holzworth instrumentation

HS9000 Series Multi-Channel RF Synthesizers

CE
RoHS

User Manual 3.15

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INDEX

1.0 INTRODUCTION

Thank you for purchasing a Holzworth Instrumentation Multi-Channel RF Synthesizer module. The combination of Holzworth's proprietary non-PLL synthesizer architecture and the multi-channel integration provides the user with unique product performance advantages which are currently only available from Holzworth Instrumentation Inc.

This User's Manual is a generic, quick reference guide for use with the Holzworth HS9000 Series Multi-Channel RF Synthesizer products. Refer to section 4 for specific configuration details with regards to the HS9000 Series hardware.

2.0 CERTIFICATIONS and EXEMPTIONS

2.1 CE CERTIFICATION

Holzworth multi-channel synthesizer 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 EXEMPTION

Holzworth multi-channel synthesizer 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.

The HS9000 Series Multi-channel products are fully compliant in accordance to the definitions given in the directives. The exemption is made resulting from the Maximum Concentration Value of Lead (Pb) being less than 0.1% of the total weight of any multi-channel product offered by Holzworth.

3.0 PRODUCT WARRANTY

Holzworth RF synthesizers 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 channel for output frequency accuracy and output amplitude accuracy. The factory calibration is valid for 2 years from the original calibration date. Holzworth provides calibration services for applicable Holzworth products. 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.

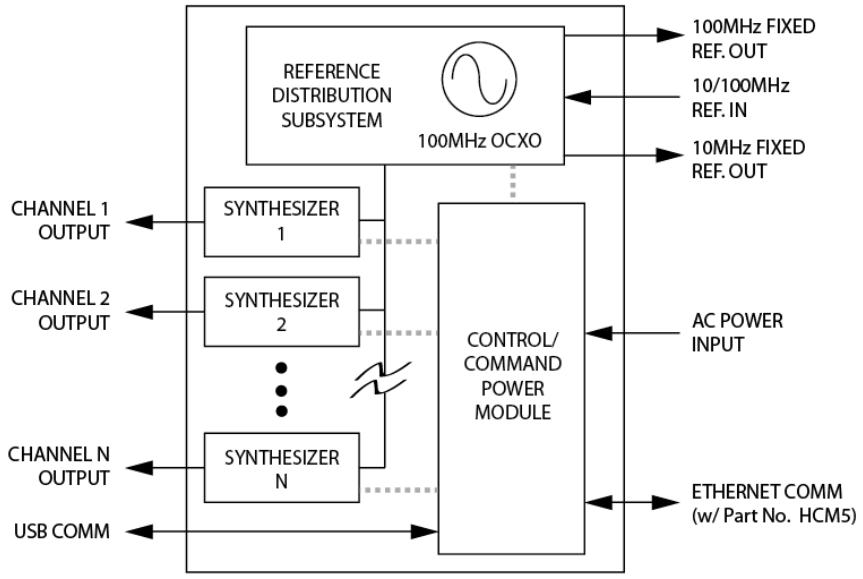
5.0 HS9000 SERIES CONFIGURATION GUIDE

5.1 CONFIGURATION SUMMARY

The Holzworth HS9000 Series multi-channel platform is designed to achieve optimal channel-to-channel stability across all integrated channel synthiesizers via a conductively cooled, fan-less enclosure. Specific attention is paid to phase coherency between the independely controllable channels.

The HS9000 Series is a unique platform allowing the user to specify custom configurations for a COTS product. Units are loaded with anywhere from 1 to 8 channels (up to 6.4GHz), with the additional flexibility to specify each channel's frequency limits and performance options. The result is a high performance, multi-channel synthesizer that is tailored to an application with an optimal price point.

Each RF output is driven by a separate, internally loaded synthesizer module. Up to 8 independently tunable synthesizers can be specified per 1U chassis allowing for the highest integrated channel density available in its class. With an average power dissipation of 7 Watts per channel, the HS9000 series is highly efficient.



Holzworth Multi-channel RF Synthesizers offer the benefits of a proprietary NON-PLL based synthesis architecture. Coupling the NON-PLL architecture with a centralized reference distribution subsystem enables truly phase coherent independently settable channels.

Different from traditional PLL based synthesizers, Holzworth's proprietary architecture creates precisely synthesized signals that exhibit both instantaneous and long term stability. Temperature variations between the channels remain the only contribution to drift. The thermally optimized, fan-less chassis was specifically developed for maintaining the lowest possible channel-to-channel thermal gradients.

Holzworth multi-channel designs are integrated into precision applications that range from particle accelerator timing clocks to satellite position tracking. Due to the necessity for the ultimate in signal stability, Holzworth synthesizers also come standard with thermal monitor outputs to track the relative channel temperature of each loaded channel.

5.2 HARDWARE CONFIGURATION

The HS9000 Series synthesizer platform is a user defined platform. The configuration is setup at the Holzworth factory based on the configuration defined by the end user. Three primary categories define the final configuration of a unit.

5.2.1 Number of Channels

The HS9000 part number signifies the number of independent channels available in the unit. The current revision of the design is revision A. A seven channel unit is defined as an HS9007A.

No. Channels	1	2	3	4	5	6	7	8
Part Number	HS9001A	HS9002A	HS9003A	HS9004A	HS9005A	HS9006A	HS9007A	HS9008A

5.2.2 Loaded Channel Frequencies

The channel frequencies are defined at the time of a product purchase order. To identify what channel frequencies are loaded, refer to the “Loaded Options” designator scribed into the front panel of the instrument (at the left side of the USB Data I/O connector).

Frequency Range	Number of Channels per Frequency Range							
	1x	2x	3x	4x	5x	6x	7x	8x
CMOS 5MHz - 500MHz	OPT-CMOS1	OPT-CMOS2	OPT-CMOS3	OPT-CMOS4	N/A	N/A	N/A	N/A
250kHz - 1GHz	OPT-A1	OPT-A2	OPT-A3	OPT-A4	OPT-A5	OPT-A6	OPT-A7	OPT-A8
250kHz - 2GHz	OPT-B1	OPT-B2	OPT-B3	OPT-B4	OPT-B5	OPT-B6	OPT-B7	OPT-B8
250kHz - 3GHz	OPT-C1	OPT-C2	OPT-C3	OPT-C4	OPT-C5	OPT-C6	OPT-C7	OPT-C8
250kHz - 4GHz	OPT-D1	OPT-D2	OPT-D3	OPT-D4	OPT-D5	OPT-D6	OPT-D7	OPT-D8
250kHz - 6.4GHz	OPT-E1	OPT-E2	OPT-E3	OPT-E4	OPT-E5	OPT-E6	OPT-E7	OPT-E8
10MHz - 12.5GHz	OPT-X1	OPT-X2	OPT-X3	OPT-X4	N/A	N/A	N/A	N/A
10MHz - 20GHz	OPT-F1	OPT-F2	OPT-F3	OPT-F4	N/A	N/A	N/A	N/A

5.2.3 Loaded Options & Available Accessories

Additional factory loaded options are also defined in the "Loaded Options" designator on the front panel. These options further customize the HS9000 Series to an application and are loaded at the factory when the unit is initially built. Accessories are external to the HS9000 platform and can be ordered separately.

