



octoBox™ Throughput Test Application Note

Automated test controls the octoBox turn table and RF attenuators to measure throughput of a MIMO link

The octoBox throughput testbed supports up to a 4x4 802.11 MIMO link using any width channels, including 160 MHz. Devices in the testbed are completely isolated from one another and from external interference – industry best isolated testbed. The OB-THROUGHPUT software automates the throughput test by programming octoScope's [quadAtten](#) RF attenuators, turn table and IxChariot software. Results are compiled in the CSV format for plotting with a preconfigured Excel template.

OB-THROUGHPUT TEST HIGHLIGHTS

- ✦ Stand-alone compact RF testbed supports Wi-Fi (802.11a/b/g/p/n/ac) and cellular (GSM, UMTS, LTE, FDD, TD-LTE and LTE-Advanced) testing
- ✦ Implements industry-standard benchmark test used by SmallNetBuilder.com
- ✦ Integrated anechoic turn table
- ✦ Integrated multipath emulator (MPE) module
- ✦ Integrated [quadAtten](#) RF attenuator module
- ✦ Supports up to a 4x4 MIMO link of any channel bandwidth in the band of near-DC to 6 GHz
- ✦ Automatically controls RF attenuators, the turn table and IxChariot traffic generator, iterating through measurements at each attenuation and rotation setting
- ✦ Can be left running overnight or longer for extensive averaging or fine resolution of attenuation and turn table rotation steps
- ✦ Better than 80 dB of isolation at close range; all power and control interfaces are filtered to ensure isolation
- ✦ 8 RF ports per octoBox accommodate 4x4 MIMO plus controlled interference or monitor connections

FEATURES & BENEFITS

- ✦ Frequency range: 700 to 6000 MHz
- ✦ Attenuator dynamic range: 63 dB; step: 0.5 dB
- ✦ 4 RF attenuators per module powered and individually controlled via single Ethernet/PoE or USB
- ✦ Conducted or over the air (OTA) signal coupling
- ✦ Test automation software controls test conditions and provides graphical reporting



Figure 1: octoBox OB-38-MPE testbed

Typically the RF signals to the DUT are coupled over the air (OTA). This example shows a 4x4 MIMO link with 4 MIMO antennas on the right. The DUT is placed on a turn table when a turn table is available.

An RF-transparent support (e.g. a block of Styrofoam) can be used to lift up the DUT, if necessary, for better alignment with the test antennas.

Power and data cables connected to the DUT can be fastened on the top rail (not shown).

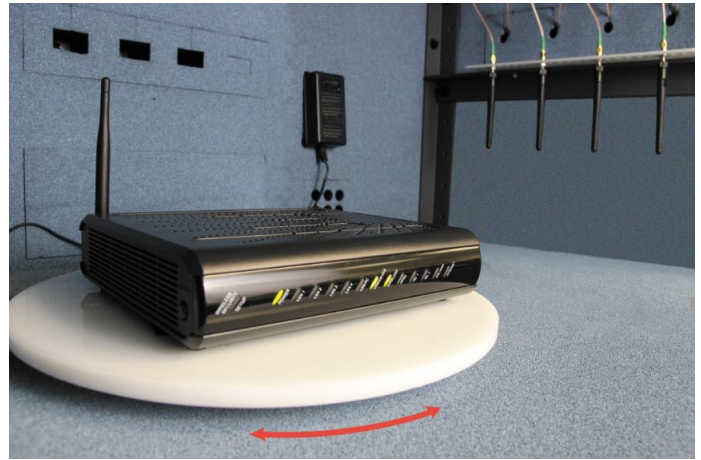


Figure 2: octoBox anechoic turn table

What is a typical throughput test configuration?

A typical throughput test configuration has the DUT and master connected through programmable attenuators in series with the MPE (multipath emulator) module, as shown in Figure 3.

Traffic generator software, such as iPerf or IxChariot, can be used to send traffic between the DUT and the master. The octoScope OB-THROUGHPUT software expects IxChariot to be installed on the console PC.

Programmable attenuators add path loss while the MPE module adds multipath between the master and the DUT, simulating typical home or office conditions.

