TECHNICAL OVERVIEW

Avionics X-Series Measurement Application, Multi-touch UI

N9092EM0E Features

- Analyzes and verifies the quality of signals used in testing basic aircraft navigation and instrument landing
- Provides exceptional accuracy for VOR bearing analysis
- Offers ILS measurements for both Localizer and Glideslope with high DDM accuracy
- Supports Marker Beacon and ADF measurements
- Capable of analyzing RF and baseband[1] input signals
- Fully specified on the N9030B PXA with multi-touch user interface

1 Requires audio input option N9030B-107 on the PXA

KEYSIGHT TECHNOLOGIES

Avionics Measurements

Keysight N9092EM0E Avionics Measurement application software, installed in the N9030B PXA high-performance signal analyzer, enables aviation customers to analyze and qualify air navigation and landing signals; specifically, VOR (VHF Omnidirectional Range), ILS (Instrument Landing System), Marker Beacon, and ADF (Automatic Direction Finder) measurements.

X-Series measurement applications

X-Series measurement applications increase the capability and functionality of Keysight Technologies, Inc. signal analyzers to speed time to insight. They provide essential measurements for specific tasks in general-purpose, cellular communications, wireless connectivity applications, covering established standards or modulation types.

X-Series measurement applications can help you:

- Gain more insight into device performance with intuitive display and graphs for your application. Select from our library of over 25 different measurement applications
- Choose the license structure that meets your business needs. We provide a range of license types (node-locked, transportable, floating or USB portable) and license terms (perpetual or time-based).

Note: The Keysight N9092EM0E is currently only available and fully specified on the N9030B PXA signal analyzer.

N9092EM0E Avionics Measurement Application Top Features

The Keysight N9092EM0E Avionics Measurement application analyzes and verifies the quality of RF signals used for testing basic aircraft navigation and instrument landing:

- VOR (VHF Omnidirectional Range)
- ILS (Instrument Landing System), for both Localizer (LOC) and Glideslope (GS) components
- Marker Beacon (used with ILS)
- ADF (Automatic Direction Finder)

The primary purpose of N9092EM0E Avionics app is to verify and calibrate signal generators (or other test equipment) used to test the aircraft's receivers. As such, it is often a companion to the N9091EM0E Measuring Receiver application, or in N5531X metrology systems, based on N9030B PXA signal analyzers.

The N9030B PXA is a precise, flexible analyzer, with its clean synthesized LO and high-dynamic-range digital IF. And the N9092EM0E app uses precision DSP (digital signal processing) to extract key parameters of VOR and ILS modulation from the RF signals. The performance and accuracy of the N9092EM0E with N9030B PXA are outstanding; for example:

- VOR Bearing Accuracy: +/- 0.025 deg
- DDM Accuracy: as low as +/- 0.2% of reading or 0.0001 DDM
- AM% Modulation Depth Accuracy: +/- 0.5% of reading
- Modulating Tone Frequency Accuracy: +/- 0.01 Hz

Of course, the power and frequency of the RF carrier are also measured. And the N9092EM0E will also process baseband (audio) signals, when the PXA is equipped with Option 107 Audio Input.

Like other applications for the X-series signal analyzers, the N9092EM0E has a rich intuitive GUI (Graphic User Interface), using a large multi-touch screen, and supports SCPI for full automation.

Although the VOR and ILS technologies have been in use for over five decades, and modern alternatives, such as GPS (Global Positioning System), are being deployed, VOR and ILS have excellent reliability, low cost and huge installed base, and so are still one of the most common technologies in helping navigate and land safely.

VOR measurements

A ground-based VOR transmitter emits two signals: a Reference signal broadcast evenly in all directions, and a Variable component on a directional beam which is rotating (as a lighthouse) around 360 deg of the compass. Both use the same RF carrier frequency, and combine in the aircraft's antenna/receiver during flight. The aircraft's receiver compares the two components, and determines the aircraft's azimuth (compass bearing) along a "radial" vector centered at the airport (e.g. "bearing" of 70 deg, relative to north, centered at airport). The system can be used in multiple ways, but pilots commonly use VOR to set up an 'approach' lined up with the runway.

