holzworth
instrumentation

HA7062B

PHASE NOISE ANALYZER

CE
RoHS

User Manual 1.08

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INDEX

1.0 INTRODUCTION

Thank you for purchasing a Holzworth Instrumentation HA7062B Phase Noise Analyzer. This user manual is setup to cover specifications, product configuration, operational features and examples of some common phase noise measurement applications as they relate to the analyzer.

2.0 CERTIFICATIONS and EXEMPTIONS

2.1 CE CERTIFICATION

Holzworth analyzer products comply by test and design, with the essential requirements and other relevant provisions of the *EMC Directive*: 2004/108/EC, and the *Electrical equipment for measurement, control and laboratory use EMC requirements* (test standard): EN 61326-1: 2006*;* as set forth by the Council of the European Union.

2.2 RoHS COMPLIANCE

Holzworth phase noise analyzer products are in compliance with Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the *Restriction and use of Certain Hazardous Substances in Electrical and Electronic Equipment* (RoHS Directive), with an exemption for Lead in Electronic Ceramic Parts (e.g. Piezoelectronic Devices) per the Directive's Annex Paragraph 7 applied.

3.0 PRODUCT WARRANTY

Holzworth analyzers come with a 2 year 100% product warranty covering manufacturing defects. All product repairs and maintenance must be performed by Holzworth Instrumentation Inc. Holzworth reserves the right to invalidate the warranty for any products that have been tampered with or subjected to improper use. If the unit becomes damaged, please contact Holzworth Instruments or your local representative for an RMA Number & instructions prior to returning the unit for repair.

4.0 CALIBRATION NOTICE

Holzworth calibrates each phase noise analyzer product to be NIST traceable per the ANSI Z540 standard. The factory calibration is valid for 2 years from the original calibration date. Note the calibration date on the calibration certificate shipped with each analyzer unit.

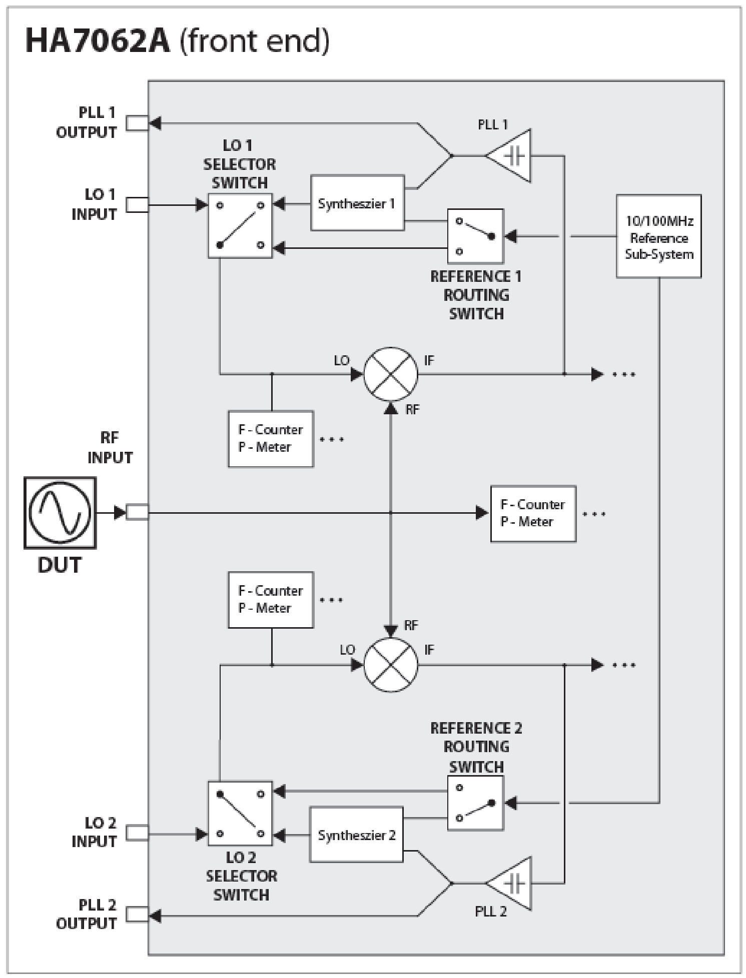
Contact sales@holzworth.com with model number and serial number for a calibration service quotation. Holzworth also makes the calibration routine and equipment list available to customers who have the capability to perform on site calibration. Contact support@holzworth.com for more information.

5.0 HA7062B CONFIGURATION GUIDE

5.1 CONFIGURATION SUMMARY

The HA7062B tunable phase noise analyzer responds to industry demands for a no frills phase noise measurement system that is highly reliable and intuitive while offering measurement speeds that eliminate bottlenecks on manufacturing test lines. The HA7062B is also an incredibly cost effective solution for R&D, offering measurement floors below -190dBc/Hz.

The core engine combines the best of traditional analog phase noise measurement front-ends (being virtually spur free) with the latest technology in cross correlation analysis. The digital analysis system leverages a proprietary DSP with a powerful cross correlation engine.



The unparalleled stability of the HA7062B is credited to a pair of Holzworth HSM Series RF Synthesizer modules. Holzworth RF synthesizers are known for industry leading stability due to the proprietary non-PLL architecture. These high performing RF sources compliment the dual core engine to provide the most advanced phase noise analyzer available.

Phase noise measurements do not benefit from modular analyzer architectures. Holzworth's fully shielded, fan-less 1U chassis completely eliminates ground loops and troublesome microphonics for uncompromising performance when compared to traditional "rack and stack" type systems.

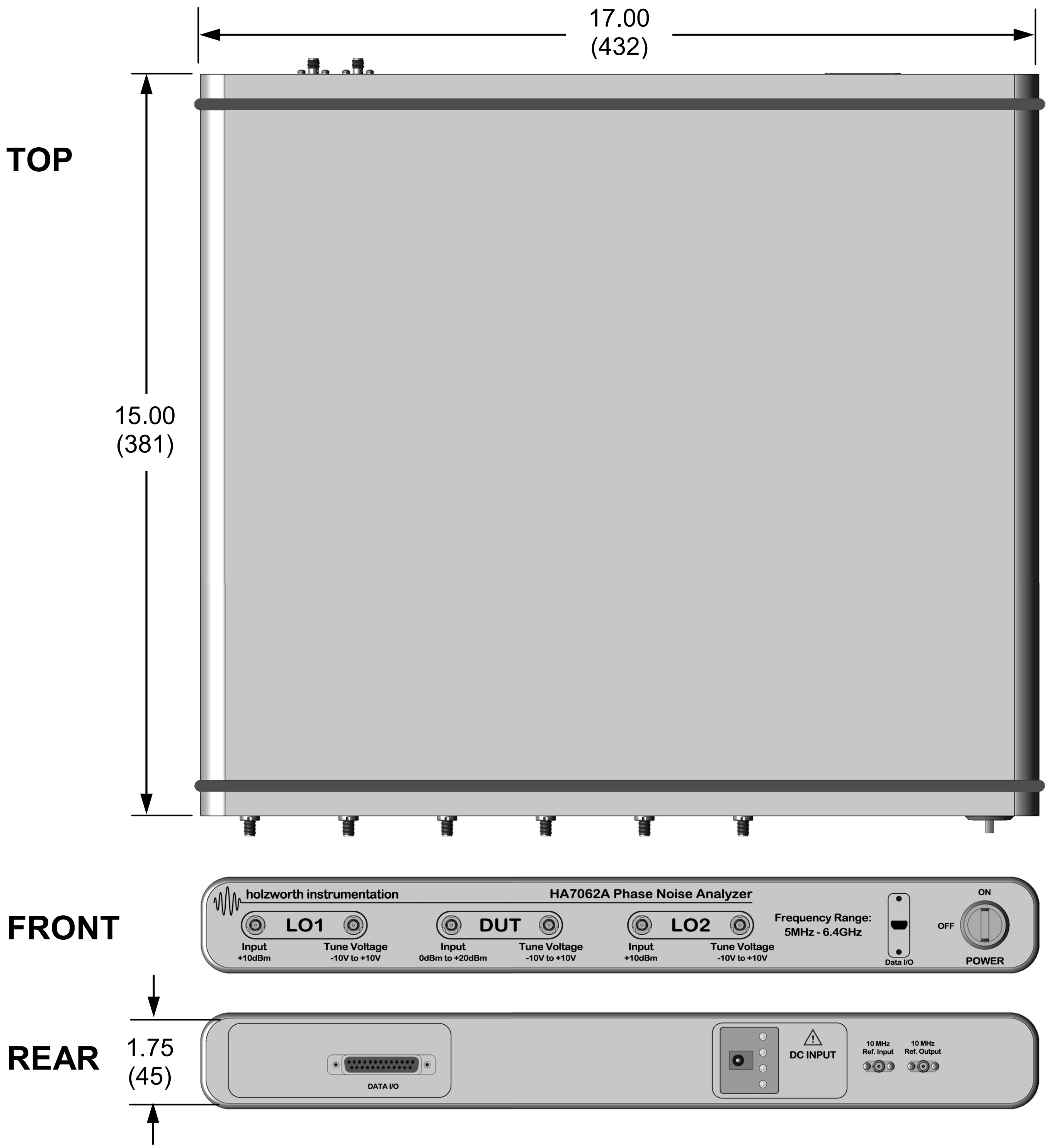
The HA7062B Phase Noise Analyzer has 3 different LO Modes available:

1. Internal LO Mode, which uses a pair of integrated Holzworth HSM Series RF Synthesizers as the LO test sources.
2. Internal LO Bypass Mode, which auto-detects 10MHz & 100MHz DUTs and then uses the lower phase noise performance of the onboard OCXOs to increase measurement speed and sensitivity at the these two test frequencies.
3. External LO Mode, which allows the user to apply high performance external LO test sources with an automatic calibration function for achieving phase lock to the DUT at the same frequency.

5.2 MECHANICAL CONFIGURATION

5.2.1 Product Dimensions

The HA7000 Series analyzers each come in a 1U high, rack mountable chassis. A universal rack mount bracket kit is an available accessory (Part No.: RACK-1U or RACK2-1U). Mechanical dimensions are listed in inches (and millimeters).



5.2.2 Front Panel Connectors

DESCRIPTION	SPECIFICATION
DUT Input	
Connector Type	SMA (3.5mm), 50ohm
Minimum Frequency	10MHz
Maximum Frequency (standard)	6.4GHz
Maximum Frequency (OPT-PD1)	1.5GHz with low noise front end option installed (OPT-PD1)
Maximum Frequency (HX4920)	20GHz
Power Level Range (standard)	0dBm to +20dBm
Power Level Range (OPT-PD1)	0dBm to +20dBm
Power Level Range (HX4920)	+0dBm to +10dBm
DUT Tune Voltage	
Connector Type	SMA (3.5mm), 50ohm
Voltage Tune Range	-10V to +10V
LO1 Input	
Connector Type	SMA (3.5mm), 50ohm
Frequency Range (standard)	10MHz to 6.4GHz
Frequency Range (OPT-PD1)	10MHz to 1.5GHz with low noise front end option installed (OPT-PD1)
Power Level (optimal)	+10dBm
LO1 Tune Voltage	
Connector Type	SMA (3.5mm), 50ohm
Voltage Tune Range	-10V to +10V
Tuning Sensitivity	1.0 to 4.5k (Hz/V)
LO2 Input	
Connector Type	SMA (3.5mm), 50ohm
Frequency Range (standard)	10MHz to 6.4GHz
Frequency Range (OPT-PD1)	10MHz to 1.5GHz with low noise front end option installed (OPT-PD1)
Power Level (optimal)	+10dBm
LO2 Tune Voltage	
Connector Type	SMA (3.5mm), 50ohm
Voltage Tune Range	-10V to +10V
Tuning Sensitivity	1.0 to 4.5k (Hz/V)

5.2.3 Rear Panel Connectors

DESCRIPTION	SPECIFICATION
Reference Output Port	
Connector Type	SMA, 50ohm
Output Frequency	10MHz ±10Hz
Output Level	+4dBm ±3dBm
Output Waveform	Sinusoid
Reference Input Port	ONLY FOR FREQUENCY COUNTERS - DOES NOT AFFECT MEASUREMENT SENSITIVITY
Connector Type	SMA, 50ohm
Input Frequency	10MHz ±10Hz
Input Level	0dBm to +10dBm (Sinusoid or Square)
DC Power Input	
Connector Type	DC Input - Jack (Male)
DC Voltage	$12V_{DC}$ $-0.5V_{DC}$ / $+1.5V_{DC}$
AC/DC Power Adapter (included)	$100\text{-}240V_{AC}$, 47-63Hz. Output: $12V_{DC}$, $5A_{DC}$. Specify country at time of order. **NO GROUND.**
Data I/O Interface	
Connector Type	DB25 (female)
Notes	For use with HCM5 Ethernet Communications Module

5.2.4 Operational Environment

DESCRIPTION	SPECIFICATION
Operating Environment **Temperature** **Humidity** **Altitude** **Vibration**	 +10C to +40C RH 20% to 80% at wet bulb temp. <29C (non-condensing) 0 to 2,000m (0 to 6,561 feet) 0.21 G-rms maximum, 5Hz to 500Hz
Storage (Non-Operating) **Temperature** **Humidity** **Altitude** **Vibration**	 -10C to + 60C RH 20% to 80% at wet bulb temp. <40C (non-condensing) 0 to 4,572m (0 to 15,000 feet) 0.5 G-rms maximum, 5Hz to 500Hz

5.2.5 Available Options & Accessories

Holzworth offers options and accessories to optimize the analyzer for an intended application. Specify all required options and/or accessories when requesting a quotation or placing a purchase order.

PART No.	DESCRIPTION	CLASSIFICATION
OPT-COMM	Custom communications configuration	OPTION
OPT-FIRM	Custom firmware – Application specific	OPTION
OPT-PD1	Low Noise Front End. 10dB improved noise floor in External LO Mode. 5MHz-1.5GHz.	OPTION
HCM5	Add on Ethernet communications module for HA7000 Series.	ACCESSORY
HX4920	Add on 20GHz frequency extension for HA7062B	ACCESSORY
HX5200	Add on calibration standard	ACCESSORY
RACK-1U	19” Rack mount bracket kit for HA7000 Series. 90° rear.	ACCESSORY
RACK2-1U	19” Rack mount bracket kit for HA7000 Series. Straight rear.	ACCESSORY
CASE		ACCESSORY

6.0 PERFORMANCE SUMMARY

The HA7062B is designed for high speed and precise phase noise measurements. The specifications outlined here capture the baseline performance and features that are currently available from the HA7062B phase noise analyzer. The highly reliable hardware is capable of additional functionality for custom requirements. Inquire with Holzworth Instrumentation or your local sales representative.

6.1 RF INPUT

DESCRIPTION	SPECIFICATION
RF Input Connector	SMA (female), 50 ohm
RF Input Frequency Range	10 MHz to 6.4 GHz (standard front end) 4GHz to 20GHz (standard front end, HX4920 installed[1]) 10 MHz to 1.5GHz (low noise front end –option OPT-PD1)
RF Input Measurement Level	0 dBm to +20 dBm
Input Damage Level	+22 dBm
Input VSWR	< 2.0:1

6.2 PHASE NOISE MEASUREMENTS

DESCRIPTION	SPECIFICATION
RF Input Frequency Range	10 MHz to 6.4 GHz (standard front end) 4GHz to 20GHz (standard front end, HX4920 installed[1]) 10 MHz to 1.5GHz (low noise front end –option OPT-PD1)
RF Tracking Range	± 100 kHz (offset dependent)
Measurement Parameters	SSB Phase Noise
Number of Traces	1 measurement, 3 memory
Offset Frequency Range	1 Hz – 1 MHz
Phase Noise Uncertainty **0.1 Hz to 1 kHz offset** **1 kHz to 1 MHz offset**	 ± 4 dB ± 2 dB
SSB Phase Noise Sensitivity	See pages 5-6
Measurement (Sample) Time	See Table 1

[1]See Section 7.4 for installation details

6.3 PHASE NOISE MEASUREMENT SPEED (SAMPLE TIME, TYPICAL)

Frequency Offset Range	No. of Points	Transfer Time (full)	Measurement Time
10kHz – 1MHz	737	~ 737 ms	8s
1kHz – 1MHz	1102	~ 1102 ms	9s
100Hz – 1MHz	1467	~ 1467 ms	11s
10Hz – 1MHz	1830	~ 1830 ms	17s
1Hz – 1MHz	2192	~ 2192 ms	46s

6.4 x CORRELATIONS vs. PHASE NOISE IMPROVEMENT

Improvement factor: dB = 5logN (N = No. of correlations)

Number of Correlations	1	10	100	1,000	10,000
dB Improvement	0dB	5dB	10dB	15dB	20dB

6.5 INTERNAL TIME BASE

DESCRIPTION	SPECIFICATION
Frequency Uncertainty / Stability	< ± 10Hz at 100MHz (±100 ppb) At time of shipment. Factory calibrated at +21C.
Frequency Temperature Effects	< 10ppb
Frequency Aging Rate	< 100ppb/yr
10MHz External Lock Range	± 2ppm (typical), ± 1ppm (specified). 10MHz is for frequency counters only.

6.6 LO MODES

MODE	DESCRIPTION
Internal LO Mode	Internal synthesized LO sources. Auto tune and phase lock. Pages 10-13.
Internal LO Bypass Mode	Internal references as LO sources. 10MHz & 100MHz only. Auto select and phase lock. Pages 13-14
External LO Mode	User supplied LO sources. Auto calibration of LO sources and auto phase lock. Pages 14-15.

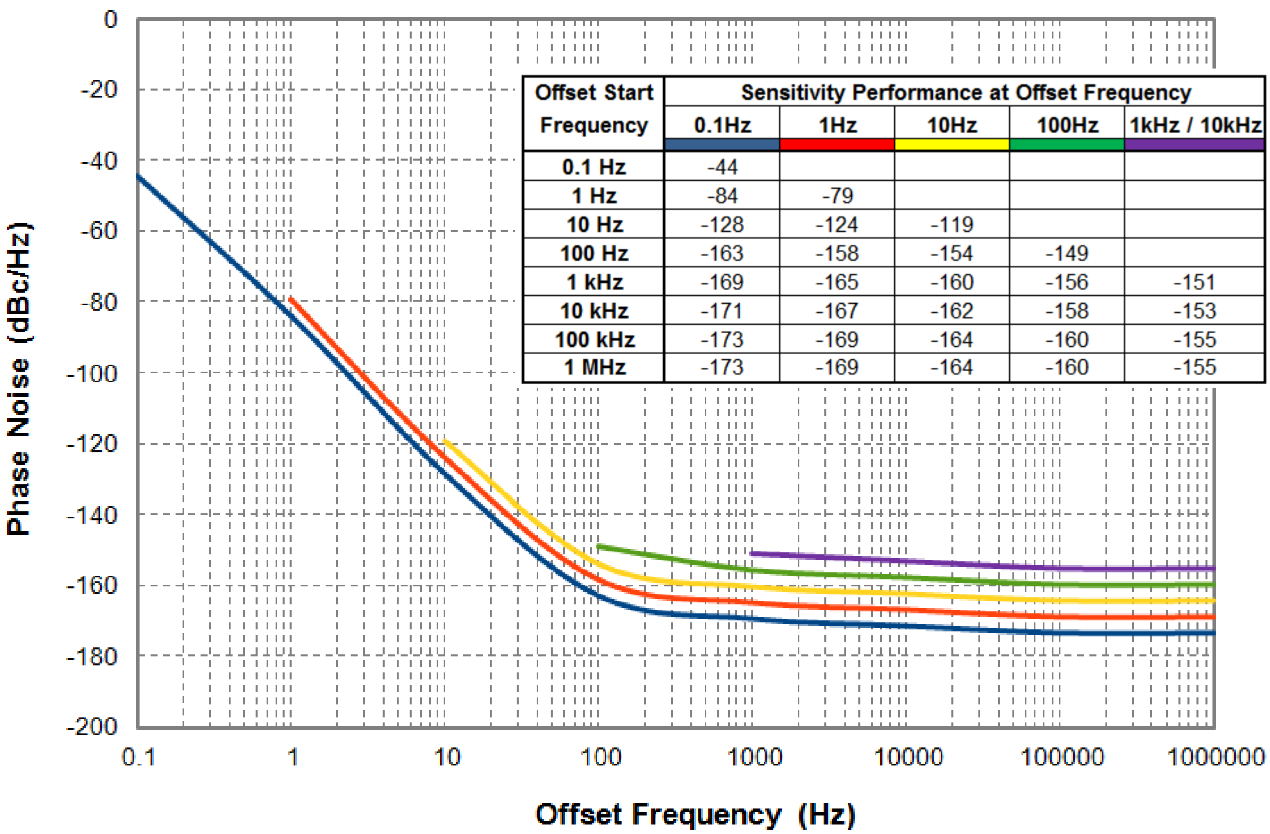
6.7 INTERNAL LO MODE - PHASE NOISE SENSITIVITY

The Phase Noise Sensitivity of the analyzer is a combination of the quality of the LO sources, the phase detectors (mixers) at the analyzer's front end, and the sampling bandwidth that is set via the low frequency offset (measurement start frequency).

The Internal LO Mode uses a pair of internal RF synthesizers that can tune between 10MHz and 6.7GHz in 0.001Hz steps. The DUT power level and frequency are detected by the system and the phase lock, and test initialization will occur automatically.

