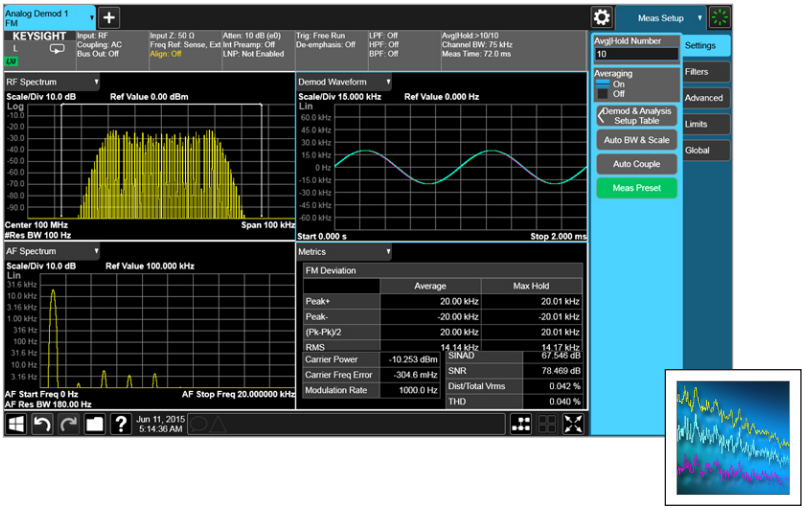
Keysight Technologies
Analog Demodulation
X-Series Measurement Application
N9063C

Technical Overview



- Perform one-button measurements for AM, FM, PM and FM stereo signals with multi-touch user interface for the UXA signal analyzer
- Quad view, simultaneously displays RF spectrum, demodulated waveform, AF spectrum, demodulation metrics, and transient events such as attack/release time
- Analyze FM stereo signals for MPX, mono, stereo, channel characterization, and RDS/RBDS decoding
- Use hardkey/softkey manual user interface or SCPI remote user interface
- Extend test assets with transportable licenses
- Smooth migration from 8901A/B modulation analyzers

KEYSIGHT TECHNOLOGIES

Unlocking Measurement Insights

Analog Demodulation Measurement Application

The analog demodulation measurement application transforms the N9040B UXA signal analyzer into an easy-to use transmitter tester for analog modulated signals, including AM, FM, PM, and FM stereo. By adding fast, one-button measurements, the analog demodulation measurement application helps you design, evaluate, and manufacture your analog devices quickly and accurately. Even in the modern digital world, the analog demodulation measurement application helps you to troubleshoot distortions due to unintentional, analog modulation from digitally-modulated transmitters -- allowing you to stay on the leading edge of your design and manufacturing challenges.

X-Series measurement applications

X-Series measurement applications increase the capability and functionality of Keysight signal analyzers to speed time to insight. They provide essential measurements for specific tasks in general-purpose, cellular communications, wireless connectivity and digital video applications, covering more than 40 standards or modulation types. Applications are supported on both benchtop and modular, with the only difference being the level of performance achieved by the hardware you select.