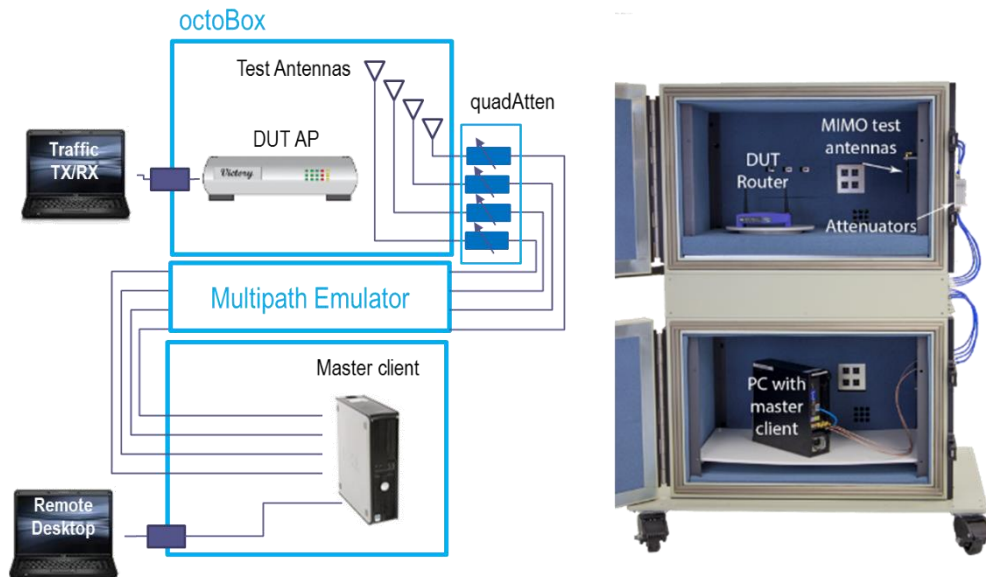


Figure 3: octoBox MPE throughput testbed block diagram (left); photo (right)

If the DUT is a client device (e.g. phone, tablet or PC), the master is typically an access point (AP) or a base station (BS). If the DUT is an AP or a BS, the master is typically a client device.

The MPE module is stacked between the master and DUT chambers. The master and DUT chambers are coupled through the MPE and programmable attenuators located in the octoBox [quadAtten](#) module (Figure 3, left). The attenuators are programmed to step through a range of 0 dB to 63 dB to measure throughput vs. path loss.

What is the minimum path loss between the Master and the DUT with RF attenuators set to 0 dB?

The path loss depends on the TX power and on whether the devices are coupled conductively or over the air (OTA). In a typical Wi-Fi test configuration where the master device is coupled conductively and the DUT is coupled OTA, the DUT's RSSI is roughly between -30 and -40 dBm. The DUT's RSSI reading will vary as a function of the master TX signal level, DUT's RX gain, operating channel, DUT's proximity to the test antennas and antenna coupling gains.

What does the automation software control?

The OB-THROUGHPUT automation software is a Windows application (.exe) that controls programmable attenuators, turn table and IxChariot traffic generator to produce throughput vs. path loss plots, such as the one shown in Figure 4. If the turn table is available every point on the plot in Figure 4 can be averaged vs DUT rotation.

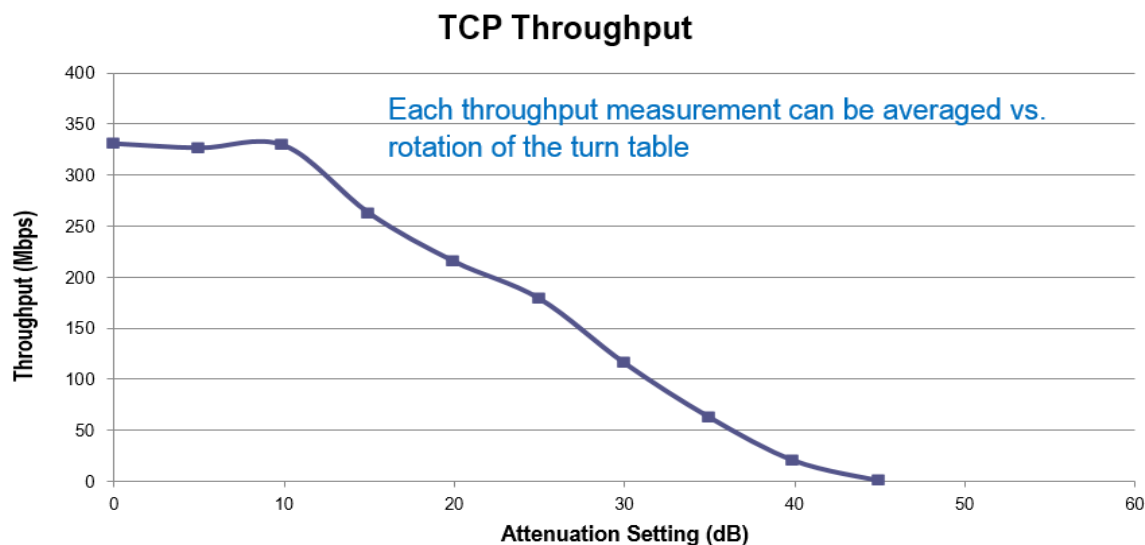


Figure 4: OB-THROUGHPUT plot of throughput vs. path loss

How do programmable attenuators work?