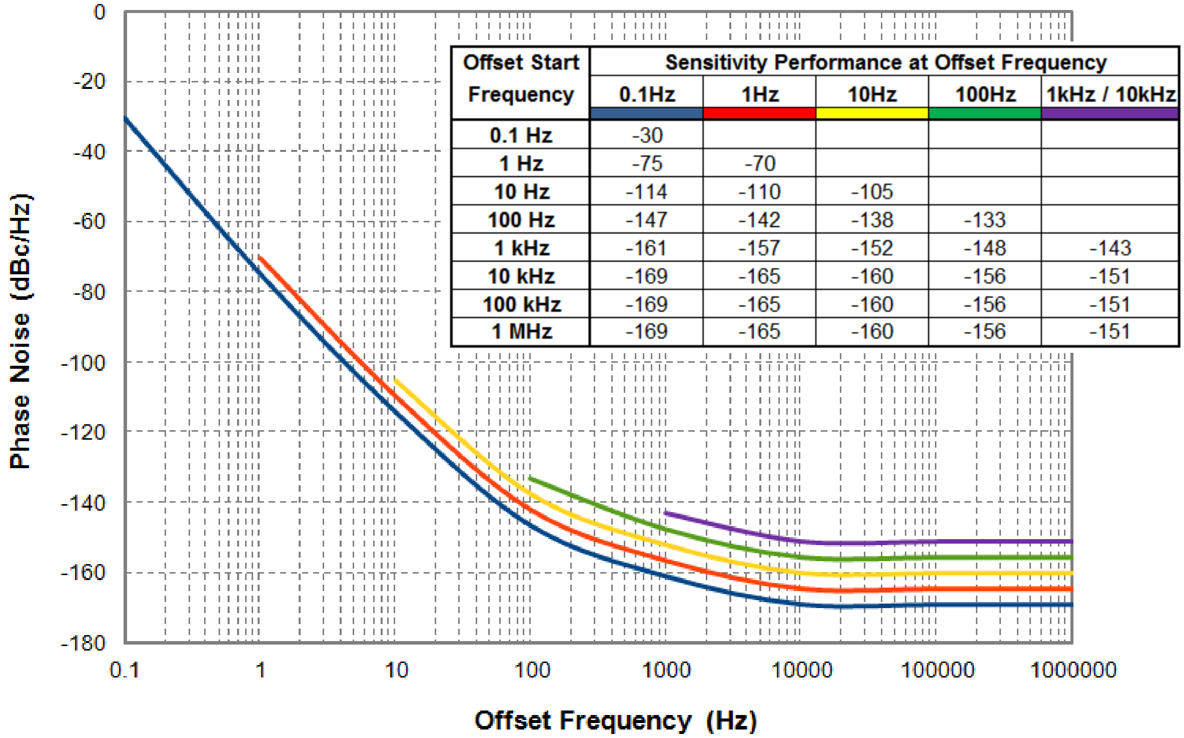
The sensitivity values outlined in this section are based on a single cross correlation. Lower phase noise measurement floors are achieved by running additional cross correlations, as outlined in section 6.4.

20MHz RF Input Frequency – Internal LO Mode Sensitivity



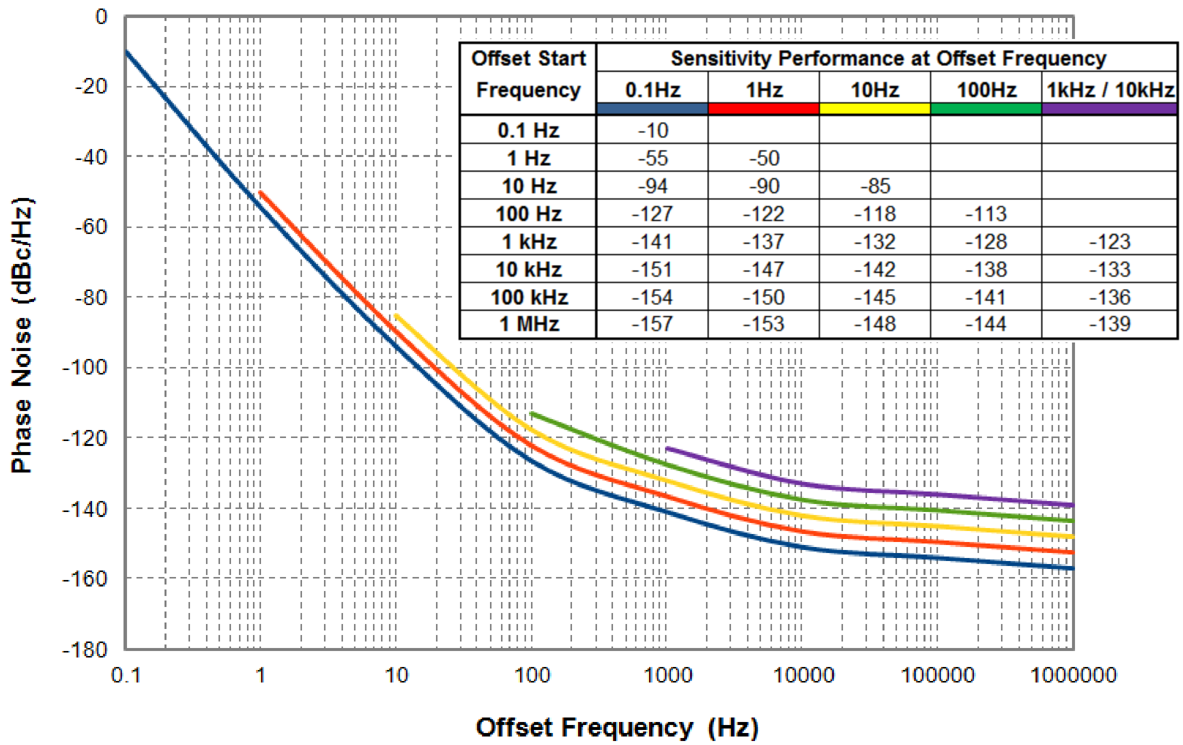
Offset Start Frequency	Sensitivity Performance at Offset Frequency				
	0.1Hz	1Hz	10Hz	100Hz	1kHz / 10kHz
0.1 Hz	-44				
1 Hz	-84	-79			
10 Hz	-128	-124	-119		
100 Hz	-163	-158	-154	-149	
1 kHz	-169	-165	-160	-156	-151
10 kHz	-171	-167	-162	-158	-153
100 kHz	-173	-169	-164	-160	-155
1 MHz	-173	-169	-164	-160	-155

120MHz RF Input Frequency – Internal LO Mode Sensitivity



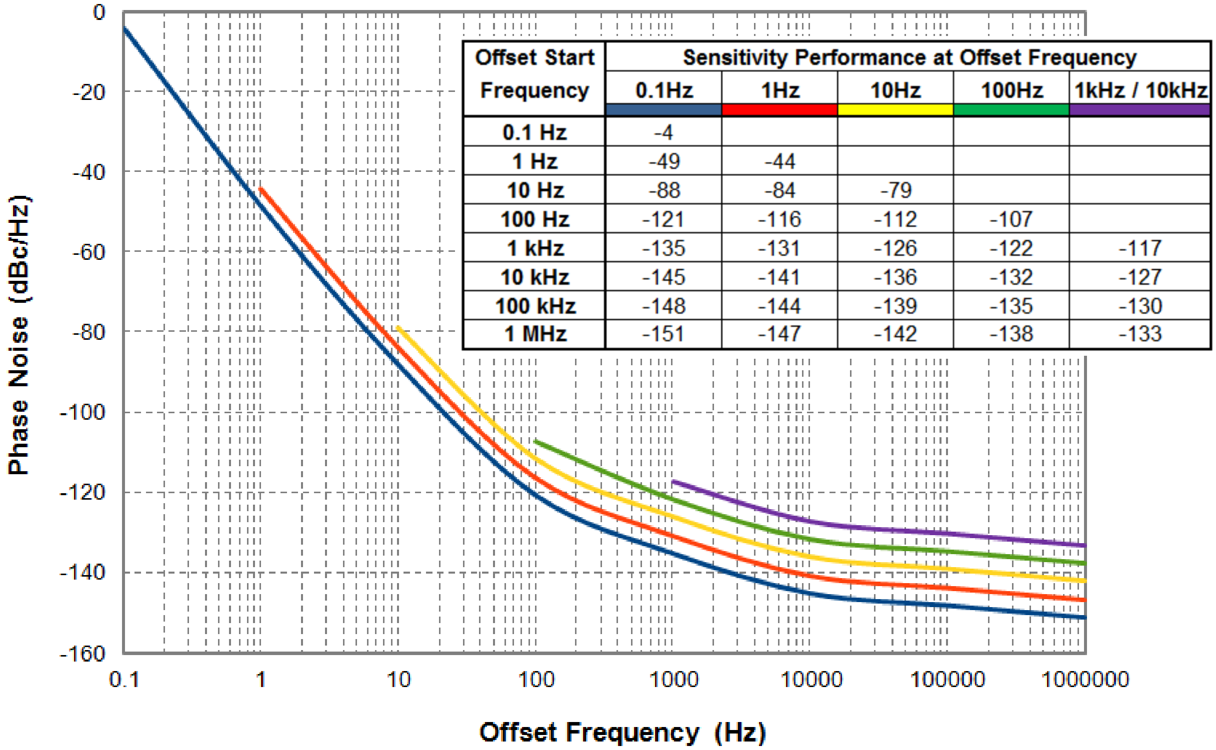
Offset Start Frequency	Sensitivity Performance at Offset Frequency				
	0.1Hz	1Hz	10Hz	100Hz	1kHz / 10kHz
0.1 Hz	-30				
1 Hz	-75	-70			
10 Hz	-114	-110	-105		
100 Hz	-147	-142	-138	-133	
1 kHz	-161	-157	-152	-148	-143
10 kHz	-169	-165	-160	-156	-151
100 kHz	-169	-165	-160	-156	-151
1 MHz	-169	-165	-160	-156	-151

1GHz RF Input Frequency – Internal LO Mode Sensitivity



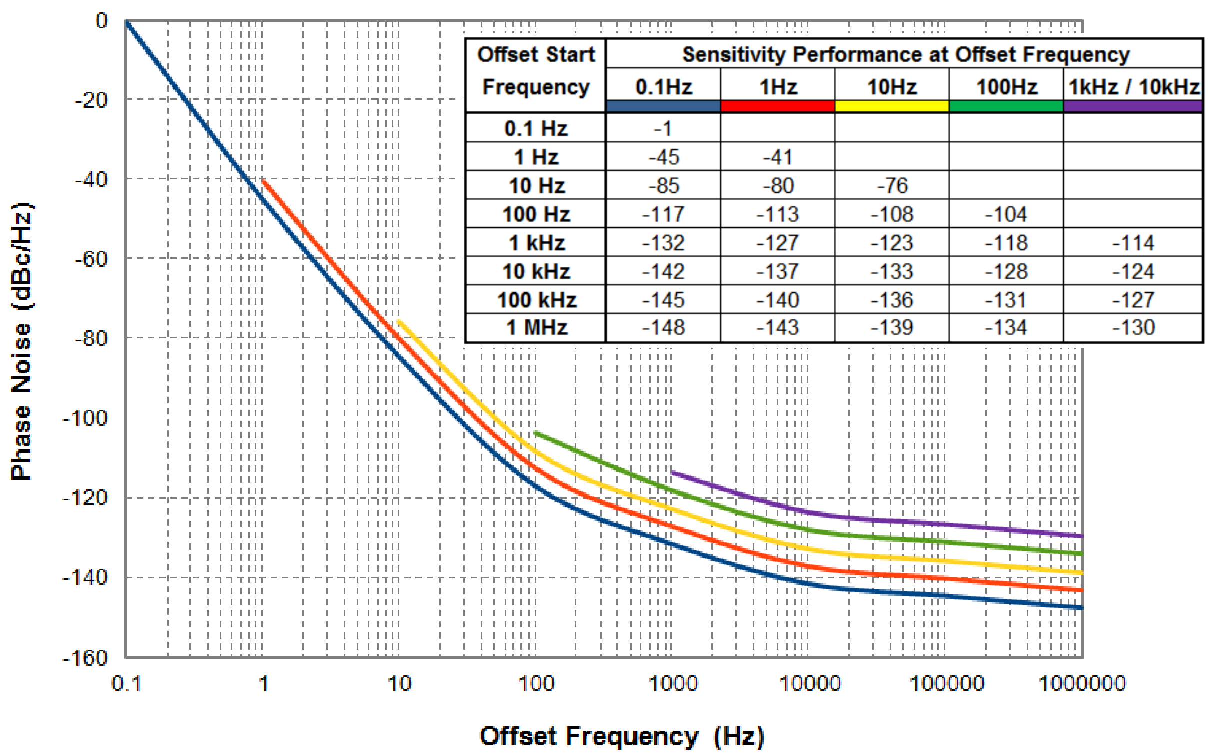
Offset Start Frequency	Sensitivity Performance at Offset Frequency				
	0.1Hz	1Hz	10Hz	100Hz	1kHz / 10kHz
0.1 Hz	-10				
1 Hz	-55	-50			
10 Hz	-94	-90	-85		
100 Hz	-127	-122	-118	-113	
1 kHz	-141	-137	-132	-128	-123
10 kHz	-151	-147	-142	-138	-133
100 kHz	-154	-150	-145	-141	-136
1 MHz	-157	-153	-148	-144	-139

2GHz RF Input Frequency – Internal LO Mode Sensitivity



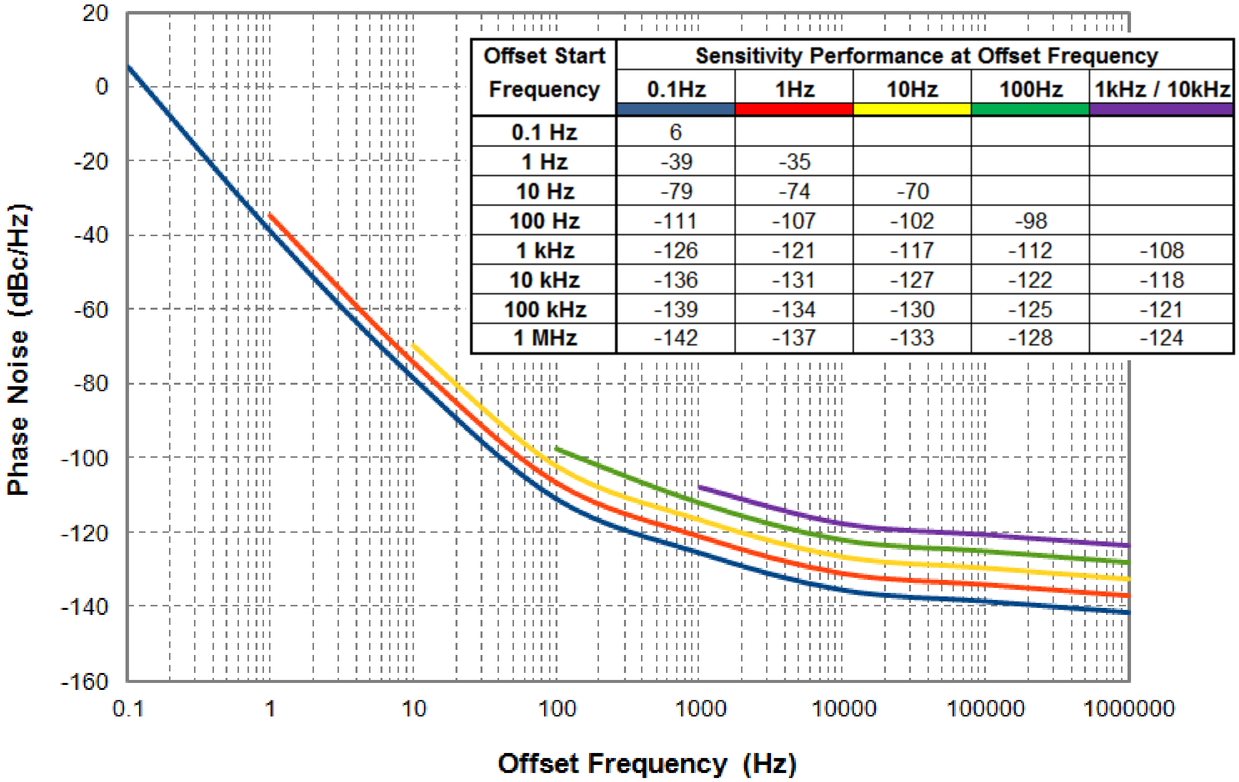
Offset Start Frequency	Sensitivity Performance at Offset Frequency				
	0.1Hz	1Hz	10Hz	100Hz	1kHz / 10kHz
0.1 Hz	-4				
1 Hz	-49	-44			
10 Hz	-88	-84	-79		
100 Hz	-121	-116	-112	-107	
1 kHz	-135	-131	-126	-122	-117
10 kHz	-145	-141	-136	-132	-127
100 kHz	-148	-144	-139	-135	-130
1 MHz	-151	-147	-142	-138	-133

3GHz RF Input Frequency – Internal LO Mode Sensitivity



Offset Start Frequency	Sensitivity Performance at Offset Frequency				
	0.1Hz	1Hz	10Hz	100Hz	1kHz / 10kHz
0.1 Hz	-1				
1 Hz	-45	-41			
10 Hz	-85	-80	-76		
100 Hz	-117	-113	-108	-104	
1 kHz	-132	-127	-123	-118	-114
10 kHz	-142	-137	-133	-128	-124
100 kHz	-145	-140	-136	-131	-127
1 MHz	-148	-143	-139	-134	-130

6GHz RF Input Frequency – Internal LO Mode Sensitivity



Offset Start Frequency	Sensitivity Performance at Offset Frequency				
	0.1Hz	1Hz	10Hz	100Hz	1kHz / 10kHz
0.1 Hz	6				
1 Hz	-39	-35			
10 Hz	-79	-74	-70		
100 Hz	-111	-107	-102	-98	
1 kHz	-126	-121	-117	-112	-108
10 kHz	-136	-131	-127	-122	-118
100 kHz	-139	-134	-130	-125	-121
1 MHz	-142	-137	-133	-128	-124

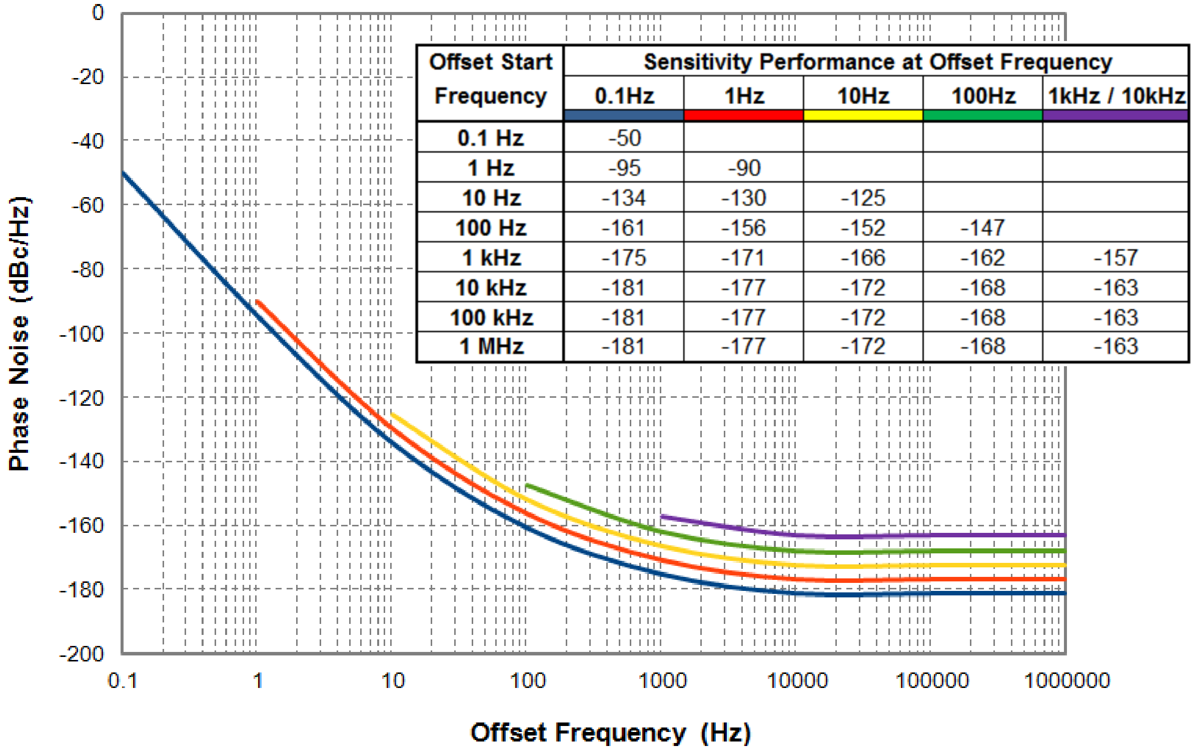
6.8 10/100 LO BYPASS MODE – SSB PHASE NOISE SENSITIVITY

The Phase Noise Sensitivity of the analyzer is a combination of the quality of the LO sources, the phase detectors (mixers) at the analyzer's front end, and the sampling bandwidth that is set via the low frequency offset (measurement start frequency).