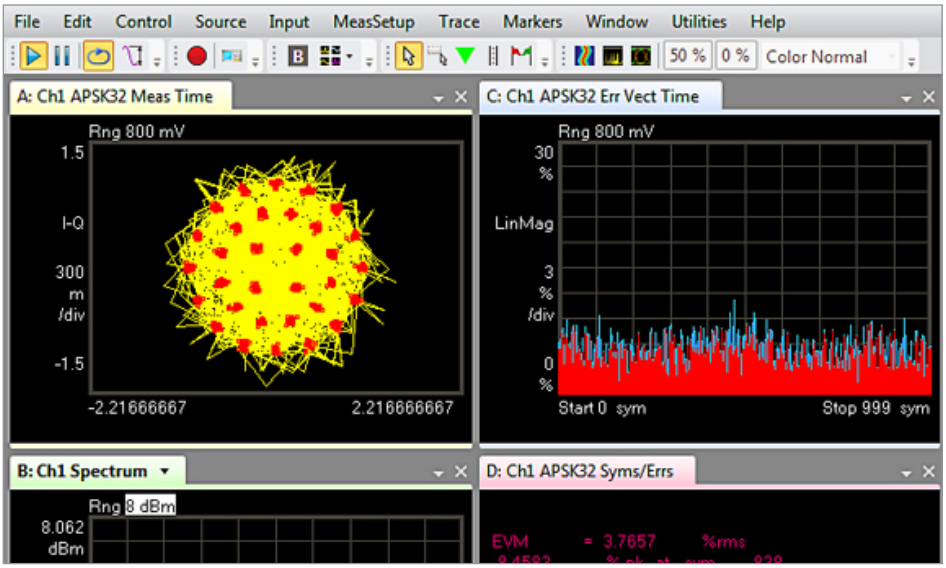


Figure 1. The quad view allows you to watch the RF spectrum, demod, waveform, AF spectrum, and demodulation metrics simultaneously.

Top Features

Monitor RF spectrum

This is the most traditional spectrum analyzer measurement viewing the modulated carrier signal power in frequency domain. Prior to being modulated, the signal power of a sinusoidal carrier concentrates at the carrier frequency. By contrast, modulation causes sidebands indicating the power redistribution over frequencies. The pattern of the sidebands depends upon the modulation format. (Refer to Figure 2.)

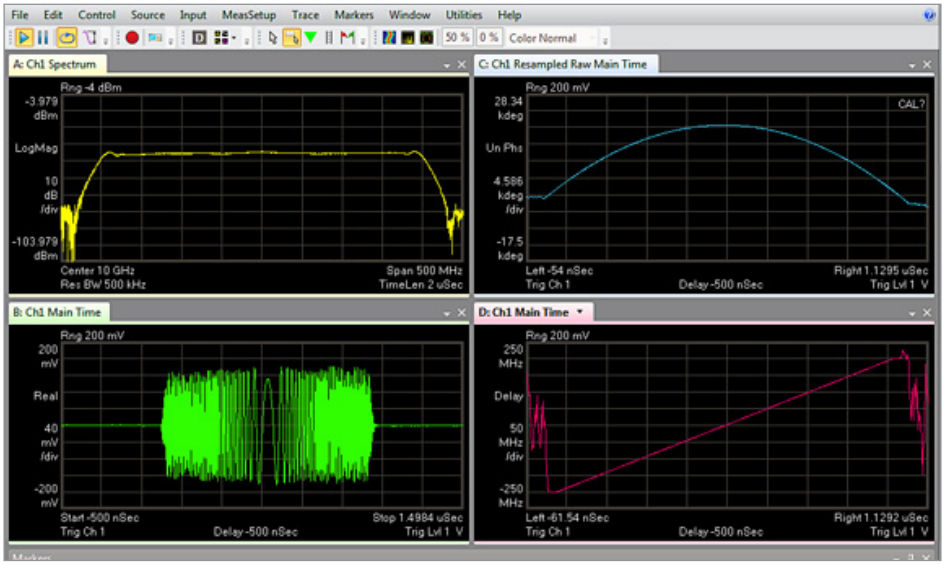


Figure 2. The RF spectrum view presents the modulated signal along with the results of demodulation.

Demod waveform and AF spectrum

This measurement retrieves the baseband signal from the modulated signal via the demodulation process, and displays the baseband signal in a pattern of modulation depth/deviation versus time. Because the modulation depth/deviation is directly proportional to the instantaneous amplitude of the baseband signal, the measurement result helps to intuitively evaluate the quality of the baseband signal. (Refer to Figure 3.)

Figure 3. The demod waveform view displays the baseband signal in time domain.

AF spectrum view

By applying the fast Fourier transform (FFT) to the baseband waveform, AF spectrum demonstrates the baseband signal behaviors in frequency domain graphically. This measurement reveals the distortion of the baseband signal clearly just as the RF spectrum does for the RF signal. (Refer to Figure 4.)

Modulation metrics

Besides the frequency domain and time domain view of analog modulation signals, one of the most important features of this application is numeric result that demonstrates the modulation parameters and error information. For AM signal, the AM depth, modulation rate and distortions like SINAD will be displayed in metrics view; for FM/PM signal, the FM deviation/ PM deviation, carrier frequency error and distortions will be displayed. (Refer to Figure 4.)

