



REAL TIME CROSS CORRELATION



RoHS

HA7062C

PHASE NOISE ANALYZER

10 MHz to 6GHz

Optional to >20GHz

Cross Correlation

Real Time Data Acquisition

DATA SHEET – JANUARY 2017

PRODUCT SUMMARY

The **HA7062C Real Time Phase Noise Analyzer** is the industry leader with respect to proven accuracy, high reliability, automation and flexibility; offering extremely fast measurement speeds to reduce product development time and/or optimize ATE manufacturing throughput.

MEASURED NOISE FLOORS: Competitive designs *approximate* their measurement noise floors, versus providing actual noise floor data. The front end of the HA7062C was designed in part, so that the noise floors limits can actually be measured (refer to pages 7-10).

UNPARALLELED ANALOG PERFORMANCE: The HA7062C has a high speed digital processor for speed, but the proven accuracy and speed starts with the analog front end. A key component of the analog front end is a pair of Holzworth 6GHz HSX Series RF Synthesizers as the test system's internal LOs. These ultra low noise RF sources not only complement the dual core FFT engine to provide one of the most advanced phase noise analyzers available, but they are also made available to the user at the front panel's *LO Output* ports.

REPEATABLE DATA: Holzworth's fully shielded, fan-less 1U chassis completely eliminates ground loops and troublesome microphonics for uncompromised performance and repeatability. See it for yourself knowing that Holzworth encourages running head-head tests with the competition. Contact Holzworth directly for availability of an evaluation unit in your area.

REAL TIME DATA ACQUISITION

ANSI Z540 CALIBRATED ACCURACY 0.1Hz - 40MHz

VERSATILE - RECONFIGURABLE FRONT END

MEASURE: PM / AM / BASEBAND / SPURIOUS / JITTER / PULSE

SIMULTANEOUS/ ISOLATED AM/PM MEASUREMENTS

AUTOMATED RESIDUAL MEASUREMENTS

MEASURABLE ULTRA LOW PHASE NOISE FLOORS

3 YEAR MANUFACTURER WARRANTY



PRODUCT SUMMARY - BLOCK DIAGRAM

VERSATILE: The HA7062C is a result of more than a decade of product development reflecting valuable customer feedback and Holzworth’s direct experience with measuring phase noise in our own manufacturing environment. The end result goes well beyond accuracy, reliability and speed... the reconfigurable front end allows users to tailor the analyzer for their specific measurement needs.

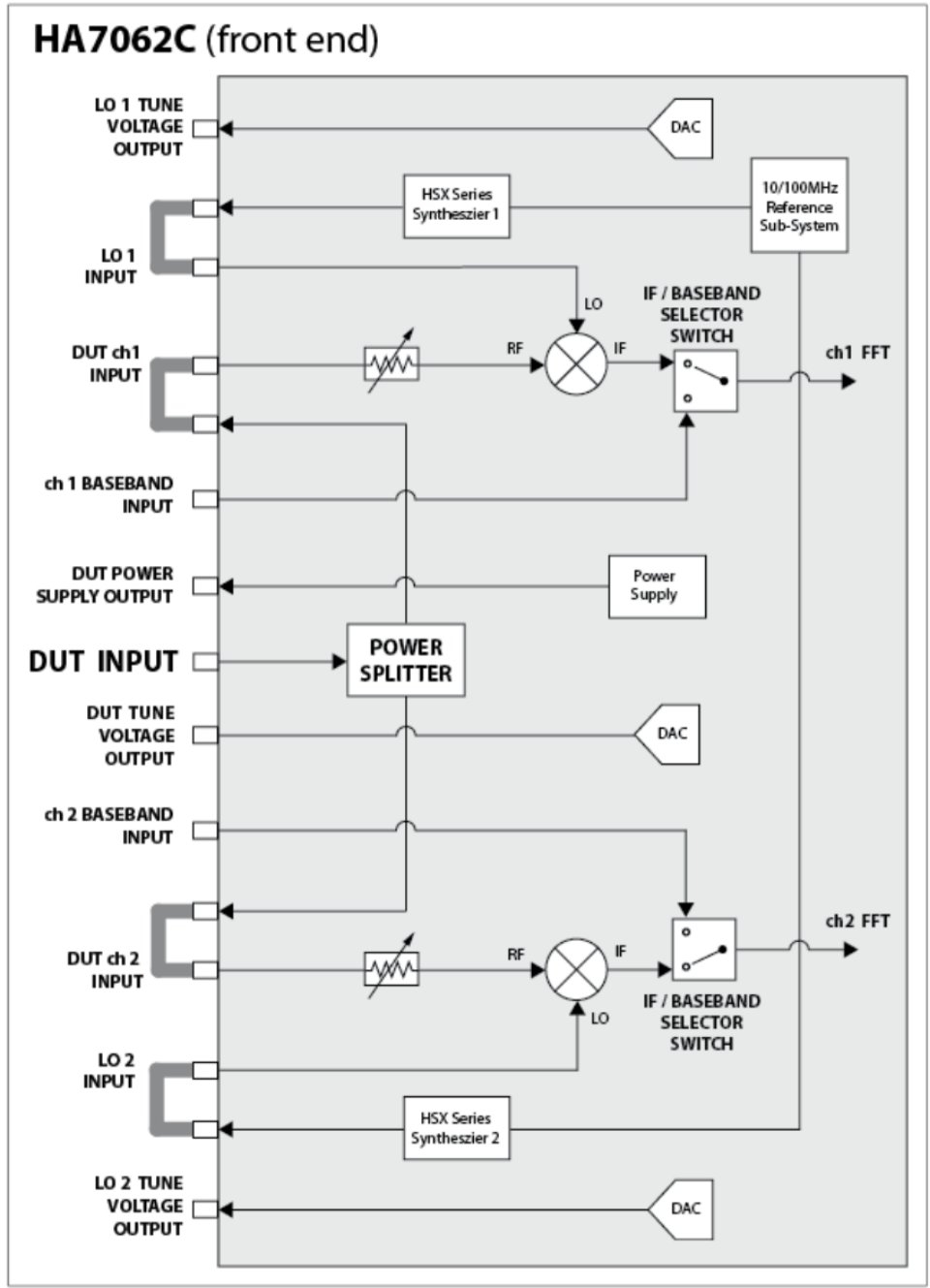


Figure 1: HA7062C Front End Block Diagram

SPECIFICATIONS - ELECTRICAL

The specifications outlined here capture the baseline performance and features that are currently available from the HA7062C phase noise analyzer. The highly reliable hardware is capable of additional functionality for custom requirements. Inquire with Holzworth Instrumentation or your local sales representative.

RF INPUT (DUT/LO)

DESCRIPTION	SPECIFICATION
RF Input Connector	SMA (female), 50 ohm
RF Input Frequency Range (standard)	10 MHz to 6 GHz
RF Frequency Extension (>20GHz)	HX4920 Frequency Divider required. Refer to pages 19-20.
RF Input Measurement Level	0 dBm to +20 dBm (Holzworth pre-amplifier available for <0dBm)
Input Damage Level	+22 dBm
Input VSWR	< 2.0:1

PHASE NOISE MEASUREMENTS

DESCRIPTION	SPECIFICATION
RF Input Frequency Range	10 MHz to 6 GHz
RF Freq. Extension (>6GHz to >20GHz)	Model HX4920 enables >20GHz frequency measurements. Refer to pages 19-20.
RF Tracking Range	±10ppm (typical), ± 5ppm (specified)
Offset Frequency Range	0.1 Hz – 40 MHz (ANSI z540 – NIST traceable)
Phase Noise Uncertainty 1 Hz to 1 kHz offset 1 kHz to 1 MHz offset 1 MHz to 40 MHz offset	± 4 dB (to be updated with improved uncertainty resulting from z540.1 calibration statistics) ± 2 dB (to be updated with improved uncertainty resulting from z540.1 calibration statistics) ± 2 dB (to be updated with improved uncertainty resulting from z540.1 calibration statistics)
Cross-Correlation Noise Floor	Refer to pages 7-10 for measured noise floor data

SPECIFICATIONS - ELECTRICAL (continued)
TABLE 1: MEASUREMENT SPEED (SAMPLE TIME) vs. MINIMUM OFFSET

1 Cross-Correlation							
128 Samples		256 Samples		512 Samples		1024 Samples	
-	-	0.1Hz	32s	0.1Hz	60s	0.1Hz	112s
1Hz	12s	1Hz	18s	1Hz	33s	1Hz	61s
10Hz	6s	10Hz	8s	10Hz	13s	10Hz	22
100Hz	4s	100Hz	5s	100Hz	7s	100Hz	10s
1kHz	4s	1kHz	4s	1kHz	6s	1kHz	8s
10kHz	4s	10kHz	4s	10kHz	5s	10kHz	7s
100kHz	4s	100kHz	4s	100kHz	5s	100kHz	6s
1MHz	4s	1MHz	4s	1MHz	4s	1MHz	5s

10 Cross-Correlations							
128 Samples		256 Samples		512 Samples		1024 Samples	
-	-	0.1Hz	186s	0.1Hz	370s	0.1Hz	732s
1Hz	67s	1Hz	96s	1Hz	189s	1Hz	371s
10Hz	19s	10Hz	28s	10Hz	52s	10Hz	100s
100Hz	6s	100Hz	8s	100Hz	13s	100Hz	20s
1kHz	4s	1kHz	5s	1kHz	7s	1kHz	9s
10kHz	4s	10kHz	4s	10kHz	6s	10kHz	8s
100kHz	4s	100kHz	4s	100kHz	6s	100kHz	7s
1MHz	4s	1MHz	4s	1MHz	5s	1MHz	6s

TABLE 2: CROSS-CORRELATIONS vs. PHASE NOISE IMPROVEMENT

 Improvement factor: $\text{dB} = 5\log N$ (N = No. of correlations)

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

INTERNAL TIME BASE (10MHz Reference)

DESCRIPTION	SPECIFICATION
Frequency Uncertainty / Stability	< $\pm 1\text{Hz}$ at 10MHz (± 100 ppb) At time of shipment. Factory calibrated at +21C.
Frequency Temperature Effects	< 10ppb
Frequency Aging Rate	< 100ppb/yr
10MHz External Lock Range	$\pm 20\text{Hz}$ (typical), $\pm 10\text{Hz}$ (specified). 10MHz is for frequency counters only.

