz	2.4 GHz: 802.11b/g/n: 5 MHz / BT: 1 MHz bandwidth: 20 MHz / 40 MHz 5GHz: 802.11a/n/ac/ax: 20, 40, 80, 160 MHz 6GHz: 802.11a/n/ac/ax: 20, 40, 80, 160 MHz
RF output power	20dBm (2400-2485 MHz) IEEE 802.11b/g/n 23dBm (5150-5725 MHz) IEEE 802.11a/n/ac/ax 20 dBm (5725-5875 MHz) IEEE 802.11 a/n/ac/ax	20dBm (2400-2485 MHz) IEEE 802.11b/g/n 23dBm (5150-5725 MHz) IEEE 802.11a/n/ac/ax 21 dBm (5725-5875 MHz) IEEE 802.11 a/n/ac/ax (5925-7125 MHz) IEEE 802.11 a/n/ac/ax 20 MHz: 4 dBm, 40 MHz: 7 dBm, 80 MHz: 10 dBm, 160MHz: 13 dBm
Rx sensitivity		2.4GHz: -96.75dBm 5GHz: -95dBm 6GHz: -95dBm
Type of modulation	Referenced antenna is PIFA type	Referenced antenna is PIFA type
Mode of operation (simplex / duplex)	Duplex (Tx/Rx)	Duplex (Tx/Rx)
Duty cycle (access protocol, if applicable)	N/A	N/A

Pal-6, Pal-6e, and STApal, STApal-6e Radio Stats – Plots vs. Time

Only STA stats are available for STApal-6Es. Reporting by STApal-6Es of the Deep Performance Metrics from the synchroSniffer is per packet and per RU. Reporting from the Pal-6E is per interval (1 second) as indicated in the last column.

Pal-6/6E STA	Pal-6/6E AP	STApal / STApal-6E	UI name	Details	Pal-6/6E reporting
√	√		TX aggregate packets		Total since last report
√	√		TX unaggregated packets		Total since last report
√	√		RX aggregate packets		Total since last report
√	√		RX unaggregated packets		Total since last report
√	√		TX block ack window advances		Total since last report
√	√		RX overruns		Total since last report
√	√		RX decryption fails		Total since last report
√	√		RX MIC fails	Rx MIC (message integrated check) failure count	Total since last report
√	√		RX bad CRC		Total since last report
√	√		RX PHY errors		Total since last report
√	√		Bad RTS	RTS failure count	Total since last report
√	√		RTS	RTS success count	Total since last report
√	√	√	Missing ACKs		Total since last report
√	√	√	Bad FCS	FCS failure count	Total since last report
√	√		Noise floor	Channel Noise Floor; NF is re-calibrated every 15 seconds	Value
√	√		NF secondary 80+80	Noise Floor on Secondary 80 MHz channel for 80+80 mode	Value
√	√	√	Control RSSI per chain	RSSI on control channel; plot for each chain on the same chart, Control RSSI. Label each plot as chain-0, 1, 2, ..., 7.	Min, Max, Linear mean in dB
√	√		Extended RSSI 80 per chain	80+80 channel RSSI on secondary 80 MHz channel; plot Extended RSSI 80. Label each plot as chain-0, 1, 2, ..., 7.	Min, Max, Linear mean in dB
√	√		ACK RSSI per chain	Plot ACK RSSI per chain; label each plot as chain-0, 1, 2, ..., 7.	Min, Max, Linear mean in dB
√	√	√	Management RSSI	Combined management RSSI for all chains	Min, Max, Linear mean in dB
√	√	√	Data RSSI	Combined data RSSI for all chains	Min, Max, Linear mean in dB
√	√	√	TX streams		Min, Max, Mode.
√	√	√	RX streams		Min, Max, Mode.
√	√		% load total	% utilization, including Wi-Fi traffic and non-Wi-Fi signals	Value
√	√		% load Wi-Fi	% for Wi-Fi traffic total including the reporting radio	Value
√	√		% load not my Wi-Fi	% utilization for Wi-Fi traffic by other than the reporting radio	Value
√	√		% airlink my Wi-Fi	% utilization for Wi-Fi traffic by the reporting radio	Value

(cont'd)

Pal-6/6E STA	Pal-6/6E AP	STApal / STApal-6E	UI name	Details	Pal-6/6E reporting
√	√	√	TX bandwidth		Min, Max, Mode
√	√	√	RX bandwidth		Min, Max, Mode
√	√	√	TX power		Value
	√		TX beacons		Total since last report
√	√		TX bytes		Total since last report
√	√		RX bytes		Total since last report
√	√		TX packets		Total since last report
√	√		RX packets		Total since last report
√	√		TX unicast		Total since last report
√	√		TX multicast		Total since last report
√	√		RX unicast		Total since last report
√	√		RX multicast		Total since last report
√	√	√	TX priority	TX packets by priority; individual plot names: BK, BE, VI, VO	Total since last report, 4 values
√	√	√	RX priority	RX packets by priority; individual plot names: BK, BE, VI, VO	Total since last report, 4 values
√	√		TX management		Total since last report
√	√		RX management		Total since last report
√	√		TX data packets		Total since last report
√	√		RX data packets		Total since last report
√	√		TX control packets		Total since last report
√	√		RX control packets		Total since last report
√	√		TX errors		Total since last report
√	√		RX errors		Total since last report
√	√	√	TX dropped packets		Total since last report
√	√	√	RX dropped packets		Total since last report
√	√	√	TX rate		Min, Max, Mode
√	√	√	RX rate		Min, Max, Mode
√	√	√	TX MCS		Min, Max, Mode
√	√	√	RX MCS		Min, Max, Mode
√	√		Retries		Total since last report
√	√		Excessive retries		Total since last report