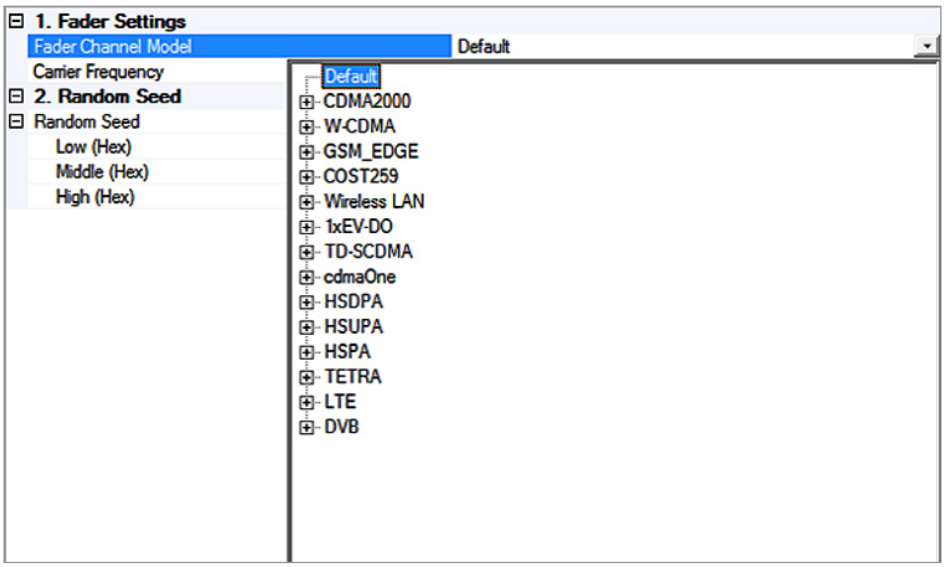


Figure 4. AF spectrum view with table facilities.

Post-demod filters

The post-demod filters help you to optimize the measurement results by filtering out undesired signals such as harmonics, noise, and spurs from the demodulated signal. You may choose a high-pass filter (20, 50, 300, or 400 Hz), and/or a low-pass filter (300 Hz or 3, 15, 30, 80, 100, 300 kHz, or any other user defined) from the available post-demod filter bank to achieve the best demodulation results. (Refer to Figure 5.) For example, applying an appropriate low-pass filter helps minimize overshoot from square-wave modulation, such as frequency shift keying (FSK).

Additionally, a CCITT filter, which simulates the frequency response behavior of the human auditory system, is also available to help you evaluate the consequences of distortion of the demodulated signal from the human hearing perspectives. The filter bank also allows you to select from various other filters to optimize your measurements and comply with certain regulatory standards. These filters include:

- A-weighte
- C-weighted
- C-message
- CCIR-1k weighted
- CCIR-2k weighted
- CCIR unweighted
- SIAND notch
- Signaling notch filters

To accommodate your pre-emphasized FM signals, the N9063C is also equipped with four separate de-emphasis filters (25, 50, 75, and 750 µs) for you to select from.