10/100 LO Bypass Mode utilizes the lower phase noise floor of the internal fixed reference signals. The HA7062B will automatically switch into this mode when either a 10MHz or 100MHz DUT is connected to the front panel.

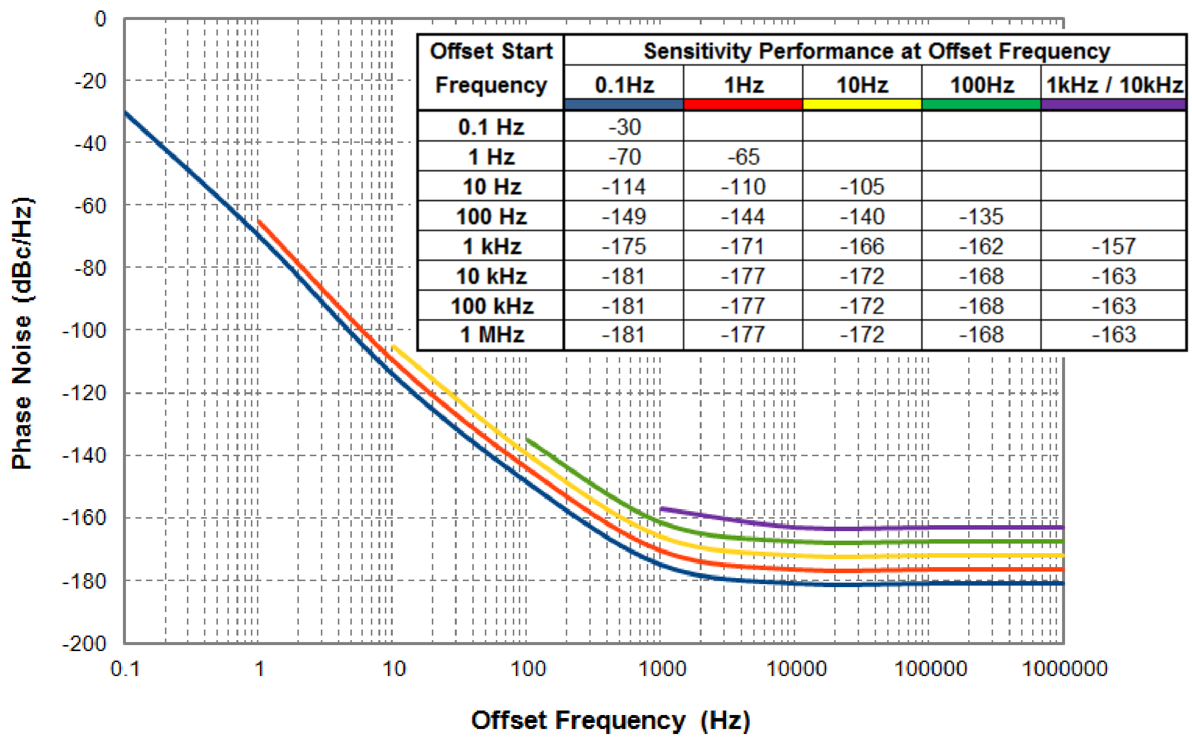
The sensitivity values outlined in this section are based on a single cross correlation. Lower phase noise measurement floors are achieved by running additional cross correlations, as outlined in Section 6.4.

10MHz RF Input Frequency – Internal LO Bypass Mode Sensitivity



Offset Start Frequency	Sensitivity Performance at Offset Frequency				
	0.1Hz	1Hz	10Hz	100Hz	1kHz / 10kHz
0.1 Hz	-50				
1 Hz	-95	-90			
10 Hz	-134	-130	-125		
100 Hz	-161	-156	-152	-147	
1 kHz	-175	-171	-166	-162	-157
10 kHz	-181	-177	-172	-168	-163
100 kHz	-181	-177	-172	-168	-163
1 MHz	-181	-177	-172	-168	-163

100MHz RF Input Frequency – Internal LO Bypass Mode Sensitivity



Offset Start Frequency	Sensitivity Performance at Offset Frequency				
	0.1Hz	1Hz	10Hz	100Hz	1kHz / 10kHz
0.1 Hz	-30				
1 Hz	-70	-65			
10 Hz	-114	-110	-105		
100 Hz	-149	-144	-140	-135	
1 kHz	-175	-171	-166	-162	-157
10 kHz	-181	-177	-172	-168	-163
100 kHz	-181	-177	-172	-168	-163
1 MHz	-181	-177	-172	-168	-163

6.9 SSB PHASE NOISE SENSITIVITY - STANDARD

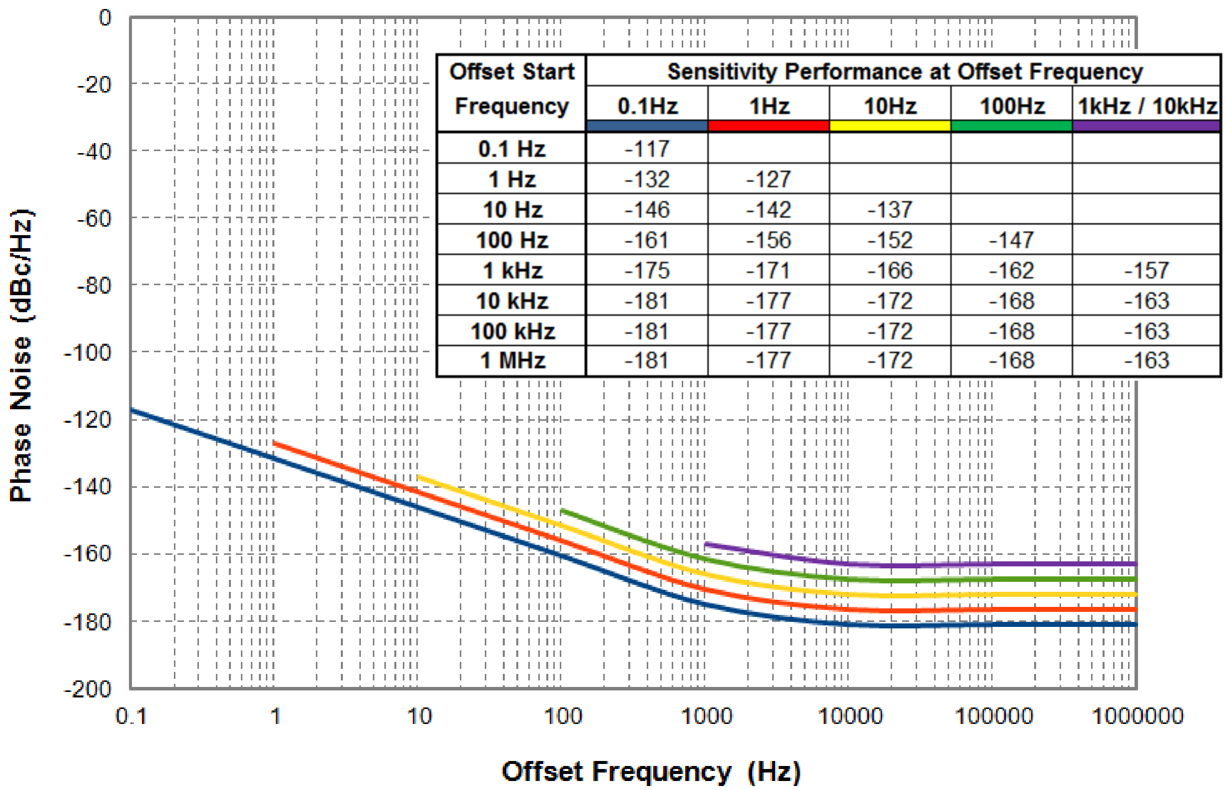
STANDARD MIXERS

The Phase Noise Sensitivity of the analyzer is a combination of the quality of the external LO test sources, the phase detectors (mixers) at the analyzer's front end, and the sampling bandwidth that is set via the low frequency offset (measurement start frequency).

External LO Mode allows the user to connect a pair of similar, non-coherent, external LO sources that must match or exceed the phase noise performance of the DUT for achieving the fastest measurement speeds and lowest noise floors. The system includes an auto-calibration function, which characterizes the voltage tuning constant for each independent LO prior to each measurement.

The sensitivity values outlined in this section are based on a single cross correlation. Lower phase noise measurement floors are achieved by running additional cross correlations, as outlined in section 6.4.

External LO Mode – Phase Detector Sensitivity



Offset Start Frequency	Sensitivity Performance at Offset Frequency				
	0.1Hz	1Hz	10Hz	100Hz	1kHz / 10kHz
0.1 Hz	-117				
1 Hz	-132	-127			
10 Hz	-146	-142	-137		
100 Hz	-161	-156	-152	-147	
1 kHz	-175	-171	-166	-162	-157
10 kHz	-181	-177	-172	-168	-163
100 kHz	-181	-177	-172	-168	-163
1 MHz	-181	-177	-172	-168	-163

6.10 SSB PHASE NOISE SENSITIVITY – OPTION OPT-PD1

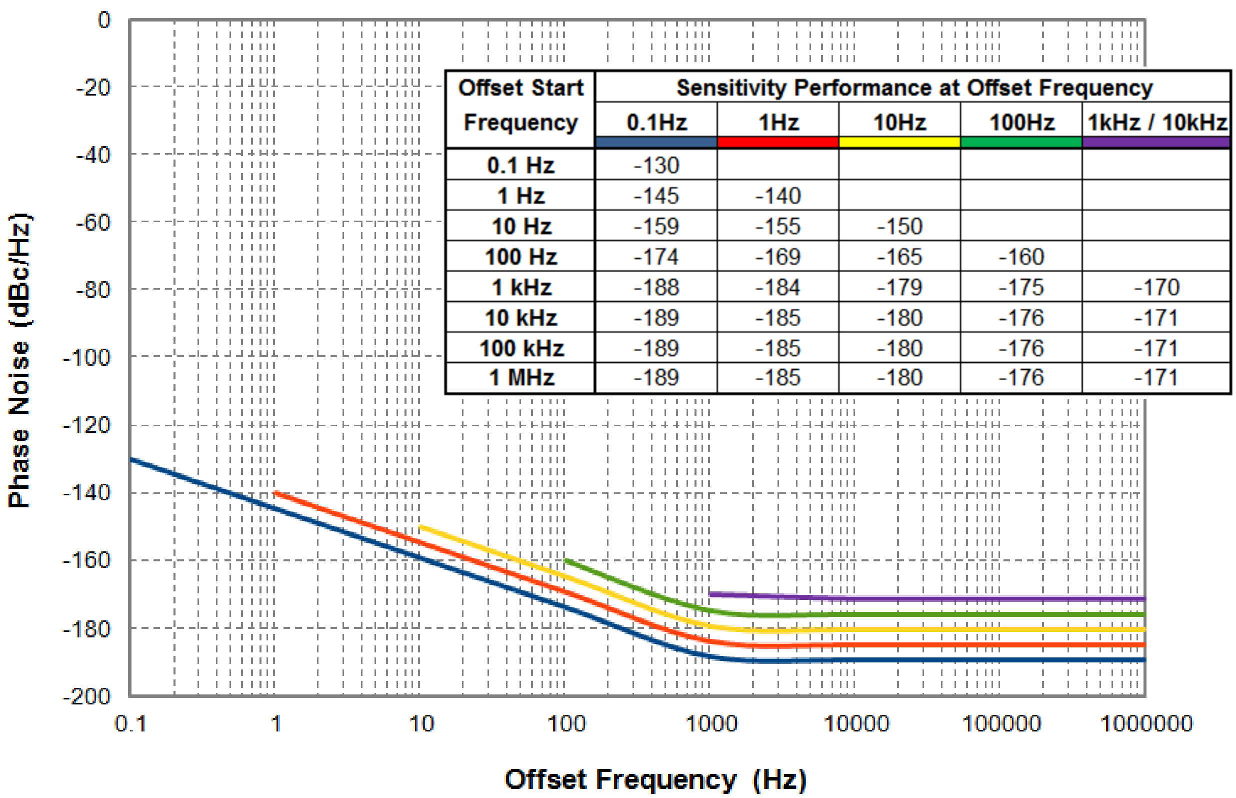
OPTION: OPT-PD1 LOW NOISE MIXERS

The Low Noise Front End option (OPT-PD1) is offered for those applications which require the ultimate combination of fast measurement speed with the lowest possible noise floor. Option OPT-PD1 replaces the standard front end phase detectors with mixers that have been optimized over a narrower bandwidth for increased sensitivity, ultimately providing the lowest possible measurement floors.

The sensitivity values outlined in this section are based on a single cross correlation. Lower phase noise measurement floors are achieved by running additional cross correlations, as outlined in section 6.4.

NOTE: Installation of OPT-PD1 limits the operating frequency range of the entire instrument from 5MHz to 1.5GHz for all LO modes of operation.

Phase Detector Sensitivity – Low Noise Front End



Offset Start Frequency	Sensitivity Performance at Offset Frequency				
	0.1Hz	1Hz	10Hz	100Hz	1kHz / 10kHz
0.1 Hz	-130				
1 Hz	-145	-140			
10 Hz	-159	-155	-150		
100 Hz	-174	-169	-165	-160	
1 kHz	-188	-184	-179	-175	-170
10 kHz	-189	-185	-180	-176	-171
100 kHz	-189	-185	-180	-176	-171
1 MHz	-189	-185	-180	-176	-171

7.0 PHASE NOISE ANALYZER INSTALLATION

This section outlines the basic installation requirements and procedures for the HA7000 Series Phase Noise Analyzer application GUI and the hardware.

First, the application GUI software must be installed. The GUI software is contained on the CD that was included with the analyzer module. If the CD is missing another can be emailed or the software can be downloaded after contacting Holzworth support via email at: support@holzworth.com or by phone at +1.303.325.3473 (option 2).

7.1 APPLICATION GUI INSTALLATION

Holzworth analyzers are PC controlled Instruments (virtual front panel) that interface with a PC via USB as a Human Interface Device (HID).

The application GUI software is Java™ based, requiring no driver installation. A single DLL file transfers high level language commands to USB level or Ethernet compatible instructions.

Java™ must be installed on the command PC in order to run the application GUI.

7.1.1 Minimum System Requirements

DESCRIPTION	SPECIFICATION
Minimum System Requirements	Pentium 4, 512MB RAM, USB 2.0
Operating System	Windows XP, 2000, 2003 Server, Vista, 7, 8 / Java 6.0 installed
Minimum Display Resolution	900 x 500 pixels
Touch Screen Compatible	Yes

7.1.2 Downloading Java™

Holzworth utilizes a Java™ based platform for development of the "HolzworthPNA" application because of its high reliability. Java™ is freeware. The latest version of Java™ can be downloaded directly from Oracle.

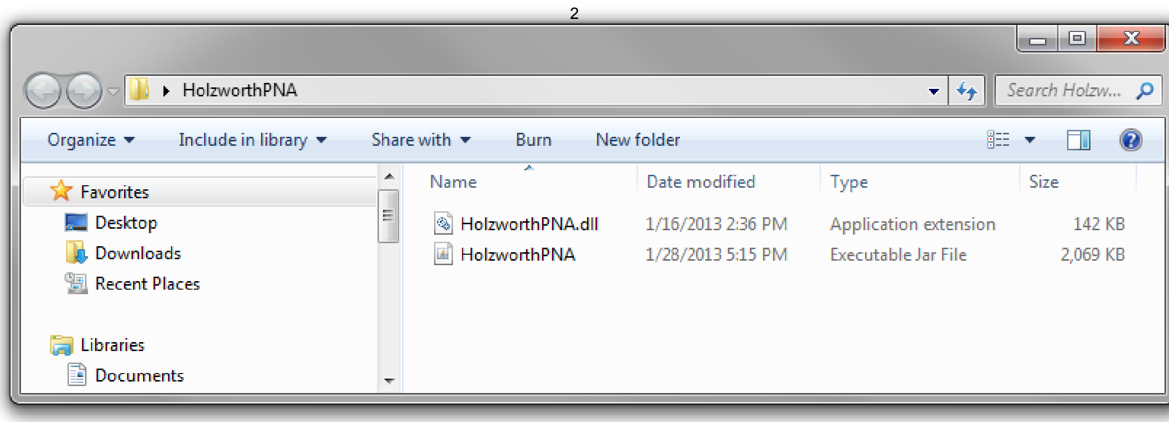
To validate what version of Java™ is installed on the host PC or to download the latest version, go to:

http://www.java.com/en/download/index.jsp

7.1.3 Loading the Application GUI

The CD included with the analyzer contains an application file folder with 2 files that include: a .dll file, a .jar file. Make sure both files remain inside the original folder location.

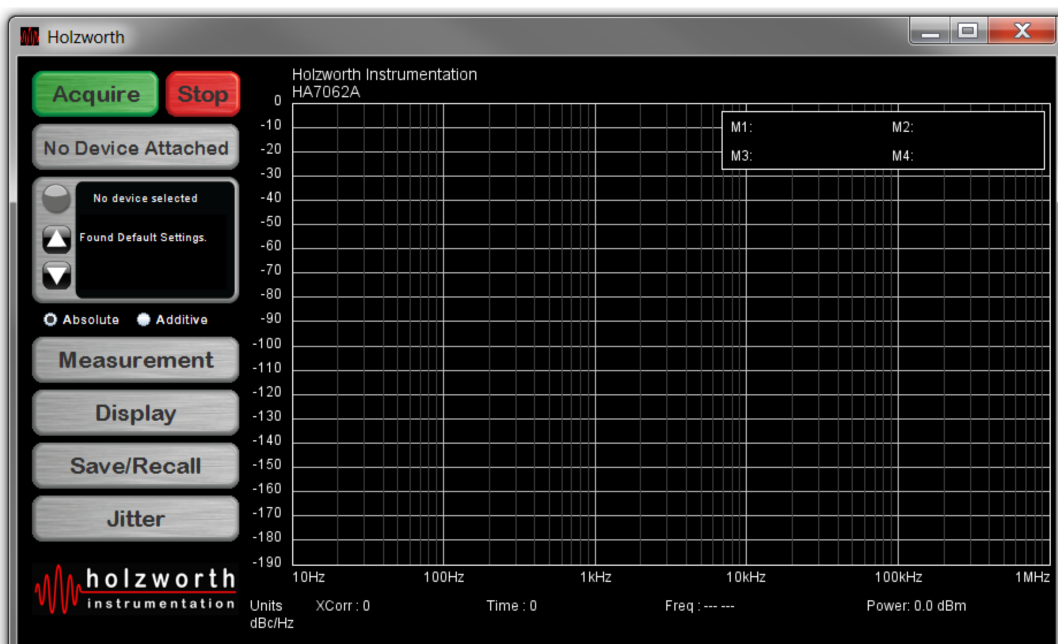
Analyzer GUI Application Folder



7.1.4 Initializing the Application GUI

The phase noise analyzer application does not utilize the Windows software Installation Wizard. The following 2 steps need occur to launch the application:

1. Save the entire folder to a preferred directory on the PC or portable memory device. Be certain that the entire folder has been extracted.
2. Double click the "HolzworthPNA.jar" Executable Jar File to open the application. The GUI will be immediately displayed on the monitor.



7.2 HARDWARE INSTALLATION

Prior to initializing the analyzer, connect the external power supply to the rear panel connector and an AC outlet. The instrument is shipped with the appropriate power cord for the final destination country/region.

The master power switch located at the right side of the front panel is equipped with a blue indicator light which illuminates when the DC power is active.

7.2.1 Powering Analyzer with a 12V Battery

The HA7000 Series has been designed with an external power supply to support clean, ultra low phase noise measurements. However, a battery is the absolute cleanest supply voltage for powering a DUT, external LOs (when used) and even the phase noise analyzer. The rear panel is equipped with a vertical row of LED indicators that are used to monitor the DC input voltage range.

LED (top to bottom)	**Indication**
Yellow	Voltage high. >13.5V_{DC}
Green	Voltage in range. 11.5-13.5V_{DC}
Yellow	Voltage low. <11.5V_{DC}
Red	Voltage out of range. Reverse polarity.

NOTE: The internal voltage regulator has built in, auto-resetting circuit protection.

7.2.2 USB Hardware

A USB 2.0 port is built into the front panel of the instrument, located to the immediate left side of the master power switch. The analyzer is an HID (Human Interface Device) that is recognized by the PC via standard Windows drivers. With the application folder installed on the PC and the GUI launched, the analyzer can now be connected via the provided USB cable.

A proprietary 10ft (3m) USB 2.0 cable is provided with the instrument. If lost, a standard USB 2.0 cable with a type A connector at the PC, and a mini-B connector at the analyzer can be utilized in its place. The cable that is included with the equipment has a proprietary end fitting that enables secure fastening at the analyzer via 2 captive panel screws (as pictured above).

7.2.3 Ethernet Hardware (Optional)

An Ethernet connection is available via the back panel of the instrument using part number: HCM5 (USB Communication Module for HA7000 Series). The HCM5 module comes with a standard 10ft (3m) CAT-6 Ethernet cable.

The HCM5 is installed directly to the DB25 connector located at the left side of the rear panel, using the 2x captive panel screws to securely fasten the HCM5 into position. Once the HCM5 is installed, an Ethernet cable can be used to connect the instrument directly to a PC or to a network.