SPECIFICATIONS - ELECTRICAL (continued)
POWER METER ACCURACY

PARAMETER	MIN	TYPICAL	MAX	COMMENTS
Input Power Meter Accuracy		±0.25dB	±2dB	

ANSI z540 CALIBRATION

DESCRIPTION	SPECIFICATION
Frequency Offset Range	0.1Hz - 40MHz
DUT Frequency Input Range	10MHz - 6GHz Standard 10MHz - 20GHz with optional HX4920 (refer to pages 19-20)

MEASUREMENT MODES

MODE	DESCRIPTION
Internal LO Mode	Internal synthesized LO sources. Auto tune and phase lock.
External LO Mode	User supplied LO sources. Auto calibration of LO sources and auto phase lock.
Additive Mode Measuring <6GHz Measuring >6GHz Measuring at Baseband Measuring a DDS	Refer to pages 21 – 24 Page 21 Page 22 Page 23 Page 24
Pulsed Measurements	Info coming soon
AM Noise Measurements	Info coming soon
Time Domain Measurements	Info coming soon
Spurious Analysis Toolbox	Info coming soon

NOISE FLOOR MEASUREMENT SETUP

The unique architecture of the HA7062C allows for direct access to key internal modules in order to measure the actual noise floor of the analyzer at any given frequency vs. minimum frequency offset and number of correlations. The noise floor of competitive phase noise analyzers is always *approximated*.

To perform a noise floor measurement, the internal power splitter is bypassed to directly access the phase detector (mixer) of each channel/core while measuring two non-correlated frequency sources at the frequency of interest. Refer to Figure 2, below.

NOISE FLOOR

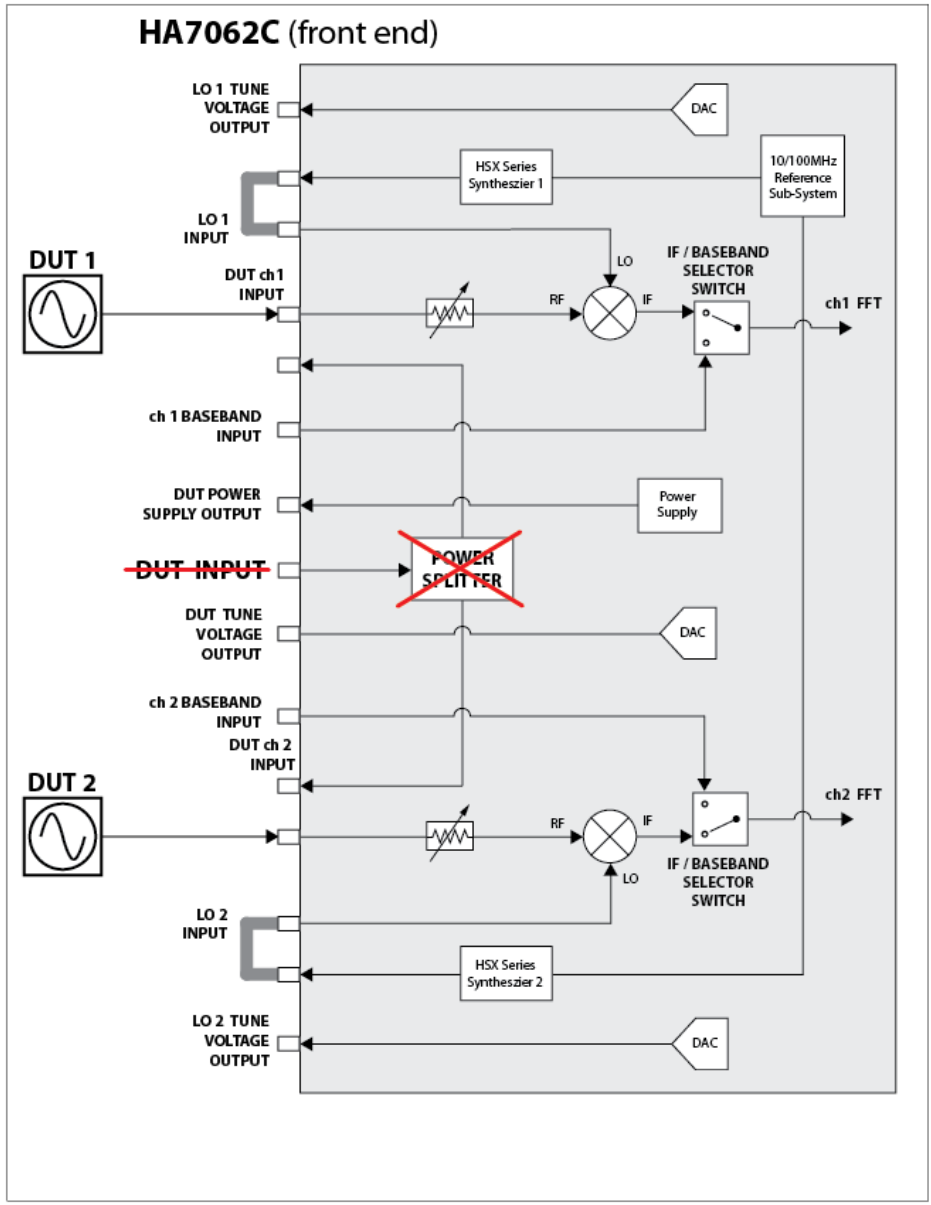


Figure 2: HA7062C Noise Floor Measurement Block Diagram

NOISE FLOOR DATA

The data contained in this section demonstrates the noise floor capability of the HA7062C at five different frequencies covering the base operating range of the instrument (10MHz, 100MHz, 1GHz, 3GHz and 6GHz). The three plots in each figure reflect the actual noise floor for 1, 10 or 100 correlations. Further improvement in the noise floor can be achieved by utilizing more correlations (refer to Table 2, located on page 5).

All data contained in this section was acquired using a minimum offset frequency of 1Hz. For reference, the data acquisition times for each measurement are as follows:

- 1 correlation: < 10s**
- 10 correlations: < 90s**
- 100 correlations: < 15 min**

NOTE: Setting the instrument to a higher minimum offset frequency will further improve the measurement speed.

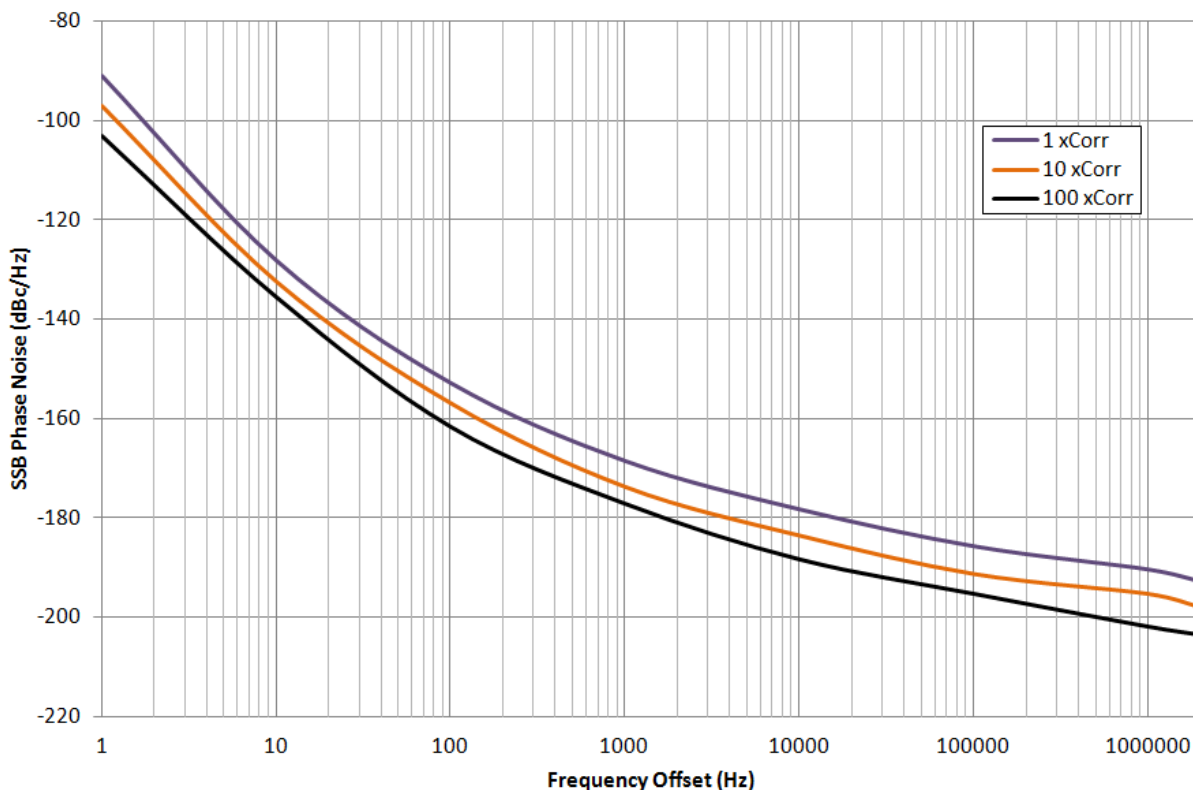


Figure 3: 10MHz Noise Floor Measurements

NOISE FLOOR DATA (continued)