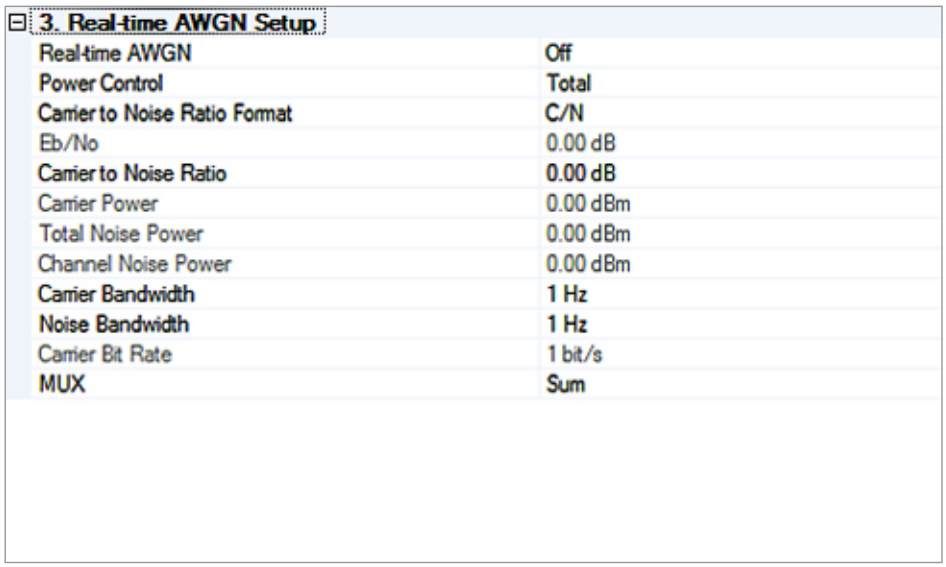


Figure 5. Apply the “post-demod” filters to optimize analysis results for the baseband (AF) spectrum.

Quantify the transient events with "Transient Analysis" view

Transient Analysis view is a new view type for measuring transient events, such as “attack” (transmitter turn-on), “release” (transmitter turn-off), and VCO settling characteristics. The upper display is RF Envelope (magnitude) versus time; the lower display is FM Demod Waveform (frequency) versus time. Transient measurements are single-shot, and require an External trigger edge to establish time t=0 (e.g. from the PTT button).

Certain measurements from TIA-603 - such as Carrier Attack Time, Transient Frequency Behavior, and Encoder Response Time - are much easier to make with this new view. The view can be used for general amplitude and frequency transient or settling measurements. And transmitters that use FM or FSK in a burst can also be aptured and measured, with RF Burst trigger.

The view supports long post-demod waveforms, storing a post-demod FM Waveform up to 3.6 M samples (previously limited to 1001 pts.); this data is available for query via SCPI. Additionally, limit lines for FM Waveform can be imported from customer-defined CSV files and displayed.

The InfoBW control allows the user to trade off the bandwidth of the measurement (frequency range of demod) with the noise in the frequency measurement. Figure 6, the "Attack/Release view", captures the transient events in time domain when the modulation starts and the carrier power switches to different levels.

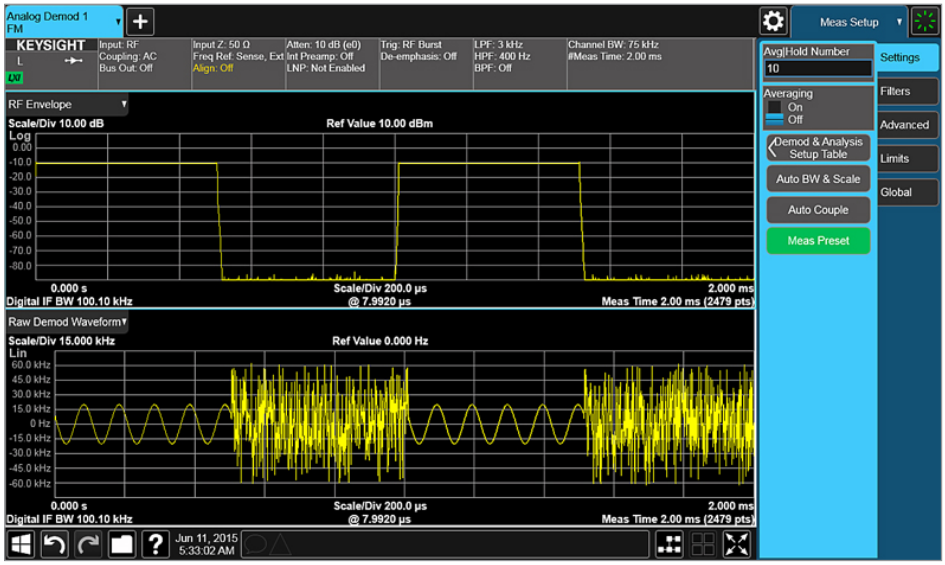


Figure 6. " Transient Analysis " view helps quantify the transient events in time domain.

Analyze FM stereo/RDS signals

FM stereo is an enhancement to FM that uses stereo multiplexing. An FM stereo signal carries stereophonic programs in which signals are transmitted for L (left) and R (right) audio channels. Radio data system (RDS) consists of the text information such as traffic, weather, and radio station information carried in the FM signals. This information can be displayed on the screen of the end-user's device. RBDS is the United States version of RDS.