However, aircraft receivers are usually tested on the ground, using a signal generator which emits both Reference and Variable signals (on the same cable or antenna) that artificially represents a radial bearing (as if the aircraft was in flight). The N9092EM0E verifies that such signal generators are accurate.

VORs are assigned radio channels between 108.0 MHz and 117.95 MHz (with 50 kHz spacing); this is in the very high frequency (VHF) range. The N9092EM0E measures the frequency and power of this RF carrier with high accuracy.

"VOR Bearing" is the key test parameter for VOR systems. The N9092EM0E measures Bearing with the accuracy specification of +/- 0.025 deg, giving users high confidence for their VOR transmitting signal's correctness. Additionally, the modulating frequencies, AM depth, and FM deviation of the subcarrier tones can also be simultaneously measured. Figure 1 shows a quad-view display of VOR measurement results by the N9092EM0E Avionics app, with graphical displays. Figure 2 shows the Results-only display, with numerical results for all important VOR parameters.

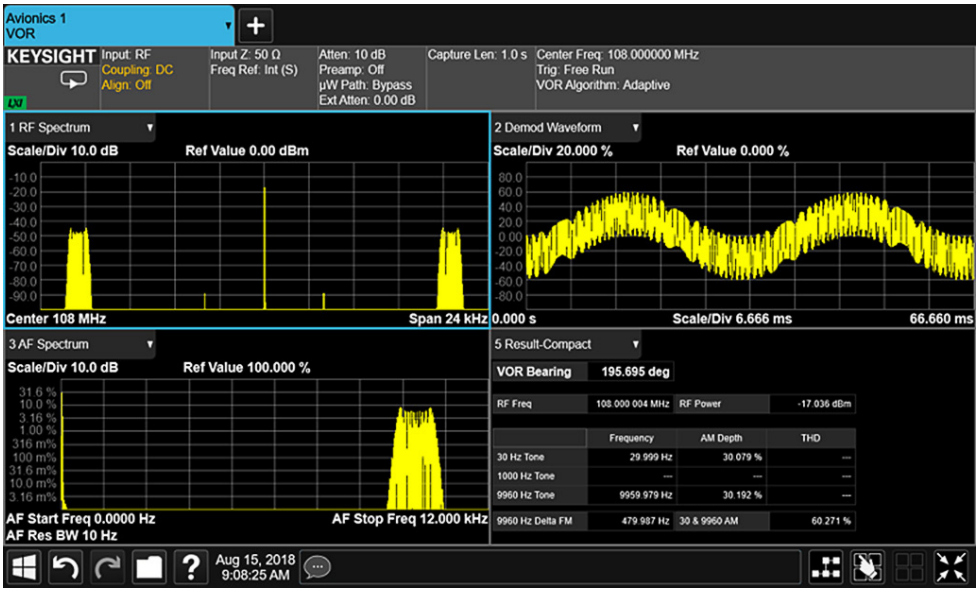

Figure 1. Quad-view of the VOR measurement results showing RF spectrum, AF spectrum, demod waveform and key VOR parameters simultaneously