TYPE	Part Number	Description
OPTION	OPT-EXTMOD-x	Channel dedicated, external modulation input. x= 1, 2, 3… (up to 6 channels)
OPTION	OPT-FIRM	Custom firmware. Application specific routines
OPTION	OPT-INTGR	Enhanced base-10 frequency accuracy. DDS FTW rounding error correction
OPTION	OPT-OCXO	High Performance OCXO. 10dB Improved Phase Noise at close to the carrier
OPTION	OPT-PWR18-x	+20dBm maximum output power level. x= 1, 2, 3… (up to 5 channels)
ACCESSORY	HCM5	Ethernet Control Module
ACCESSORY	HCM10	RS232 Control Module
ACCESSORY	RACK-1U	19" Rack Mount Bracket Kit, 90° Rear Brackets
ACCESSORY	RACK2-1U	19" Rack Mount Bracket Kit, Straight Rear Brackets

5.2.4 Part Number Example

Ordering a 6 channel synthesizer with 1x CMOS channel, 2x 3GHz channels, 3x 6.4GHz channels, and a high performance OCXO would result in the following configuration:

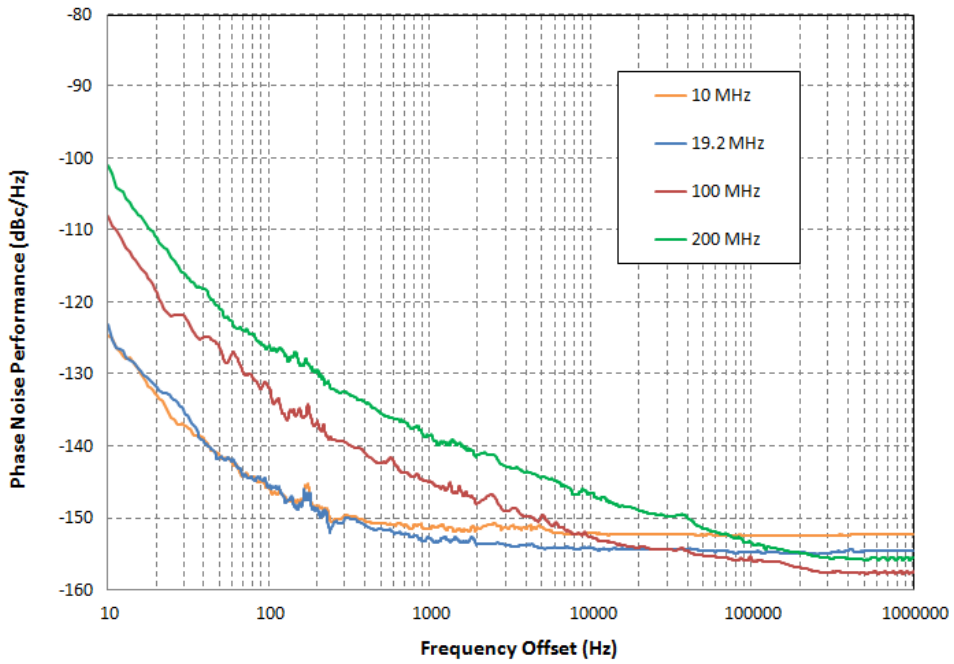
		Description:
Part Number:	**HS9006A**	6 ch, Multi-Channel RF Synthesizer
Options:	**OPT-CMOS1**	1x CMOS Channel
	OPT-C2	2x 3GHz Channels
	OPT-E3	3x 6.4GHz Channels
	OPT-OCXO	High Performance OCXO

5.3 OPTION SPECIFICATIONS

5.3.1 OPT-CMOS

Option OPT-CMOS is an additional channel (or channels) loaded into the multi-channel system. OPT-CMOS provides a CMOS logic output signal, which may be optimal for a system that requires square wave trigger or clock signals.

PARAMETER	MIN[2]	TYPICAL[3]	MAX[2]	COMMENTS
Frequency Range	5MHz		500MHz	
Output Voltage (CMOS Logic)		0V - 5V		0V to 2.5V into 50Ω
Phase Noise 10MHz, 10kHz Offset 19.2MHz, 10kHz Offset 100MHz, 10kHz Offset 200MHz, 10kHz Offset		 -152 dBc/Hz -154 dBc/Hz -152 dBc/Hz -146 dBc/Hz	 -145 dBc/Hz -145 dBc/Hz -143 dBc/Hz -135 dBc/Hz	
Rise Time / Fall Time (Tr / T_f)		900ps		
Output Impedance		50Ω		



[1] Specifications are subject to change per the discretion of Holzworth Instrumentation, Inc.
[2] All MIN/ MAX (Minimum/ Maximum) performance parameters are guaranteed and 100% verified during final performance test.
[3] Typical performance is "by design" and consistent with field performance data.

5.3.2 OPT-OCXO

Option OPT-OCXO replaces the standard internal reference (100MHz OCXO) with a higher performing reference source. A phase noise performance improvement of approximately 10dB is realized at close to the carrier. The 1GHz channel output example (below) demonstrates the typical performance with OPT-OCXO verses that of the standard reference oscillator.

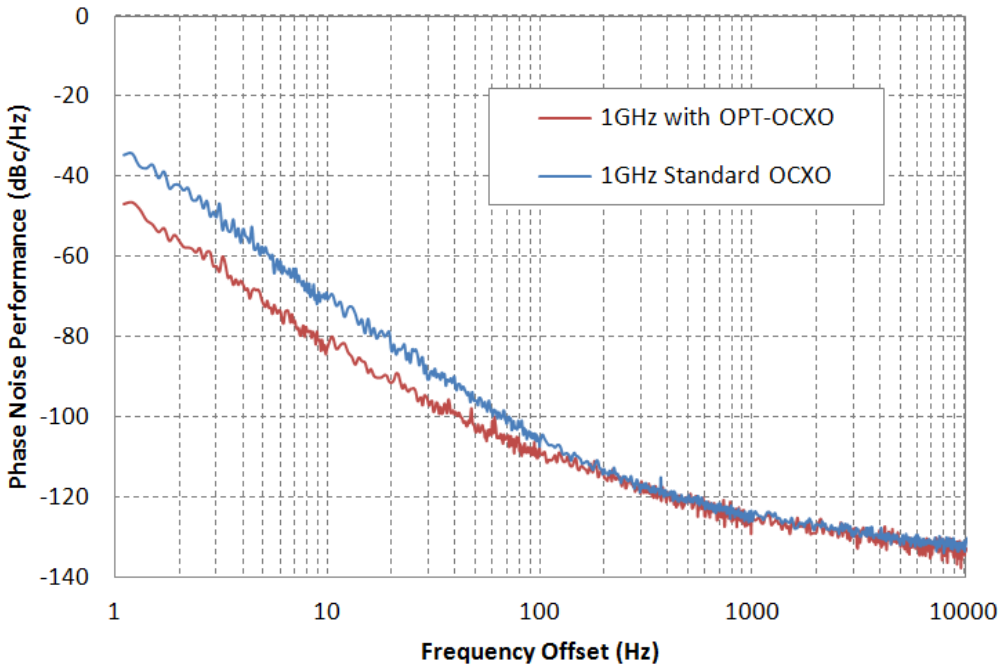


Figure 14: SSB Phase Noise OPT-OCXO Comparison (P_{OUT}=+10dBm)