The N9063C analog demodulation application supports FM stereo/RDS signal analysis with multiple views including MPX view, mono/stereo/left/right view, RDS/RBDS decoding results view and numeric result summary view.

Figure 7. FM stereo MPX view/display with RF spectrum, AF spectrum, demod waveform and demodulation metrics results.

Tune and listen

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

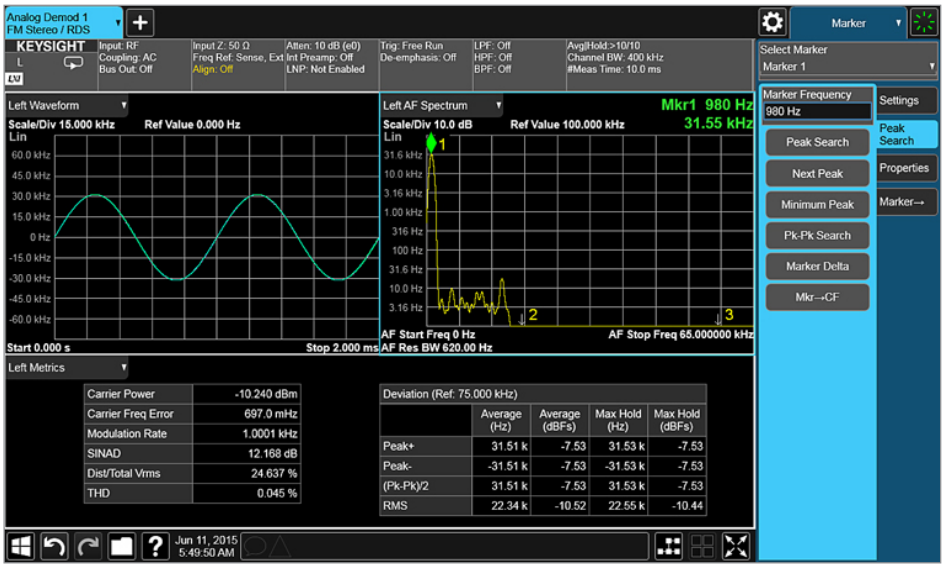


Figure 8. FM stereo mono/stereo/left/right view/display with demod waveform, AF spectrum and demodulation metrics results.

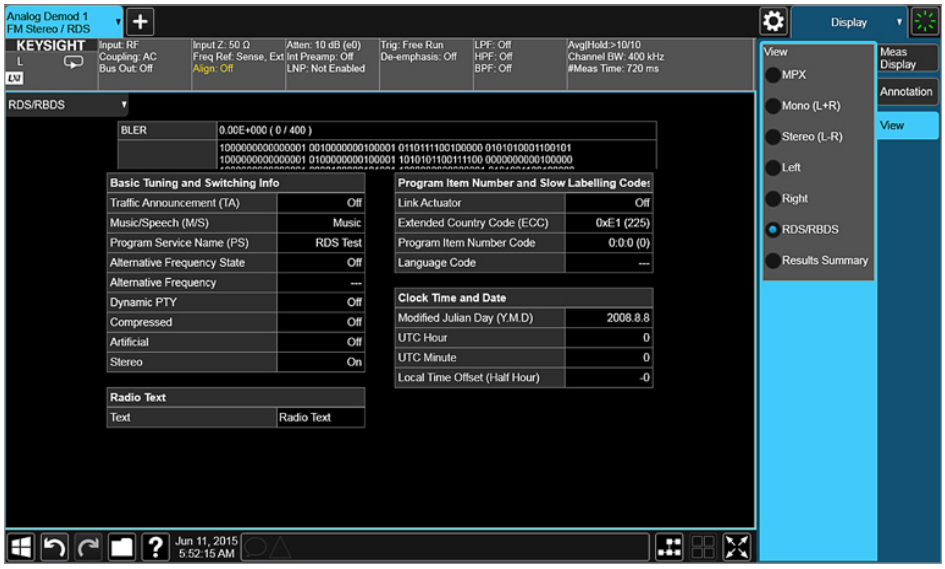


Figure 9. FM stereo RDS/RBDS decoding results view/display with BLER and decoded RDS information.