NOTE: USB INACTIVATED. Once the HCM5 module is physically mated to the synthesizer, USB control will no longer be available to the user. This scenario is valid whether or not an Ethernet cable is installed. To regain a USB connection, the HCM5 module must be completely removed from the instrument.

7.2.4 Ethernet Configuration

The HCM5 module supports a static IP address or DHCP. The default setup is DHCP. The network parameters can be configured using the Holzworth Ethernet Finder GUI.

1) From the included CD, save the entire HolzworthEthFinder folder onto the PC.
2) Open the “EthernetFinder.jar” file to launch the network configuration GUI.
3) Click the Locate Device Button and select the device. Changes can now be made to the HCM5 module.

In the event the static IP network parameters are incorrectly set and the module cannot be found on the network, turn off power to the HA7000 Series analyzer. Use a pin to depress the internal reset button located below the Ethernet port on the HCM5 module. The HCM5 module will come online with a DHCP assigned address.

The HCM5 module accepts TCP requests over port 9760. The Holzworth HA7000 Series GUI communicates with the analyzer using TCP.

The host name on the network will be the complete HA7000 Series analyzer serial number.

For applications using a crossover Ethernet cable to connect to the analyzer directly, using a Windows computer, the following steps may need to be performed to establish communication with the instrument:

1) Open the Control Panel and navigate to:
   "**Control Panel > Network and Internet > Network and Sharing Center**"
2) In the left hand side of the window, click on "**Change adapter settings**."
3) Right-click on "**Local Area Connection**" and select "**Properties**."
4) Click on "**Internet Protocol Version 4**" to highlight and click on "**Properties**."
5) In the Properties pop-up, make sure the radio button next to "**Obtain IP address automatically**" is selected.

If connection or control problems are persistent, or for general performance/operational questions; contact Holzworth Instrumentation technical support directly at:

TECHNICAL SUPPORT

Email: support@holzworth.com

Phone: +1.303.325.3473 (option 2)

7.3 DEVICE CONNECTION

To locate and connect to the device, press the button labeled: No Device Attached. This button is located at the upper left area of the GUI window, immediately below the green Acquire button.

Depressing the No Device Attached button initiates the Devices popup window which lists all Holzworth phase noise analyzer devices that are connected to the PC, including demo mode (HA7062B-DEMO).

NOTE that the firewall for 64 bit Windows machines may attempt to block access to this function. In the Windows Security Alert window, select the Allow access button to proceed.

Select the unit to be controlled by the GUI. If multiple devices are connected and to be controlled, the user must initiate separate instances of the GUI and designate each instance to a separate available unit.

The device name protocol is by part number, followed by serial number. The unique part number/serial number can be found at the rear and/or front panel of the hardware.

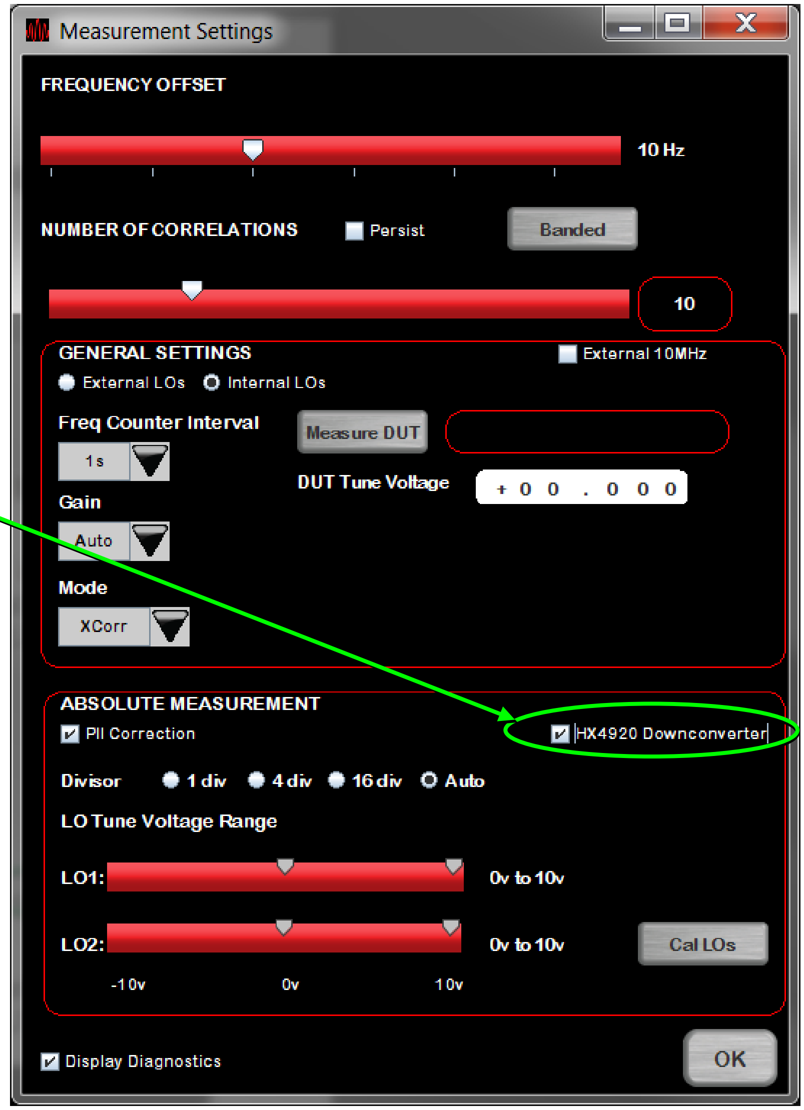
The selected device's unique identifier (part number / serial number) will replace the "No Device Attached" message inside the button, as shown in the diagram above.

NOTE that the GUI is universal for Holzworth phase noise analyzer products. GUI functionality will automatically update to appropriately match the capabilities of the selected /attached device.

7.4 HX4920 INSTALLATION

The Holzworth HX4920 Frequency Downconverter adds high frequency phase noise measurement capability to the HA7062B phase noise analyzer.

Installation of the HX4920 simply involves mating the output to the DUT input of the HA7062B analyzer and supplying 12V_{DC} to the supply input. The HX4920 must be enabled in software by selecting the *HX4920* option under ***Measurement Settings*** **(8.2.8)**.



Once the HX4920 is properly connected and the software is configured properly, as above, the HA7062B can measure DUT phase noise up to 20GHz.

The HX4920 has an additive phase noise floor of -138dBc/Hz at 10kHz offset across the entire operating range, which maintains signal integrity of high performance DUTs.

SPECIFICATIONS [1]

PARAMETER	MIN	TYP	MAX	UNITS	COMMENTS
Input Frequency	4		20	GHz	50 ohms
Input Power	4	7	10	dBm	50 ohms
Output Power	6	8	10	dBm	50 ohms
Phase Noise (Additive)		-138		dBc/Hz	Input Referred, 10kHz offset
DC Supply	9	12	15	V_{DC}	±10%, 100mA
Input RF Connector	SMA Plug, Female				
Output RF Connector	SMA Jack, Male				
DC Connector	SMB Jack, Male				
Housing Dimensions (LxWxH)	2” x 1.625” x 0.5” (50.8mm x 41.3mm x 12.7mm)				

[1] Specifications are subject to change per the discretion of Holzworth Instrumentation, Inc.

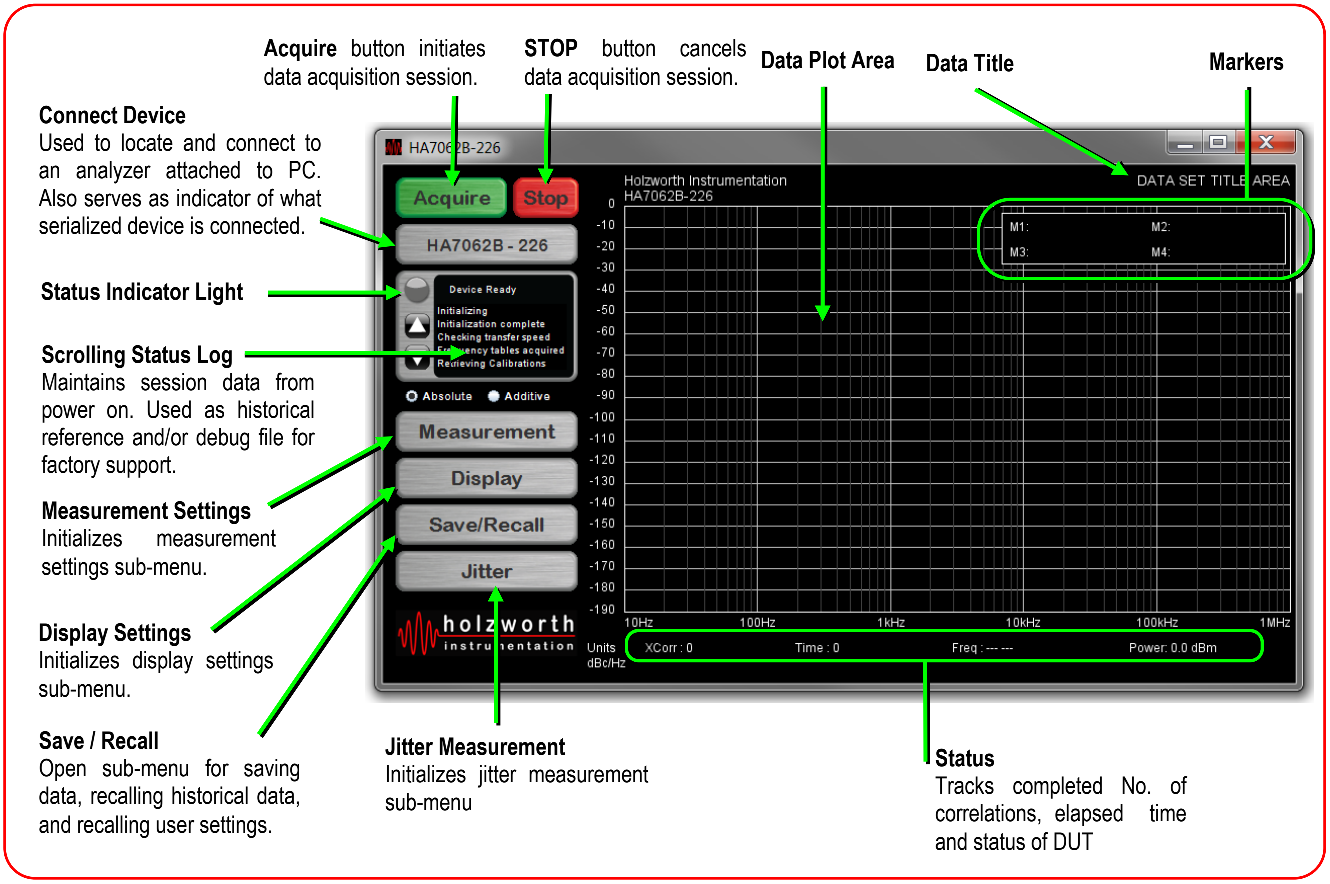
8.0 APPLICATION GUI / OPERATION

The application GUI is opened by double clicking on the “HolzworthPNA.jar” executable file.

This section defines the basic operation of the standard application GUI that is provided for the phase noise analyzer platform. If the Holzworth was ordered with the OPT-FIRM option, then a separate document will have been supplied, which outlines the operation of the custom application GUI.

8.1 MEASUREMENT DASHBOARD

The measurement dashboard contains the data display, status indicators and is the access portal to all of the analyzer settings.



8.1.1 Keyboard and Mouse Functions

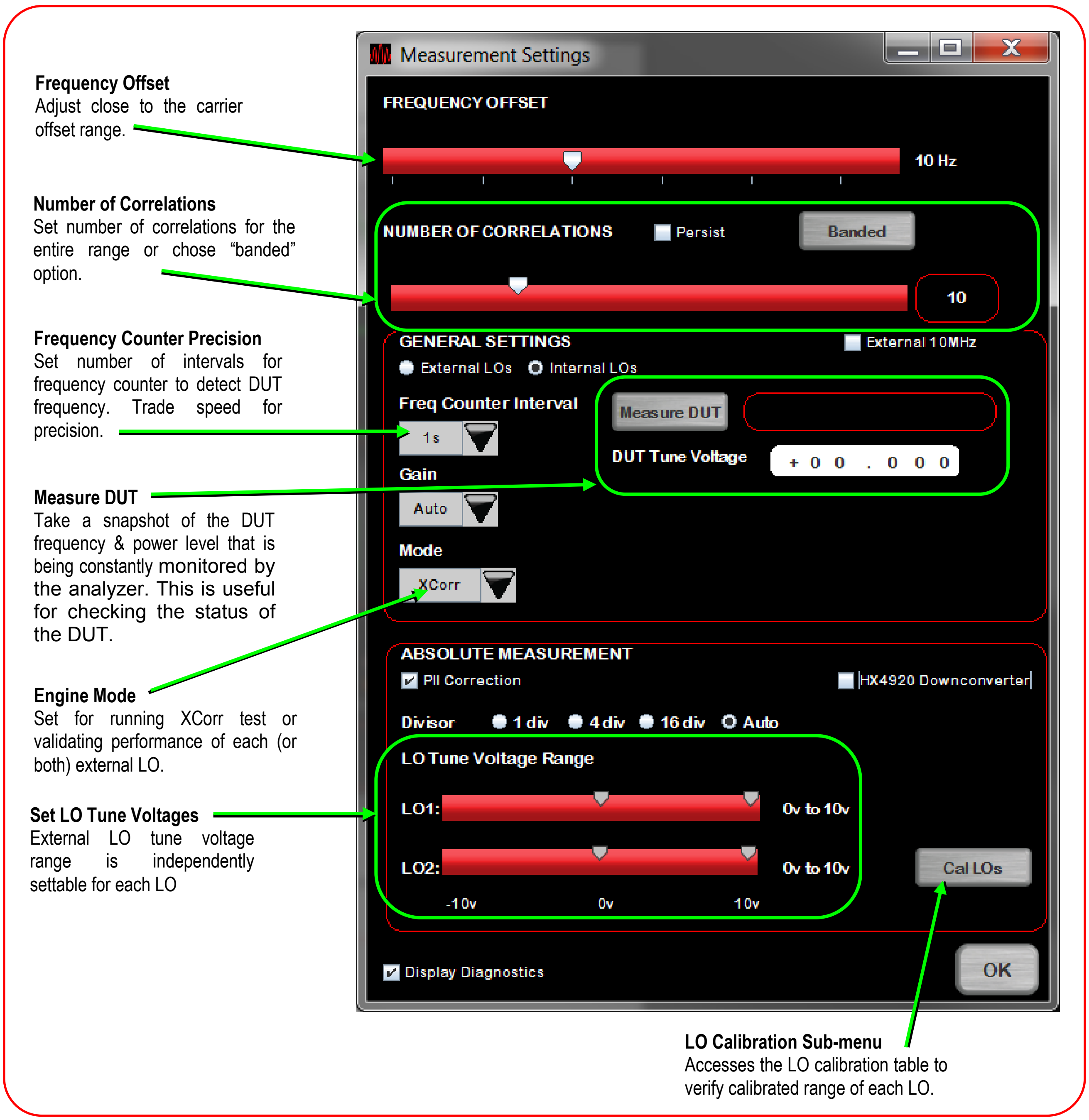
As a virtual instrument, the PC keyboard and mouse functions are intuitively integrated for ease of operation.

KEY	FUNCTION
Tab	used to move the Highlighted Field indicator from left to right
Left/Right Arrows	used to move the Highlighted Field both left and right
Up/Down Arrows	used to increase/decrease the value of the Highlighted Field
Number Keys	used to directly enter value into active field

8.2 MEASUREMENT SETTINGS SUB-MENU

The *Measurement* button provides access to the measurement settings sub-menu. The functions available in this sub-menu allow for: setting the frequency offset range of the measurement, and the number of correlations (either for the entire band or independently for specific bands).

This submenu also contains the *INPUT* control panel for checking DUT status, and setting up the calibration files for the external LOs. A specific example of external LO calibration is provided in Appendix A.



8.2.1 Frequency Offset Adjustment

The frequency offset of the measurement is fixed at 1MHz for the high frequency offset (far from the carrier). The adjustment is made for lower offsets (close to the carrier). The frequency close to the carrier offset can be set from 1Hz, 10Hz, 100Hz, 1kHz or 10kHz.

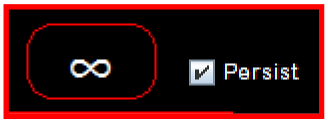
NOTE: Changing the offset will affect both measurement speed and sensitivity.

The data plot area of the measurement dashboard will auto-scale the frequency offset axis based on this setting.

8.2.2 Number of Correlations Settings

Using the slider bar, the number of correlations can be manually set to pre-determined increments between 1 and 10,000 correlations. Furthermore, the number of correlations can be manually set to any specific number of correlations by entering the desired number in the correlations window.

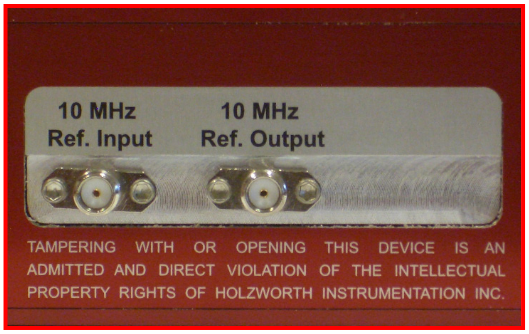
If it is useful for the analyzer to correlate indefinitely, the *Persist* check box can be selected for infinite correlations.



8.2.3 Frequency Counter Precision Setting

The precision of the DUT and LO frequency counters are set to 1 second intervals by default. The user can sue the drop down menu to set the intervals to predetermined values that range between 0.01 seconds and 10 seconds.

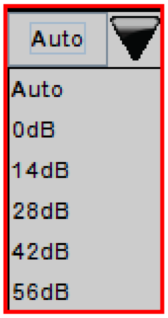
An internal, precision 10MHz reference is used as the synchronization clock for the frequency counter. An external 10MHz reference can be applied to the rear panel of the instrument for synchronization to other peripheral equipment.



NOTE that smaller interval settings will provide greater accuracy in the frequency measurements, but will also increase the amount of time it takes to complete a measurement.

8.2.4 ADC Gain Setting

The ADC *GAIN* settings can be adjusted here to optimize the phase noise measurement. Factory default is *Auto*. Adjusting the gain setting is an advanced user control and Holzworth factory support should be consulted for proper operation of the instrument with these setting changes.



8.2.5 DUT Status Verification

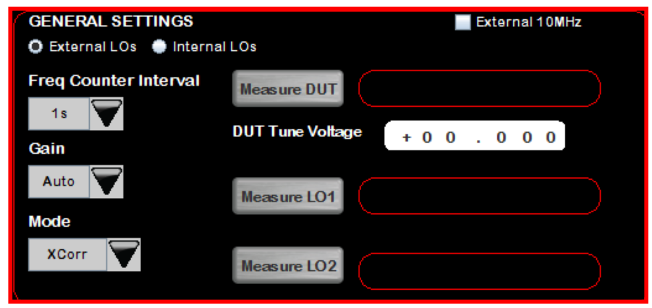
The analyzer constantly monitors the frequency and amplitude of the DUT. However, the DUT status verification function is available to the user as a quick reference tool.

This status function is useful for verification of:

1. ***DUT frequency*** being within the calibrated tune range of the external LOs
2. ***DUT amplitude*** at an optimal level for accurate phase noise measurement

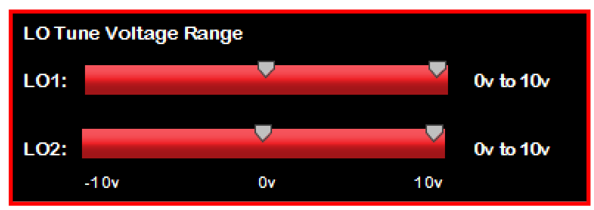
8.2.6 Setting LO Tune Voltage Ranges

When the analyzer is set to External LOs, the software will automatically enable the ability to measure the signal present at both LO ports on the front of the analyzer. This functionality serves as a means to verify the signal frequency and power level on the LO1 and LO2 input ports.



8.2.7 Setting LO Tune Voltage Ranges

Accurately setting the tune voltage range of each external LO is necessary for achieving a valid calibration lookup table. The external LO devices must be non-coherent to one another.



The phase noise performance of each LO should be similar. However, the tune voltage slope of the external LOs devices need not be similar. Furthermore, their tune voltage slopes could be completely opposite one another.

8.2.8 LO Calibration Sub-Menu

Access the LO Calibration sub-menu by depressing the *Cal LOs* button. Press the SAVE button to store the calibration data to the instrument's internal memory.

To account for any drifting of the internal references, **Internal LOs** should be manually calibrated using this sub-menu every 3 months (in the 1st year of use). An annual calibration is recommended after the 1st year of use. The system will notify the user when a new calibration of the internal LOs is required. The instrument must have been powered on for ten minutes prior to calibration to ensure that the OCXOs are fully warmed up and stable.