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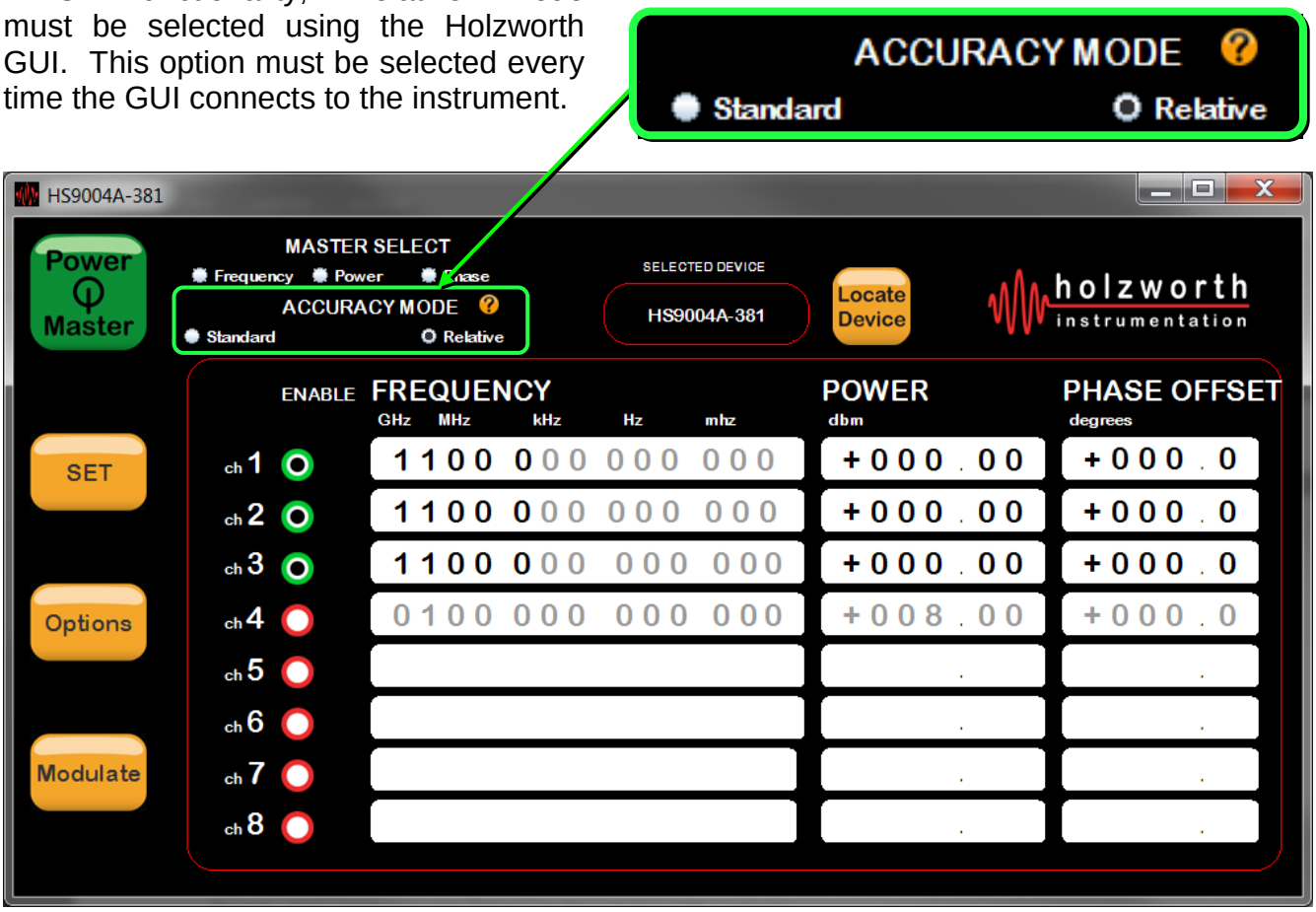
[3] Typical performance is "by design" and consistent with field performance data.

5.3.3 OPT-INTGR

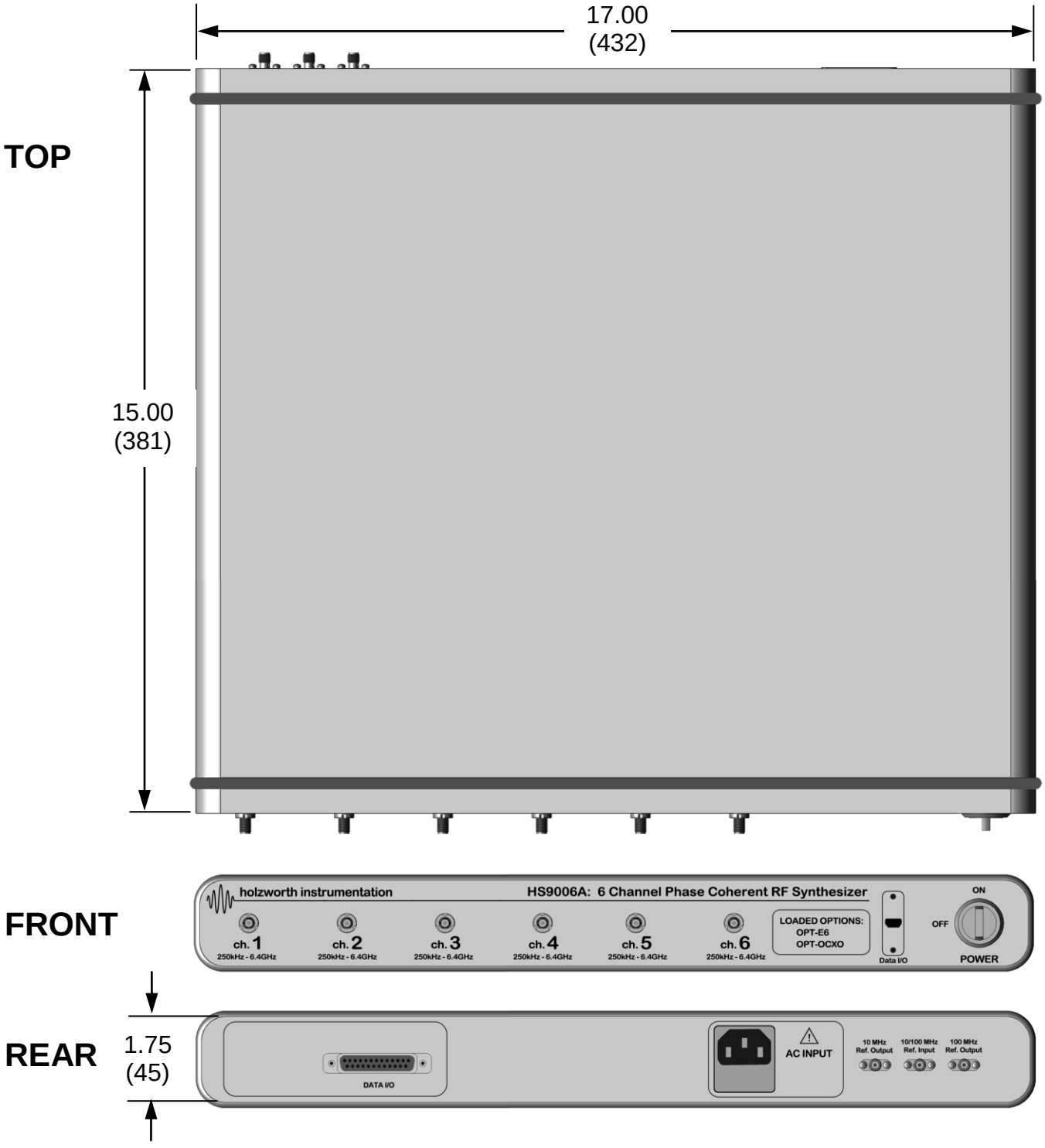
Option OPT-INTGR adds a feedback network internal to the chassis which increases base-10 frequency accuracy of all synthesizer channels by correcting for the DDS rounding error. Up to 7 channels can be loaded into a chassis with OPT-INTGR enabled. When "Relative is selected while using an HS9000 Series synthesizer equipped with OPT-INTGR, the minimum step size is limited for each channel. For settings up to 4.096GHz, the minimum step size is 100kHz, while the step size is limited to 200kHz for frequencies >4.096GHz.

In order to utilize the enhanced OPT-INTGR functionality, "Relative" mode must be selected using the Holzworth GUI. This option must be selected every time the GUI connects to the instrument.



5.4 MECHANICAL CONFIGURATION

The HS9000 Series comes in a 1U high, rack mountable chassis. The example shown is of a 6 channel unit (front panel configuration may vary). A universal rack mount bracket kit is an available accessory (Part No.: RACK-1U). Mechanical dimensions are listed in inches (and millimeters).



6.0 PERFORMANCE SUMMARY

The specified parameters for the Multi-Channel RF Synthesizers are fully verified at final performance test and 100% guaranteed for the warranted life of the product. Specification limits cover the entire frequency range of the product line. Therefore, there are frequency limitations based on the appropriate model number.

