

Wi-Fi 6E Multipath Emulators

Simulates 'true' multipath effects in a wireless environment
Models 10444-4, 10483-4, 10484



Intro

Spectrum Control's Weinschel has worked with customers to develop two variants of multipath emulators. Both emulators attempt to replicate the impairment that would be introduced to a Wi-Fi connection by real world multipath effects. The first variant – model 10444-4 – aims to implement the TG-B multipath model described in IEEE 802.11-03/940r1.

The second emulator, model 10483-4, provides expanded functionality. Specifically, model 10483-4 supports the expanded channel bandwidths described in the TGac Channel model addendum (802.11-09/0308r12). Additionally model 10483-4 supports an external expansion module(10484) that enables support for an outdoor multipath model(TG-D). This additional flexibility comes at a cost of increased insertion loss when compared to the 10444-4.

Theory of Operation

The multipath emulators attempt to replicate real world multipath effects by producing "clusters" and "taps." In the TG-B model there are two clusters, separated in time by 20 ns. Each cluster has a series of taps, with a 10 ns spacing. The roll-off between each tap is roughly 6 dB.

The combination of taps and clusters determine the frequency response. Specifically, they produce constructive and destructive interference. This results in a series of nulls and peaks. A programmable phase shifter, on the tap path, allows the user to tune the interference pattern at a given frequency. 180 degrees of phase shift is sufficient range to induce both peaks and nulls at a given frequency.

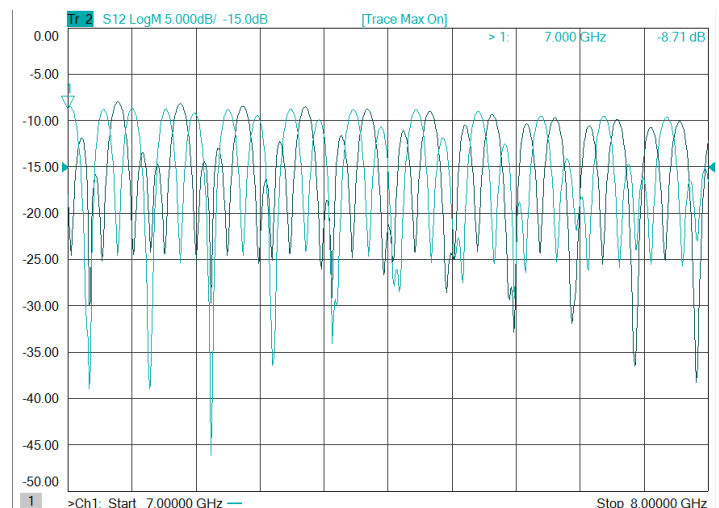


Figure 1: 10444-4 Frequency Response.
Black: 0 degrees, Teal: 180 degrees

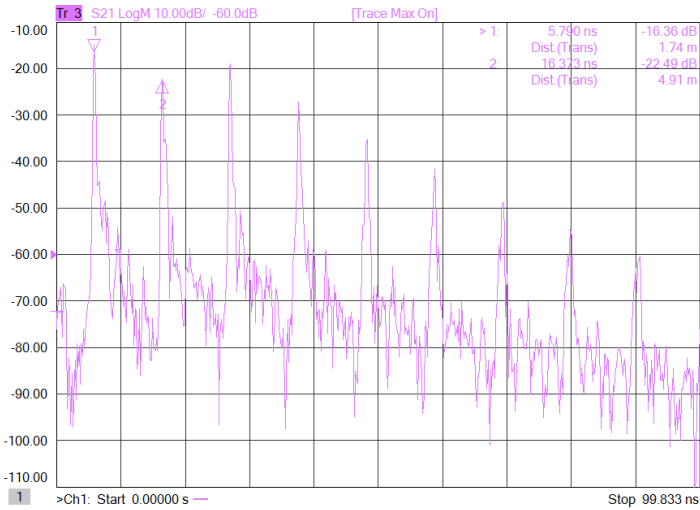


Figure 2: 10444-4 S21 time impulse response

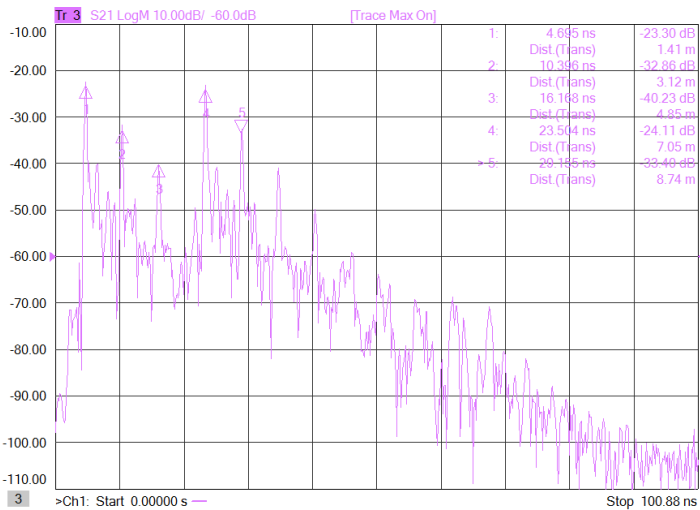


Figure 3: 10483-4 Time Impulse Response – 5 ns tap spacing

The 10483-4 includes support for the TGac channel model addendum. The ac addendum extends the TG-n model to support wider Wi-Fi system bandwidths. This is achieved by reducing the time spacing between taps.

System Bandwidth W	Tap Spacing
$W \leq 40 \text{ MHz}$	10 ns
$40 \text{ MHz} < W \leq 80 \text{ MHz}$	5 ns
$80 \text{ MHz} < W \leq 160 \text{ MHz}$	2.5 ns
$160 \text{ MHz} < W \leq 320 \text{ MHz}$	1.25 ns

The 10444-4 has a fixed delay line producing a tap spacing of 10 ns. The 10483-4 has a programmable switch, enabling 10, 5, 2.5 or 1.25 ns tap spacing.

By default the systems produce multipath effects consistent with NLOS (Non Line of Sight) channel conditions. The 10483-4 includes an internal switch network to enable a Line of Sight Mode. In Line of Sight mode, the roll-off between the first and second taps in a cluster will be increased by 3dB. This results in a less severe multipath condition than the LOS condition.

The 10483-4 includes a switch to enable connection to an external box. This expansion box allows for implementation of the TG-D outdoor multipath model. This module has a delay between clusters of 110 and 240 ns.

Model Number	# Chan.	IEEE model	LOS/NLOS	Tap Spacing	Clusters	IL(Cluster 1, Tap 0, typ.)	Tap Roll-off, typ.
10444-4	4	TG-B	NLOS	10 ns	0 ns, 20 ns	16 dB	6 dB
10483-4	4	TG-B	NLOS, LOS	10,5, 2.5, 1.25 ns	0 ns, 20 ns	23 dB	9 dB
10483-4 (with 10484 expander)	4	TG-B/TG-D	NLOS, LOS	10, 5, 2.5, 1.25 ns	0 ns, 20 ns or 0 ns, 110 ns, 240 ns	23 dB	9 dB