Internal LO1

Tune Voltages	Frequency	Power
0	999.980 268 0 MHz	5.3 dBm
0.50	999.981 644 0 MHz	5.3 dBm
1	999.983 320 0 MHz	5.2 dBm
1.50	999.984 956 0 MHz	5.2 dBm
2	999.986 440 0 MHz	5.2 dBm
2.50	999.987 794 0 MHz	5.2 dBm
3	999.989 068 0 MHz	5.1 dBm
3.50	999.990 330 0 MHz	5.2 dBm
4	999.991 636 0 MHz	5.2 dBm
4.50	999.993 014 0 MHz	5.2 dBm
5	999.994 492 0 MHz	5.2 dBm
5.50	999.996 060 0 MHz	5.2 dBm
6	999.997 716 0 MHz	5.2 dBm
6.50	999.999 440 0 MHz	5.2 dBm
7	1 000.001 208 0 MHz	5.2 dBm
7.50	1 000.002 996 0 MHz	5.2 dBm
8	1 000.004 774 0 MHz	5.2 dBm
8.50	1 000.006 526 0 MHz	5.2 dBm
9	1 000.008 240 0 MHz	5.2 dBm
9.50	1 000.009 898 0 MHz	5.2 dBm
10	1 000.011 502 0 MHz	5.2 dBm

Internal LO2

Tune Voltages	Frequency	Power
0	999.978 724 0 MHz	5.4 dBm
0.50	999.979 618 0 MHz	5.4 dBm
1	999.980 654 0 MHz	5.4 dBm
1.50	999.981 806 0 MHz	5.4 dBm
2	999.983 038 0 MHz	5.4 dBm
2.50	999.984 336 0 MHz	5.4 dBm
3	999.985 708 0 MHz	5.4 dBm
3.50	999.987 184 0 MHz	5.4 dBm
4	999.988 786 0 MHz	5.4 dBm
4.50	999.990 530 0 MHz	5.4 dBm
5	999.992 408 0 MHz	5.4 dBm
5.50	999.994 406 0 MHz	5.4 dBm
6	999.996 506 0 MHz	5.4 dBm
6.50	999.998 674 0 MHz	5.4 dBm
7	1 000.000 884 0 MHz	5.4 dBm
7.50	1 000.003 092 0 MHz	5.4 dBm
8	1 000.005 270 0 MHz	5.4 dBm
8.50	1 000.007 404 0 MHz	5.4 dBm
9	1 000.009 470 0 MHz	5.4 dBm
9.50	1 000.011 458 0 MHz	5.4 dBm
10	1 000.013 368 0 MHz	5.4 dBm

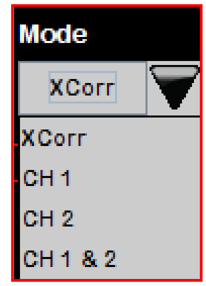
(NOTE: When calibrating the instrument's internal LOs, nothing can be attached to the LO or DUT inputs on the front panel.)

External LOs must be calibrated prior to performing a measurement. As with the internal LOs, the external LOs must be fully warmed up prior to calibration.

The LO calibration table is also a valuable reference for External LO Mode to verify that the DUT is within the calibrated range of the LOs for proper phase locking.

Refer to the measurement examples in the Appendices for more details.

8.2.9 Analyzer Engine Mode

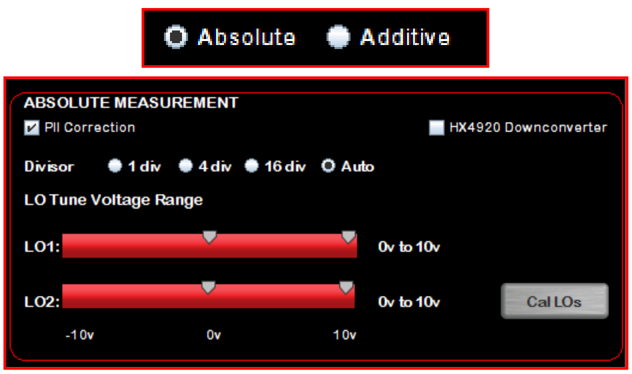


The analyzer engine MODE can be used as a way to verify the performance of each LO individually or at the same time. By default, *XCorr* mode is selected for running the analyzer to test a DUT. Selecting *CH 1* will run a phase noise floor verification test of the external source connected to the LO1 input port. Likewise, selecting *CH 2* will run a phase noise floor verification test of the external source connected to the LO2 input port. Selecting *CH 1 & CH 2* will overlap the phase noise floor of both external LO sources.

NOTE that both external LO sources and a DUT must be connected in order for any MODE to be active and display data in the measurement dashboard plot area.

8.2.10 Absolute/Additive Measurement Settings

The *Absolute/Additive Measurement* section provides access to set the instrument up for the type of phase noise measurement being made. This section will change based on the type of measurement selected on the main page of the GUI.



If using the HX4920 Frequency Downconverter on the front end of an HA7062B analyzer, the *ABSOLUTE MEASUREMENT* section contains the option to select this component in order to enable phase noise measurements of DUTs up to 20GHz.

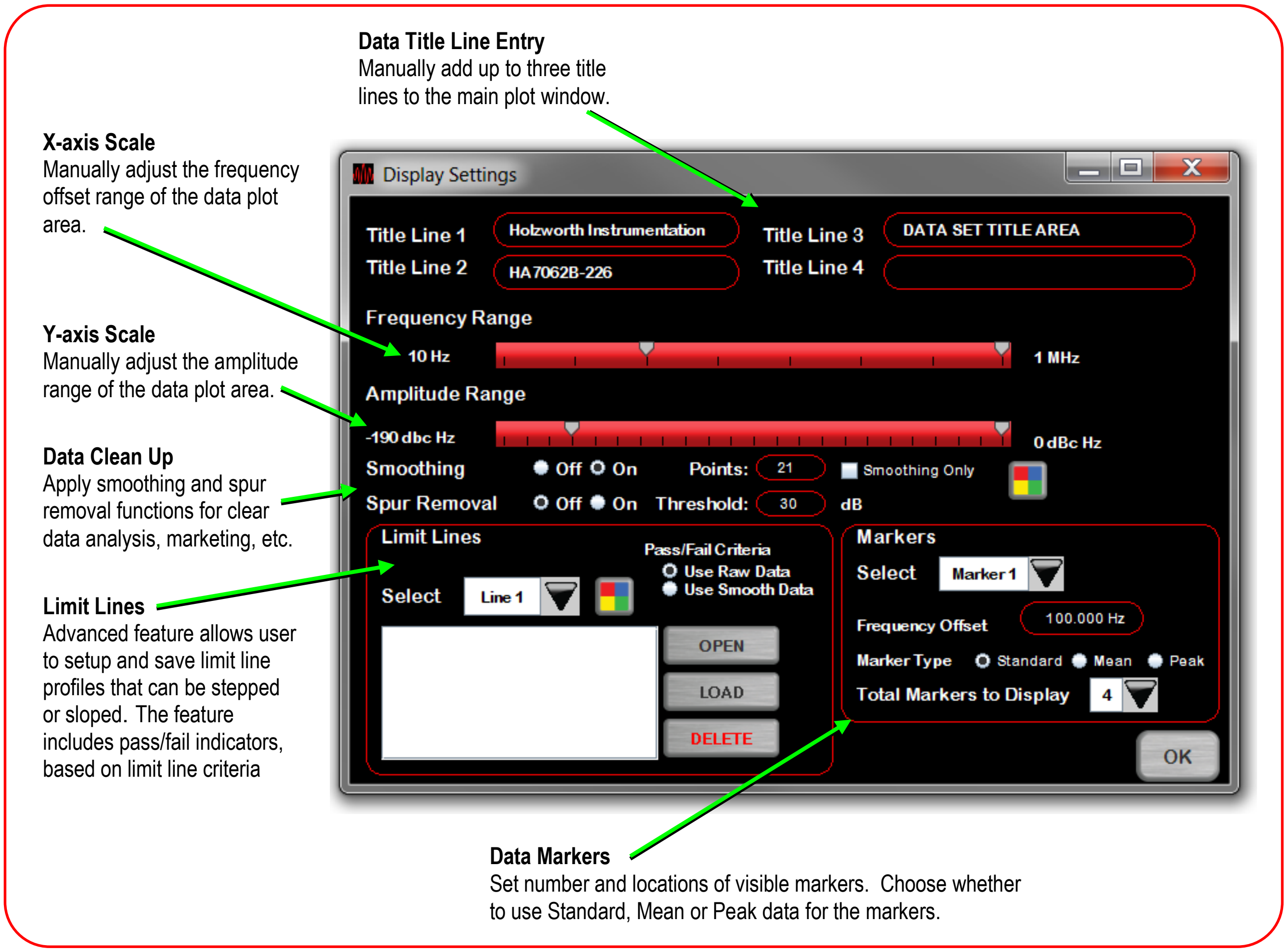
When *Additive* is selected on the main page of the GUI, the *ADDITIVE MEASUREMENT* section can be used to configure any of the Holzworth calibration kits that are available as external add-ons to simplify the process of performing additive phase noise measurements.

NOTE: Kd = Phase Detector Constant

Kd is the Phase Detector Constant. Kd is automatically calculated and loaded for all Absolute phase noise measurements. When making Additive (Residual) phase noise measurements, the *Quadrature Monitor* tool is used to calculate Kd once quadrature is achieved via phase offset adjustments. Kd is then manually entered into this field by pressing the *Apply Kd* button inside the *Quadrature Monitor* sub-menu.

8.3 DISPLAY SETTINGS SUB-MENU

The Display button provides access to the Display Settings sub-menu. Display settings allow for title insertion, adjusting the scale of the axes, entering test limit lines, and applying smoothing/spur removal functions.



8.3.1 X-Axis Scale: Frequency Offset

Adjust the frequency offset range of the data plot area with the *Start* and *Stop* frequency slide bars. Start Frequency Offset can be adjusted in decades from 1Hz to 10kHz.

NOTE that the X-axis will automatically scale to match the measurement offset range that is setup in the *Measurement Sub-Menu*.

Refer to section 8.6 for instructions for applying the mouse zoom function directly to the data plot area.

8.3.2 Y-Axis Scale: Amplitude

Adjust the amplitude range of the data plot area with the *Maximum* and *Minimum* amplitude range slide bars. The overall range limits are 0dBc/Hz to -220dBc/Hz and the the Y-axis will automatically default to these maximum limits when the application GUI is first initiated.

Refer to section 8.6 for instructions for applying the mouse zoom function directly to the data plot area.

8.3.3 Smoothing Function

The *Smoothing* function can be applied to the data and viewed simultaneously with the raw data or the user can view only the smoothed data by clicking the *Smoothing Only* checkbox.

The smoothing function applies an N number of points as a sliding-average algorithm to compute the smoothing curve. The user enters an odd value for the number of Points. If an even number is entered, the application will round up to the next odd number to apply the curve.

Each point in the smoothing curve is calculated as the sum of the original raw point plus half of the number of points on each side of the raw point. The sum is then divided by the number of smoothing points resulting in the smoothed point in the calculated curve.

8.3.4 Spur Removal Function

The *Spur Removal* function is applied based on a spur *Threshold* value as entered by the user. Unlike the *Smoothing* function, the *Spur Removal* function is applied directly to the raw data and/or smoothed data that is viewable on the screen.

The *Spur Removal* function, creates a smoothed curve for comparison with the raw data. A point-by-point comparison between the raw data and the smoothed data is made. If the difference between a raw data point and the corresponding smoothed data point is greater than the *Threshold* value, then the spur is reduced to the level of the *Threshold* value.

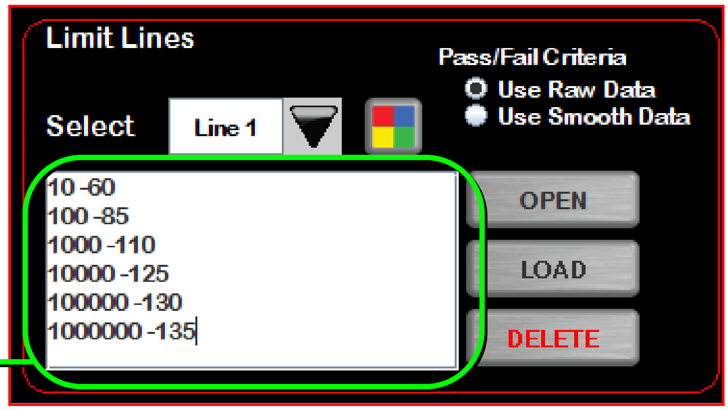
Note that applying the Spur Removal function to the data does not affect the raw data when saving. Rather, the software will save both the raw data and the Spur Removal data into separate .csv files. Refer to section 8.4 for more information on saving data.

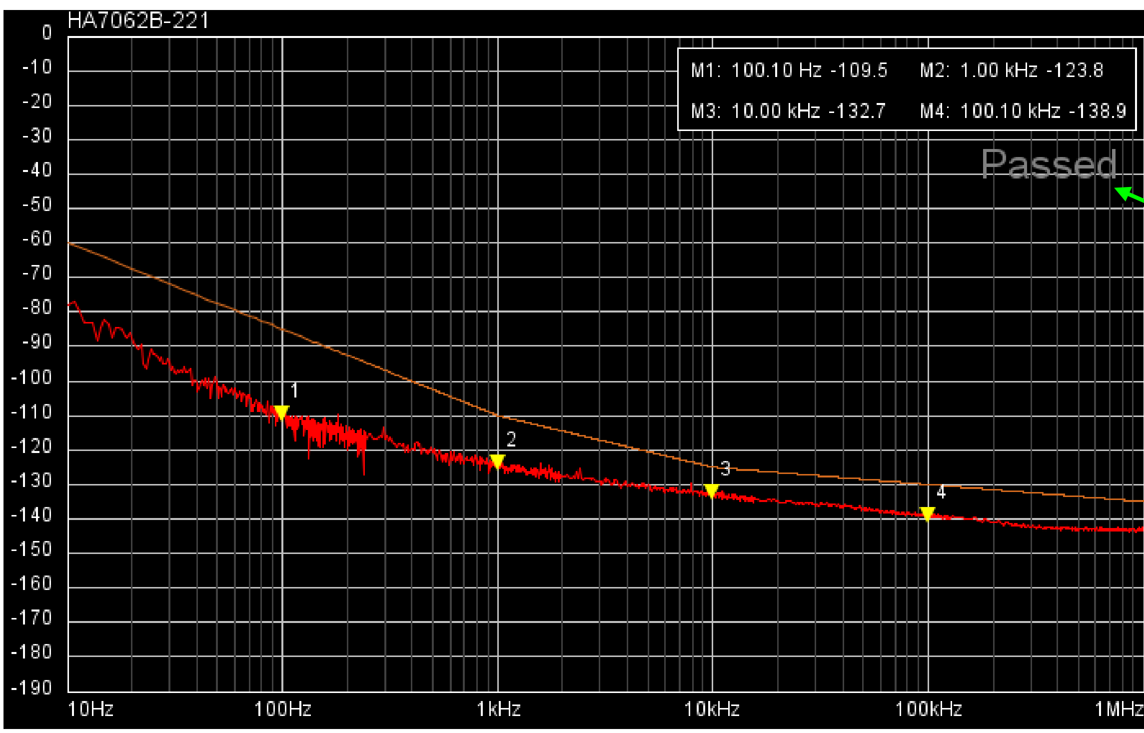
8.3.5 Test Limit Lines

The *Limit Lines* section is used to insert up to 10 different limit lines into the plot area. The limit lines incorporate a pass/fail indicator for when the DUT performance has not met the set test limits. Pass/Fail can be determined using raw or smoothed plot data.

Test Limit Lines are setup using a standard “x - y” coordinate system, stacking up as many points as required to define a stepped, sloping, or curved limit line.

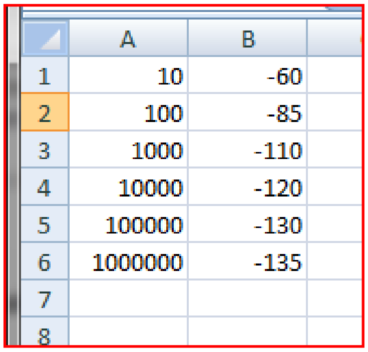
As shown here, a single, 6 point limit line is built point-by-point in the data entry field. The X coordinate is the frequency offset in Hz, while the Y coordinate is the amplitude in dBc/Hz. Once all points have been entered, pressing the *LOAD* button will apply the curve to the data plot. The X,Y coordinates for each point can be separated by a space or a comma.





Pass / Fail Indicator
Automatically monitors data crossover when a limit line has been applied to the plot

Using the same limit line example, test limit lines can be preconfigured using a program like MS Excel to create a .CSV file to define limit lines that can be saved and then quickly loaded as necessary for repeat use.



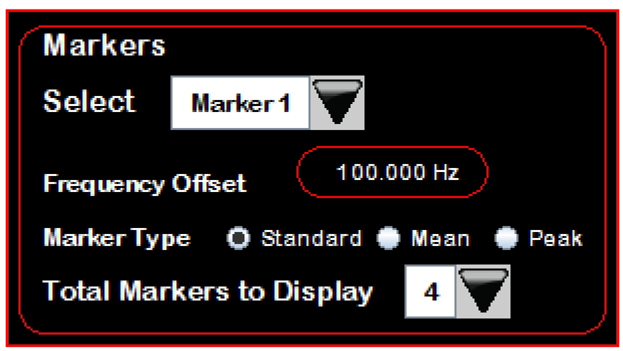
	A	B
1	10	-60
2	100	-85
3	1000	-110
4	10000	-120
5	100000	-130
6	1000000	-135
7		
8		

Using the same limit line example, the file would be setup with column A being all the X (frequency offset) coordinates and column B being all the Y (amplitude) coordinates.

Once the .CSV file has been saved, the user will select the *OPEN* button to locate the file. Opening the file will load the coordinates into the data entry field. Note that the user must finalize the process by pressing the LOAD button to apply the limit line to the data plot area.

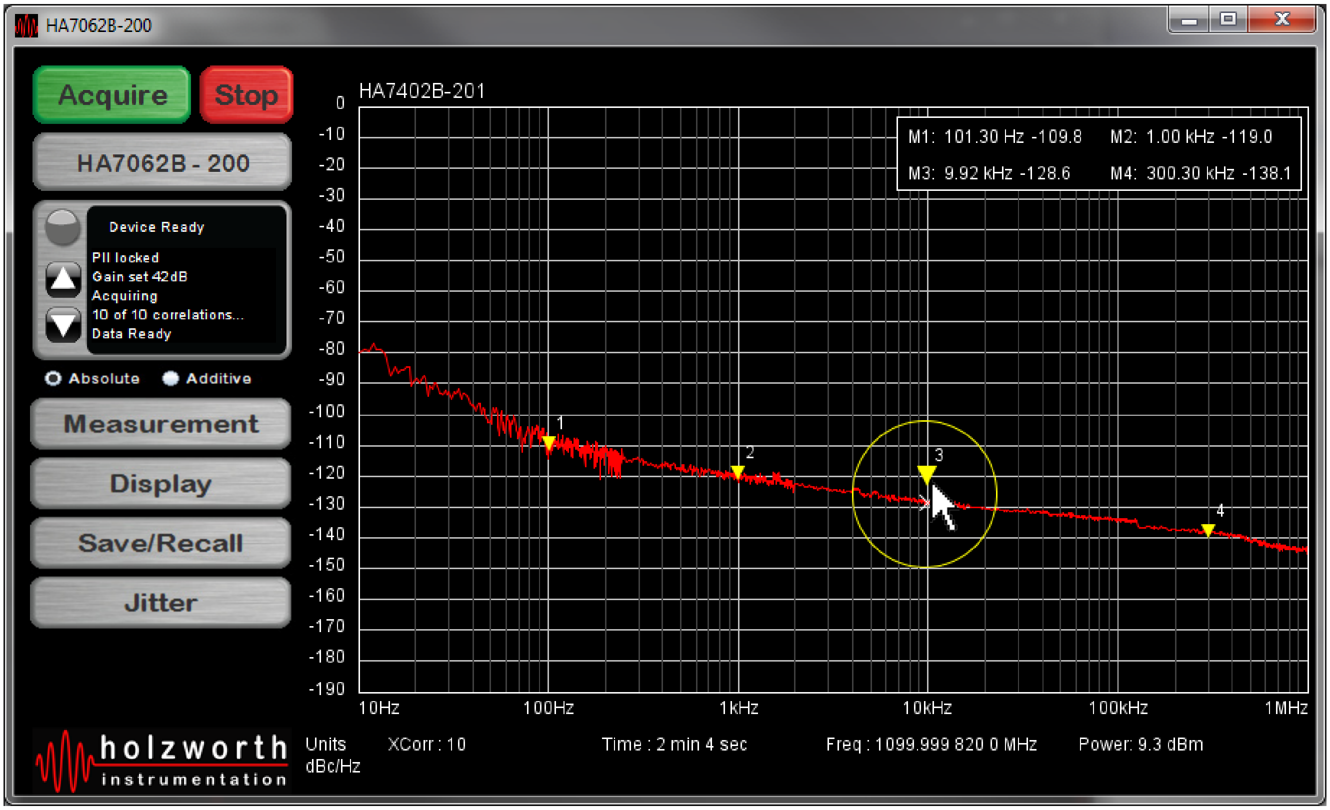
8.3.6 Set Trace Markers

Trace markers can also be configured from within the display settings sub-menu. Up to ten markers can be displayed at once on an individual trace. The number of markers to be displayed must be set using the "Total Markers to Display" drop-down menu. Up to ten markers can be displayed in a plot window. The frequency offset and marker type can them be set for each by choosing the marker (from 1 to the total number displayed) using the "Select" drop-down menu at the top of the window.