6.1 FREQUENCY PERFORMANCE

6.1.1 Channels up to 6.4 GHz Maximum Output[1]

PARAMETER	MIN[2]	TYPICAL[3]	MAX[2]	COMMENTS
Frequency Option Ranges[4]				
OPT-A1 thru OPT-A8	250 kHz		1.024 GHz	Settable from 100 kHz.
OPT-B1 thru OPT-B8	250 kHz		2.048 GHz	Settable from 100 kHz.
OPT-C1 thru OPT-C8	250 kHz		3.072 GHz	Settable from 100 kHz.
OPT-D1 thru OPT-D8	250 kHz		4.096 GHz	Settable from 100 kHz.
OPT-E1 thru OPT-E8	250 kHz		6.400 GHz	Settable from 100kHz to 6.720 GHz
Frequency Resolution		0.001 Hz		
Phase Offset Resolution				**Offset Accuracy:**
250 kHz – 512 MHz		0.1 deg		±0.05 deg
512 MHz – 1.024 GHz		0.2 deg		±0.10 deg
1.024 GHz – 2.048 GHz		0.4 deg		±0.20 deg
2.048 GHz – 4.096 GHz		0.8 deg		±0.40 deg
4.096 GHz – 6.40 GHz		1.6 deg		±0.80 deg
Switching Speed (Frequency)				
SPI Mode (ASCII)		300 µs maximum by design.		
SPI Mode (Binary)		< 3.072 GHz, 100 µs maximum by design. 75 µs typical.		
		≥ 3.072 GHz, 100 µs by design.		
List/Step Sweep Mode (WB)		100 µs by design. Wideband Steps (full bandwidth)		
List/Step Sweep Mode (NB)		6 µs by design. Narrowband Steps (<5% bandwidth)		
Internal Time Base Reference (Oscillator Aging Rate)		± 1 ppm/yr		1st year. ±0.5 ppm/yr each subsequent year
Temperature Effects		± 1 ppm		0 to 55 °C
Line Voltage Effects (12V)		± 0.1 ppm		• ±5%
10 MHz Reference Output				
Amplitude		+ 5 dBm		Fixed, Nominal
Impedance		50 Ω		Nominal
100 MHz Reference Output				
Amplitude		+ 5 dBm		Fixed, Nominal
Impedance		50 Ω		Nominal
External Reference Input				
Input Frequency		10 / 100		10MHz or 100MHz, software selectable
10MHz Lock Range		± 4 ppm	± 1 ppm	20Hz Locking BW, Internal OCXO remains on
10MHz External Amplitude	0 dBm		+10 dBm	20Hz Locking BW, Internal OCXO remains on
100MHz External Amplitude	+2 dBm		+6 dBm	Internal OXCO shuts off
Impedance		50 Ω		50 Ω (nom)
Waveform				Sine
Digital Sweep Modes				
Operating Modes				Step sweep (linear, internal) List Sweep (arbitrary list of freq steps) Simultaneous Amplitude sweep (list)
Sweep Range	250 kHz		6.720 GHz	
Dwell Time	100 µs		100 s	1 µs increments
Number of Points (STEP)	2		65535	
Number of Points (LIST)	2		3201	
Triggering				Free Run, External Trigger

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[2] All MIN/ MAX (Minimum/ Maximum) performance parameters are guaranteed and 100% verified during final performance test.
[3] Typical performance is "by design" and consistent with field performance data.

6.1.2 12 GHz or 20 GHz Channels[1]

PARAMETER	MIN[2]	TYPICAL[3]	MAX[2]	COMMENTS
Frequency Range				
OPT-X1 thru OPT-X4	10 MHz		12.5 GHz	VHF through X Band
OPT-F1 thru OPT-F4	10 MHz		20 GHz	VHF through K_u Band
Frequency Step Size		0.001 Hz		
Phase Offset	0 deg		+360 deg	
Phase Offset Resolution				**Offset Accuracy:**
250 kHz – 512 MHz		0.1 deg		±0.05 deg
512 MHz – 1.024 GHz		0.2 deg		±0.10 deg
1.024 GHz – 2.048 GHz		0.4 deg		±0.20 deg
2.048 GHz – 4.096 GHz		0.8 deg		±0.40 deg
4.096 GHz – 5.0 GHz		1.6 deg		±0.80 deg
5.0 GHz – 10 GHz		3.2 deg		±1.60 deg
10 GHz – 20GHz		6.4 deg		±3.20 deg
Switching Speed (Frequency)				
SPI Mode (ASCII)			300us	
SPI Mode (Binary)			100us	
Internal Time Base Reference				
(Oscillator Aging Rate)		± 1 ppm/yr		1st year. ±0.5 ppm/yr each subsequent year
Temperature Effects		± 1 ppm		0 to 55 °C
Line Voltage Effects (12V)		± 0.1 ppm		±5%
Reference Output				
Frequency		100 MHz		
Amplitude	+2 dBm		+6 dBm	Nominal
Impedance		50 Ω		Nominal
External Reference Input				
Input Frequency		10 / 100		Software Select 10MHz, 100MHz or No Ext. Ref.
10MHz Lock Range		± 4 ppm	± 1 ppm	20Hz Locking BW, Internal OCXO remains on
10MHz External Amplitude	0 dBm		+10 dBm	20Hz Locking BW, Internal OCXO remains on
100MHz External Amplitude	+2 dBm		+6 dBm	Internal OXCO shuts off
Impedance		50 Ω		50 Ω (nom)
Waveform				Sine

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[2] All MIN/ MAX (Minimum/ Maximum) performance parameters are guaranteed and 100% verified during final performance test.
[3] Typical performance is “by design” and consistent with field performance data.
[4] Option OPT-PWR18 limits calibrated minimum frequency to 32MHz

6.2 AMPLITUDE PERFORMANCE

6.2.1 Channels up to 6.4 GHz Maximum Output[1]

The specified parameters for the HS9000 Series RF Synthesizers are fully verified at final performance test and 100% guaranteed for the warranted life of the product. Performance specifications listed on this page are specific to Amplitude.

PARAMETER	MIN[2]	TYPICAL[3]	MAX[2]	COMMENTS
Output Power	-70 dBm		+10 dBm	Settable from -100 to +15 dBm
Output Power with +18dBm Option	-60 dBm		+20dBm	(See information on p. 19)
Resolution		0.01 dB		
Connector		50 Ω		SMA
SWR				
f < 32MHz		1.4 (-15.6 dB)	1.7 (-11.7 dB)	
32MHz < f < 1.024GHz		1.15 (-23.0 dB)	1.4 (-15.6 dB)	
1.024GHz < f < 6.720GHz		1.3 (-17.7 dB)	1.5 (-14 dB)	
Maximum Reverse Power				
Max DC Voltage	25 VDC maximum by design.			*** Some applications may require reverse power protection.
> 100 kHz	10 mW (10dBm) max by design.			
Switching Speed (Amplitude)				
SPI Mode	300 µs maximum by design. Settling to within 0.1 dB.			
List / Step Sweep Mode	100 µs maximum by design.			
Absolute Level Accuracy				
f < 10MHz 0 to -70dBm		+0.25/ -2.0 dB	NS	25C to 35C (case temperature)
10MHz < f < 32MHz 0 to -70dBm		+0.1/ -1.25 dB	+0.6/ -2.0 dB	
32MHz < f < 4.096GHz +10 to -30dBm		± 0.10 dB	± 0.5 dB	
32MHz < f < 4.096GHz -30 to -70dBm		± 0.25 dB	± 1.0 dB	
4.096GHz < f < 6.4GHz +10 to -30dBm		± 0.15 dB	± 0.6 dB	
4.096GHz < f < 6.4GHz -30 to -60dBm		± 0.25 dB	± 1.1 dB	
SSB Phase Noise				
100 MHz, 10kHz offset		≤ -153 dBc/Hz	≤ -145 dBc/Hz	≤ -154 dBc/Hz @ 20kHz offset
500 MHz, 10kHz offset		≤ -139 dBc/Hz	≤ -134 dBc/Hz	≤ -140 dBc/Hz @ 20kHz offset
1.0 GHz, 10kHz offset		≤ -133 dBc/Hz	≤ -128 dBc/Hz	≤ -134 dBc/Hz @ 20kHz offset
2.0 GHz, 10kHz offset		≤ -127 dBc/Hz	≤ -122 dBc/Hz	≤ -128 dBc/Hz @ 20kHz offset
3.0 GHz, 10kHz offset		≤ -123 dBc/Hz	≤ -117 dBc/Hz	≤ -124 dBc/Hz @ 20kHz offset
4.0 GHz, 10kHz offset		≤ -121 dBc/Hz	≤ -115 dBc/Hz	≤ -122 dBc/Hz @ 20kHz offset
6.0 GHz, 10kHz offset		≤ -117 dBc/Hz	≤ -111 dBc/Hz	≤ -118 dBc/Hz @ 20kHz offset
Harmonics (CW mode)				
Pout = 0dBm		-40 dBc	-30 dBc	
Pout = +10dBm		-30 dBc	NS	
Non-Harmonics (CW mode)				
250 kHz to 3.072 GHz		-70 dBc	-60 dBc	@ 0 dBm
3.072 GHz to 6.400 GHz		-60 dBc	-50 dBc	@ 0 dBm
Sub-Harmonics (CW mode)				
250 kHz to 3.072 GHz		-70 dBc	-60 dBc	@ 0 dBm
3.072 GHz to 6.400 GHz		-60 dBc	-50dBc	@ 0 dBm
Jitter				
155 MHz		60 fs	NS	100Hz < BW < 1.5MHz
622 MHz		61 fs	NS	1kHz < BW < 5MHz
2.488 GHz		55 fs	NS	5kHz < BW < 20MHz

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[3] Typical performance is "by design" and consistent with field performance data.
[4] Option OPT-PWR18x limits calibrated minimum frequency to 32MHz.