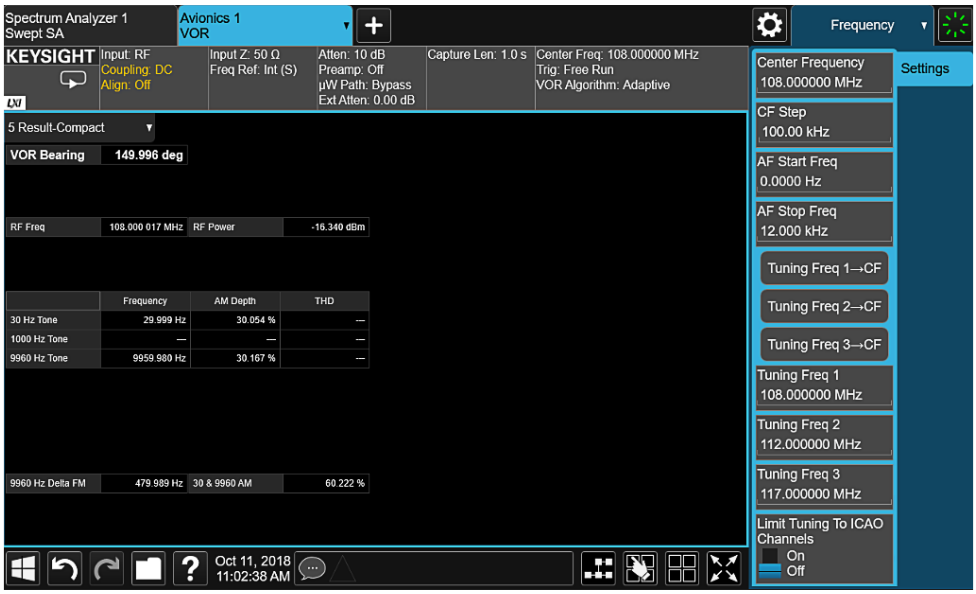

Figure 2. VOR measurement results in numerical form, intuitively showing the key VOR parameters including VOR bearing, frequency and AM depth of the 30-Hz and 9,960-Hz tones, as well as the 1,000-Hz COM/ID tone

ILS measurements

A ground-based ILS system emits 4 directional beams arranged around the ideal flight path leading to the runway. One pair of beams, called “Localizer” (LOC), form a left/right pair. The left beam is modulated at 90 Hz, and the right at 150 Hz; however, both are on the same RF carrier frequency. They combine in the aircraft’s antenna/receiver, and the relative strength on the two beams tells the pilot if the plane is left or right from ideal. Likewise, another pairs of beams, called “Glideslope” (GS), form an up/down pair, and tell the pilot if the plane is coming in high or low vs ideal.

Since aircraft receivers are usually tested on the ground, an ILS signal generator emits both 90-Hz and 150-Hz modulated signals (on the same cable or antenna), and artificially simulates the signal that would be seen by an aircraft that was left/right or high/low in its approach. The N9092EM0E verifies that such signal generators are accurate.

The radio transmitter of the LOC uses the RF signal at frequency between 108.1 MHz 119.95 MHz, while GS works at frequencies between 329.15 MHz and 335.0 MHz. The difference in depth of modulation (DDM) of these 2 base tones can be translated into the deviations from the ideal landing path. Therefore, the DDM is one of the most critical parameter in the ILS and the accuracy of the DDM measurements is paramount.

The N9092EM0E Avionics application automatically set up the measurement conditions per the avionics standards. Figure 3 shows the quad view of the ILS LOC measurement results including DDM, SDM (sum of depth of modulation), frequency of the base tones and their corresponding AM depth, along with the RF frequency, RF power level, and the spectra of RF and basebands, respectively. The industry-leading DDM accuracy of +/-0.0001 offers ultimate userconfidence for their ILS testing.