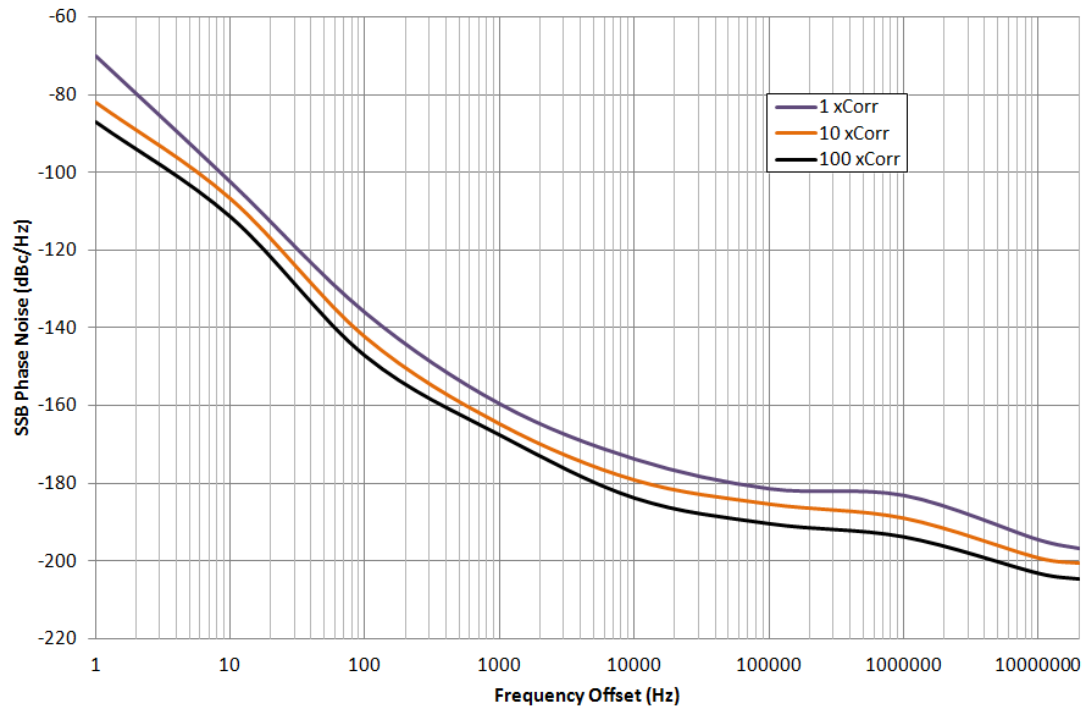


Figure 4: 100MHz Noise Floor Measurements

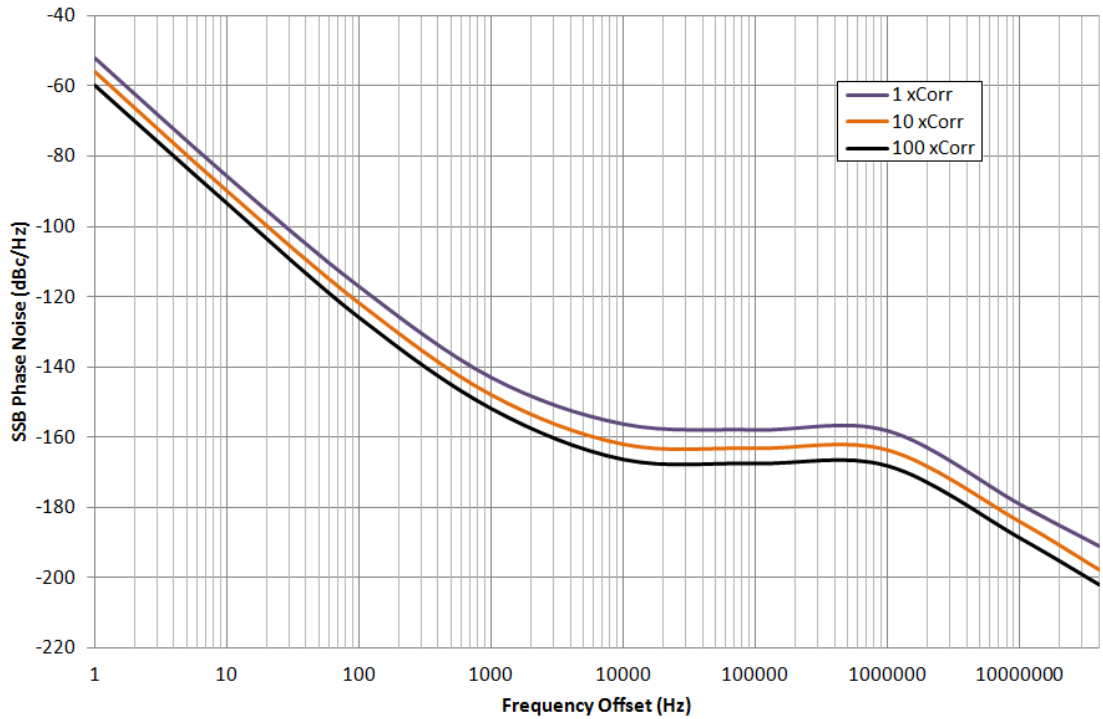


Figure 5: 1GHz Noise Floor Measurements

NOISE FLOOR

NOISE FLOOR DATA (continued)