6.2.2 12 GHz or 20 GHz Channels[1]

PARAMETER	MIN[2]	TYPICAL[3]	MAX[2]	COMMENTS
Output Power (Calibrated) 10 MHz to 12 GHz 12 GHz to 18 GHz	 -10 dBm -10 dBm		 +18 dBm +16 dBm	Settable -20 to +23 dBm
Resolution		0.01 dB		
Connector		50 Ω		SMA
SWR (S_{11}) 10 MHz < f ≤ 6 GHz 6 GHz < f ≤ 18 GHz		 1.33 (-17.0 dB) 1.43 (-15.0 dB)		
Maximum Reverse Power Max DC Voltage > 100 kHz	25 V_{DC} maximum by design. 16 dBm max by design.		*** Some applications may require reverse power protection.	
Switching Speed (Amplitude)			100us	Settling to within 0.1dB
Absolute Level Accuracy 10 MHz - 6 GHz 6 GHz - 18 GHz 0 dBm to 5 dBm 5 dBm to 10 dBm		 ± 0.5 dB ± 1 dB ± 0.5 dB		25C to 35C (case temperature)
SSB Phase Noise 2.0 GHz, 10 kHz offset 4.0 GHz, 10 kHz offset 8.0 GHz, 10 kHz offset 12.0 GHz, 10 kHz offset 18.0 GHz, 10 kHz offset		 ≤ -128 dBc/Hz ≤ -122 dBc/Hz ≤ -114 dBc/Hz ≤ -110 dBc/Hz ≤ -106 dBc/Hz		
Harmonics (CW mode)		-30 dBc		
Non-Harmonics (CW mode) 10 MHz to 8 GHz 8 GHz to 18 GHz		 -60 dBc -50 dBc		
Sub-Harmonics (CW mode) 10 MHz to 8 GHz 8 GHz to 18 GHz		 -60 dBc -50 dBc		
Jitter (RMS) at 18 GHz		55 fs		5 kHz < BW < 20 MHz

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[3] Typical performance is “by design” and consistent with field performance data.
[4] Option OPT-PWR18x limits calibrated minimum frequency to 32MHz.

6.3 MODULATION PERFORMANCE[1]

The external stimulus modulation parameters are only available on units equipped with the external modulation option (OPT-EXTMOD). Units with OPT-EXTMOD have channel dedicated modulation input ports installed for up to 6 integrated channels. An external modulation stimulus signal must be applied as specified here. Refer to the operating instructions in section 8.3 for units that are equipped with the external modulation option.

6.3.1 External Modulation, Channels up to 6.4 GHz Maximum Output[1]

PARAMETER	PERFORMANCE	COMMENTS
FREQUENCY MODULATION[1] (Analog)		
Max Deviation	100 kHz	
Resolution	0.01% or 1mHz, whichever is greater	
Deviation Accuracy	< ± 2%	
Modulation Freq. Response	DC to 20 kHz (-3dB)	DC Coupled
Sensitivity when using Ext. Input	± 1V peak into 50Ω	+ 1V: Maximum Positive Deviation 0V: Zero Deviation from Carrier - 1V: Maximum Negative Deviation
PHASE MODULATION[1] (Analog)		
Modulation Deviation	±1.6 deg to ±180 deg	
Frequency Response	DC to 20 kHz (-3dB)	DC Coupled
Resolution	Frequency Dependent	See Phase Offset Specification
Sensitivity when using Ext. Input	± 1V peak into 50Ω	+ 1V: Maximum Positive Deviation 0V: Zero Deviation from Carrier - 1V: Maximum Negative Deviation
AMPLITUDE MODULATION[1] (Analog)		
AM Depth Type	Linear	
Depth Maximum Resolution Depth Accuracy	 5% to 75% <3% of Maximum Depth 5% of Maximum Depth	0.45 dB to 12 dB
Modulation Rate	DC to 10 kHz (-3dB)	DC Coupled
Sensitivity when using Ext. Input	± 1V peak for indicated Depth (into 50Ω)	+ 1V: Maximum Amplitude 0V: 50% of Maximum Depth - 1V: Maximum Depth
PULSE MODULATION[1] (Analog)		
Risetime (T_r)	<100 ns	
Falltime (T_f)	<100 ns	
On/Off Ratio	> 70dB	
Minimum Pulse Width	200 ns	
ALC Loop Deviation (ALC disabled)	1dB difference from ALC enabled	

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

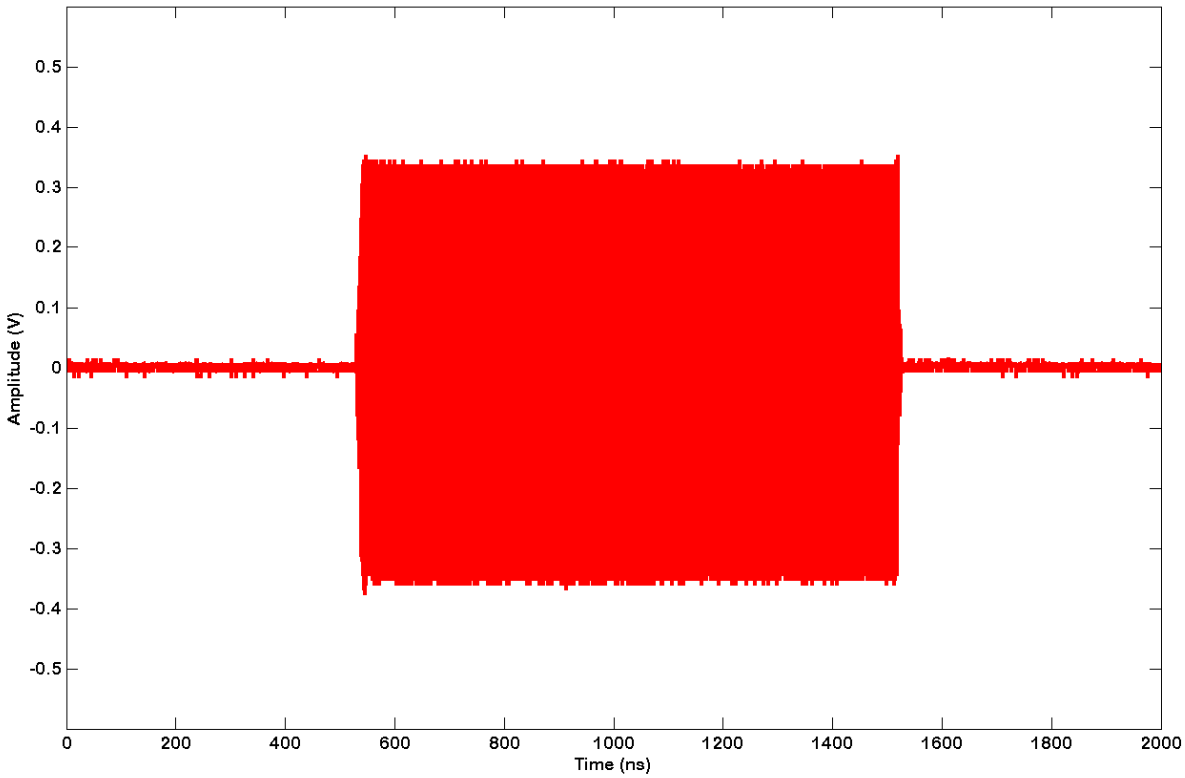
PARAMETER	PERFORMANCE	COMMENTS
External Trigger Threshold	+1.2V	±5% into 50Ω

6.3.2 Self Pulse Modulation, Channels up to 6.4GHz[1]

HSM Series synthesizers up to 6.4GHz maximum output frequency that have firmware version 3.3.1 or higher, are capable of operating in internal pulse modulation mode, which does not require an external stimulus signal.

