Keysight Technologies N9063A & W9063A Analog Demodulation

X-Series Measurement Application

Demo Guide

KEYSIGHT TECHNOLOGIES

FM is the most widely used analog demodulation scheme today, therefore this demonstration used uses an FM signal. This demonstration guide shows how to begin the FM demodulation measurement, view traces, use markers, use the speaker to listen to the demodulated signals, observe frequency settling time, and make faster measurements.

Demonstration Preparation

All demonstrations use a Keysight Technologies, Inc. X-Series signal analyzer and the N5182A MXG vector signal generator.

In this document, keystrokes are highlighted in bold text. Keystrokes surrounded by [ ] indicate front panel keys, while keystrokes surrounded by { } indicate soft keys located on the right edge of the display.

Minimum equipment configuration requirements

Product type/ instrument	Model number	Required options
MXG (or ESG) vector signal generator	N5182A (or E4483C) firmware revision of MXG A.01.10 or later OR N5181A firmware revision of MXG A.01.10 or later	– 503 or 506 – frequency range at 3 GHz or 6 GHz – UNT – AM, FM, phase modulation
X-Series signal analyzer	N9000A, N9010A, N9020A, or N9030A firmware revision A.06 or later	– N9000A-503 or -507, or N9010A-503, -507, -513, or -526, or N9020A/N9030A, -508, -513, or -526
Analog demodulation measurement application	N9063A – PXA/MXA/EXA W9063A – CXA	

Helpful tip:

Update your instrument firmware and software to the latest version, available at

www.keysight.com/find/xseries_software
and
www.keysight.com/find/signalstudio

Demonstration Setup

Connect the X-Series, and MXG

Perform the following steps to interconnect the MXA and MXG (see Figure 1 for a graphical overview):

A. Using a 50 Ω RF cable, connect the RF Output 50 Ω port on the MXG to the RF INPUT 50 Ω port on the X-Series signal analyzer as shown in Figure 1.

B. Using a second 50 Ω RF cable, connect the 10 MHz OUT on the X-Series signal analyzer to the REF IN on the MXG signal generator

C. Set the signal generator as follows:

– Frequency 2 GHz, amplitude –10 dBm

– FM modulation ON

– FM deviation 1 kHz, FM rate 400 Hz

– Turn RF out and modulation ON

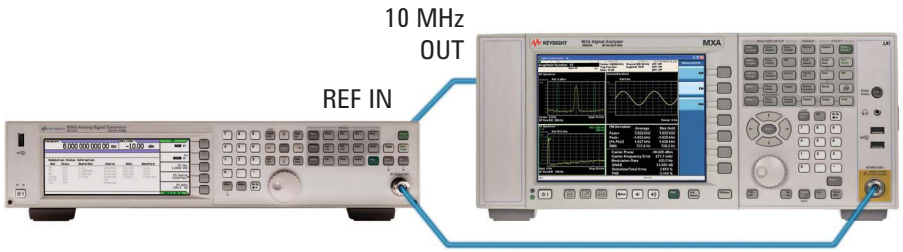

Figure 1. An example of demo configuration

Helpful tip:

Make sure the RF signal and reference clock connections are as indicated in Figure 1. Note that we change the FM deviation and FM rate slightly during the demonstration.

Demonstrations

Demonstration 1:

FM demodulation measurement

The quad view shows the RF spectrum, AF spectrum, demod waveform, and the FM demod measurement metrics simultaneously. By watching these traces in the various domains along with the metrics, you can understand the signal characteristics precisely and, especially during troubleshooting, you can quickly and easily identify the cause of a problem.

Instructions	Keystrokes
Set MXA to analog demo	**[Mode] {Analog Demod}** (Press **{More 1 of 2}** if you don't see **{Analog Demod}** in the soft key area)
Set mode to preset	**[Mode Preset]**
Set frequency channel	**[FREQ Channel] [2] {GHz}**
Initiate measurement	**[Meas] {FM}**
On the X-Series signal analyzer you will see the quad view as shown in Figure 2	