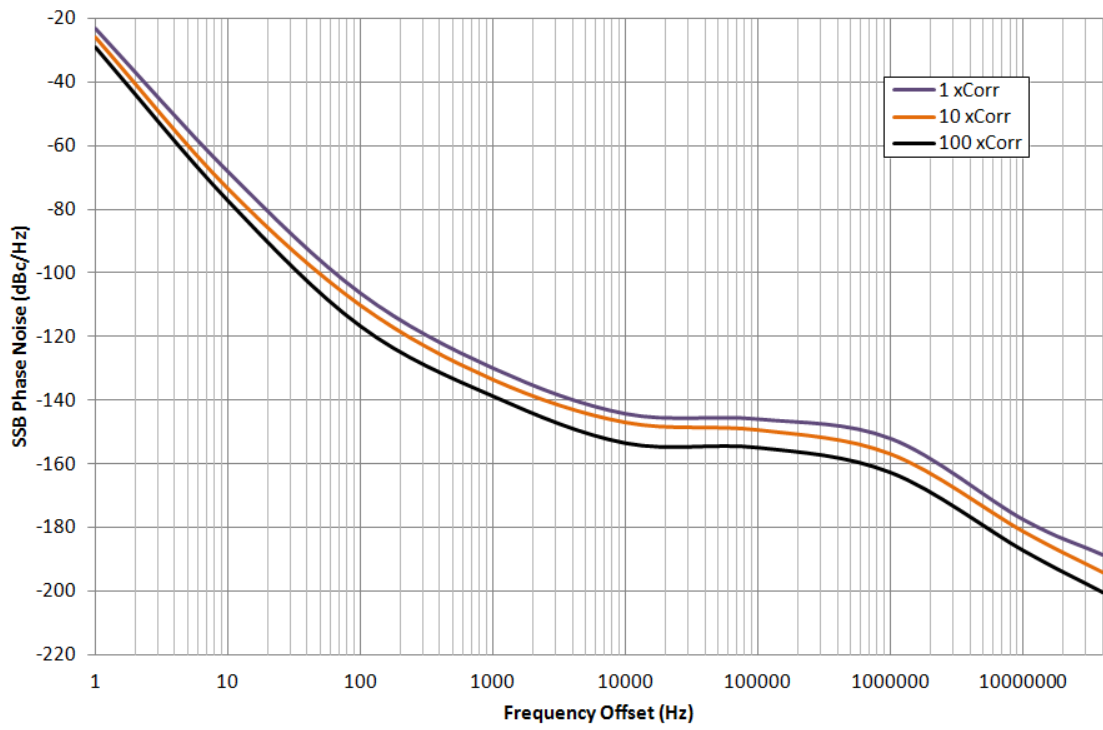


Figure 6: 3GHz Noise Floor Measurements

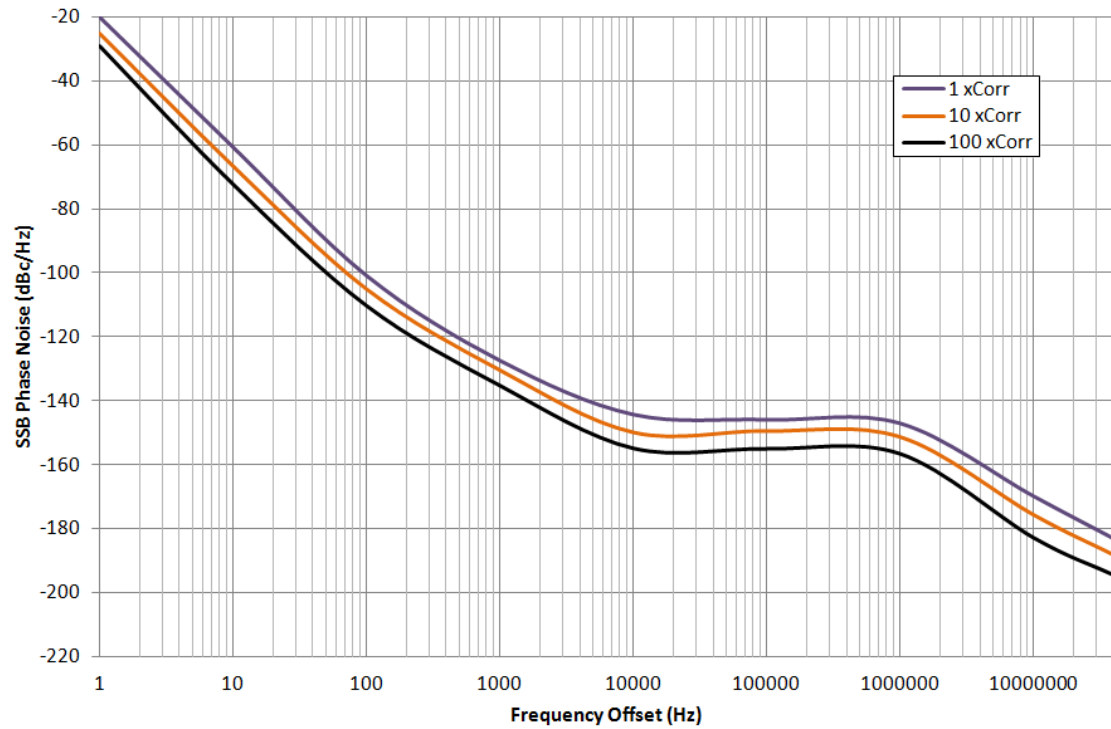


Figure 7: 6GHz Noise Floor Measurements

NOISE FLOOR

CONFIGURATION

FRONT PANEL

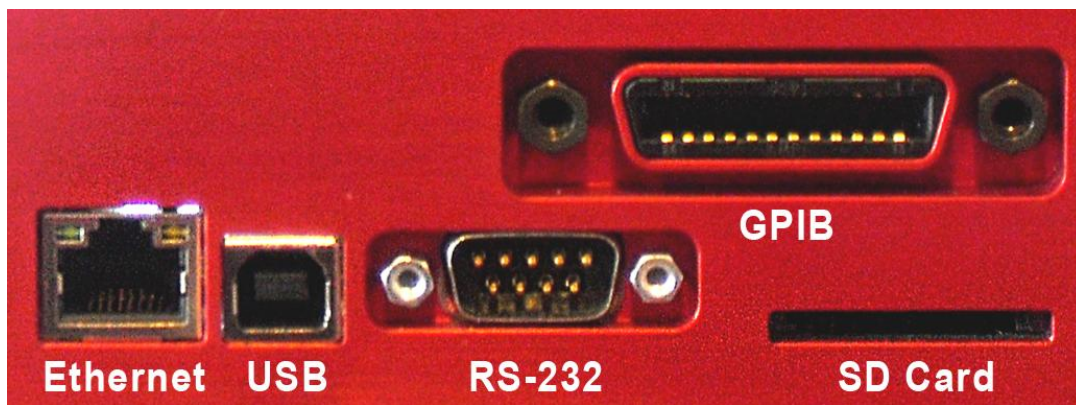
The HA7062C allows for a high level of measurement flexibility to accommodate different test scenarios by allowing the user access to various system input points. However, only the *DUT Input* port is necessary for making straight forward absolute phase noise measurements of a frequency source.

DESCRIPTION	SPECIFICATION
Front Panel Connector(s) Type	SMA (3.5mm), 50ohm
DUT Input Frequency Range (standard) Power Level Range Input Damage Level	10MHz to 6GHz 0dBm to +20dBm +22dBm
DUT Tune Voltage Voltage Tune Range Max Current	For Vcc control of some DUTs. -10V to +10V 5mA
DUT Power Supply Voltage Supply Range Maximum Current	Integrated power supply. 0V to +12V 300mA
LO1/LO2 Input(s) Frequency Range (standard) Power Level Range Input Damage Level	Connect to LO1/LO2 Output(s) for standard operation. 10MHz to 6GHz 0dBm to +20dBm > +22dBm
LO1/LO2 Output(s) Frequency Range (standard) Power Level Range	CW sources for residual measurements. Connect to LO1/LO2 Input(s) for standard operation. 10MHz to 6GHz (0.001Hz step size) 0dBm to +10dBm (0.01dB step size)
LO1/LO2 Tune Voltage Voltage Tune Range Max Current Tuning Sensitivity	For independent Vcc control of external LO sources during External LO Mode of operation. -10V to +10V 5mA TBD
DUT ch1/ch2 Input(s) Frequency Range (standard) Power Level Range Input Damage Level	Allows bypass of DUT power splitter for direct access to the phase detector of each channel. 10MHz to 6GHz 0dBm to +14dBm > +16dBm
ch1/ch2 Splitter Bypass Output(s)	Connect jumper cable to ch1/ch2 DUT Input(s) for standard operation.
ch1/ch2 Baseband Input(s) Frequency Range Power Level Range Input Damage Level	DC to 40MHz ± 1Vdc ± 2Vdc, or 50mA (whichever is greater)

CONFIGURATION

CONFIGURATION (continued)
REAR PANEL

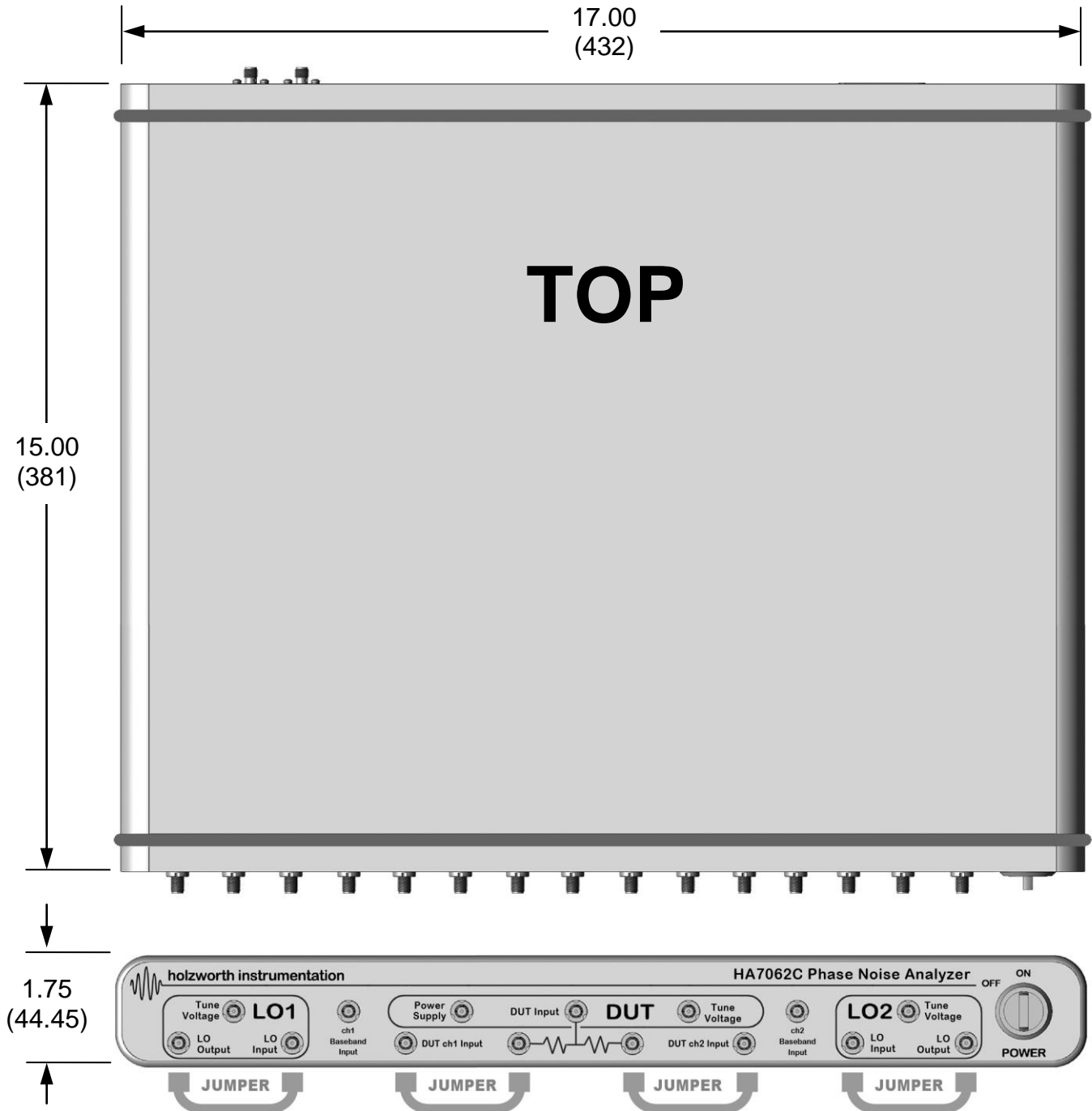
DESCRIPTION	SPECIFICATION
Reference Output Port Connector Type Output Frequency Output Level Output Waveform	SMA, 50ohm 10MHz \pm 10Hz +5dBm \pm 2dBm Sinusoid
10MHz Reference Input Port Connector Type Input Frequency Input Level	ONLY FOR FREQUENCY COUNTERS - DOES NOT AFFECT MEASUREMENT SENSITIVITY SMA, 50ohm 10MHz \pm 10Hz 0dBm to +10dBm (Sinusoid or Square)
AC Power Input Connector Type AC Input Rating	International Power Supply IEC 320-C13 90-260V _{AC} , 50-60Hz. Specify country at time of order for proper power cord.
Data I/O Interface Connectivity Storage	USB B-Type (virtual comm. port), Ethernet, RS-232, GPIB SD Card Reader


Figure 8: HA7062C Communication Ports

CONFIGURATION (continued)

MECHANICAL DIMENSIONS

The HA7062C has a 1U high, rack mountable chassis form factor. The fan-less design was adopted to eliminate the potential for microphonics. 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).



CONFIGURATION

CONFIGURATION (continued)

AC POWER SUPPLY

The HA7062C utilizes an ultra-clean, international, switching power supply. Units ship with a country specific, AC supply cable. Please specify country of end use at the time of purchase.



CONFIGURATION

ENVIRONMENTAL

DESCRIPTION	SPECIFICATION (by design)
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

CONFIGURATION (continued)

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
HX4920	>20GHz Downconverter (measurement floor limit -137dBc/Hz)	ACCESSORY
HX4920-2	HX4920 PAIR for improved measurement floors (limit -155dBc/Hz)	ACCESSORY
HX5100-x	Electronic Phase Shifter PAIR, Additive Measurements, 1 Octave Bandwidth, Specify fc	ACCESSORY
CASE-1U	Ruggedized Carrying Case with TSA security lock	ACCESSORY
RACK-1U	19" Rack mount bracket kit for HA7000 Series. 90 degree rear bracket.	ACCESSORY
RACK2-1U	19" Rack mount bracket kit for HA7000 Series. Straight rear bracket.	ACCESSORY

INCLUDED HARDWARE AND CERTIFICATIONS

Each standard product delivery includes specific, standard hardware and certifications.

