Keysight Technologies

Creating and Optimizing 802.11ac Signals with the M8190A AWG

Application Note

KEYSIGHT TECHNOLOGIES

Introduction

The new IEEE 802.11ac wireless LAN standard aims to provide higher data throughput rates of over 1 gigabit per second, to improve the user experience and to enable new applications, such as transmission of multiple streams of high-definition multimedia data. To achieve these data rates, the Very High Throughput (VHT) physical layer specification has introduced new features, including wider bandwidth channels of up to 160 MHz and 256 QAM modulation.

802.11ac devices will need to meet more stringent specifications for RF performance, especially for error vector magnitude (EVM) over wider bandwidths, so it is important to have test tools that provide the best reference signals and EVM measurements, particularly for R&D and design validation.

This application note details how to create and optimize 802.11ac signals using the N7617B Signal Studio for WLAN 802.11a/b/g/n/ac software with the Keysight Technologies, Inc. M8190A Arbitrary Waveform Generator (AWG) to get the highest quality signals from the instrument. This application note is based on the application note Creating and Optimizing 802.11ac Signals and Measurements, Literature number 5991-0574EN, which also includes the analysis of 802.11ac signals using the N9030A PXA signal analyzer and provides hints for achieving the best EVM measurements with this solution.

Prerequisites

- The M8190A AWG needs to have the option ‘DUC’ installed.
- The M8190A AWG should have the option ‘AMP’ installed for best EVM performance.
- The M8190A should have licenses installed for the N7617B Signal Studio for WLAN software. The minimum required licenses for generating 802.11ac signals are N7617B-AFP (Connect to M8190A) and N7617B-GFP (Basic 802.11ac WLAN). For receiver test applications, option N7617B-TFP (Advanced 802.11ac WLAN) is also required. Transportable versions of these licenses are also available. The installed licenses are displayed at the bottom of the “Status/Control” tab of the Soft Front Panel (SFP) of the M8190A AWG.

Generation of 802.11ac Signals

The N7617B Signal Studio for WLAN 802.11a/b/g/n/ac software allows users to configure parameters to create waveform files, which can then be downloaded to various RF signal generators for playback. The choice of which signal generator to use depends on the requirements for channel bandwidth, performance characteristics and price. 802.11ac requires the support of 20, 40, and 80 MHz channel bandwidths, with optional support for 160 MHz and 80+80 MHz (consisting of two 80 MHz channels that are not adjacent in frequency).

This application note concentrates on generating high bandwidth signals using the M8190A AWG, in combination with the N9030A PXA signal analyzer and 89600 VSA software for analysis.

In this example we create a 160 MHz wide 802.11ac signal.

When opening the N7617B Signal Studio for WLAN, select ‘New hardware configuration’ in the Welcome Screen. On the next screen select the “IEEE 802.11ac MxN” configuration as shown in Figure 2.

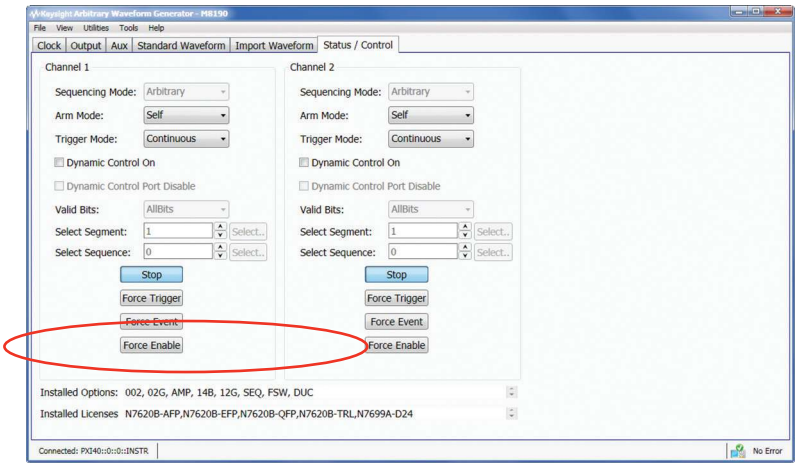

Figure 1: M8190A SFP ‘Status / Control’ tab.