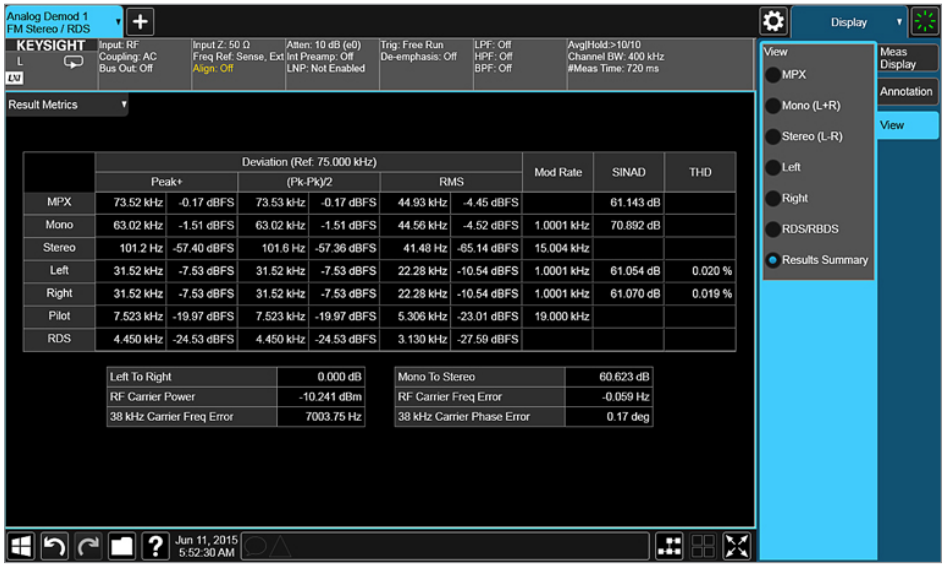


Figure 10. FM stereo numeric result metrics view/display with deviation, mod rate, SINAD, THD, left to right ratio, mono to stereo ratio and 38 kHz carrier frequency error, and phase error.

Measurement Summary

One-button measurements

All of these measurements are available on the UXA with the press of a button. The measurements are fully remote controllable via the IEC/IEEE bus or LAN, using SCPI commands.

Measurement details

Technology	**AM**	**PM**	**FM**	**FM stereo/RDS**
Measurement				
RF spectrum	•	•	•	•
RF carrier power (dBm)	•	•	•	•
RF carrier freq error (Hz)		•	•	•
AF spectrum	•	•	•	MPX, mono, stereo, left, right
Demodulated waveform	•	•	•	MPX, mono, stereo, left, right
Demodulation	AM depth (%)	PM deviation (rad, deg)	FM deviation (Hz)	FM deviation (Hz)
Peak+	•	•	•	•
Peak–	•	•	•	•
(Pk-Pk)/2	•	•	•	•
RMS	•	•	•	•
Modulation rate (Hz)	•	•	•	•
SINAD (dB)/SNR (dB)	•	•	•	•
THD (dB or %)	•	•	•	•
Distortion/total power (dB or %)	•	•	•	•
Left to right ratio (dB)				•
Mono to stereo ratio (dB)				•
38 kHz carrier power (dB)				•
38 kHz freq error (Hz)				•
RDS/RBDS decoding				•
BLER				•
Radio text				•
Attack/release time			•	
Long capture (3.6 MSa)	•	•	•	•

Key Specifications

– Nominal values are designated with the abbreviation “nom.” These values indicate expected performance, or describe product performance that is useful in the application of the product.