[quadAtten](#) module containing programmable attenuators is mounted on the side of the top octoBox.

[quadAtten](#) can be powered and controlled from a console PC using either Ethernet/PoE or USB port.

Attenuation range is 0 to 63 dB in 0.5 dB steps. [quadAtten](#) is the industry-first attenuator module that is well enough isolated to maintain testbed impenetrability by stray interference. To maintain high isolation, quadAtten features filtered Ethernet and USB connections.



Figure 5: octoBox [quadAtten](#) module

What test results does the software produce?

OB-THROUGHPUT can produce either waterfall or polar plots. For waterfall plots, your plot will look similar to the one shown in Figure 6.

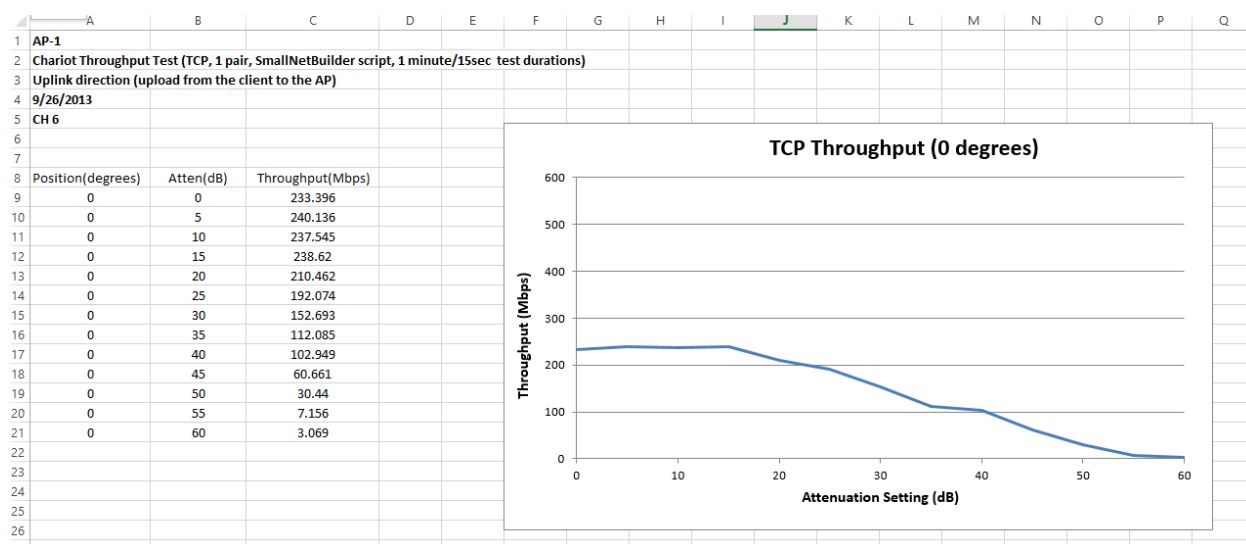


Figure 6: OB-THROUGHPUT test results are managed in Excel. OB-THROUGHPUT comes with a pre-configured plotting template.

If you are using a turn table you have the option of waterfall or polar plots. Waterfall plots (Figure 6) can be configured to have each throughput measurement averaged vs. rotation. If you would like to see polar plots indicating throughput vs. orientation angle, the plot will look similar to the one shown in Figure 7 where the polar scale is degrees of rotation with respect to the 0 degree position and each circular plot is taken at a particular attenuation setting.

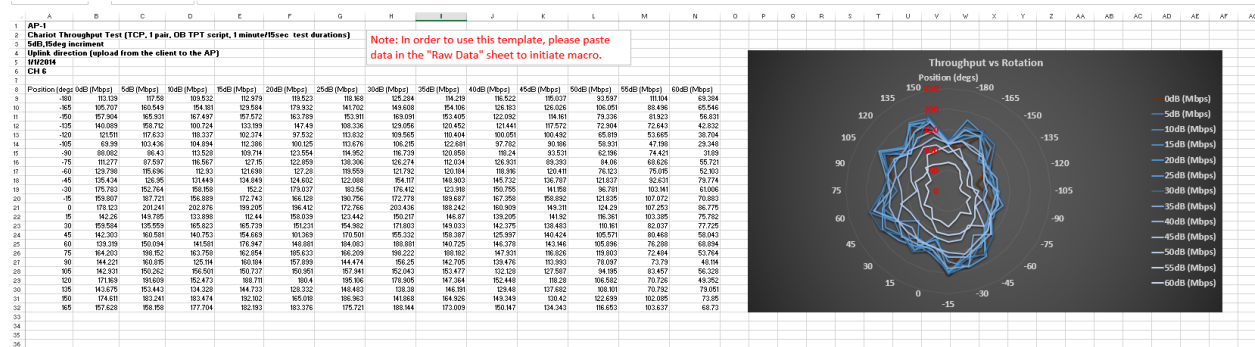


Figure 7: OB-THROUGHPUT polar plots – throughput vs. angular position vs. path loss