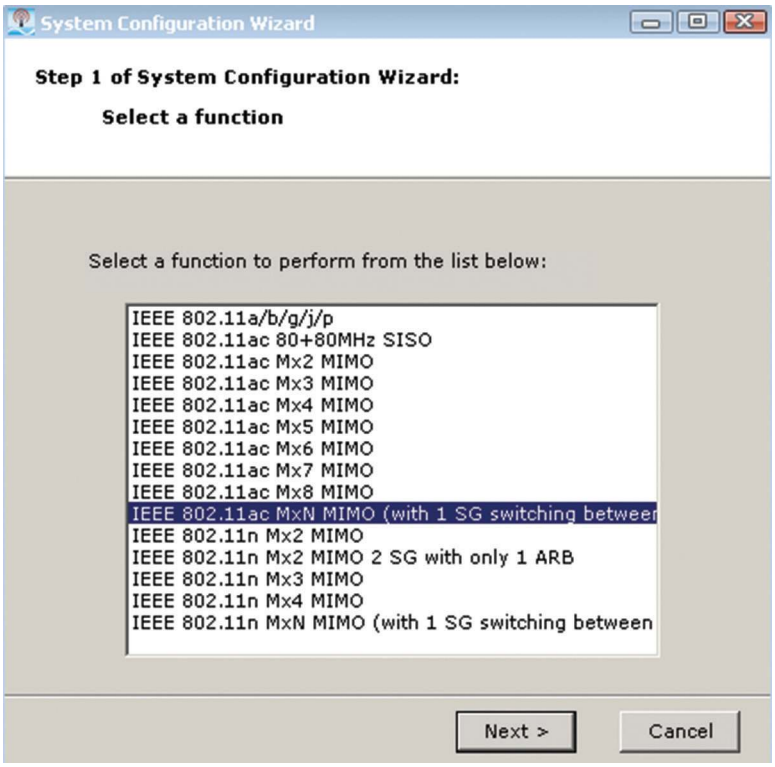

Figure 2: N7617B Signal Studio for WLAN function selection.

For the hardware configuration in the next step, choose “M8190A Arbitrary Waveform Generator” as shown in Figure 3.

In the ‘Waveform Setup’ dialog of the N7617B software (and sub-dialogs) one can modify certain settings for the desired 802.11ac signal. Here we have changed the Bandwidth (to 160 MHz) and the Oversampling Ratio (to 1.875) from their default values, to create a 160 MHz wide signal, which is played at 5.25 MHz center frequency with the M8190A settings.

The signal configuration in figure 4 results in a very short frame with only 4 data symbols. Depending on the final application, one would probably want a longer frame, which means increasing the number of data bytes in the frame. This change can be done either on the “User-settings” page by adding MPDUs, or on the MPDU setup (next level down in the navigation tree on the left).

Also, one can see how many data symbols are in the frame and how long the frame is on the “Waveform Setup” page.

By setting the Oversampling Ratio to 1.875, a 300 MHz wide baseband signal is generated. Thus, by using DUC mode within the M8190A, herein selecting the interpolation factor to be 24, one may set the AWG sampling frequency to 7.2 GHz which is optimal for best overall signal performance.