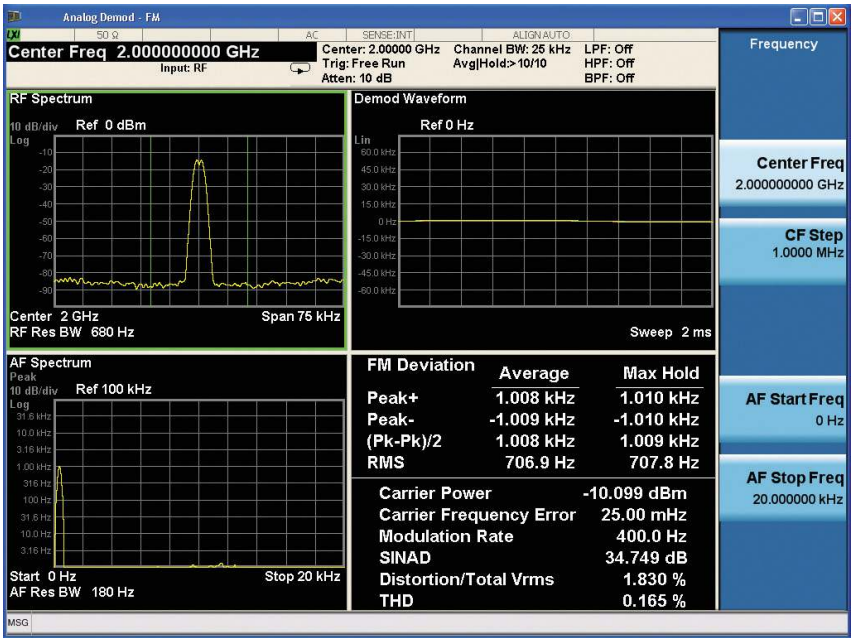

Figure 2. Example of X-Series analyzer screen after starting FM measurement

Demonstration 2:

View traces more clearly

While the quad view offers comprehensive results of demodulation with a single display that combines windows of RF, AF, baseband waveform, and demod metrics, there may still be needs to look into each window individually. Individual windows offer a more detailed analysis with the ability to finely adjustment test conditions.

Increase demodulation time

You may see the status message, "Insufficient Data. Increment Demod Time" on the bottom of the display. This is because the current FM rate of 400 Hz is too low for the analyzer to make accurate measurements with the analyzer's default settings. In general, the demodulation time should be longer than 1/(FM rate), or, in other words, it needs to be longer than at least one modulation cycle.

RF spectrum window

In the upper left corner of the display is the RF spectrum window. This window can be used to show both the modulated signal and any other signals or spurs that may be present nearby. The two green vertical lines define the demodulation channel bandwidth, showing which part of the RF frequency domain that the analyzer is currently demodulating. The value is also shown on the measurement bar at the top of the display.

Instructions	Keystrokes
Increase demodulation time	**[Sweep/Control] {Demod Wfm Sweep Time}** push **[up arrow]** until "Insufficient Data" message is gone OR **[Sweep/Control] {Demod Wfm Sweep Time} [5] {ms}**
After making these adjustments, the status message will disappear and the sweep time value in the bottom left corner of the demod waveform window will read 5 ms	

Helpful tip:

Be aware that increasing the demodulation time too much will cause the measurement to run slower.

Demod waveform window

This window is in the upper right corner of the display. Since the FM deviation is 400 Hz, it cannot be easily viewed on the screen and it will be necessary to adjust the demod waveform amplitude scale.

Instructions	Keystrokes
Press the **[Change Window]** several times until the active window surrounded by the green lines is changing. The change window hard key is located below the display screen of analyzer, and is the third from the power cycle button	**[AMPTD Y Scale] [Change Window]** (Refer to Figure 7 to locate the "Change Window" hard key)
Activate the demod waveform window	
Set scale division	**{Scale/Div} [500] {Hz}**
There are four traces with different colors, to see the larger view of this demod waveform with metrics (see Figure 3 for an example)	**[View/Display] {Demod}**
Return to the quad view	**{Quad View}**

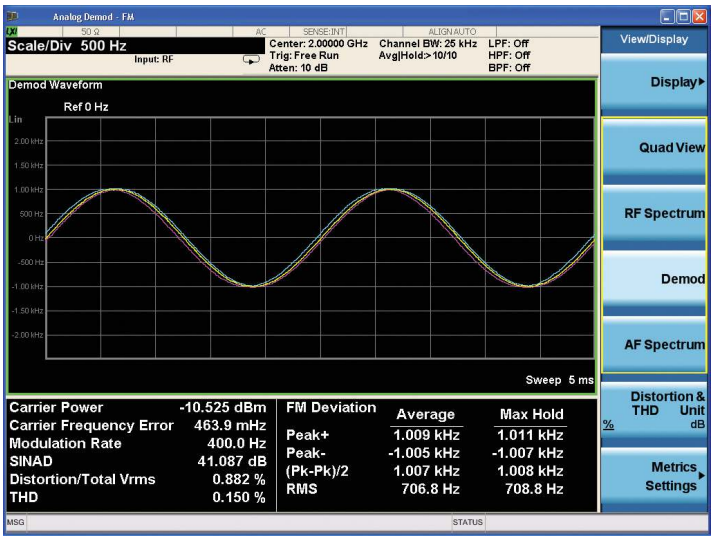

Figure 3. Large view of demod waveform with simultaneous multiple detectors (max hold, min hold, average and current) on