PARAMETER	PERFORMANCE	COMMENTS
Risetime (T_r) **fc < 512MHz** **fc > 512 MHz**	11ns (typical)	
Falltime (T_f)	<100 ns	
On/Off Ratio	> 70dB	
Minimum Pulse Width	200 ns	
ALC Loop Deviation (ALC disabled)	1dB difference from ALC enabled	

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



(Figure 1: Self Pulse Mod f_c = 500MHz, 2us Pulse[2])

[2] Internal pulse modulation for frequencies greater than 512MHz will exhibit increased settling time. Contact Holzworth customer support for additional data.

6.3.2 Self Pulse Modulation, Channels up to 6.4GHz (continued)

Pulse modulation will exhibit longer rise/fall times for frequencies greater than 512 MHz. Figures 2 and 3 below demonstrate this difference between set frequencies.

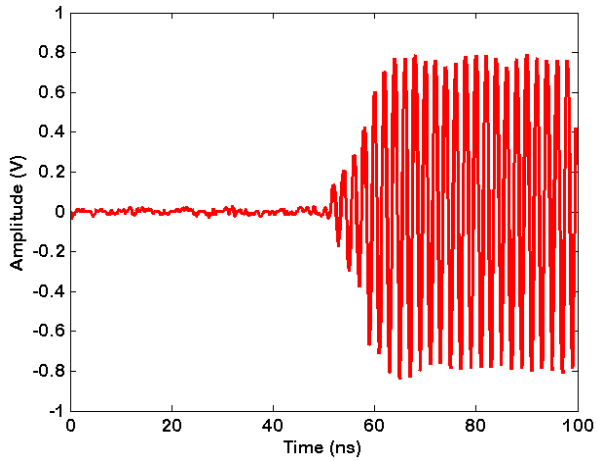


Figure 2a: Pulse Mod Rise Time, f_c = 500MHz

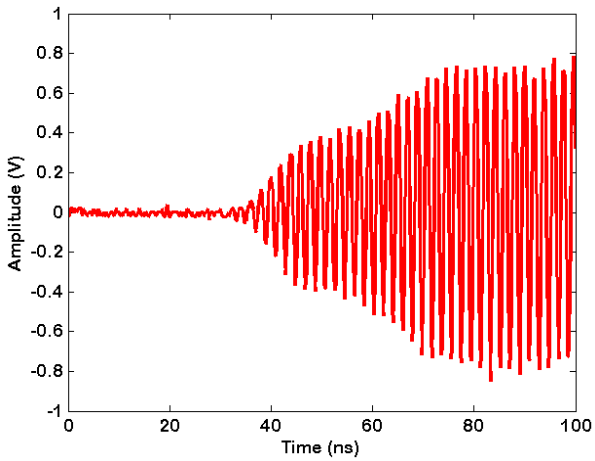


Figure 2b: Pulse Mod Rise Time, f_c = 530MHz

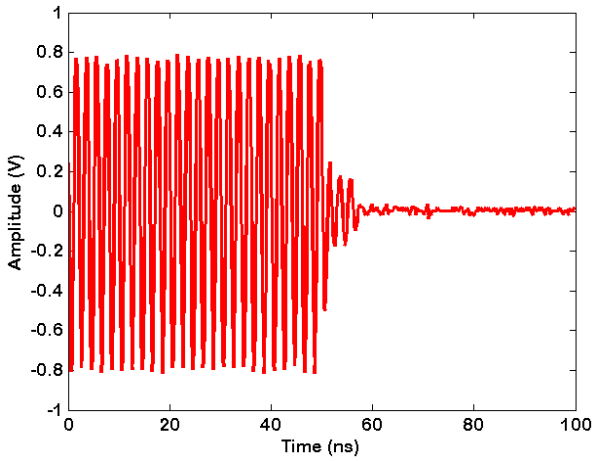


Figure 3a: Pulse Mod Fall Time, f_c = 500MHz

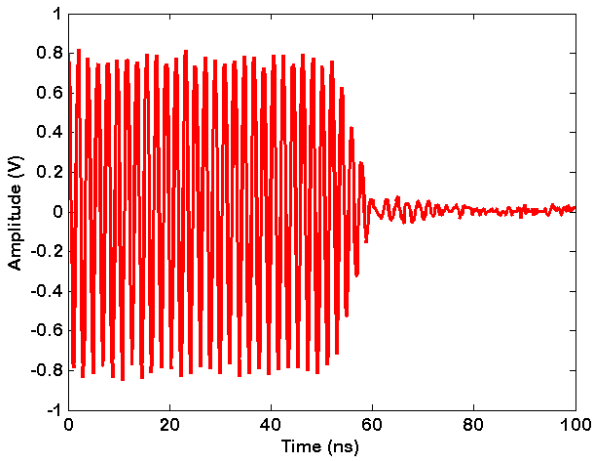


Figure 3b: Pulse Mod Fall Time, f_c = 530MHz

6.3.4 External Modulation Performance, 12 GHz or 20 GHz Channels[1]

Modulation capabilities on channels equipped with OPT-X1 or OPT-F1 are different than those on the lower frequency channels. Currently modulation is limited to externally driven pulse modulation. This pulse modulation exhibits better performance than the same capability on the lower frequency channels, however.

EXTERNAL MODULATION (12 and 20 GHz channels)

PARAMETER	PERFORMANCE	COMMENTS
Risetime (T_r)	<20 ns	
Falltime (T_f)	<20 ns	
On/Off Ratio 10MHz to 10GHz 10GHz to 20GHz	 > 80dB > 50dB	
Minimum Pulse Width	50 ns	
ALC Loop Deviation (ALC disabled)	1dB difference from ALC enabled	

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

PARAMETER	PERFORMANCE	COMMENTS
External Trigger Threshold	+1V	±5% into 50Ω

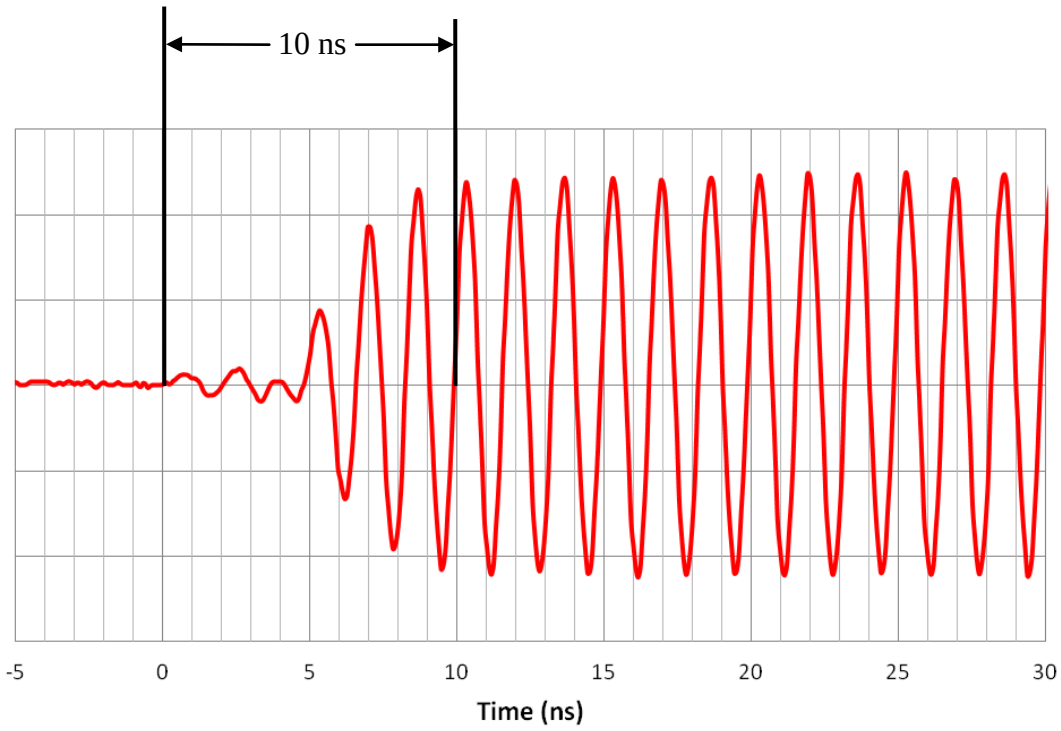


Figure 1: External Pulse Modulation Rise Time (seconds)

6.4 ENVIRONMENTAL SPECIFICATIONS[1]

Environmental specifications are based on component margins, thermal verification testing and current draw tests. Production unit performance is not verified over temperature.