Note: Data subject to change

For a complete list of specifications, refer to the UXA specification guide: **www.keysight.com/find/uxa_specifications**

Description	**N9040B UXA signal analyzer**
FM demodulation (all in nominal)	
FM deviation accuracy [1, 2, 3]	$\pm(0.3\% to f reading + 0.15\% \times Rate)$
FM rate accuracy [4]	$\pm(0.008\% to f reading)$
Carrier frequency error [5, 6] (Modulation index ≤ 100)	$\pm(6 tppm \times Deviation + 10 tppm \times Rate) + tfa$
Post-demod distortion residual [7]	
Distortion (SINAD) [8]	$0.5\% / \sqrt{ModIndex} + 0.06\%$
THD	$0.3\% / \sqrt{ModIndex} + 0.02\%$
Post-demod distortion accuracy (Rate: 1 to 10 kHz, Modulation index: 0.2 to 100)	
Distortion	$\pm(2\% to f reading + DistResidual)$
THD	$\pm(2\% to f reading + DistResidual)$ (2nd and 3rd harmonics)
AM rejection [9]	2.8 Hz
Residual FM [10]	1.2 Hz (rms)

1. This specification applies to the result labeled “(Pk-Pk)/2”.
2. For optimum measurement, ensure that the channel bandwidth is set wide enough to capture the significant RF energy. Setting the channel bandwidth too wide will result in measurement errors.
3. Reading is a measured frequency peak deviation in Hz, and Rate is a Modulation Rate in Hz.
4. Reading is a measured modulation rate in Hz.
5. tfa = transmitter frequency x frequency reference accuracy
6. Deviation is a frequency peak deviation in Hz, and Rate is a modulation rate in Hz.
7. For optimum measurement, ensure that the channel bandwidth is set wide enough to capture the significant RF energy. Setting the channel bandwidth too wide will result in measurement errors.
8. SINAD [dB] can be derived by 20*log10(1/Distortion).
9. AM rejection describes instruments FM reading for an input that is strongly AMed (with no FM); this spec includes contribution from residual FM. AM signal (Rate = 1kHz, Depth = 50%), HPF = 50 Hz, LPF = 3 kHz, Channel BW = 15 kHz
10. Residual FM describes instruments FM reading for an input that has no FM and no AM; this spec includes contribution from FM deviation accuracy. HPF = 50 Hz, LPF = 3 kHz, Channel BW = 15 kHz

Description	N9040B UXA signal analyzer
AM demodulation (all in nominal)	
AM depth accuracy [1, 2]	$\pm(0.1\%\ of\ reading + 0.05\%)$
AM rate accuracy [3] (Rate: 1 kHz to 100 kHz)	$\pm\left((2.5\ ppm\ of\ reading)\times\left(\frac{100\%}{Depth}\right)\right)$
Post-demod distortion residual [4, 5]	
Distortion (SINAD)	$0.1\%\times\left(\frac{100\%}{Depth}\right)+0.02\%$
THD	$0.014\%\times\left(\frac{100\%}{Depth}\right)+0.01\%$
Post-demod distortion accuracy (Rate: 1 to 10 kHz, Depth: 5 to 90%)	
Distortion	$\pm(1\%\ of\ reading + DistResidual)$
THD	$\pm(1\%\ of\ reading + DistResidual)$ (2nd and 3rd harmonics)
FM rejection [6]	0.05%
Residual AM [7]	0.02% (rms)

1. This specification applies to the result labeled "(Pk-Pk)/2".
2. Reading is a measured AM depth in %, and Rate is a Modulation Rate in Hz.
3. Reading is a modulation rate in Hz and Depth is in %.
4. SINAD [dB] can be derived by $20*\log_{10}(1/\text{Distortion})$.
5. Channel bandwidth is set to 15 times of Rate (Rate ≤ 50 kHz) or 10 time of Rate (50 kHz < Rate ≤ 100 kHz).
6. FM rejection describes instruments AM reading for an input that is strongly FMed (with no AM); this spec includes contribution from residual AM. FM signal (Rate = 1 kHz, Deviation = 50 KHz), HPF=300 Hz, LPF=3 kHz, channel BW = 420 kHz
7. Residual AM describes instruments AM reading for an input that has no AM and no FM; this spec includes contribution from AM depth accuracy. HPF=300 Hz, LPF=3 kHz, channel BW = 15 kHz