AF spectrum

AF spectrum is the FFT of demod waveform. The AF spectrum shows the distortion of the demodulated signal very clearly just as the spectrum analyzer does for RF microwave signals. Change the reference level to see the noise floor. Activate the AF spectrum window and change the ref value.

Instructions	Keystrokes
Change the reference level to see the noise floor	**[AMPTD] {Ref Value} [20] {kHz}**
You will see the trace is not complete. See the AF spectrum window in Figure 4. This is because the AF spectrum shows the upper side of whole channel bandwidth. Therefore, the available frequency span is about half of the channel bandwidth. Note that the current channel bandwidth is 25 kHz as indicated in the measurement bar	
Increase the channel bandwidth	**[BW] {Channel BW (Demod)} [50] {kHz}**
The green vertical lines in the RF spectrum view move accordingly, and now you have AF spectrum in full 20 kHz span. See Figure 5 as an example. See the metrics summary in the lower right window and notice that SINAD and Distortion/Total Vrms get worse when the demodulation channel bandwidth increases. This is because the wider the demodulation channel, the more unwanted power is included	

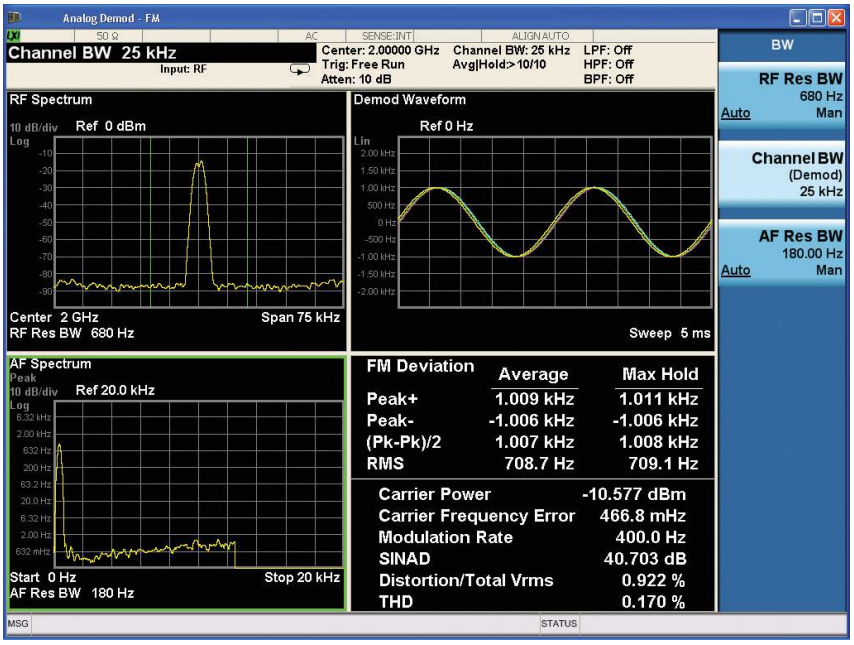

Figure 4. Adjust a few settings to see the traces better

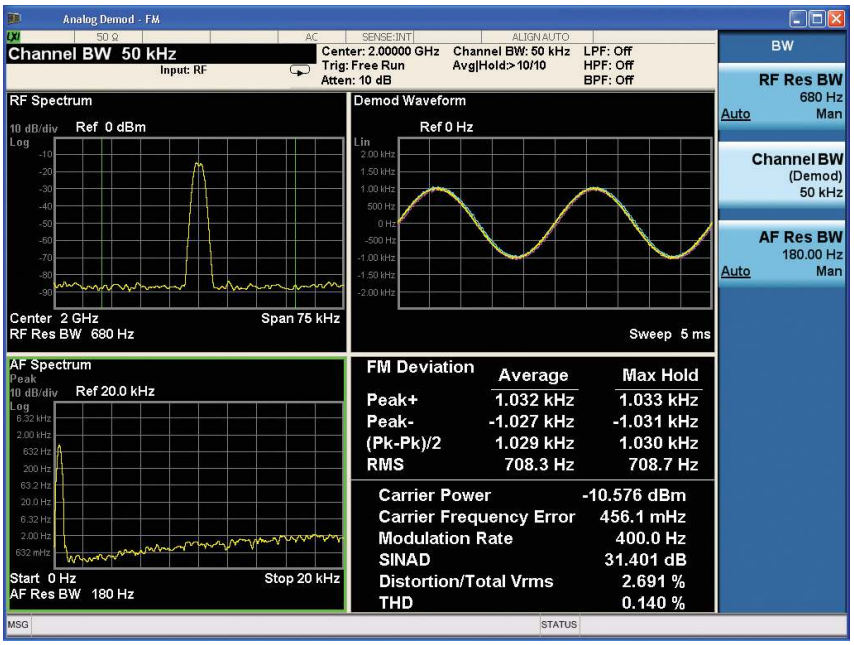

Figure 5. Increase the demodulation channel bandwidth to see the traces better

Demonstration 3:

Using markers