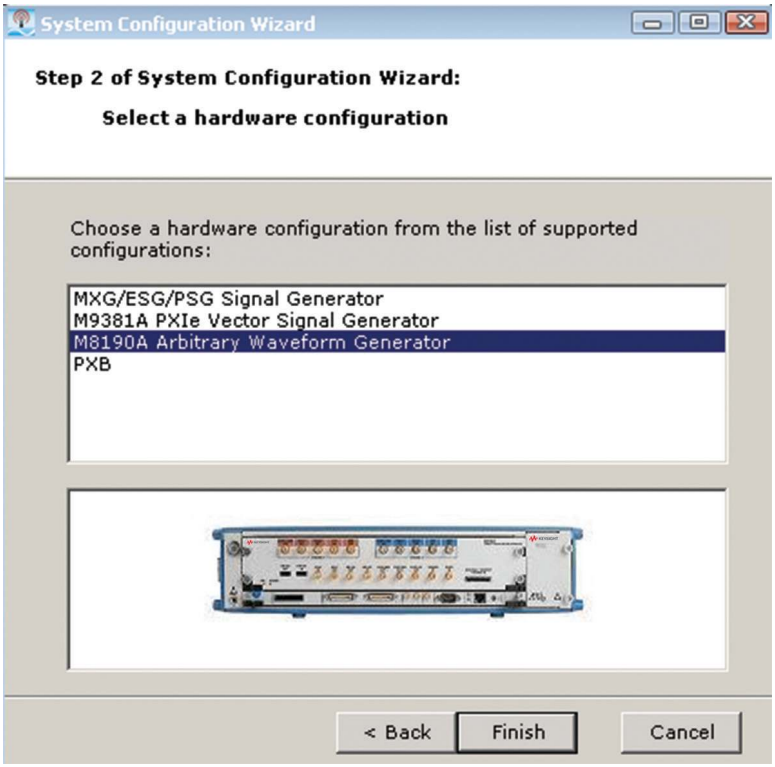

Figure 3: N7617B Signal Studio for WLAN hardware selection

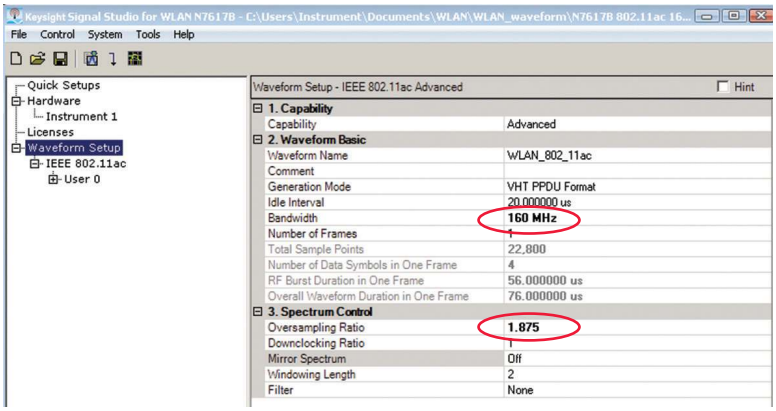

Figure 4: N7617B Signal Studio for WLAN Waveform Setup tab.

In DUC mode, the carrier frequency may be set and modified independent of these settings (and modified 'on the fly'). For this example it is set to 5.25 MHz; see figure 5.

When selecting the "download" function, one will see the File -> Save dialog box to save the waveform file, so that it can later be imported into the AWG through the M8190A Soft Front Panel (SFP). The example waveform file described above is also provided with the M8190A firmware installation (from 2.4.0.0 onwards), in the 'examples' section, which may be accessed through the Start Menu -> Agilent -> M8190 -> Examples -> N7617B Signal Studio WLAN.

Setting and optimizing M8190A AWG parameters and performance

The M8190A AWG offers several parameters that influence the EVM performance of the instrument, including different (amplified) outputs, doublet mode, amplitude setting and carrier scaling.

This application note is based on the settings provided with the M8190A firmware installation (from 2.4.0.0 onwards), in the 'examples' section, which may be accessed through the Start Menu -> Agilent -> M8190 -> Examples -> N7617B Signal Studio WLAN.

These settings can be applied through the M8190A Soft Front Panel (SFP) by choosing 'File -> Load Configuration' and opening the file 'IEEE802_11ac_160MHz_5250MHz.txt'. For standard installations, this file is located at: C:\Program Files (x86)\Agilent\M8190\Examples\N7617B Signal Studio WLAN. For further details, also on the 'Import Waveform' tab mentioned below, check the 'Readme.pdf' at the same location.