Marker Type can be independently set for each marker. If "Standard" is selected, the software will place the marker at the exact amplitude level associated with the marker offset data point. Selecting "Mean" will initiate a smoothing calculation as described above in section 8.3.3 and place the marker amplitude at the value calculated for the chosen offset, without actually displaying the "Smoothing" data trace. Markers set to "Peak" will be placed at the maximum amplitude located by the software over a limited range of data around the frequency offset.

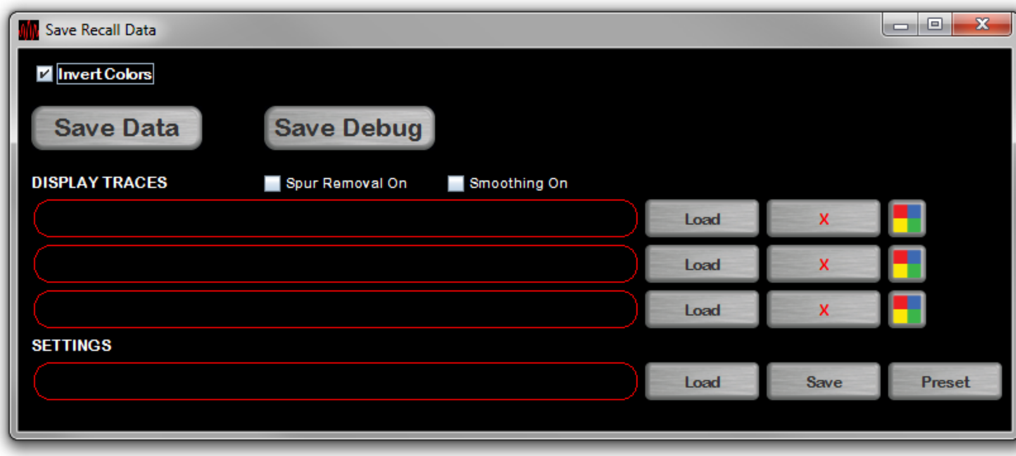
The marker position can also be modified by utilizing a "drag and drop" operation. Simply move the cursor arrow over an active marker and left click. As demonstrated below, an indicator circle with highlight the marker and it can then be moved.



Markers can be removed either by changing the number of markers in the drop down menu under advanced display settings or simply by clicking and dragging off of the plot area.

8.4 SAVE / RECALL SUB-MENU

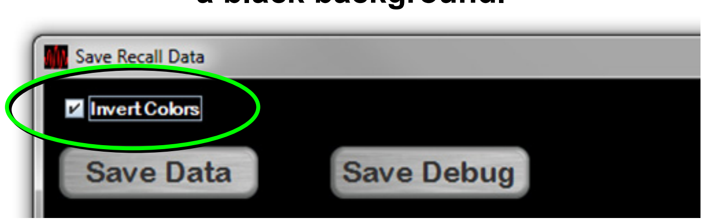
Saving data and/or recalling previously saved data is available via the *Save/Recall* sub-menu. This menu offers many useful functions: *Save Data*, image file and .CSV file(s); *Save Debug,* for use with factory troubleshooting support; *Load Traces*, for loading previously saved .CSV files for reference; and a *Save/Load Settings* operation.



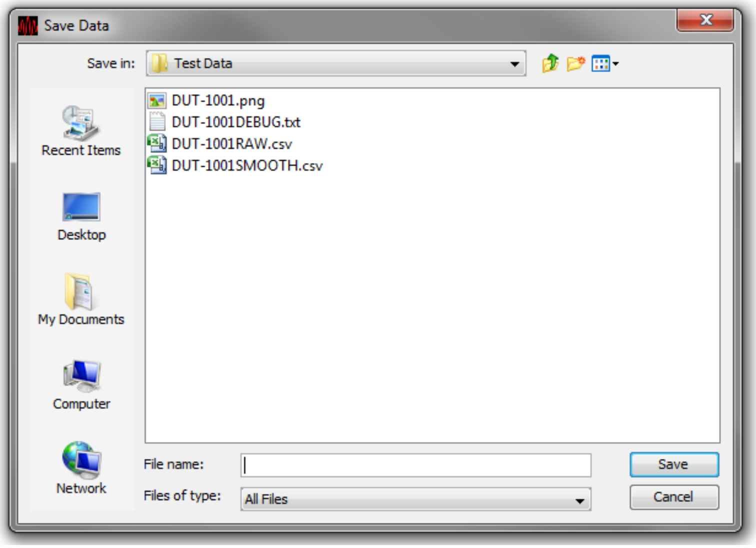
8.4.1 Saving Data

The HA7000 Series Analyzers are setup to save all the data necessary for total recall with the push of a button. When data is saved, the analyzer will automatically save an image file in a .PNG format and a raw data file in a .CSV format. Note that the image file will be a screen capture of whatever data is displayed in the plot area at the time of making the save.

NOTE: By default the save data is set to "Invert Colors," which will result in the plot being saved with a white background. Disable this option to save with a black background.



Clicking the Save Data button will open a Save Data window. The File Name given to the data set will be applied to the .PNG image file and the .CSV data file(s).



In this example, 2 different .CSV files have been saved. The "*filename*RAW" file contains 100% raw data including all spurs and no averaging (smoothing). The RAW file is the default and will always be saved for any given data set.

In addition, if the *Smoothing* and/or *Spur Removal* function have been applied to the data plot, a separate CSV data file will be saved as "*filename*SMOOTH". This .CSV data file will contain the corrected data, representative of what is shown in the saved data image for the session.

8.4.2 Saving the Debug file

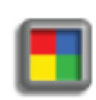
The occasional need for technical support is made straight forward by the *Save Debug* function. If during a session, the instrument is not acquiring data properly or there is some other function that seems to be suspect, saving the debug .TXT file will capture the entire status log from when the instrument was last powered on. A debug file will also be saved along with plot data when "Save Data" is selected.

The information in the debug file is extremely useful to Holzworth technical support to quickly resolve issues. It will help isolate an issue to analyzer test hardware, external LOs or the DUT. This .TXT file can be emailed to Holzworth technical support at support@holzworth.com for a quick solution.

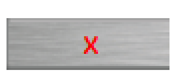
8.4.3 Display Traces

The Display Traces function allows a user to load up to 3 separate traces that have been previously saved in a .CSV format. These traces can be data that has been saved from the HA7062B or from an analyzer made by an alternate manufacturer. Furthermore, hand built .CSV files can also be loaded.

Once the traces are loaded, the color of each trace can be changed by pressing the color button. This will access the Trace Line Color sub-menu. Select the new color and press the *OK* button.



To remove a trace, simply press



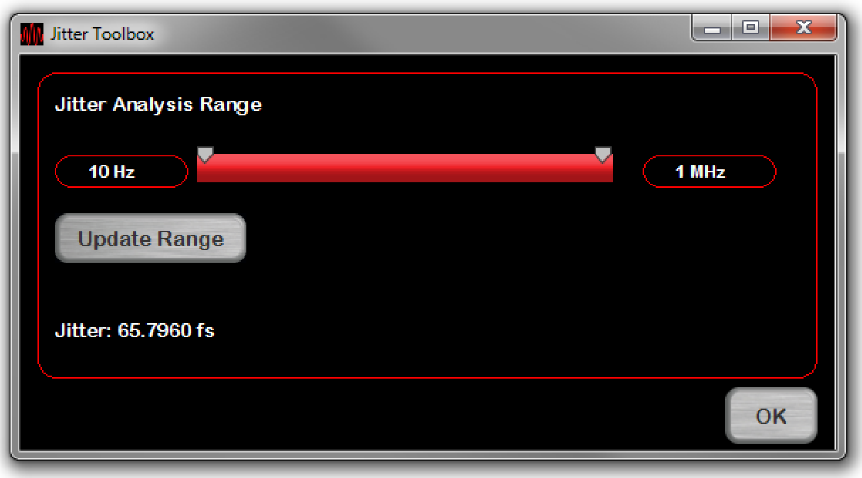
8.4.4 Settings Save / Recall

Settings Save/Recall is an extremely valuable, time saving function for applications where tests will be repeated again at a later time. This function area allows the user to save all of the instrument settings, including limit lines, etc. from a given test session. When performing the test in the future, the entire setup can be recalled and loaded.

The saved settings file will be saved in an .XML format. If a single .XML settings file is saved in the same location as the HA7062B .JAR file, it will automatically load each time the GUI is activated. If more than one settings .XML file is saved in the same folder location as the .JAR file, no settings file will be auto-loaded.

8.5 JITTER MEASUREMENT SUB-MENU

The Holzworth GUI has the ability to convert phase noise data into jitter information. Clicking on the *Jitter* button on the main page of the GUI brings up the Jitter measurement sub-menu. From this menu, the user can select the bandwidth over which the software will approximate the jitter value (in femtoseconds).



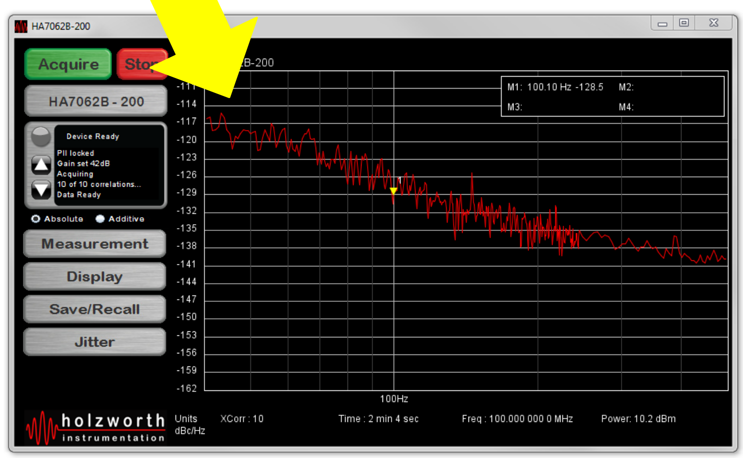
The Jitter value will continually update as long as phase noise data is being collected. The range can be changed at any time during the measurement, but will not be applied until the *Update Range* button is clicked.

8.6 DISPLAY DATA ZOOM

A quick zoom function is available to the user both during data acquisition or after the measurement has ended. The user can zoom in on a section of the plot area by holding down the right mouse button dragging the mouse to define the zoom area. This function can be applied as many times as desired by repeating the operation to zoom in closer and closer to the area of interest.

Note that saving data when the plot area has been zoomed will result in a saved PDF image file of the precise data scale that is being viewed.

Zoom back to normal scale by double clicking the left or right mouse button with the mouse pointer located inside the plot area.



9.0 CONTACT INFORMATION

Contact Holzworth directly for product support. A list of US Sales Representatives and non-US Distribution partners are listed on the Holzworth website.

Holzworth Instrumentation Sales Support

Phone: +1.303.325.3473 (option 1)

Email: sales@holzworth.com

Holzworth Instrumentation Technical Support

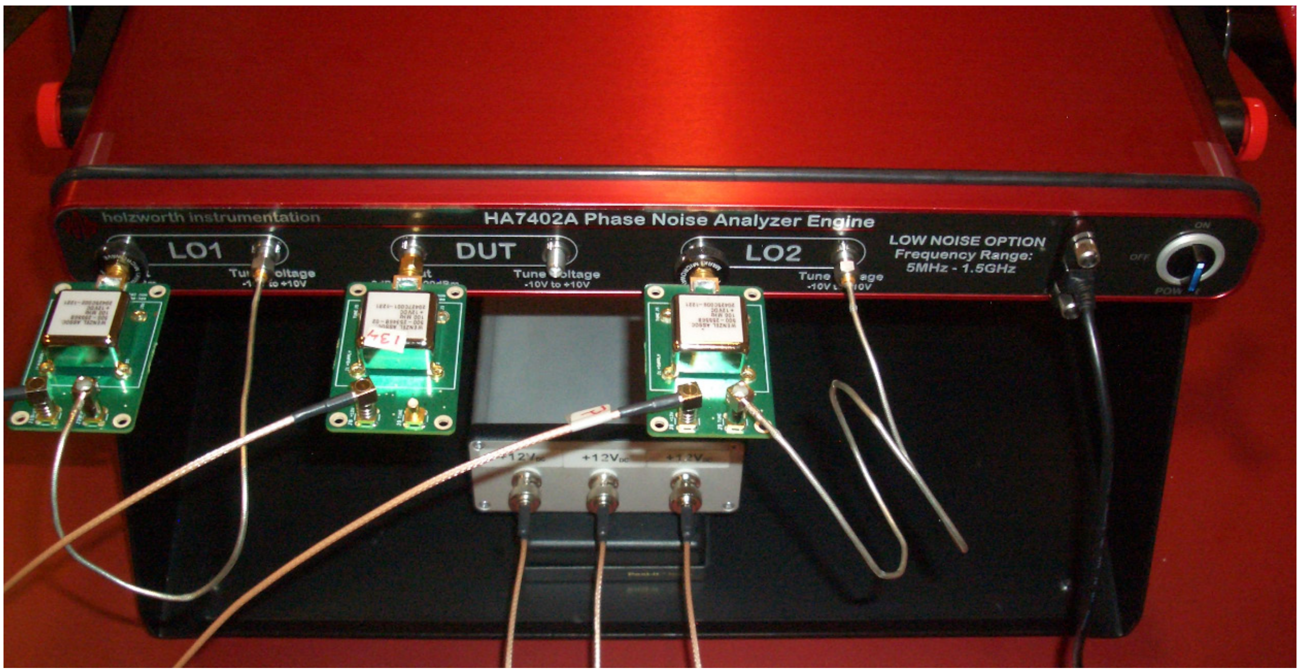
Phone: +1.303.325.3473 (option 2)

Email: support@holzworth.com

www.HOLZWORTH.com

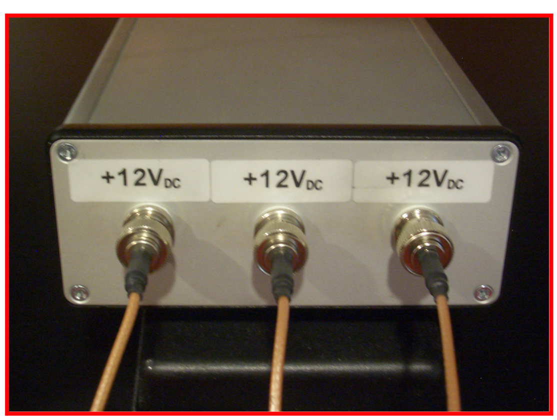
APPENDIX A:
EXTERNAL LO MODE - ABSOLUTE MEASUREMENT EXAMPLE

The example provided here is a phase noise test performed on a 100MHz OCXO, using an HA7402B that is equipped with OPT-PD1 (low noise front end). The procedure and settings are identical for an HA7062B. For demonstrational purposes, the external LOs used are 100MHz OCXOs exhibiting phase noise performance that is approximately 5 dB worse than that of the DUT.



HA7042B with External LOs and DUT connected

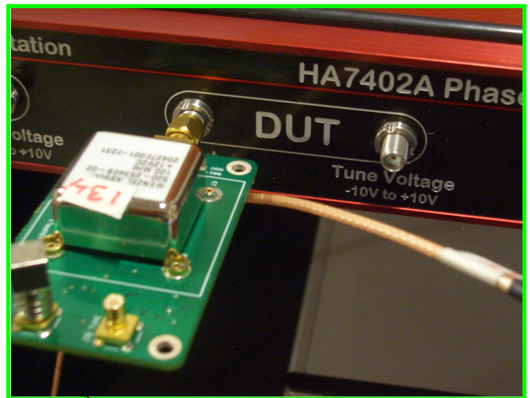
For the most optimal, spur free phase noise measurements, Holzworth engineering recommends the use of batteries as the power supplies for the DUT and the LOs. Holzworth engineering uses Nickel Cadmium, rechargeable battery packs in various configurations to achieve necessary voltage levels. This example uses a triple, 12V NiCad battery pack.

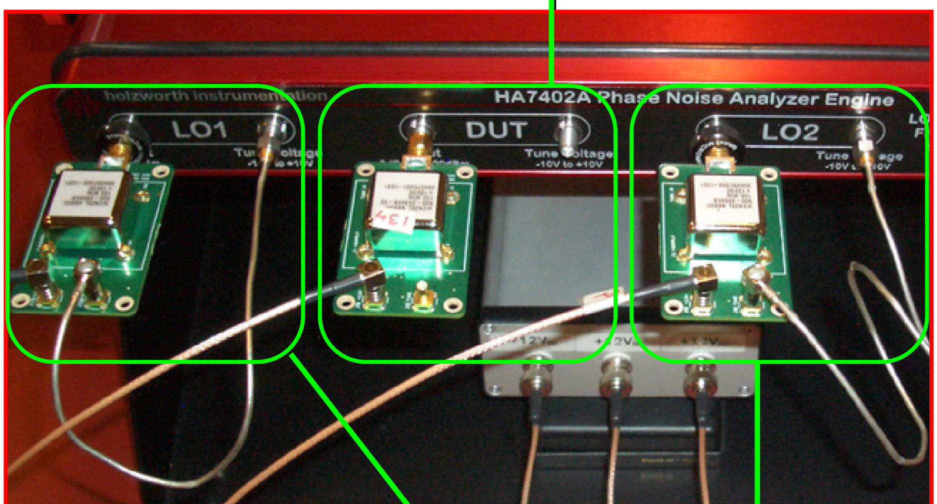


3x 12V_{DC} NiCad Battery Pack

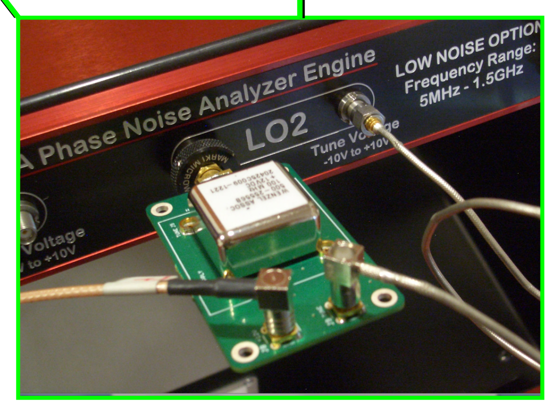
HARDWARE CONFIGURATION

DUT Connection
In the case of an OCXO, the DUT is used as a free running device. Therefore, there is no connection made to the *Tune Voltage* port of the analyzer. **NOTE** that the Tune Voltage port can also be manually set to a fixed voltage to be used as a low current power supply (limited to approximately 10mA).





LO Connection
For proper calibration and operation the LO sources must each have a tune voltage port available to connect to the respective *Tune Voltage* output port of the analyzer. **NOTE** that two non-coherent LO sources must be used. Power dividing a single LO source will not allow the analyzer to function properly.



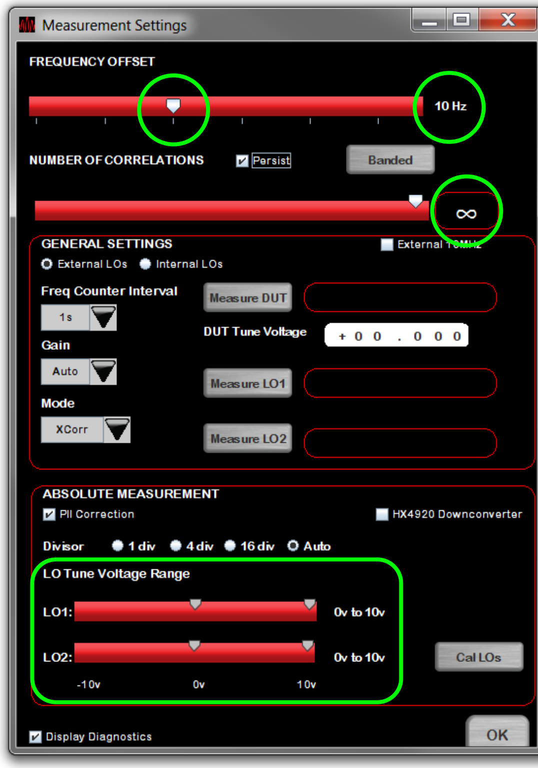
Once the DUT and LOs are setup and phase noise analyzer is connected to the GUI on the host PC, the steps towards making the measurement are as follows:

1. ADJUST MEASUREMENT SETTINGS

To balance noise floor performance with measurement speed, the tables in section 6.3 and 6.4, as well as the sensitivity chart in section 6.8 were referenced.

Per the introduction, it is understood that the cross correlation engine will need to improve the phase noise floor of the LOs by 5dB in order to accurately measure the DUT. The table in section 6.4 shows that 5dB improvement will require 10 correlations. The table in section 6.3 shows that for a 10Hz close to the carrier offset limit, the analyzer engine will take 3.2 seconds per correlation. Therefore, a valid measurement of the DUT should occur in approximately 32 seconds, not including transfer time (also included in the table located in section 6.3).

For this example, the number of correlations were set to *infinite* by selecting the *Persist* check box.