Instructions	Keystrokes
Use the marker to read the FM deviation and FM rate in the RF spectrum view	**[Marker]**
You will see the green diamond shaped marker in the active window, which is surrounded by the green line (see Figure 6)	
Activate the marker in the AF spectrum view	**Press {Properties} {Marker Trace} {AF Spectrum}**
Move the maker to the peak of the trace	**[Peak Search]**
Readings of the marker are located in the upper left corner of the AF spectrum window. Verify the values are close to the signal source settings	

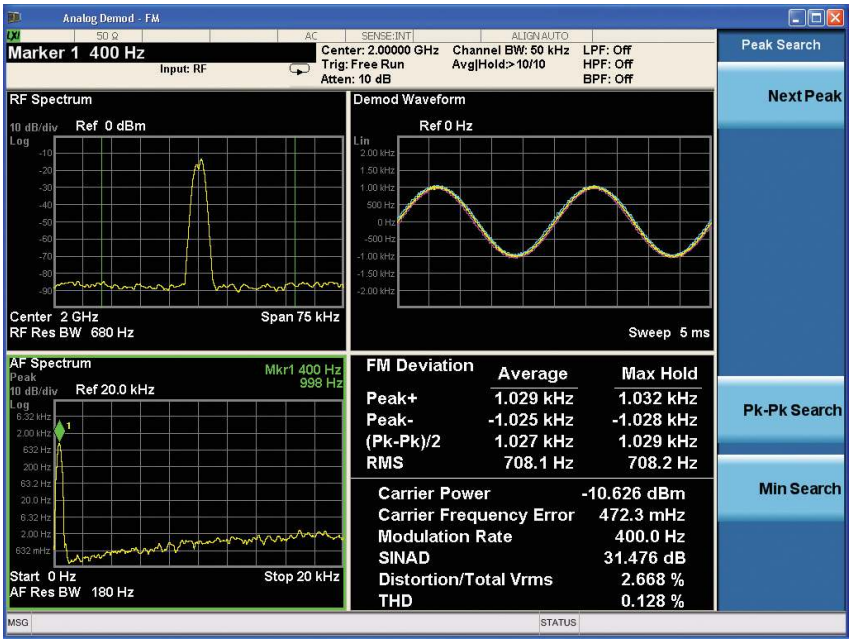

Figure 6. Reading FM deviation and FM rate with a marker

Demonstration 4:

Using the speaker to listen to the demodulated signal

Listening to the demodulated signal through a speaker gives you more insight. Many experts and technicians can figure out the cause of a problem by hearing buzzing, humming, and/or clicking noises.

Instructions	Keystrokes
Turn speaker on	**[Meas Setup] {Demod to Speaker}**
Increase the FM rate of the signal generator from 400 Hz to 3 KHz. See the traces changing, and hear the tone getting higher through the speaker. Use the mute and volume up or down buttons below the display if necessary. See Figure 7 for the location of these buttons	
Set the FM rate of signal generator to 3 kHz	
Activate the low pass filter of the analyzer	**[Meas Setup] {Filters} {Lowpass Filter} {300 Hz}**
Watch the AF spectrum and listen to the speaker out as the signal is filtered	