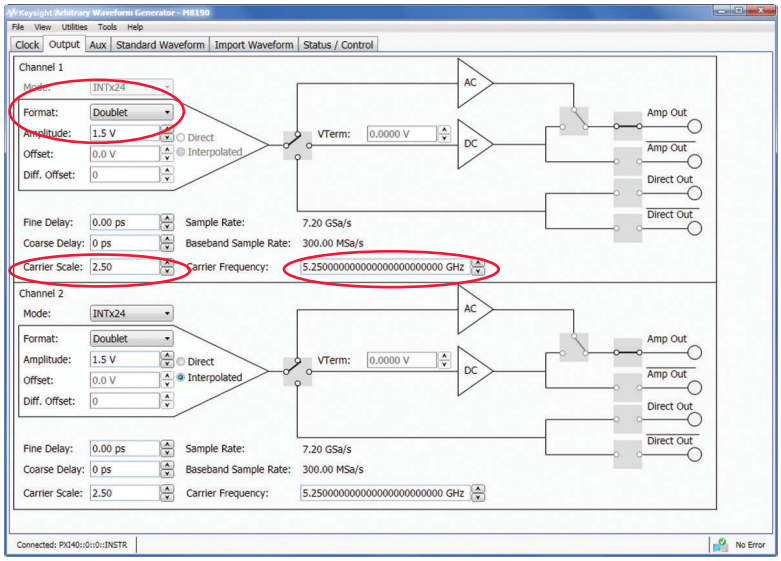

Figure 5: M8190A SFP 'Output' tab.

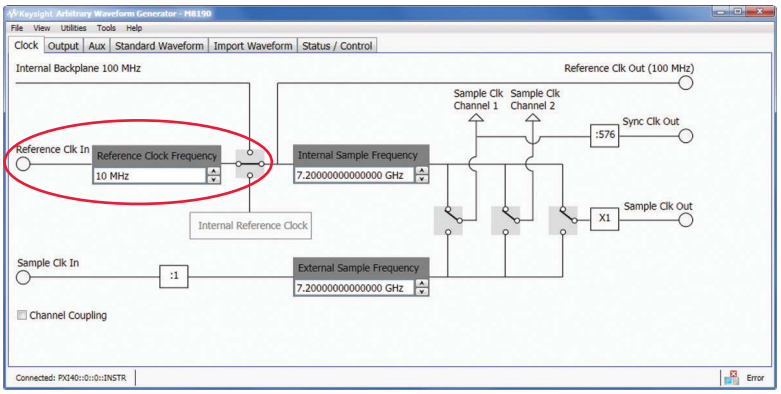

Figure 6: M8190A SFP 'Clock' tab.

These settings require the 'DUC' option to be licensed for the M8190A AWG. The AC amplified output of channel 1 is used.

From the same location, through the SFP 'Import Waveform' tab, one can either import the self-created 802.11ac waveform file, or the file provided with the M8190A firmware installation, which is called 'IEEE802_11ac_160MHz_5250MHz.wfm'.

If connecting the 10 MHz out of the N9030A PXA signal analyzer to the 'REF CLK IN' of the M8190A, make sure to adjust the parameters accordingly in the SFP 'Clock' tab; first edit the frequency to 10 MHz, then select 'Reference Clk In'.

After pressing 'Run' within the 'Status / Control' tab, the waveform is put out through the AC amplified normal output of channel 1. This output should be directly connected to the input of a N9030A PXA signal analyzer. See figure 7 below and the next section.

For baseband output operation, if required or of interest for some reason, one may set the 'carrier frequency' to zero, which is possible in DUC mode. With this setting, one may not use the AC amplified output due to its bandwidth limitation towards low frequencies, rather the DC amplified output instead.

Furthermore, one would need to split up the waveform into I and Q data, which also requires the use of both channels.

Analyzing 802.11ac signals with the N9030A PXA signal analyzer and optimizing EVM measurements using 89600 VSA software

The 89600 VSA software offers comprehensive modulation analysis for single-channel and multi-channel signals using a variety of different instruments for signal capture. 89601B option BHJ supports analysis of 802.11ac WLAN signals, along with the required option B7Z for 802.11n WLAN analysis.

PXA hardware settings in 89600 VSA

When the 89600 VSA software is used with the PXA, the software chooses general settings for the PXA hardware that are not necessarily optimal for 802.11ac modulation analysis, so it is necessary to change some of the settings. Once this has been done, you can save the settings in a file for later recall and reuse.

Such a file, with the VSA software settings optimized for the example waveform file and example M8190A settings, may be found in the 'Programming Examples' section of the M8190A AWG on Keysight.com.