TYPE	DESCRIPTION	COMMENTS
HARDWARE	HA7062C PHASE NOISE ANALYZER	DELIVERABLE
HARDWARE	AC Power Cord (7ft/2.1m). Specify country of end use.	DELIVERABLE
HARDWARE	Ethernet Cable (10ft/3m)	DELIVERABLE
HARDWARE	USB Cable (6ft/1.8m)	DELIVERABLE
CERTIFICATE	ANSI z540.1 CALIBRATION CERTIFICATE (0.1Hz - 40Mhz)	DELIVERABLE
WARRANTY	3 YEAR MANUFACTURER'S WARRANTY	NON-APPLICABLE
CERTIFICATE	CE COMPLIANCE CERTIFICATE <i>DIRECTIVE: 2004/108/EC, TEST STANDARD: EN 61326-1: 2006</i>	WEB DOWNLOAD
CERTIFICATE	RoHS COMPLIANCE CERTIFICATE <i>DIRECTIVE: 2002/95/EC</i>	WEB DOWNLOAD
CERTIFICATE	WEEE COMPLIANCE STATEMENT <i>DIRECTIVE: 2002/96/EC</i>	WEB DOWNLOAD

CONFIGURATION

HA7062C OPERATION

All data processing is performed internally on the HA7062. Measurement settings can be changed using serial commands sent to the HA7062C via any of the included communication options (see *CONFIGURATION* on page 12). Measurement results can be read back directly from the instrument, eliminating the use of the GUI software. This capability provides unparalleled operational flexibility, ideal for ATE applications.

Purchase of an HA7062C includes access to the MATLAB™ compiled GUI for hardware operation and viewing/saving data. All software upgrades and functionality additions are freely available for the life of the instrument at no additional cost to the user.

Each unit comes with an open license to operate the MATLAB™ Runtime based application on any number of Windows based PCs. The MATLAB™ Runtime is MathWorks shareware that can be used without the purchase of a MATLAB™ license/seat.

HA7062C SOFTWARE

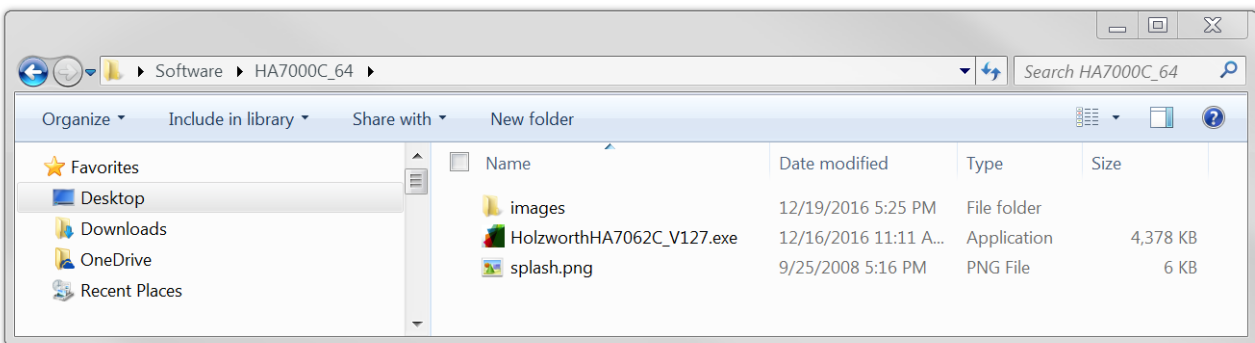
The HA7062C GUI offers an extremely user-friendly means to utilize the full functionality of the HA7062C on any Windows-based PC. Absolute, Residual, Time-Domain, Jitter, AM Noise, and more can be performed using the intuitive software GUI.

The Holzworth HA7062C Series GUI can be run on any Windows PC by first installing the MATLAB Runtime which can be downloaded directly from the MathWorks website. This installation is also located on the USB thumb drive that is included with the instrument.

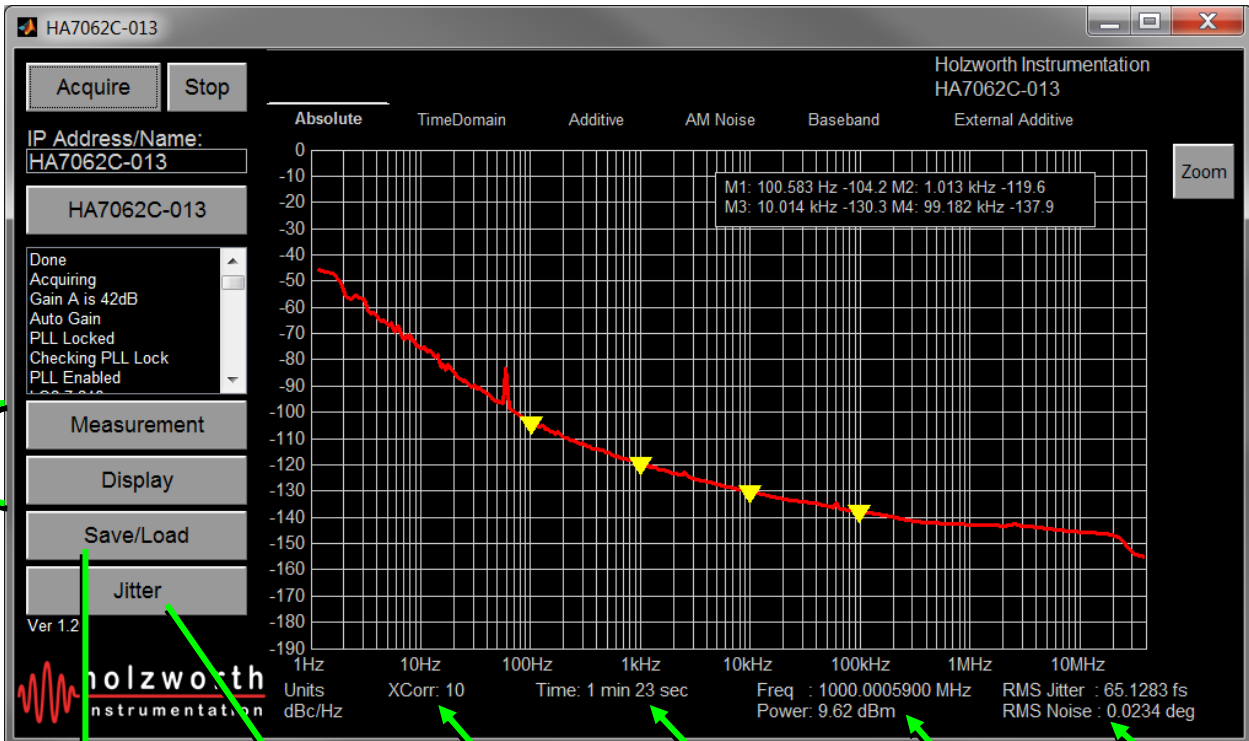
(NOTE: The Holzworth GUI is compiled using the libraries for version R2014a. This is the Runtime version that *must* be installed in order for the Holzworth GUI to run.)

Once the MATLAB Runtime is installed, the Holzworth GUI can be launched from the extracted file folder by double-clicking the executable file: **HolzworthHA7062C_Vxxx.exe**

Analyzer GUI Application Folder

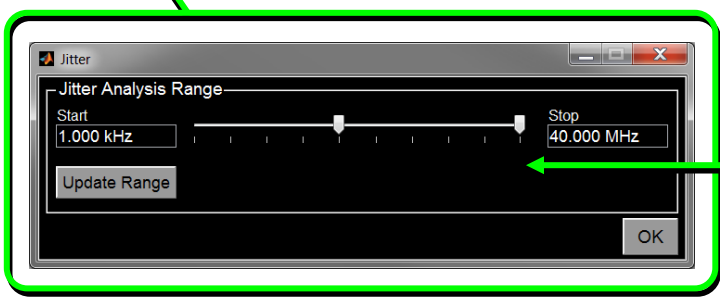


HA7062C SOFTWARE (continued)



See Page 18

Number of Correlations Measurement Timer DUT Input Frequency and Power Time Domain Stability Data



Adjust Settings for Jitter display data



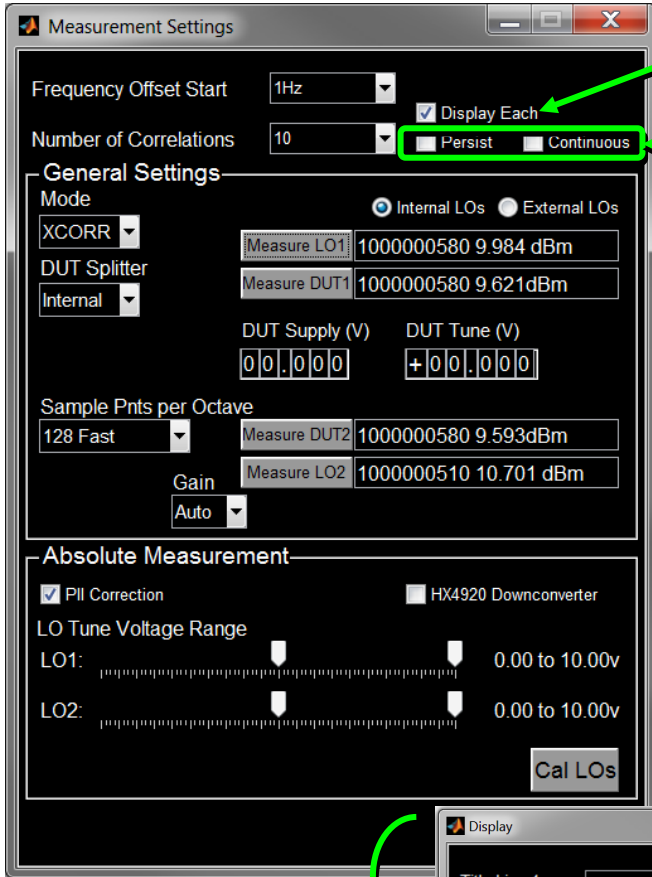
Save/load data (.csv file) as well as save an image file in the format of choice (.png, .jpg or .bmp).