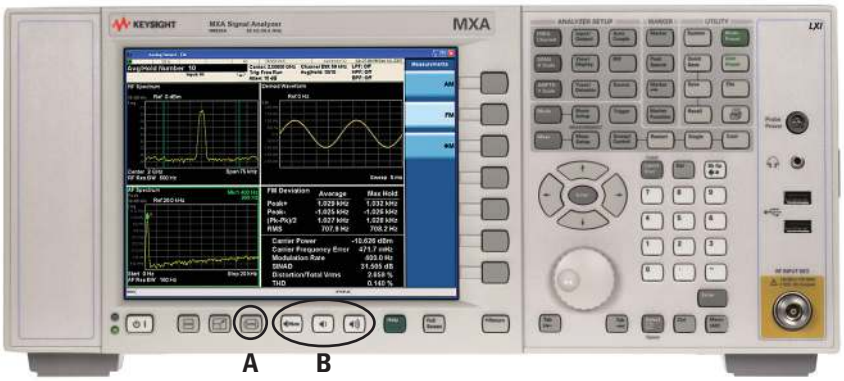

Figure 7. Change window A key and speaker control buttons B

Demonstration 5:

Observing frequency settling time

FM demod waveform is also a good way to see the frequency settling of the signal of interest. The simultaneous detectors in the X-Series analyzers (max hold/min hold/average/current) give you more insight into the settling behavior of your transmitter output. Let's take a look at the signal sources RF output settling.

Instructions	Keystrokes
Reset the FM measurement	**[Meas Setup] {Meas Preset}**
Enlarge the Demod Waveform window and adjust the Y scale	**[View/Display] {Demod} [AMPTD] {Scale/Div} [5] {kHz}**
Use MXA/EXA's burst trigger function	**[Trigger] {RF Burst} {RF Burst} {Trig Delay} [-2] {ms}**
Turn the signal sources modulation off	
Toggle the RF output repeatedly	
Figure 8 shows the settling of the signal	

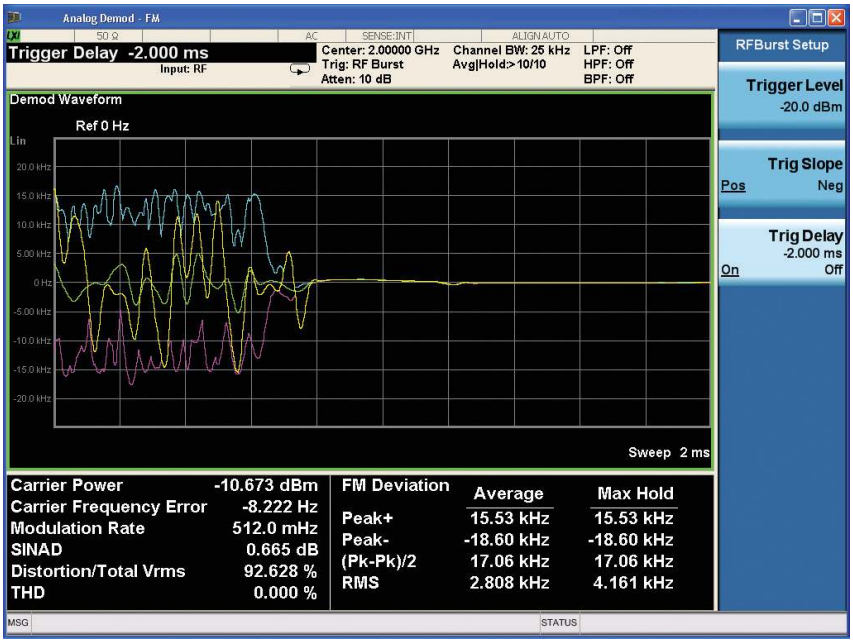

Figure 8. Frequency settling of signal generator RF output

Demonstration 6:

Making faster measurements

As discussed earlier, you should set the demodulation time as short as possible to capture two cycles of the measurement. Also, by setting the RF span equal to the demodulation channel bandwidth, you can get the fastest measurement speed possible. In addition, the analog demodulation application has the capability of turning off some measurements that you don't need to deliver the results much faster.

Instructions	Keystrokes
If you measure only carrier power, carrier frequency error, and FM deviation in RMS, try the following keystrokes	**[View/Display] {Metrics Settings}**
Turn modulation rate off	**{Modulation Rate}**
Turn SINAD/distortion/THD off	**{SINAD, Distortion, THD}**
Choose only RMS	**{Modulation Magnitude all} {RMS only (Fast)}**
You will see the update cycle of metrics improve drastically. (See Figure 9)	

Figure 9. Get even faster measurement by turning some metrics off

Web Resources

Product page:
www.keysight.com/find/n9063a and
www.keysight.com/find/w9063a

X-Series signal analyzers:
www.keysight.com/find/X-Series

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