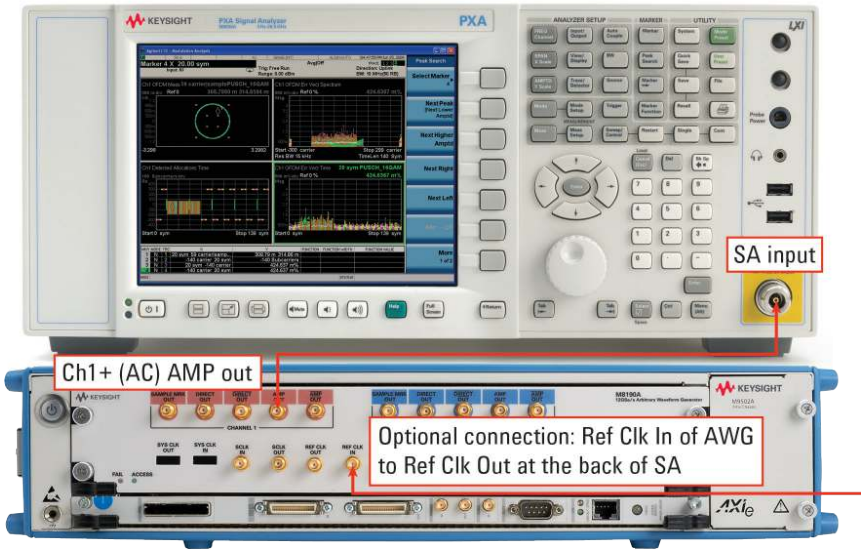

Figure 7: M8190A and N9030A for WLAN Setup.

For further details and explanations on PXA and 89600 VSA software settings, refer to the application note 'Creating and Optimizing 802.11ac Signals and Measurements, 5991-0574EN', which was also used to create the VSA settings file mentioned above.

VSA demodulation properties

The 802.11ac Demodulation Properties settings screen provides another opportunity to improve the EVM results. The "Advanced" tab is shown in Figure 8. Note that Equalizer Training is set to the default value of "Preamble Only." The 802.11ac standard indicates that this is the appropriate method for the equalizer training when testing the EVM of a transmitter. However, for other applications, such as testing of power amplifiers or other components, you may want to set the Equalizer Training to use "Preamble, Pilots & Data." This will allow the software to average out noise over a greater number of symbols, resulting in 2-4 dB better EVM results. This is the setting used in the VSA settings file mentioned above. Since you are generally interested in comparing the EVM at the input and output of a component, using the same equalizer training settings for both EVM measurements allows you to make a valid comparison to determine the impact of the component under test on the EVM results.

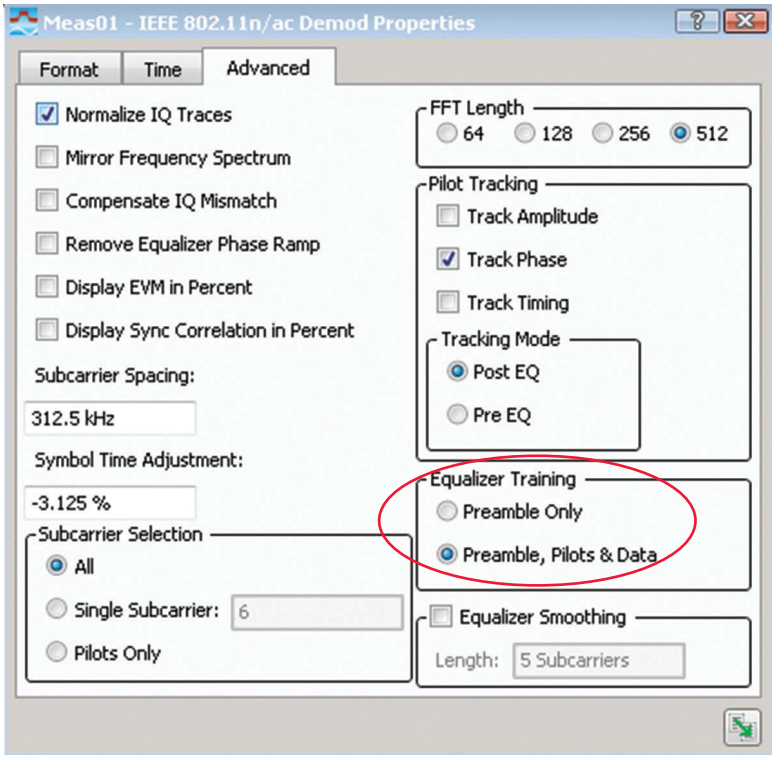

Figure 8: 802.11ac Demod Properties "Advanced" tab.