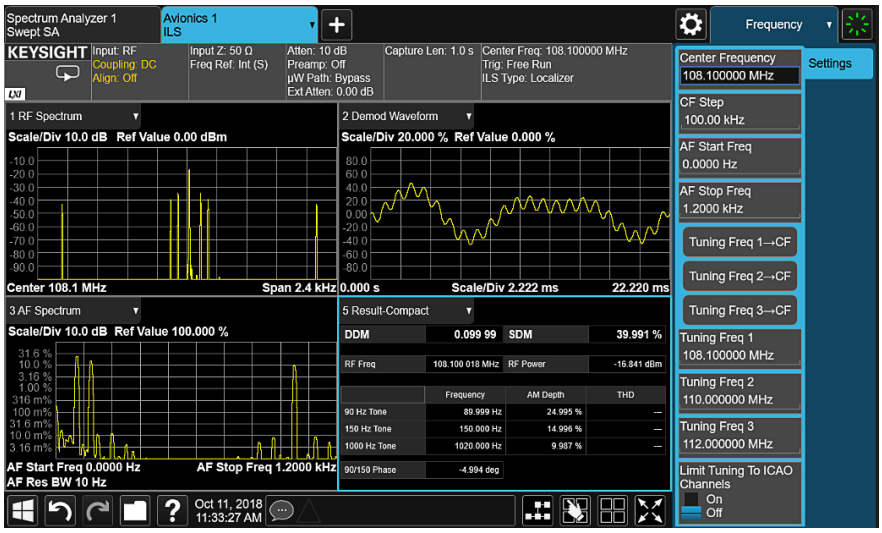

Figure 3. Quad-view of the ILS LOC measurement results showing RF spectrum, AF spectrum, demod waveform and key ILS LOC parameters simultaneously

Marker Beacon measurements

A marker beacon is a 75-MHz RF beacon to be emitted upwardly from an antenna installed under the landing approach path to a runway. It is used in conjunction with ILS to provide pilots with information about the lateral distances to the end of the runway (or the runway threshold). There are 3 types of marker beacons modulated at different AM tones: (1) Outer marker at 400 Hz; (2) Middle marker at 1,300 Hz; and (3) Inner marker (closest to runway) at 3,000 Hz.

The key parameters are measured with exceptionally high accuracy: +/-0.1 Hz for the tone frequency, and as low as +/-0.1% AM for the AM depth. Figure 4 shows the measurement results specifically for a 400-Hz tone for the outer marker.

Figure 4. Measurement result for the outer marker at 400 Hz tone, AM depth, frequency and power level of the carrier signal, as well as the spectra of RF and baseband and a demod waveform

Automatic Direction Finder (ADF)

ADF is based on non-directional beacons (NDBs), transmitting from the ground. An aircraft would need a directional antenna to determine its direction. The N9092EM0E provides basic measurements of RF frequency and power, and tone frequency and modulation depth, for a limited set of tones.

Key Specifications

Note 1: The N9092EM0E Avionics Measurement application is currently available on the Keysight N9030B PXA only. The detailed conditions and specifications can be found in the N9030B PXA specification guide at **www.keysight.com/find/pxa_specifications**.

Note 2: While the following key specifications are specifically for the RF input of the PXA, the N9092EM0E also supports the audio input for baseband Avionics Measurements if the PXA is equipped with option N9030B-107 (audio input and digitizer) . Note that N9091EM0E is strongly recommended for general flexible audio measurements, since N9092EM0E is limited to aviation waveforms.

Description	Specifications	Supplemental Information
VOR		
RF input frequency range	108 to 118 MHz	
VOR bearing range	0 to 360°	
VOR bearing accuracy	± 0.025°	30 Hz and 9,960 Hz tones at 10% to 40% AM depth each
VOR bearing resolution	0.001°	
Frequency accuracy for tones (30 Hz, 1,020 Hz, and 9,960 Hz)	± 0.01 Hz	At 10% to 40% AM depth
AM depth accuracy (30 Hz, 1,020 Hz)	± 0.1% of AM, or ± 0.5% of reading, whichever is greater	
AM depth accuracy (9,960 Hz)	± 0.3% AM	
FM deviation accuracy (0-to-peak) of 9,960 Hz subcarrier	± 1 Hz	At 10% to 40% AM depth
ILS (LOC and GS)		
RF input frequency range	108.0 to 335.0 MHz	
DDM accuracy	± 0.0001 or 0.004 of reading, whichever is greater	≤ ± 10% DDM
	± 0.002 of reading + 0.0002	> ± 10% DDM
Frequency accuracy of tones (90, 150, and 1,020 Hz)	± 0.01 Hz	
AM depth accuracy of tones (90, 150, and 1,020 Hz)	± 0.1% AM or ± 0.5% of reading, whichever is greater	
Marker Beacon		
Frequency of tones		Tone at 400, 1,300, or 3,000 Hz (only 1 tone at a time)
Frequency accuracy of tones	± 0.1 Hz	for 2% to 99% AM
AM depth accuracy (measured)	± 0.1% AM, or ± 0.7% of reading, whichever is greater	± 0.1% AM, or ± 0.5% of reading, whichever is greater (nominal)
ADF		
Frequency of tones		Tones at 50, 100, 1,020, 5,000 Hz; Continuous sine, no Morse, no Voice
Frequency accuracy of tones		± 0.2% of reading, nominal; At > 10% AM
AM depth accuracy		± 0.1% AM, or ± 0.5% of reading, whichever is greater (nominal)