A debug file is auto-saved, but can also be saved at any time for real time Holzworth support to diagnose potential issues during a measurement. Up to three traces can be loaded and displayed along with the current measurement data.

Measurement and Display settings can be saved and recalled (in .xml format) from this menu as well.

SOFTWARE

HA7062C SOFTWARE (continued)



Selecting **Display Each** displays the phase noise data for each correlation. De-selecting this will display data only after the total number of set correlations is complete, increasing the overall measurement speed.

Select "**Persist**" for infinite correlations. "**Continuous**" performs a single correlation measurement indefinitely (resetting the data after each correlation).

The **General Settings** area allows the user to:

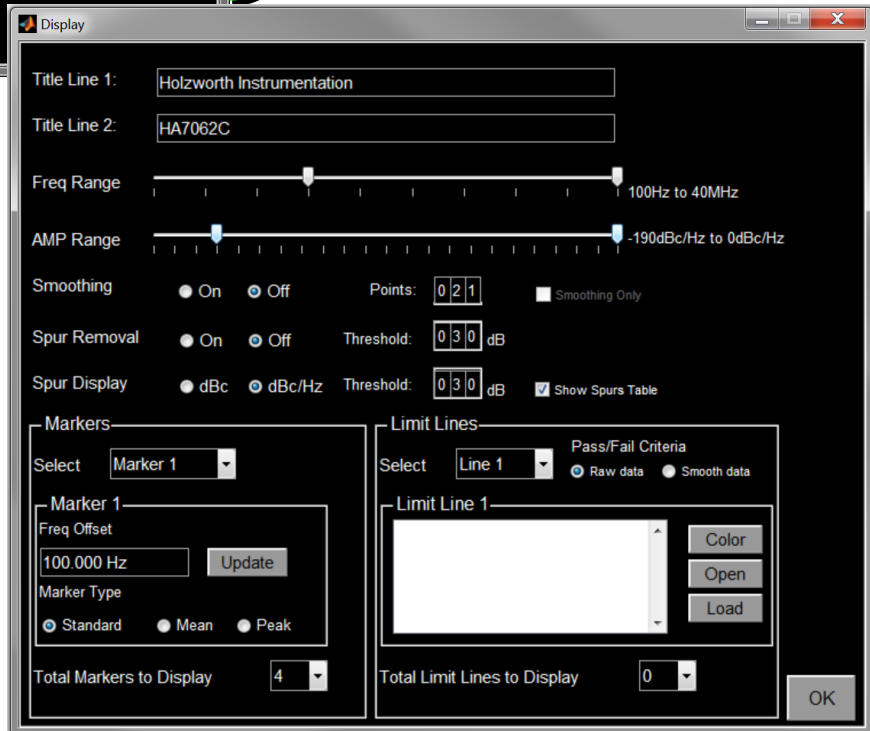
- select **Internal LO** or **External LO** mode
- select **DUT Splitter** (internal or bypass)
- number of Sample Points per Octave (Increasing points increases data resolution while decreasing acquisition speed)
- Frequency counter & power meter access for the **LO1**, **LO2**, **DUT1** and **DUT2** Input ports.
- Control of **DUT Supply** and **DUT Tune** ports

The **Absolute Measurement** area allows the user to:

- enable/disable the **PLL Correction** factor
- adjust data for use of **HX4920 Downconverter**
- independently adjust each **External LO Tune Voltage Range**
- **Cal LOs** = calibrate external LOs

The **Display Settings** area:

- change plot area titles
- adjust the plot axis ranges
- apply/adjust **Smoothing**
- apply/adjust **Spur Removal**
- apply/adjust **Spur Display** (spurious analysis toolbox)
- apply/adjust data **Markers**
- apply/adjust **Limit Lines**

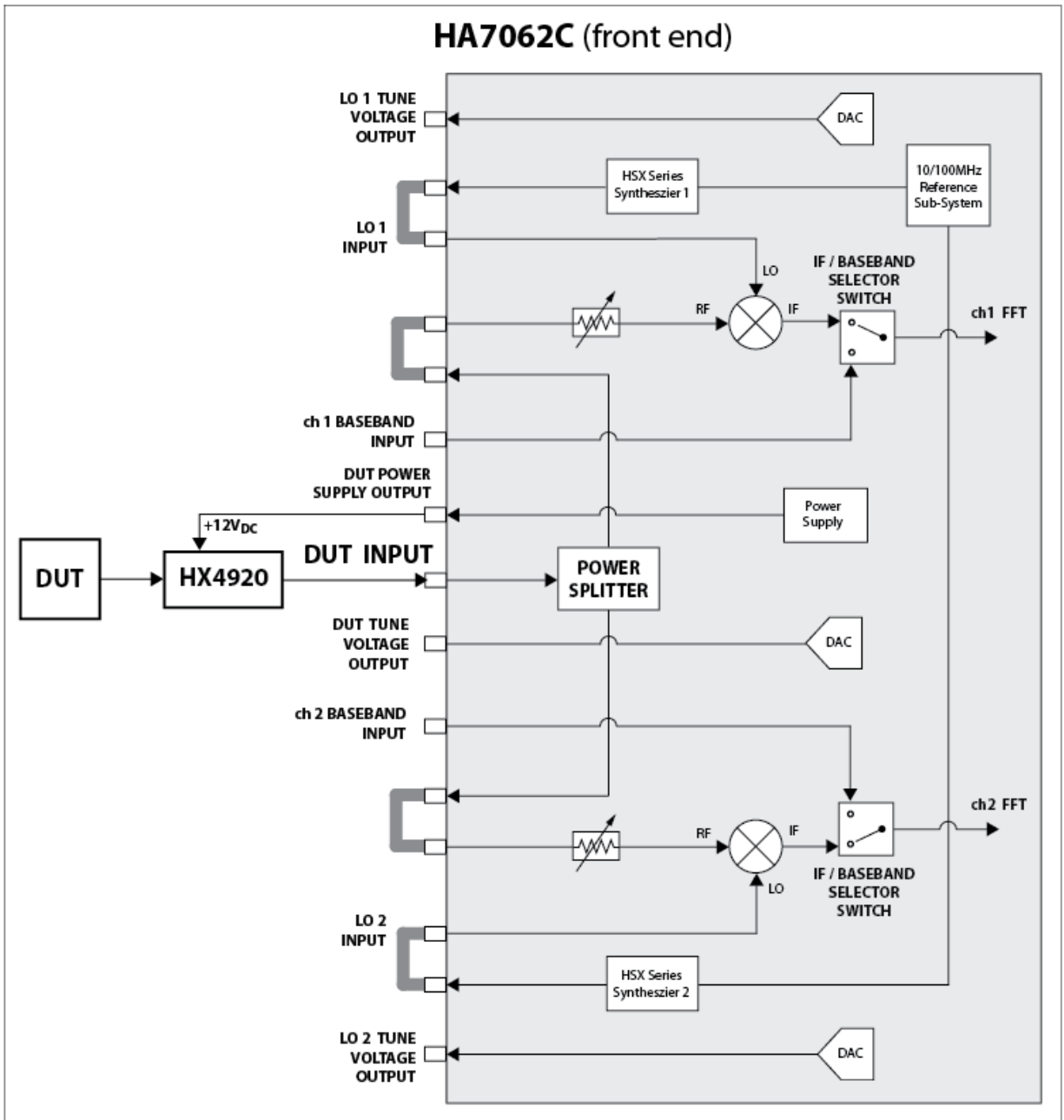


SOFTWARE

HX4920 FREQUENCY EXTENSION

Absolute measurements from 6GHz to greater than 20GHz can easily be performed by introducing the Holzworth HX4920 Downconverter as shown below.

NOTE: Using a single HX4920 Downconverter in the test setup will limit the measurement floor (example: -137dBc/Hz at 10GHz) due to the additive phase noise performance of the HX4920 device (refer to the HX4920 datasheet for more information). The additive measurement noise floor can be improved by using a pair of HX4920 units as shown on the following page.