Due to the difference in EVM results based on the Equalizer Training settings, it is important to know which setting was used for an EVM measurement in order to compare results fairly.

With these settings and setup, the VSA screen should look like figure 9. The EVM value should be about -45 dB (~ 0.59 %). One may vary parameters like amplitude and carrier scaling (see figure 5) to optimize the EVM for the M8190A in use.

If the application requires a specific power level into the DUT, one would change the range and mixer level settings for the PXA to optimize its front end for whatever level of signal is coming into the instrument. These settings are available from the "Input" menu in the VSA software.

Summary

Designing components, transmitters, and receivers to meet the demanding requirements for 802.11ac WLAN devices requires test equipment that can provide the best reference test signals and measurements. N7617B Signal Studio for WLAN 802.11a/b/g/n/ac provides a convenient way to enable this type of signals to be generated with the M8190A AWG.

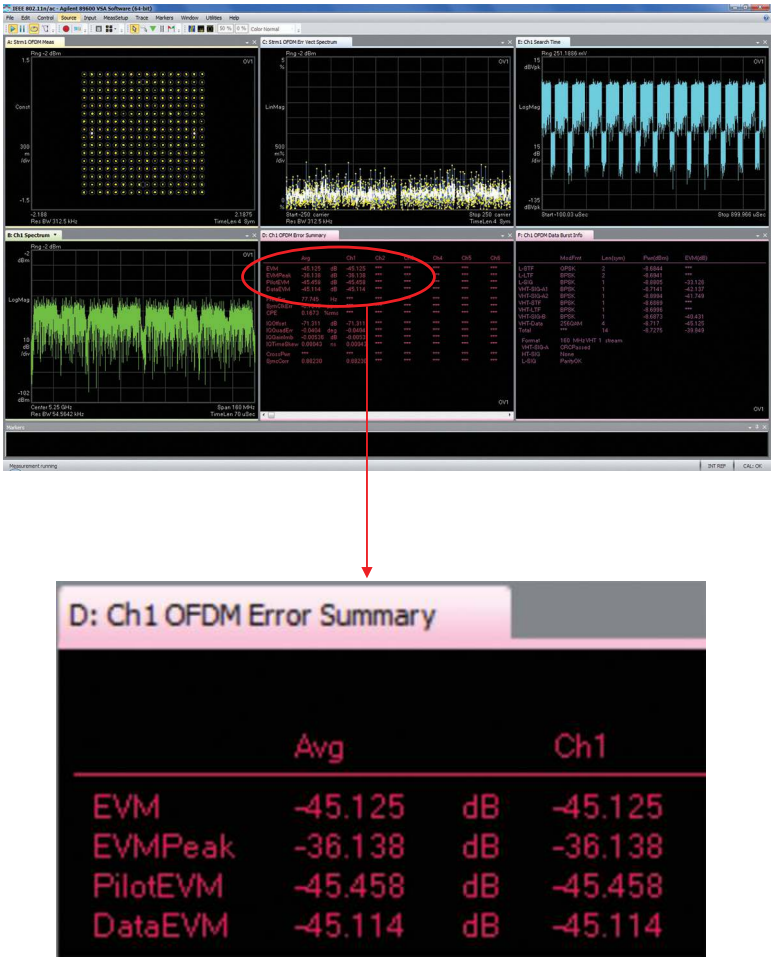

Figure 9: 89600 VSA software screen and EVM value.

Related literature

- *Creating and Optimizing 802.11ac Signals and Measurements,* 5991-0574EN
- *N7617B Signal Studio for WLAN 802.11a/b/g/n/ac Technical Overview,* 5990-9008EN
- *89601B/BN-B7R, 89601B/BN-B7R, 89601B/BN-B7Z WLAN Modulation Analysis VSA Software Technical Overview*, 5990-6389EN
- *Testing New-generation Wireless LAN*, 5990-8856EN

Web

- M8190A Arbitrary Waveform Generator: www.keysight.com/find/M8190
- N9030A PXA Signal Analyzer: www.keysight.com/find/pxa
- WLAN technology information: www.keysight.com/find/WLAN

Recorded webcasts

Webcasts can be viewed at: www.keysight.com/find/events

- Introduction to 802.11ac Technology and Testing
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