2. VERIFY DUT AND LO FREQUENCY & AMPLITUDE

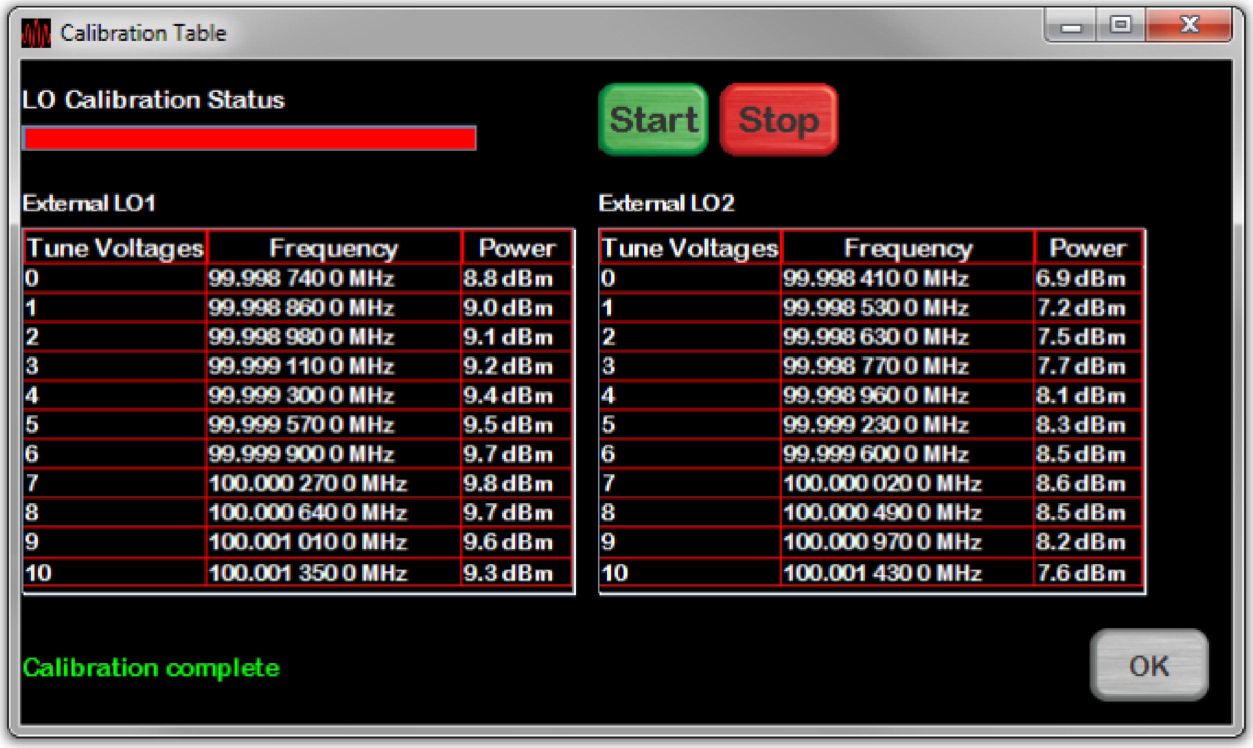
Verification that the DUT is properly connected and that it has stabilized is as simple as pressing the *Measure DUT* button. The analyzer is constantly monitoring the status of the DUT and LO sources, but this step is a fast method for the user to verify that the DUT is operating properly for making a phase noise measurement.

3. SET EXTERNAL LO TUNE VOLTAGE RANGES

Both external LO sources have a tune voltage range that is closest to $0V_{DC}$ to $10V_{DC}$. As shown in the figure above, the *Tune Voltage Range* for both LO1 and LO2 are appropriately set to" 0 to 10V". **Note** that even though the phase noise performance of the external LOs should be similar, the tune voltages and their slopes need not be the same. The analyzer will make the appropriate adjustments if the proper tune voltage range has been set.

4. CALIBRATE EXTERNAL LOs

In this example, both external LO sources have a tune voltage range that is closest to $0V_{DC}$ to $10V_{DC}$. **NOTE** that for the system to properly calibrate the LOs, each LO must be connected to its respective *Tune Voltage* port and DUT must also be connected to the system.



External LO1

Tune Voltages	Frequency	Power
0	99.998 740 0 MHz	8.8 dBm
1	99.998 860 0 MHz	9.0 dBm
2	99.998 980 0 MHz	9.1 dBm
3	99.999 110 0 MHz	9.2 dBm
4	99.999 300 0 MHz	9.4 dBm
5	99.999 570 0 MHz	9.5 dBm
6	99.999 900 0 MHz	9.7 dBm
7	100.000 270 0 MHz	9.8 dBm
8	100.000 640 0 MHz	9.7 dBm
9	100.001 010 0 MHz	9.6 dBm
10	100.001 350 0 MHz	9.3 dBm

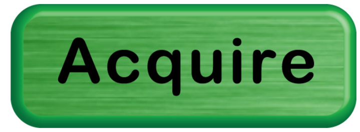
External LO2

Tune Voltages	Frequency	Power
0	99.998 410 0 MHz	6.9 dBm
1	99.998 530 0 MHz	7.2 dBm
2	99.998 630 0 MHz	7.5 dBm
3	99.998 770 0 MHz	7.7 dBm
4	99.998 960 0 MHz	8.1 dBm
5	99.999 230 0 MHz	8.3 dBm
6	99.999 600 0 MHz	8.5 dBm
7	100.000 020 0 MHz	8.6 dBm
8	100.000 490 0 MHz	8.5 dBm
9	100.000 970 0 MHz	8.2 dBm
10	100.001 430 0 MHz	7.6 dBm

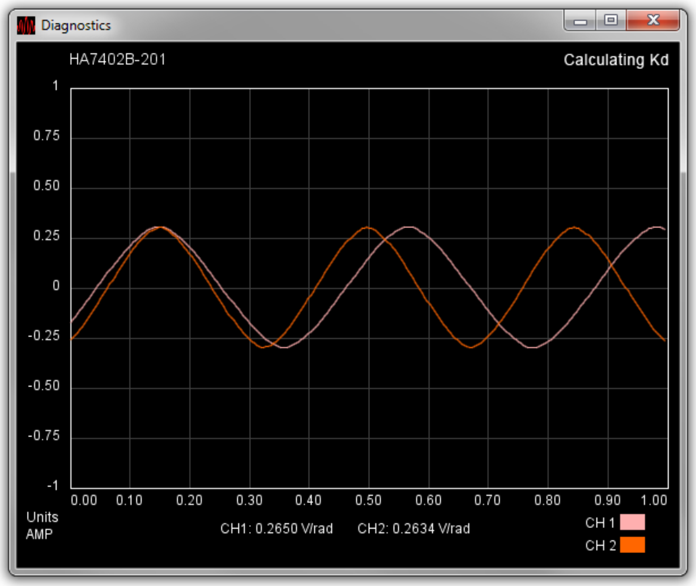
The LO calibration is fully automated. Upon selecting *Start*, the calibration speed is automatically adjusted by the system as it calculates and sets the time base interval. Once the calibration tables are fully populated, the message “Calibration complete” will appear in the lower left hand corner. At this point, the user can close the *Calibration Table* window and proceed to begin the measurement.

5. MEASURING THE DUT

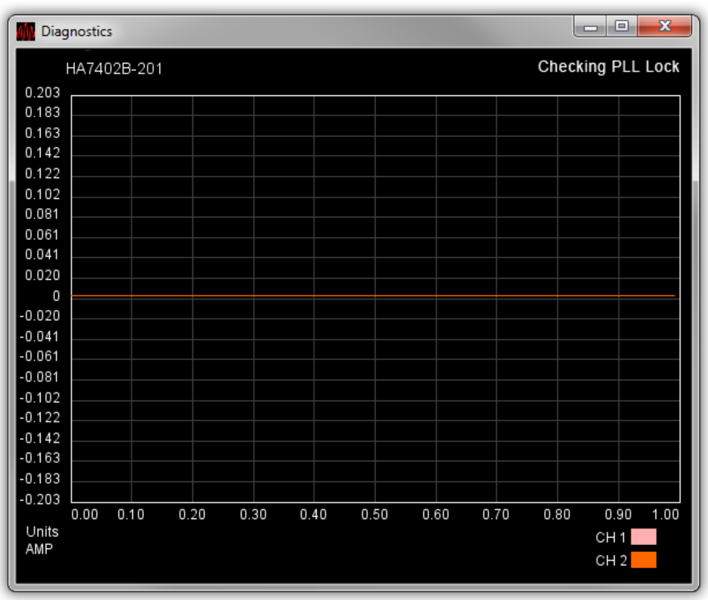
Press the *Acquire* button to initiate the measurement. The user can see that the status log will begin recording calibration status, power levels, gain settings, etc. as it goes through the various stages of the DUT phase locking process.



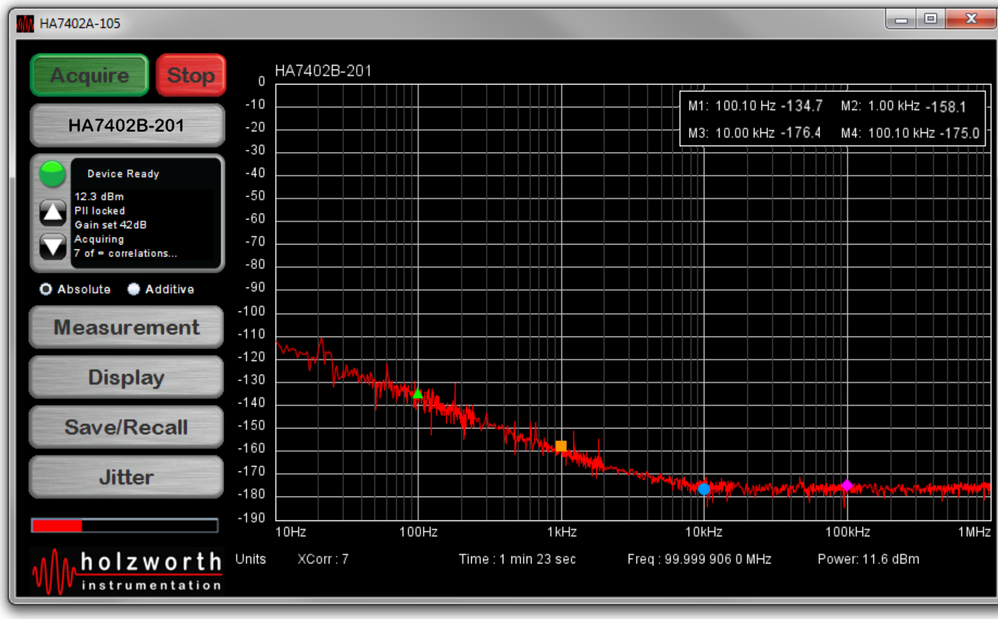
The system will initiate a Diagnostics window as it calculates Kd (Phase Detector Constant) for each channel.



Once Kd has been calculated, the value is loaded into the system and the Diagnostics window will then change over to verify a proper phase lock to the DUT.



Once the system is phase locked to the DUT the “Acquiring” step will appear in the log window and the data acquisition will begin.



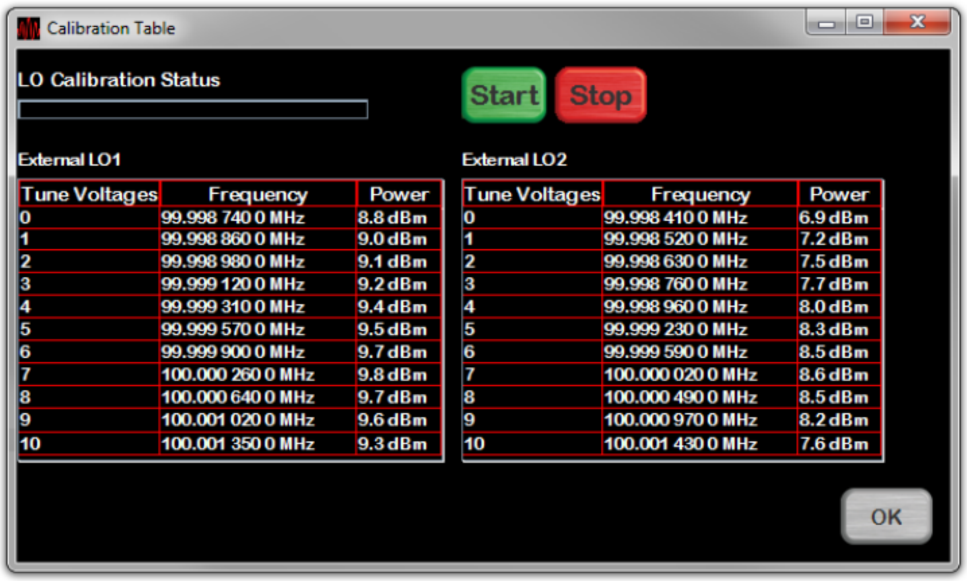
Data will be displayed as it becomes available by band, starting with the offset band that is furthest from the carrier (125kHz to 1MHz). Therefore the data with appear to “stack up” as each correlation for the respective band is complete, which gives the appearance of a more real time data update occurring with the band located furthest from the carrier.

The status bar in the lower left hand of the main dashboard will reach 100% at the end of one full correlation for the band that is set closest to the carrier. The range of each band is shown in section 8.2.2.

6. CALIBRATION VERIFICATION

In the event a measurement has failed to initiate, the most likely scenario is that the LOs are not properly phase locking to the DUT. This can occur when the DUT and/or the External LOs are still warming up and have not fully settled at the steady state frequency.

For verification, the calibration file can be opened to check that the calibration range of each LO overlaps the measured frequency of the DUT. The calibration file can also be used to verify that proper LO power levels are present.



External LO1

Tune Voltages	Frequency	Power
0	99.998 740 0 MHz	8.8 dBm
1	99.998 860 0 MHz	9.0 dBm
2	99.998 980 0 MHz	9.1 dBm
3	99.999 120 0 MHz	9.2 dBm
4	99.999 310 0 MHz	9.4 dBm
5	99.999 570 0 MHz	9.5 dBm
6	99.999 900 0 MHz	9.7 dBm
7	100.000 260 0 MHz	9.8 dBm
8	100.000 640 0 MHz	9.7 dBm
9	100.001 020 0 MHz	9.6 dBm
10	100.001 350 0 MHz	9.3 dBm

External LO2

Tune Voltages	Frequency	Power
0	99.998 410 0 MHz	6.9 dBm
1	99.998 520 0 MHz	7.2 dBm
2	99.998 630 0 MHz	7.5 dBm
3	99.998 760 0 MHz	7.7 dBm
4	99.998 960 0 MHz	8.0 dBm
5	99.999 230 0 MHz	8.3 dBm
6	99.999 590 0 MHz	8.5 dBm
7	100.000 020 0 MHz	8.6 dBm
8	100.000 490 0 MHz	8.5 dBm
9	100.000 970 0 MHz	8.2 dBm
10	100.001 430 0 MHz	7.6 dBm

LO Calibration Sub-Menu

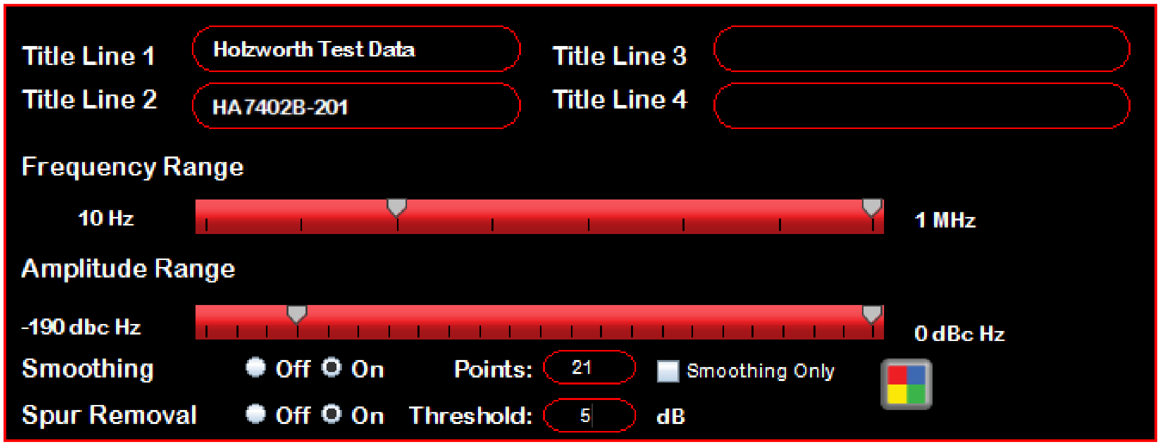
Initiate the Calibration Table window under the *Measurement* sub-menu by clicking the *Cal LOs* button.

Close the *Calibration Table* window by selecting the 

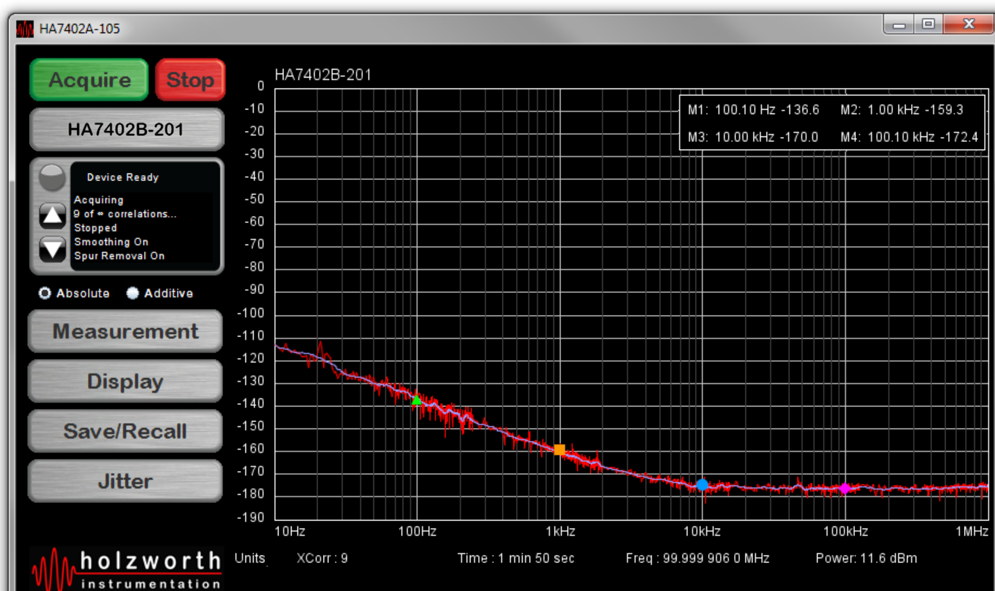
7. DISPLAY SETTINGS

Display settings can be modified while the analyzer is acquiring data, if desired. These settings can also be applied to data once a measurement is complete. The frequency offset range was auto-scaled based on the measurement offset applied in step 1.

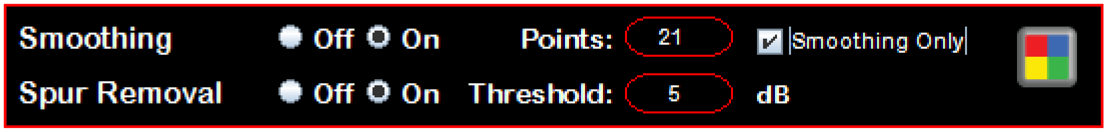
For this example, a title line was added to the data: “Holzworth Test Data”.



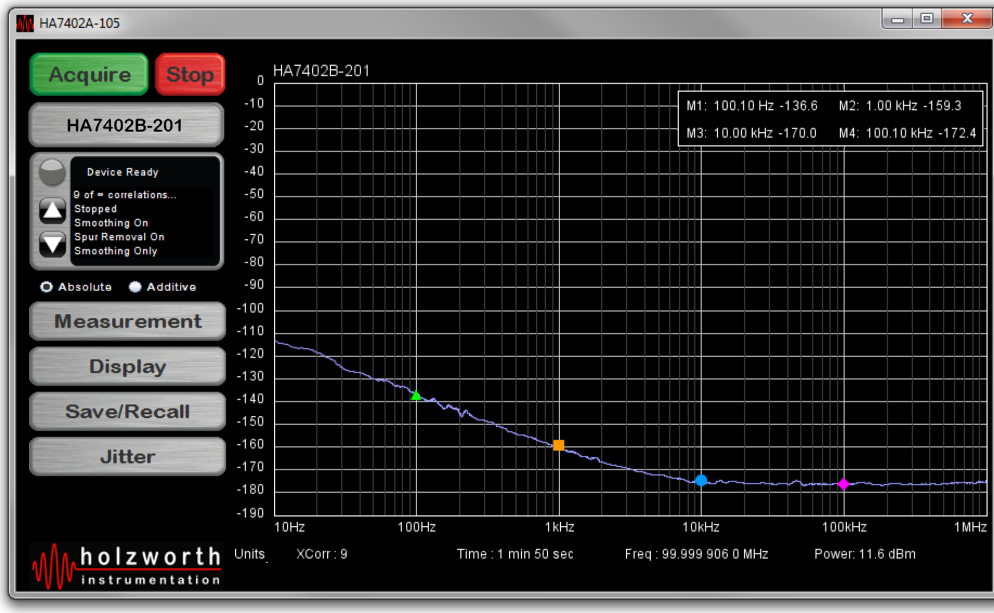
This example also demonstrates the use of the *Smoothing* and *Spur Removal* functions of the analyzer. The *Smoothing* function applies a sliding average with the number of points defined by the user. In this case, a 20 point sliding average is applied to the data (internally rounded to 21 points per section 8.3.3). The *Spur Removal* function applies a amplitude threshold to the data as set by the user. In this example, a 5dB spur threshold is applied to the data. The modified display shows the modified data overlapping the raw data as the blue colored trace.