Ordering Information

Flexible licensing and configuration

- Perpetual: License can be used in perpetuity.
- Time-based: License is time limited to a defined period, such as 12-months.
- Node-locked: Allows you to use the license on one specified instrument/computer.
- Transportable: Allows you to use the license on one instrument/computer at a time. This license may be transferred to another instrument/computer using Keysight's online tool.
- Floating: Allows you to access the license on networked instruments/computers from a server, one at a time. For concurrent access, multiple licenses may be purchased.
- USB portable: Allows you to move the license from one instrument/computer to another by end-user only with certified USB dongle, purchased separately.
- Software support subscription: Allows the license holder access to Keysight technical support and all software upgrades

Avionics measurement application (N9092EM0E)

Software License Type	Software License	Support Subscription
Node-locked perpetual	R-Y5C-001-A	R-Y6C-001-z[2]
Node-locked time-based	R-Y4C-001-z[1]	Included
Transportable perpetual	R-Y5C-004-D	R-Y6C-004- z[2]
Transportable time-based	R-Y4C-004-z[1]	Included
Floating perpetual	R-Y5C-002-B	R-Y6C-002-z[2]
Floating time-based	R-Y4C-002-z[1]	Included
USB portable perpetual	R-Y5C-005-E	R-Y6C-005- z[2]
USB portable time-based	R-Y4C-005-z[1]	Included

One-month software support subscription extension[3]

Support Subscription	Description
R-Y6C-501	1-month of support subscription for node-locked perpetual license
R-Y6C-502	1-month of support subscription for floating perpetual license
R-Y6C-504	1-month of support subscription for transportable perpetual license
R-Y6C-505	1-month of support subscription for USB portable perpetual license

1. z means different time-based license duration. F for six months, L for 12 months, X for 24 months, and Y for 36 months. All time-based licenses have included the support subscription same as the time-base duration.
2. z means different support subscription duration. L for 12 months (as default), X for 24 months, Y for 36 months, and Z for 60-months. Support subscription must be purchased for all perpetual licenses with 12-months as the default. All software upgrades and KeysightCare support are provided for software licenses with valid support subscription.
3. Support subscription for all perpetual licenses can be extended with monthly extensions.

Hardware configuration

For optimizing measurements on Avionics Measurement applications, Keysight recommends a minimum level of X-Series multi-touch instrument hardware functionality at each instrument performance point.

Supported instruments include:

- N9030B PXA Signal Analyzer (Multi-touch) with any available options
- Option N9030B-107 (audio input and digitizer) is required if baseband avionics measurements are conducted

Related Literature

VOR and ILS Radio Navigation Receiver Test Using Option 302 for Keysight Signal Sources, Application Note, literature number 5992-1919EN

Analog Demodulation X-Series Measurement Application N9063EM0E, Technical Overview, literature number 5993-2853EN

X-Series Signal Analyzer, Brochure, literature number 5989-8019EN

Web

Avionics Measurement app, multi-touch UI, product webpage:
www.keysight.com/find/N9092EM0E

N9030B PXA Signal Analyzer, Multi-touch, 2 Hz to 50 GHz, product webpage:
www.keysight.com/find/PXA

N5182B MXG X-Series RF Vector Signal Generator, 9 kHz to 6 GHz, product webpage: **www.keysight.com/find/N5182B**

Aerospace and defense industry, solution webpage:
https://www.keysight.com/us/en/industries/aerospace-defense.html

Learn more at: www.keysight.com

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at:
www.keysight.com/find/contactus

KEYSIGHT TECHNOLOGIES