Wi-Fi Alliance STA Security Modes

WFA Security Mode	RSN IE AKM Suite(s)	RSN IE Pairwise/Group Cipher Suite(s)	RSN IE Group Management Cipher Suite for PMF	RSN IE PMF	wpa_supplicant Settings
WPA2-Personal with PMF	00-0f-ac:2 (PSK with SHA-1) 00-0f-ac:6 (PSK with SHA-256)	00-0f-ac:4 (CCMP-128)	00-of-ac:6 (BIP-CMAC-128)	Supported	key_mgmt=WPA-PSK ieee80211w=1
FT-WPA2-Personal with PMF	00-0f-ac:4 (FT-PSK with SHA-256)	00-0f-ac:4 (CCMP-128)	00-of-ac:6 (BIP-CMAC-128)	Supported	key_mgmt=FT-PSK ieee80211w=1
OWE	00-0f-ac:18 (OWE with SHA-256)	00-0f-ac:4 (CCMP-128)	00-of-ac:6 (BIP-CMAC-128)	Mandatory	key_mgmt=OWE ieee80211w=2
SAE	00-0f-ac:8 (SAE with SHA-256)	00-0f-ac:4 (CCMP-128)	00-of-ac:6 (BIP-CMAC-128)	Mandatory	key_mgmt=SAE ieee80211w=2
FT-SAE	00-0f-ac:9 (FT-SAE with SHA-256)	00-0f-ac:4 (CCMP-128)	00-of-ac:6 (BIP-CMAC-128)	Mandatory	key_mgmt=FT-SAE ieee80211w=2
WPA2-Enterprise with PMF	00-0f-ac:1 (802.1X with SHA-1)	00-0f-ac:4 (CCMP-128)	00-of-ac:6 (BIP-CMAC-128)	Supported	key_mgmt=WPA-EAP ieee80211w=1
FT-WPA2-Enterprise with PMF	00-0f-ac:3 (FT-802.1X with SHA-256)	00-0f-ac:4 (CCMP-128)	00-of-ac:6 (BIP-CMAC-128)	Supported	key_mgmt=FT-EAP ieee80211w=1
WPA3-Enterprise	00-0f-ac:5 (802.1X with SHA-256)	00-0f-ac:4 (CCMP-128)	00-of-ac:6 (BIP-CMAC-128)	Mandatory	key_mgmt=WPA-EAP-SHA256 ieee80211w=2
WPA3-Enterprise with 192-bit Security	00-0f-ac:12 (802.1X with SHA-384)	00-0f-ac:9 (GCMP-256)	00-of-ac:12 (BIP-GMAC-256)	Mandatory	key_mgmt=WPA-EAP-SUITE-B-192 ieee80211w=2
FT-WPA3-Enterprise	00-0f-ac:3 (FT-802.1X with SHA-256)	00-0f-ac:4 (CCMP-128)	00-of-ac:6 (BIP-CMAC-128)	Mandatory	key_mgmt=FT-EAP ieee80211w=2
FT-WPA3-Enterprise with 192-bit Security	00-0f-ac:13 (FT-802.1X with SHA-384)	00-0f-ac:9 (GCMP-256)	00-of-ac:12 (BIP-GMAC-256)	Mandatory	key_mgmt=FT-EAP-SHA384 ieee80211w=2

NOTE 1: While WPA2 modes can have PMF disabled, WFA certification requires WPA2 PMF to be set to “supported”.
NOTE 2: FT-WPA2-Enterprise already uses SHA-256 key derivation, therefore the same AKM suite is also used for FT-WPA3-Enterprise.
NOTE 3: WPA3-Enterprise-192-bit only supports EAP-TLS with ECDHE_ECDSA / ECDHE_RSA / DHE_RSA curves (AES_256_GCM_SHA384).
NOTE 4: BIP-CMAC-128 is configured as AES-128-CMAC in wpa_supplicant.
NOTE 5: For Enterprise modes, the EAP method used for authentication can be verified with “sudo wpa_cli status”.

About Spirent

Spirent Communications (LSE: SPT) is a global leader with deep expertise and decades of experience in testing, assurance, analytics and security, serving developers, service providers, and enterprise networks. We help bring clarity to increasingly complex technological and business challenges. Spirent's customers have made a promise to their customers to deliver superior performance. Spirent assures that those promises are fulfilled.

For more information visit: www.spirent.com

Glossary

A2DP	advanced audio distribution profile
ACS	automated channel selection
AFH	adaptive frequency hopping
AID	association ID
AP	access point
BE	best effort (priority)
BK	background (priority)
BLE	Bluetooth low energy
BT	Bluetooth
DFS	dynamic frequency selection
DL	downlink
HE	high efficiency
HFP	hands free profile
HID	human interface device profile
KPI	key performance indicator
MCS	modulation coding scheme
MIMO	multiple input multiple output
MP2MP	multi-point to multi-point (traffic generator)
MU	multi-user
Nss	number of streams
OFDMA	orthogonal frequency domain multiple access
OPP	object push profile
OTA	over the air
RSSI	receive signal strength indicator
RU	resource unit
RvR	rate vs. range
RvRvO	rate vs. range vs. orientation
RvOvR	rate vs. orientation vs. range
RX	receive
STA	station (aka client)
TX	transmit
UL	uplink
VI	video (priority)
VO	voice (priority)
vSTA	virtual STA

Americas 1-800-SPIRENT
+1-800-774-7368 | sales@spirent.com

Europe and the Middle East
+44 (0) 1293 767979 | emeainfo@spirent.com

Asia and the Pacific
+86-10-8518-2539 | salesasia@spirent.com