Furthermore, the raw data can be completely removed by selecting the *Smoothing Only* check box located to the right side of the set number of smoothing points.



The resultant data display is a smoothed, spur free plot.



APPENDIX B:
ADDITIVE MEASUREMENT WITH HX5200 TIME DELAY STANDARD

The HX5200 is a time delay standard designed to help simplify the process of performing an additive measurement using the HA7000B Series phase noise analyzer. When used in conjunction with the Holzworth HA7000 Series GUI, the phase detector constant (K_D) is calculated and applied to the measurement automatically. Each HX5200 is z540 calibrated to ensure that measured data is fully ANSI traceable.

A typical additive phase noise measurement is shown in the block diagram below. Quadrature is set between The RF input and both LO inputs of the analyzer using mechanical phase shifters on each LO signal path. The HX5200 on the DUT signal path is used by the analyzer software to calculate the calibration constant in volts per radian.

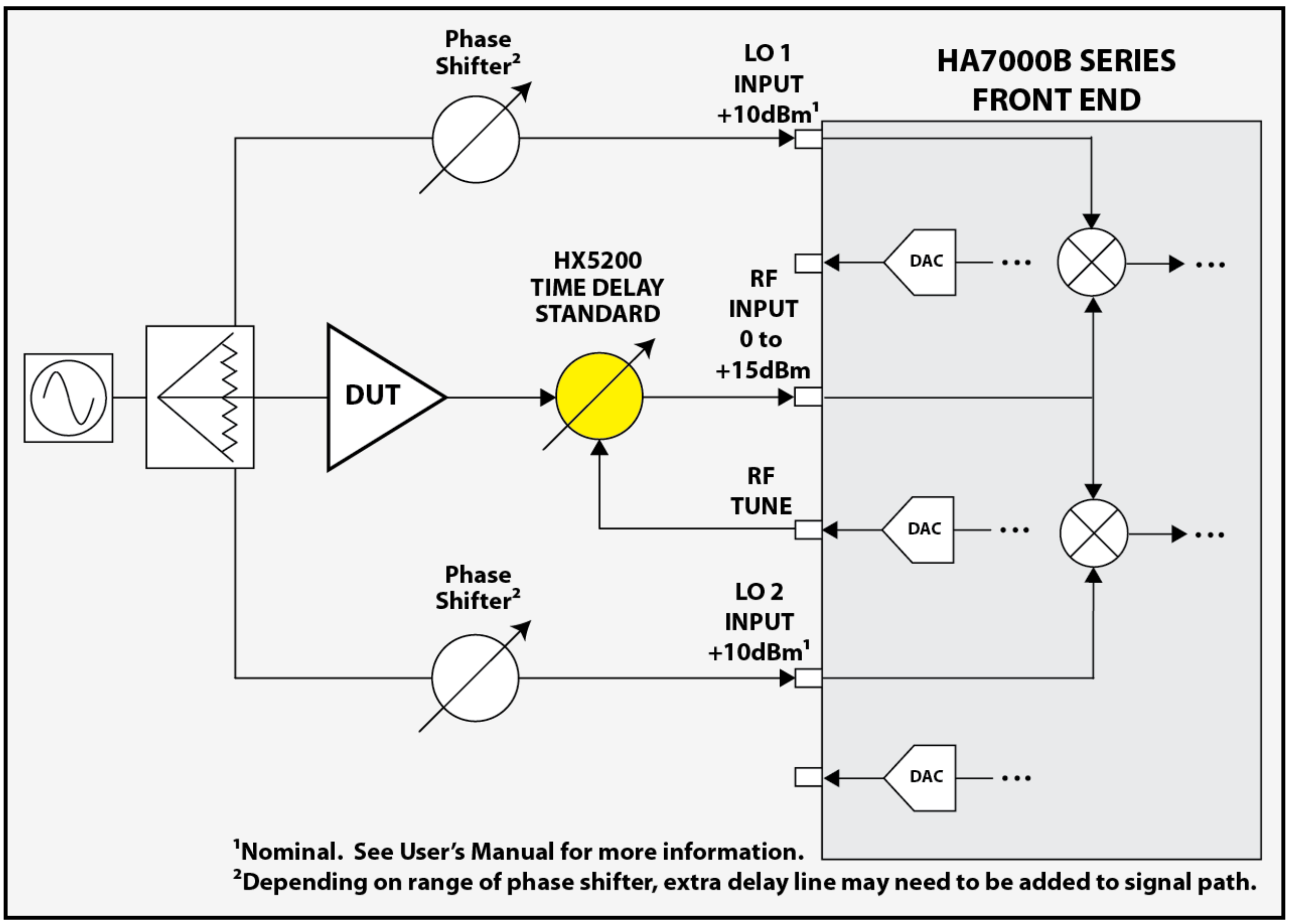
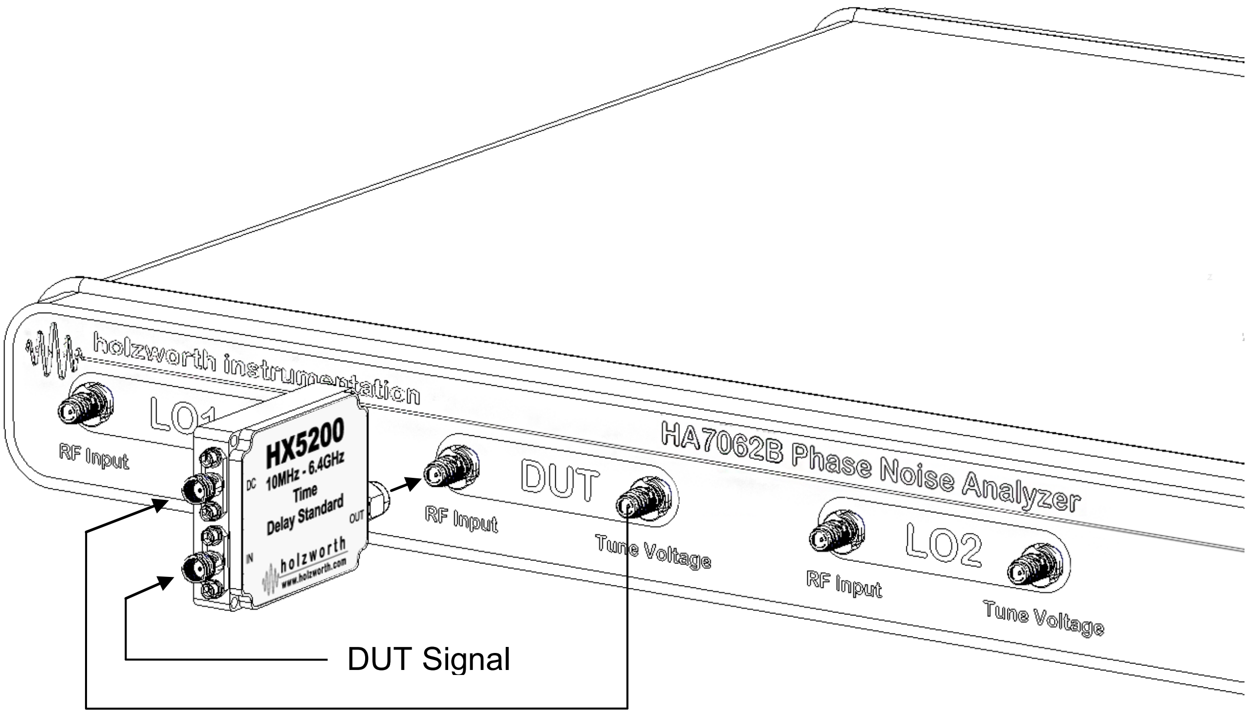


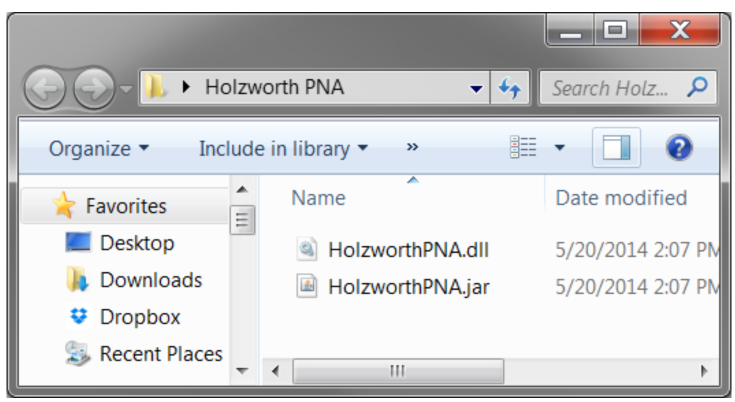
Figure 1: Block Diagram of Additive Measurement Setup

1. HARDWARE INSTALLATION

The HX5200 must be installed between the device under test and the DUT RF Input of the phase noise analyzer. Connect the Tune Voltage line to the DC input of the HX5200. LO1 and LO2 RF Inputs should be connected as normal.



2. SOFTWARE INSTALLATION



The CD included with the analyzer contains an application file folder with 2 files that include: a .dll file, a .jar file. Make sure both files remain inside the original folder location.

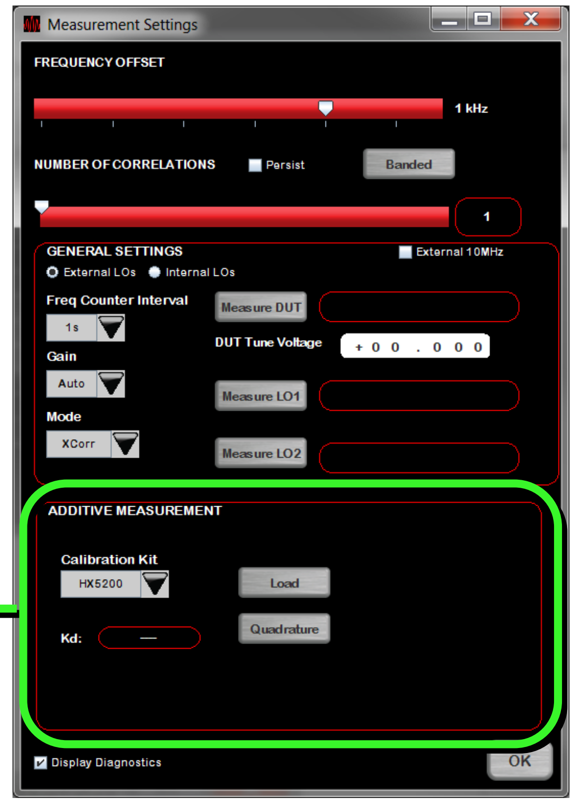
The phase noise analyzer application does not utilize the Windows software Installation Wizard. The following 2 steps need occur to launch the application:

3. Save the entire folder to a preferred directory on the PC or portable memory device. Be certain that the entire folder has been extracted.
4. Double click the “HolzworthPNA.jar” Executable Jar File to open the application. The GUI will be immediately displayed on the monitor.

3. GUI OPERATION

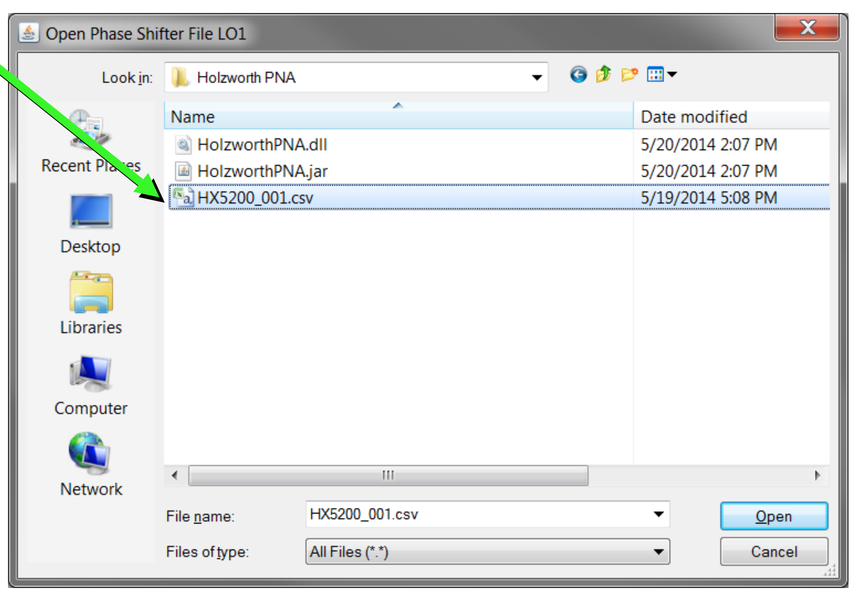
Selecting "Additive" from the front page of the HA7000 GUI will enable the necessary settings within the "Measurement" sub-menu.

From this menu select "HX5200" from the drop-down list under "Calibration Kit" in the Additive section of the Measurement window.



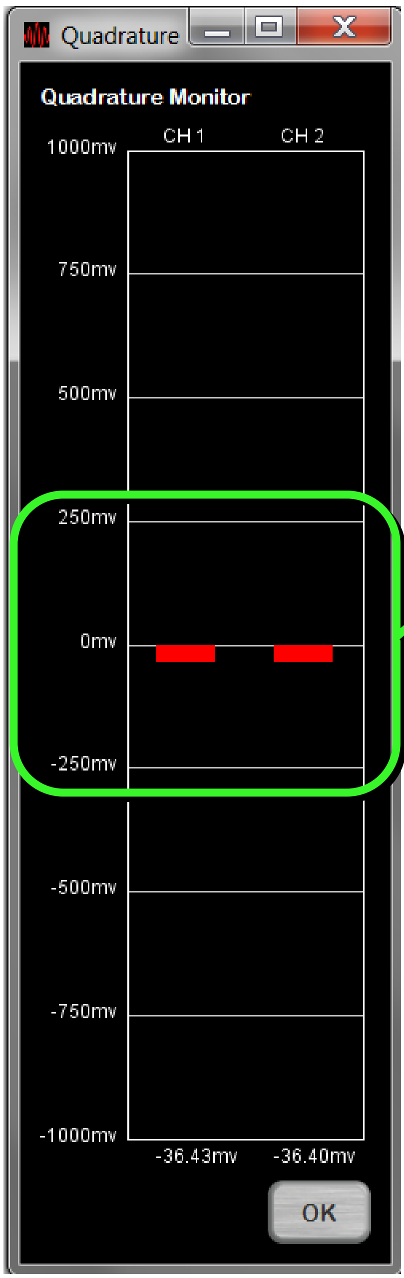
Once the HX5200 is selected, the calibration table specific to that particular unit must be loaded into software. Use the "Load" button, navigate to the appropriate directory and load the cal table into the software.

Select the calibration file associated with the serial number of the HX5200 being used.



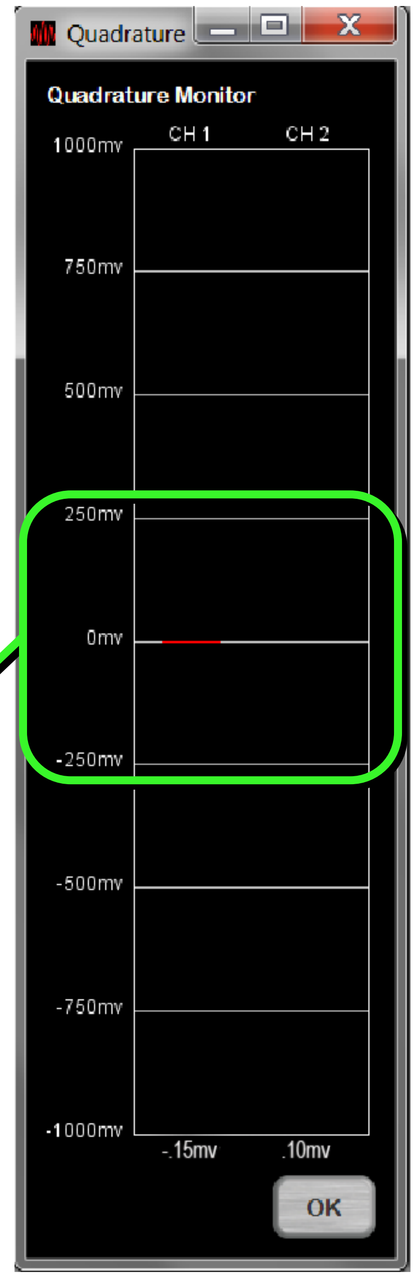
4. SETTING QUADRATURE

Setting quadrature is an essential part of performing an additive measurement. Pressing the "Quadrature" button under Measurement Settings brings up the Quadrature Monitor which is used to accomplish that task. Mechanical phase shifters are used to align the signals on the LO paths to be exactly 90 out of phase from the DUT signal.



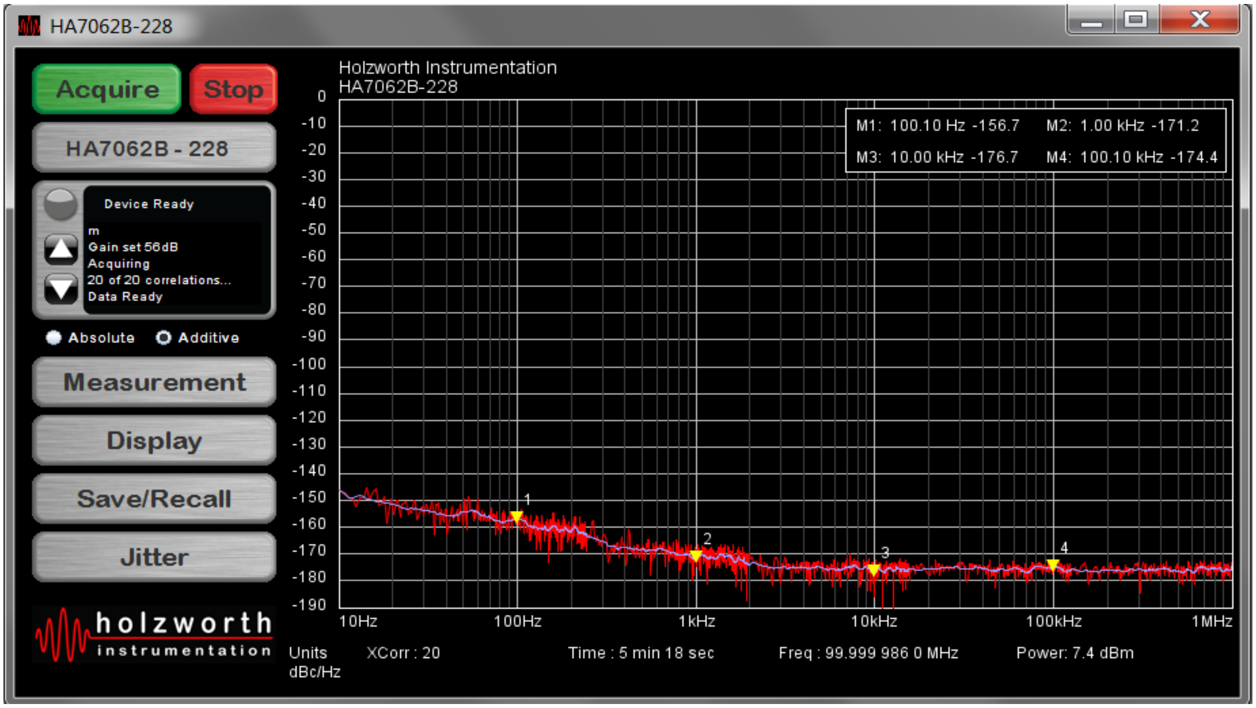
If necessary (see note at bottom of Figure 1) introduce the correct amount of RF cable in the DUT signal path to get within the range of the phase shifters.

Adjust the phase shifters to achieve quadrature between the LO and DUT inputs. Perfect quadrature is indicated by a $0V_{DC}$ offset. <1mV is ideal for best measurement sensitivity, however up to 5mV is adequate for noisier signals.



5. ACQUIRING A MEASUREMENT

With the HX5200 properly installed in the measurement setup and quadrature set between the DUT and both LO signals, click "Acquire" and the software will automatically calculate K_D and apply it to the measurement.



6. TROUBLESHOOTING

I. APPLICATION WILL NOT LAUNCH: Install the latest version of Java on the PC. Java^{TM} downloads and updates are available at: http://java.com/en/download/index.jsp

II. APPLICATION DOES NOT RECOGNIZE DEVICE: Check for device recognition after each of the following steps. Most recognition issues are resolved at step one.

1. Click on “No Device Attached” button and select the appropriate analyzer by serialized model number from the popup menu.
2. Verify that the “HolzworthPNA.jar" and "HolzworthPNA.dll" files are contained in the same folder/directory.
3. Close all applications. Disconnect analyzer from PC. Restart analyzer and verify blue light is present on power switch.

If connection or control problems remain, or for general performance/operational questions; contact Holzworth Instrumentation technical support directly at the email address or phone number at the end of this document.

USER NOTES

USER NOTES

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