When a polar plot is selected, OB-THROUGHPUT creates a plot of throughput at each turn table rotation step and for each attenuator setting. You can configure the following:

- Duration of each measurement (IxChariot test run)
- Attenuator step and range
- Turn table angular step and range

The IxChariot traffic is configured as it is normally don using the IxChariot .tst file.

Can I introduce interference into the testbed?

Interference and desired signal can be injected into the DUT chamber in several ways, including OTA, as shown in Figure 8, or through RF combiners.

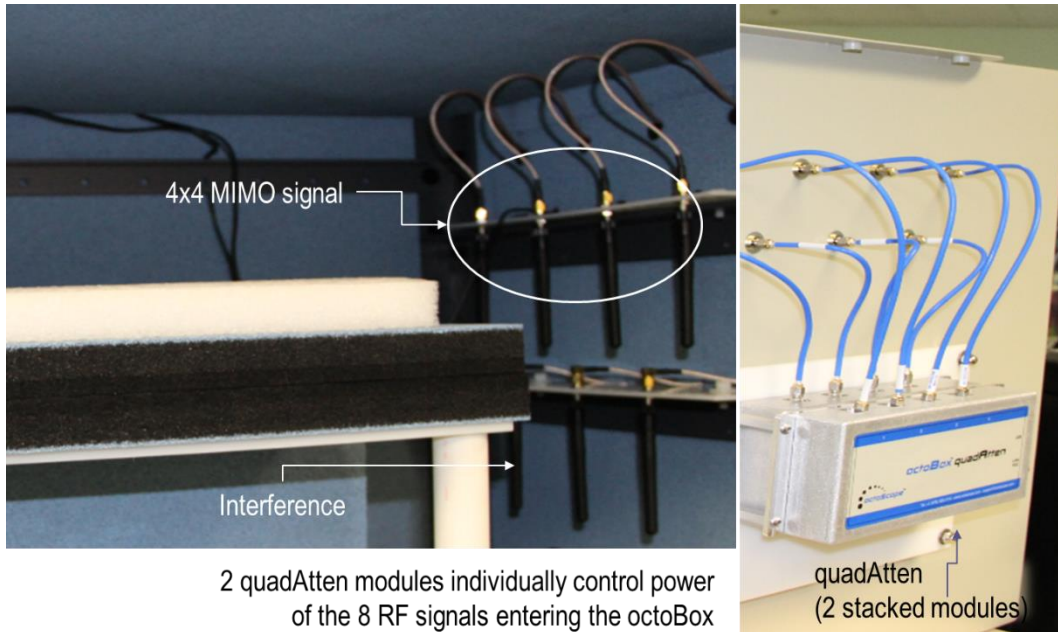


Figure 8: Extra antennas can be mounted to bring interference into the test chamber. octoScope has capture and replay software to generate interference that allows you to generate controlled interference level and traffic load. You can, for example, inject ACI (adjacent channel interference) below the operating band, above the operating band and CCI (co channel interference) in the operating band.

As Figure 8 shows, multiple [quadAtten](#) modules can be neatly fixture to provide 8 individually power-controlled RF connections into the octoBox. 4 of the RF connections can be dedicated to the 4x4 MIMO signal. You can then use the remaining 4 connections as follows:

- Lower channel ACI
- Higher channel ACI
- CCI
- Random noise

octoBox [waveGen](#)™ module can also be used to emulate common sources of wireless interference, including radar interference for 802.11h DFS (dynamic frequency selection) testing. [waveGen](#) can emulate signals from radar, cordless phones, Bluetooth devices, microwave ovens, baby monitors and other sources of interference. It can also be programmed to emulate OOK (on/off keying) and frequency hopping devices. It has the same formfactor and mounting arrangement as the octoScope [quadAtten](#) (Figure 9) and can be easily integrated into the octoBox wireless testbed.



Figure 9: octoBox [waveGen](#) interference generator for generating radar, cordless phone, Bluetooth and other interference. [waveGen](#) is a tone generator in the frequency range of 500 to 6000 MHz. The tones are independently programmable for on/off duty cycle and frequency. Thus, for example, a frequency hopping Bluetooth waveform can be generated.

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