Description	N9040B UXA signal analyzer
PM demodulation (all in nominal)	
PM deviation accuracy [1, 2, 3] (Rate : 100 Hz to 50 kHz)	$\pm(0.1\% \times Reading + 2 tmrad)$
PM rate accuracy [2, 4]	
Rate : < 1 kHz	$\pm\left(0.002 tHz / Deviation + 0.002 tHz\right)$
Rate : 1 kHz to 50 kHz	$\pm\left(2 tppm / Deviation + 2 tppm\right) \times Rate$
Carrier frequency error [2, 5, 6]	$\pm(1.5 tppm \times Deviation + 1 tppm) \times Rate + tfa$
Post-demod distortion residualg [7]	
Distortion (SINAD) [8, 9]	$0.15\% / Deviation + 0.1\%$
THD [9]	$0.05\% / Deviation + 0.01\%$
Post-demod distortion accuracy (Rate: 1 to 10 kHz)	
Distortion	$\pm\left(2\% toftreading + DistResidualt\right)$
THD	$\pm\left(2\% toftreading + DistResidualt\right)$ (2nd and 3rd harmonics)
AM rejection [10]	1.2 mrad
Residual FM [11]	0.7 mrad (rms)
FM stereo/RDS (all in nominal)	**FM stereo with 67.5 kHz reference deviation and 1 kHz modulation rate plus 6.75 kHz pilot deviation**
SINAD (with A-Weighted filter)	69 dB
SINAD (with CCITT filter)	71 dB
Left to right ratio (with A-Weighted filter)	72 dB
Left to right ration (with CCITT filter)	76 dB

1. This specification applies to the result labeled "(Pk-Pk)/2".
2. For optimum measurement, ensure that the channel bandwidth is set wide enough to capture the significant RF energy. Setting the channel bandwidth too wide will result in measurement errors.
3. Reading is a measured peak deviation in radian.
4. Deviation is a peak deviation in radian.
5. Rate is a Modulation Rate in Hz.
6. tfa = transmitter frequency x frequency reference accuracy
7. For optimum measurement, ensure that the channel bandwidth is set wide enough to capture the significant RF energy. Setting the channel bandwidth too wide will result in measurement errors.
8. Deviation is a peak deviation in radian.
9. SINAD [dB] can be derived by 20*log10(1/Distortion).
10. AM rejection describes instruments PM reading for an input that is strongly AMed (with no PM); this spec includes contribution from residual PM. AM signal (Rate = 1kHz, Depth = 50%), HPF=50 Hz, LPF = 3 kHz, Channel BW = 15 kHz
11. Residual PM describes instruments PM reading for an input that has no PM and no AM; this spec includes contribution from PM deviation accuracy. HPF = 50 Hz, LPF = 3 kHz, Channel BW = 15 kHz

Software Licensing and Instrument Configuration

Signal Studio offers flexible licensing options, including:

- **Fixed, perpetual license:** This allows you to run the application in the X-Series analyzer in which it is initially installed.
- **Transportable, perpetual license:** This allows you to run the application in the X-Series analyzer or controller in which it is initially installed, plus it may be transferred from one X-Series analyzer or controller to another.

N9063C analog demodulation measurement application

Model-Option	Description, license type
N9063C-1FP	Analog demodulation and FM stereo measurements, fixed perpetual
N9063C-1TP	Analog demodulation and FM stereo measurements, transportable perpetual

N9040B UXA signal analyzer configuration

Description	Model-Option	Additional information
8.4, 13.6, or 26.5 GHz frequency range	N9040B-508, -513, or -526	One required

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Additional Information

Measurement, user's and programming guides can be found on the product Web page in the document library: **www.keysight.com/find/N9063C**

Use N/W9063A Analog Demodulation Measurement Application to Replace HP 8901 Modulation Analyzers, application note, literature number 5991-4913EN.

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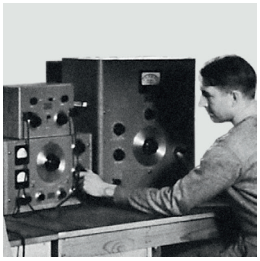

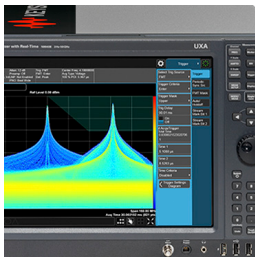

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