PARAMETER	MIN	TYPICAL	MAX	COMMENTS
Operating Temperature	0 C		+55 C	
Temperature Monitor Range	-40 C		+85 C	Absolute, channel dedicated outputs
AC Power Supply	100 V_{AC}		240 V_{AC}	50 – 60Hz
Power Consumption **Base Power Consumption** **Channel ≤ 6.4 GHz** **12 or 20GHz Channel**		 5 W 7 W 15 W		
Warm-Up Time		10 min	20 min	20 C (ambient temp. dependent)

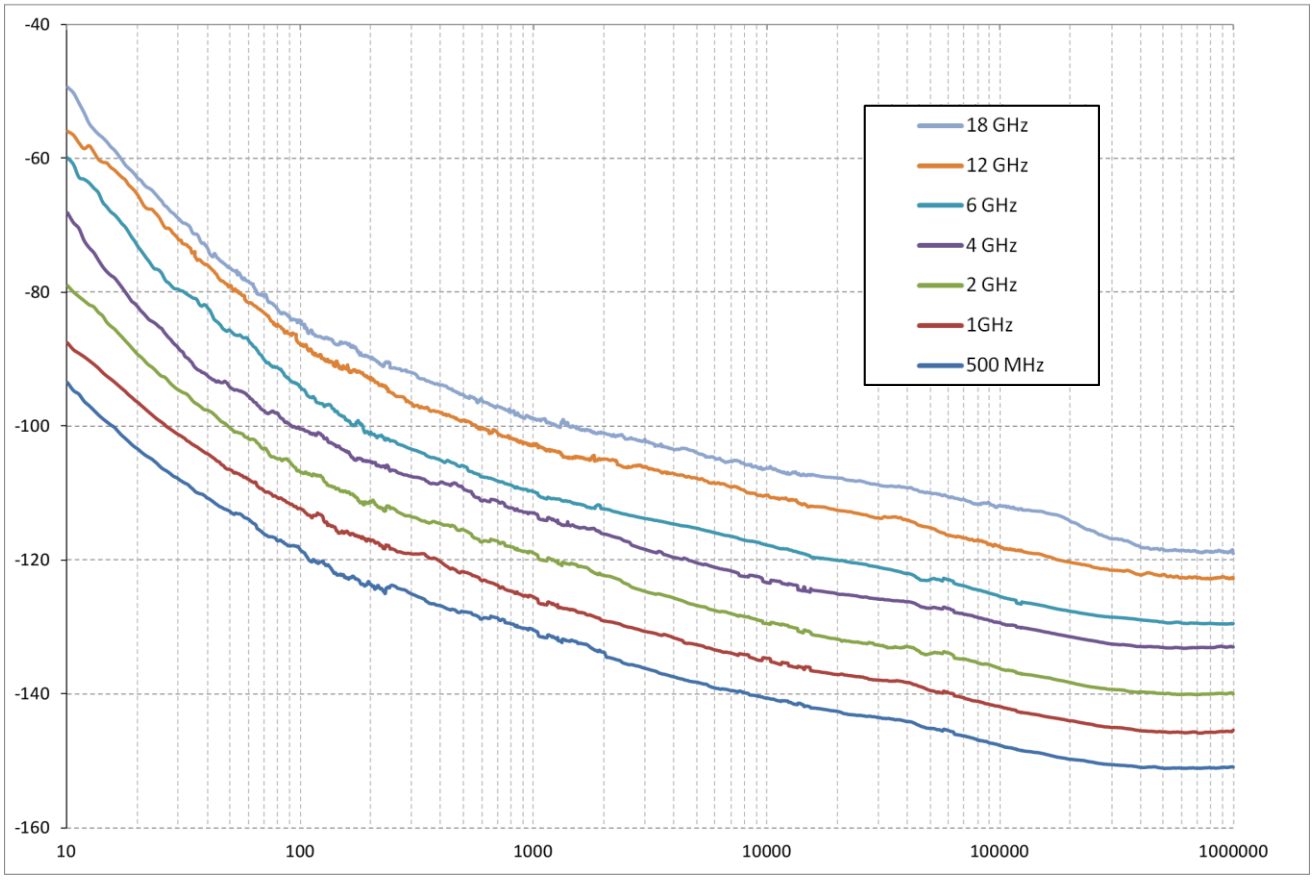
[1] Specifications are subject to change per the discretion of Holzworth Instrumentation, Inc

DESCRIPTION	SPECIFICATION (by design)
Operating Environment **Humidity** **Altitude** **Vibration**	 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

6.5 PHASE NOISE PERFORMANCE

6.5.1 Synthesized Channel Output Phase Noise

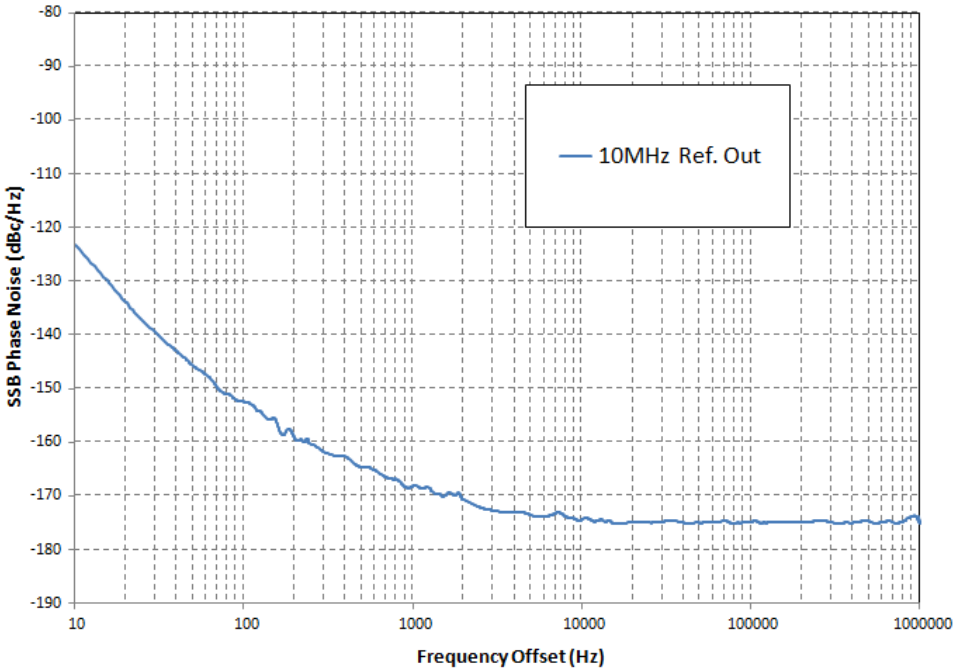
The raw data displayed in the figure below is of SSB Phase Noise vs. Frequency Offset as measured for the entire range of channel options available. All data was collected at an output power setting of +10dBm.