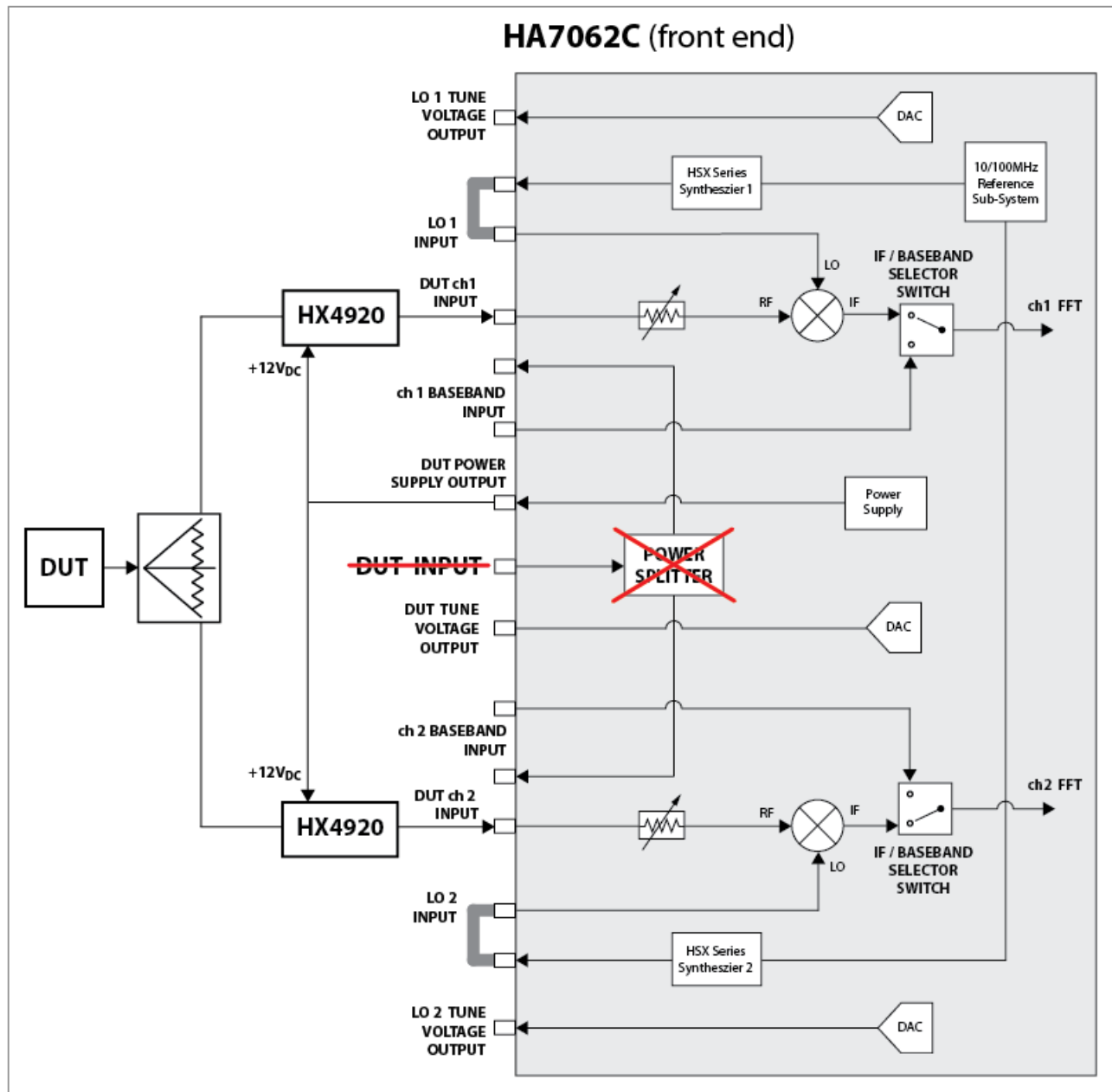


FREQUENCY EXT.

HX4920 FREQUENCY EXTENSION (continued)

For measuring higher frequency sources with performance of better than -137dBc/Hz (10kHz offset at 10GHz), a pair of HX4920 frequency downconverters are implemented as shown below.

Bypassing the internal power splitter as shown, allows for 2x HX4920s to be used with the analyzer. In this configuration, the downconverters are non-coherent, and their noise floor contribution is then cross-correlated out of the measurement.



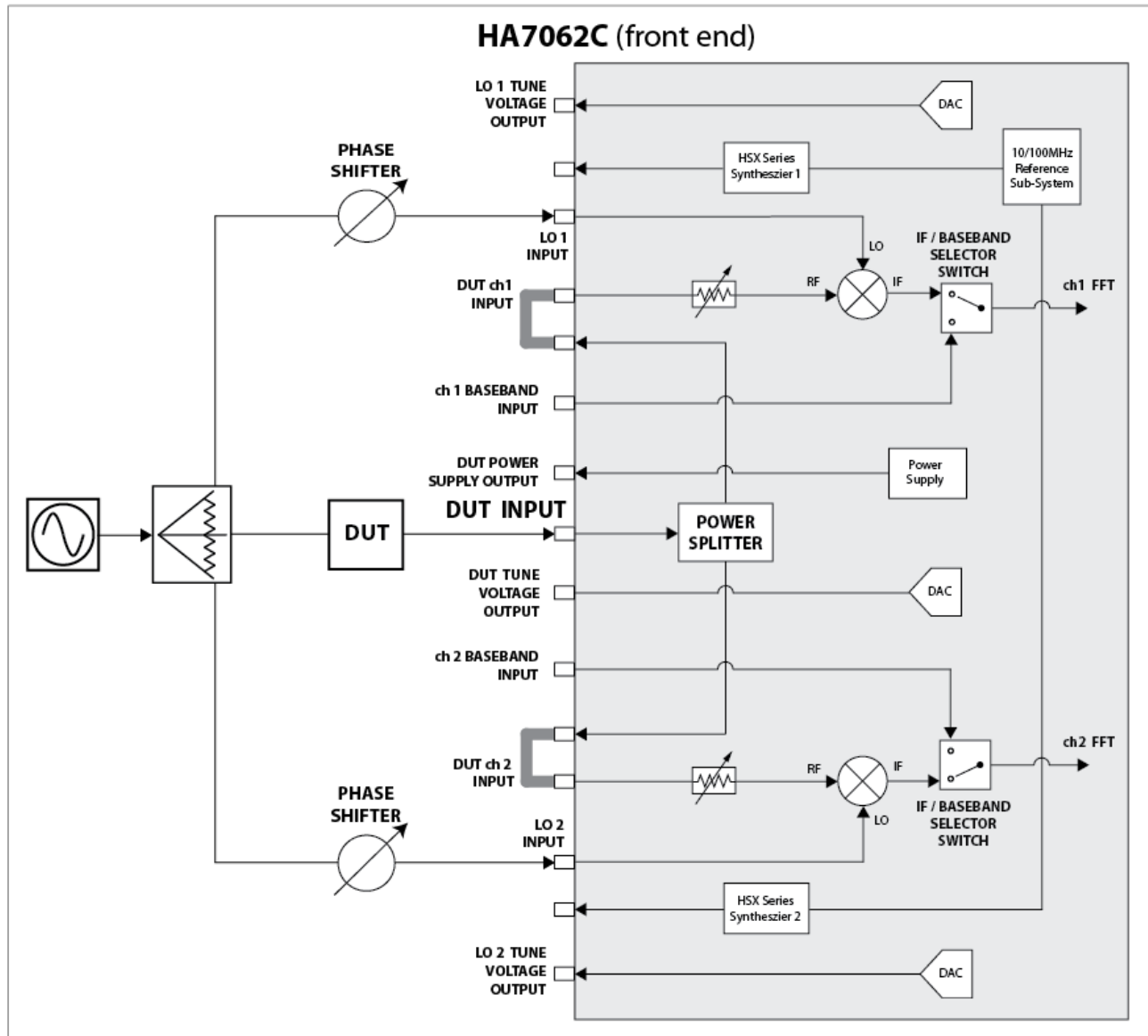
FREQUENCY EXT.

HA7062C RESIDUAL MEASUREMENT BLOCK DIAGRAMS

The architecture of the HA7062C greatly simplifies the additive measurement process. The block diagram below shows the basic configuration for an additive phase noise measurement.

A pair of Holzworth HX5100 Electronic Phase Shifters can be used in place of mechanical phase shifters to fully automate the additive measurement. The HX5100 Phase Shifters automate the process of setting quadrature between the LO and DUT inputs by using the tune voltages of LO1 and LO2 to adjust the phase offset of each signal path.

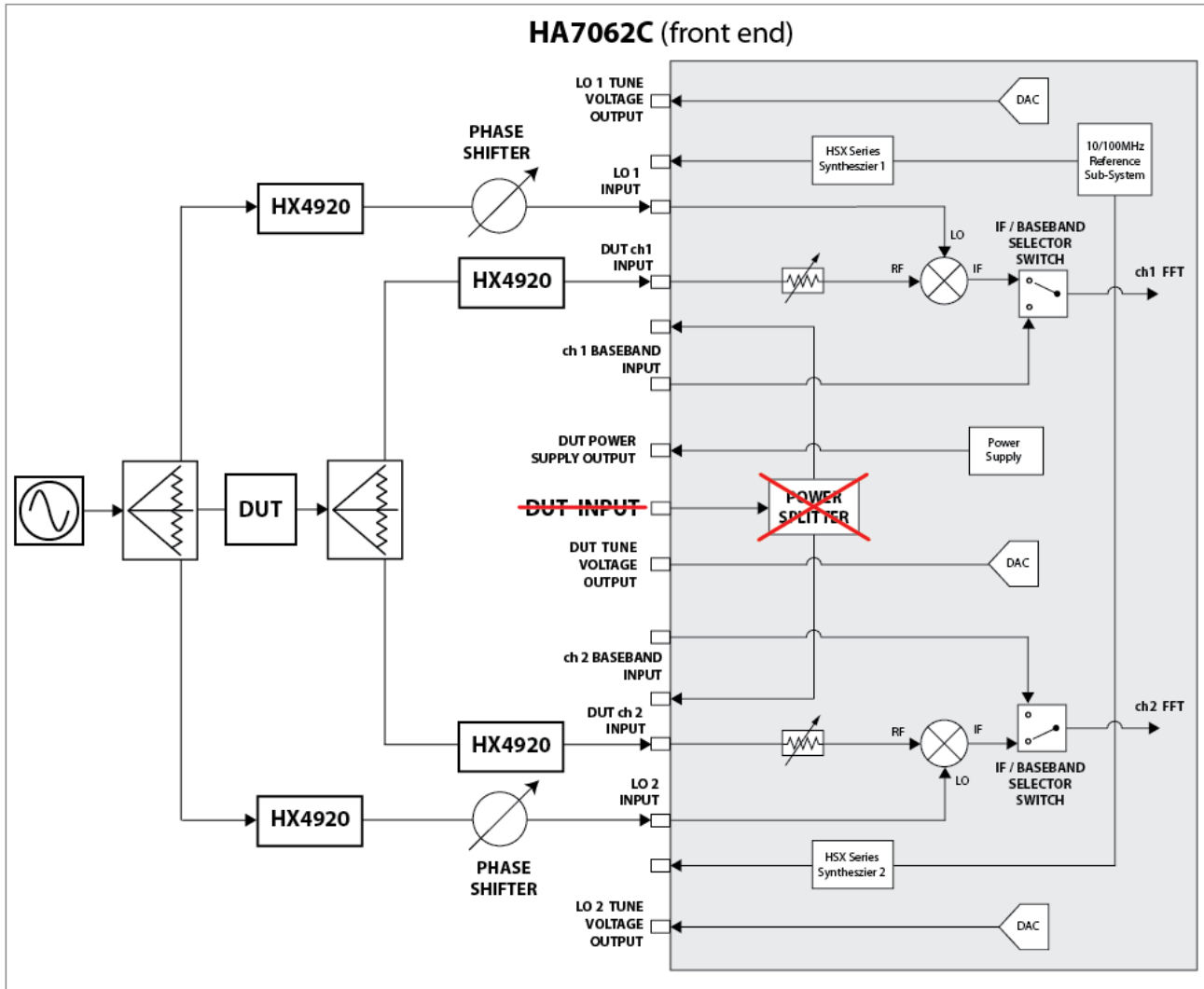
Mechanical phase shifters can also be used in place of the HX5100 Electronic Phase Shifters (recommended for DUT measurements >6GHz). The built in *Quadrature Monitor* is employed for visual feedback while adjusting mechanical phase shifters.



HA7062C RESIDUAL MEASUREMENT BLOCK DIAGRAMS (continued)

>6GHz ADDITIVE MEASUREMENT EXAMPLE

Additive measurements for frequencies of greater than 6GHz can be performed using 4x HX4920 Downconverters as shown below. This configuration can be used to measure DUT phase noise floors to as low as -155dBc/Hz.



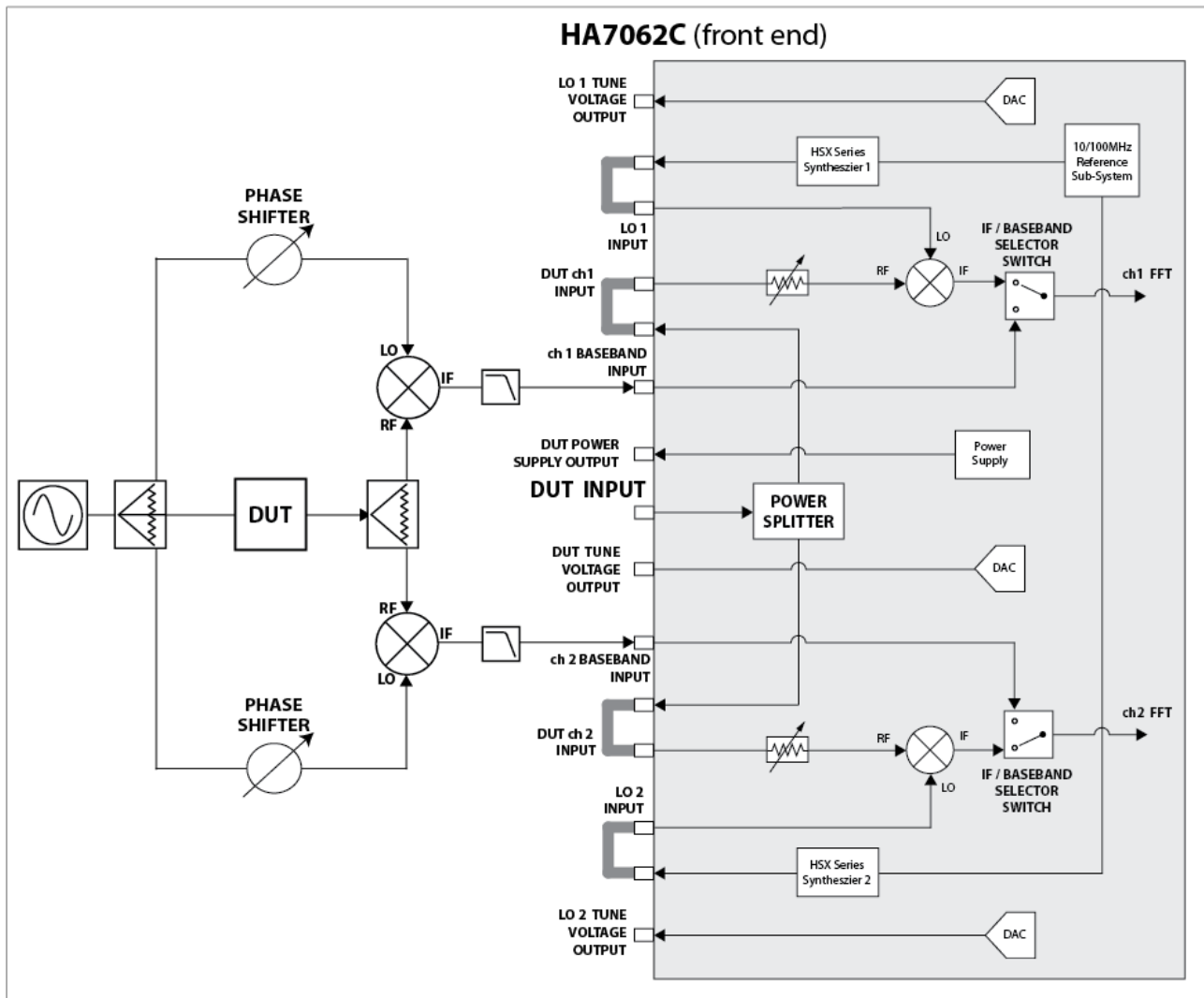
TEST SETUPS

HA7062C RESIDUAL MEASUREMENT BLOCK DIAGRAMS (continued)

BASEBAND ADDITIVE MEASUREMENT EXAMPLE

The baseband inputs can be utilized for measuring additive phase noise as shown in the example below. This configuration allows for the lowest noise floor measurements possible.

NOTE: This configuration can be used to measure the additive phase noise of pulsed signals as well as CW signals.



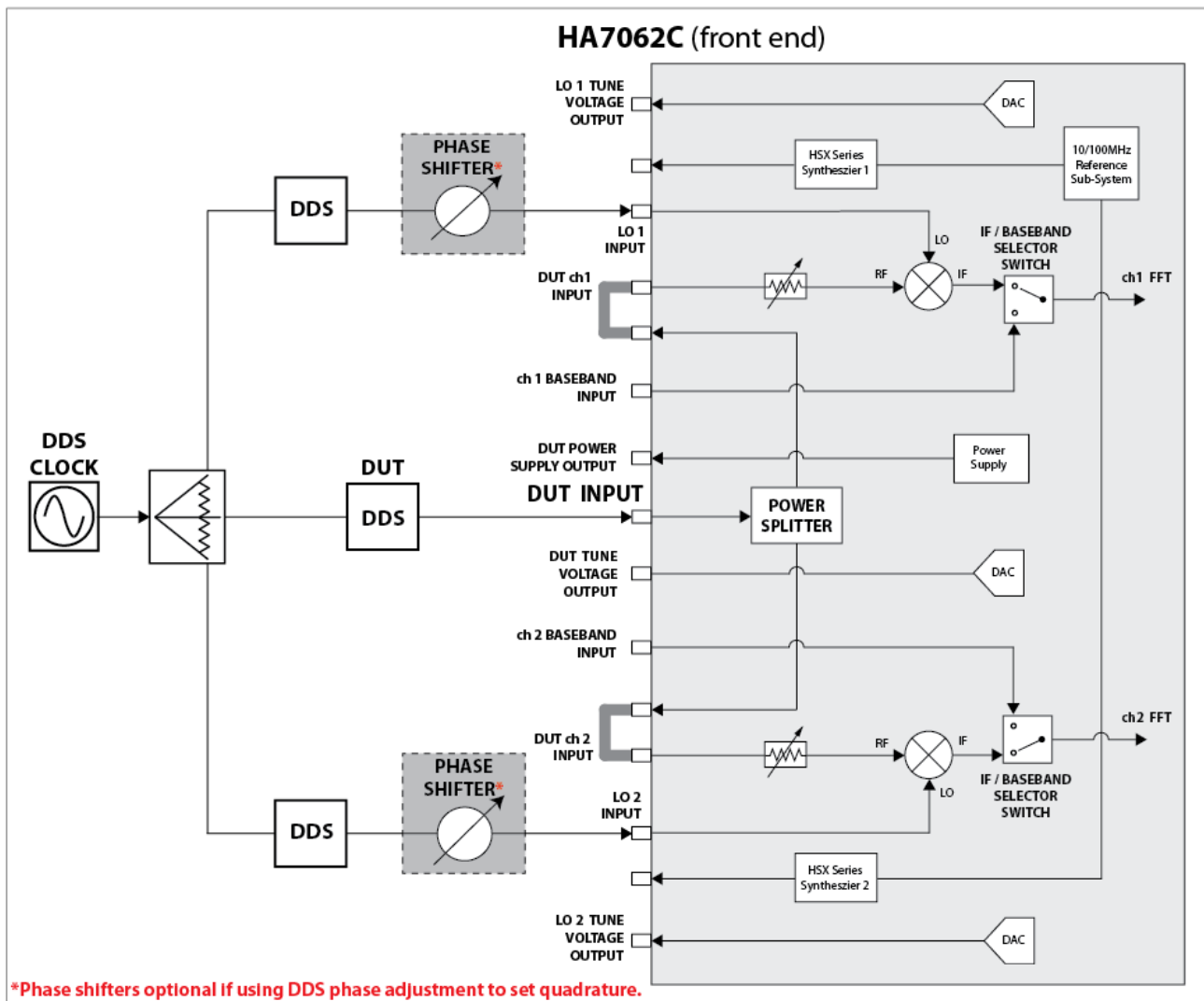
TEST SETUPS

HA7062C RESIDUAL MEASUREMENT BLOCK DIAGRAMS (continued)

DDS MEASUREMENT EXAMPLE

The highly configurable front end of the HA7062C can accommodate a large number of measurement configurations. Below is a block diagram showing the HA7062C being used to measure the additive phase noise of a DDS.

NOTE: The same clock/signal source must be used to drive each DDS in this measurement.



TEST SETUPS



HA7062C

PHASE NOISE ANALYZER

3 YEAR WARRANTY

All Holzworth phase noise analyzer products come with a standard 3 year 100% product warranty covering manufacturing defects and workmanship. All product repairs and maintenance must be performed by Holzworth Instrumentation. Holzworth reserves the right to invalidate the warranty for any product that has been tampered with or used improperly. Refer to Holzworth Terms & Conditions of Sales for more details.

Holzworth products are proudly designed and manufactured in the USA.



CONTACT INFORMATION

Contact Holzworth directly for a product quotation, a product demonstration, or for technical inquiries.

Holzworth Instrumentation Sales Support
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