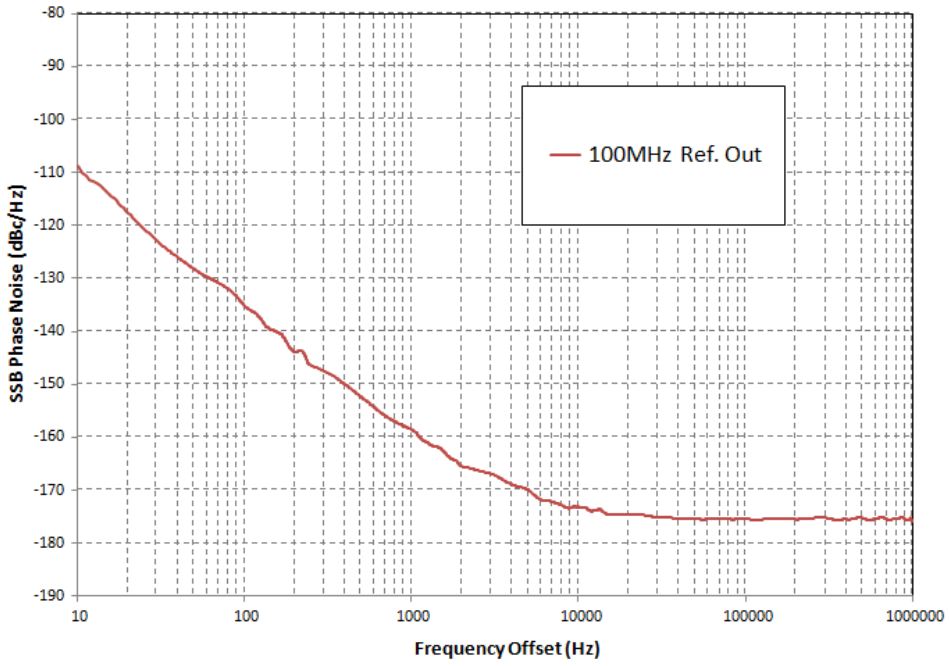
SSB Phase Noise (P_{OUT} = +10dBm)

6.5.2 Fixed Reference Output Phase Noise

The HS9000 Series come equipped with fixed 10MHz and 100MHz reference outputs. The fixed reference output signals are derived directly from the internal reference standard (100MHz OCXO). The data include below is representative of typical performance.



10MHz Reference Output SSB Phase Noise



100MHz Reference Output SSB Phase Noise

7.0 MULTI-CHANNEL INSTALLATION

This section outlines the basic installation requirements and procedures for the HS9000 Series Multi-Channel Synthesizer application GUI and the hardware either via USB or Ethernet.

First, the application GUI software must be installed. The GUI software is contained on the CD that was included with the synthesizer module. If the CD was lost another can be emailed or 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 synthesizers are PC controlled Instruments (virtual front panel) that interface with a PC via USB as a Human Interface Device (HID) or via an Ethernet connection at the rear panel (HCM5 Ethernet Communications Module accessory required).

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 / Java 6.0 installed
Minimum Display Resolution	1000 x 500 pixels
Touch Screen Compatible	No

7.1.2 Downloading Java™

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

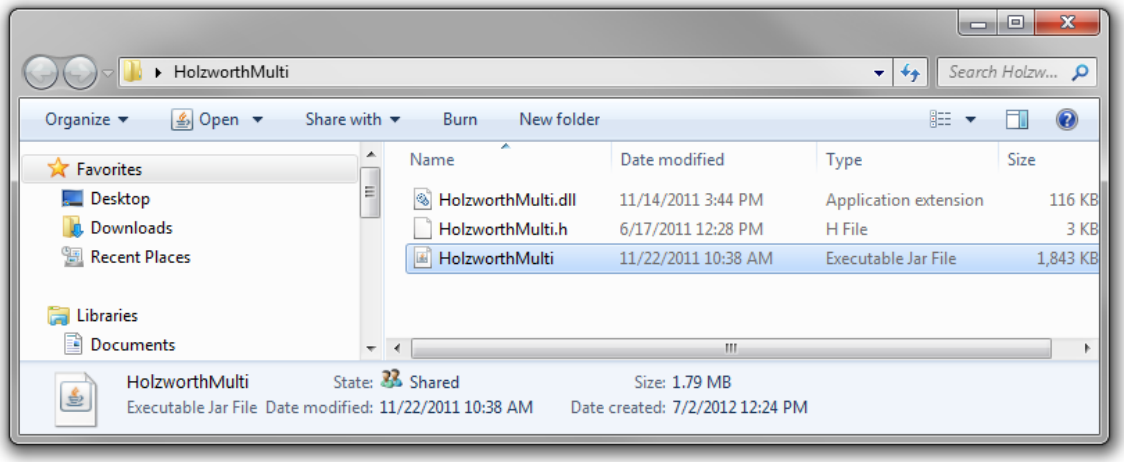
To validate what version of Java™ is installed on the host PC or to download the latest version, go to:

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

7.1.3 Loading the Application GUI

The CD included with the synthesizer contains an application file folder with 3 files that include: a .dll file, a .jar file and a .h file, which contains the header commands for operating the analyzer with programs such as LabVIEW™ and MATLAB™. Contact Holzworth for available instructions related to non-Holzworth GUI operation.

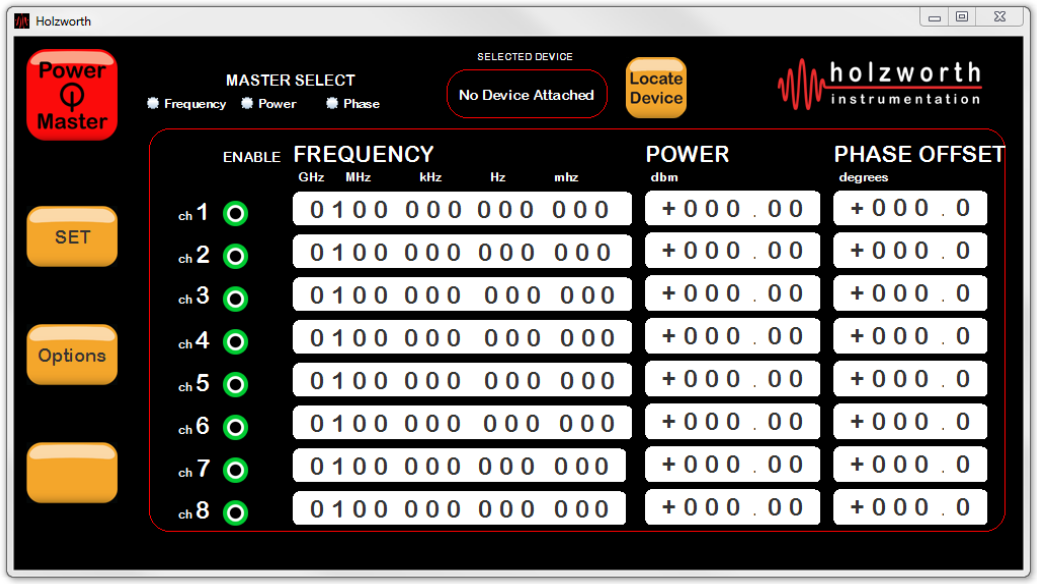
Multi-Channel Application Folder



7.1.4 Initializing the Application GUI

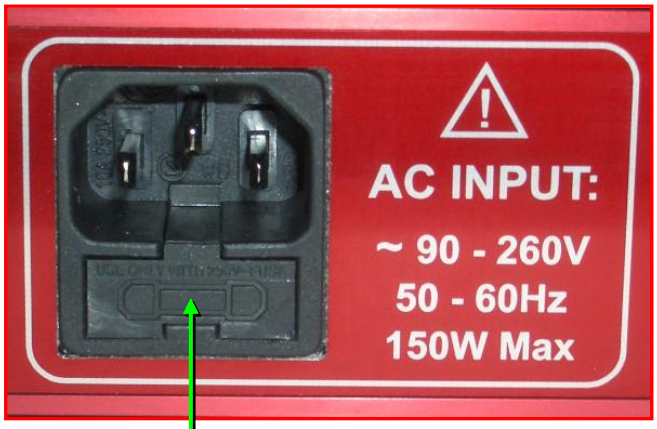
The multi-channel application does not utilize the Windows software Installation Wizard. The following 2 steps need occur to launch the application:

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 "HolzworthMulti.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 synthesizer, connect the power cord to an active AC power supply. 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 AC power is active.



FUSE

NOTE: If the power light is not illuminated while the front panel switch is in the "ON" position, verify that there is power at the AC outlet/supply and that the fuse has not blown. Fuse is located in the service tray on the power cord receptacle (rear panel). A spare fuse is provided inside the service tray.

7.2.1 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. Under the USB connection, the synthesizer 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 synthesizer 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 synthesizer 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 synthesizer via 2 captive panel screws (as pictured above).

7.2.2 Ethernet Hardware

An Ethernet connection is available via the back panel of the instrument using part number: HCM5 (USB Communication Module for HS9000 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 1: 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.

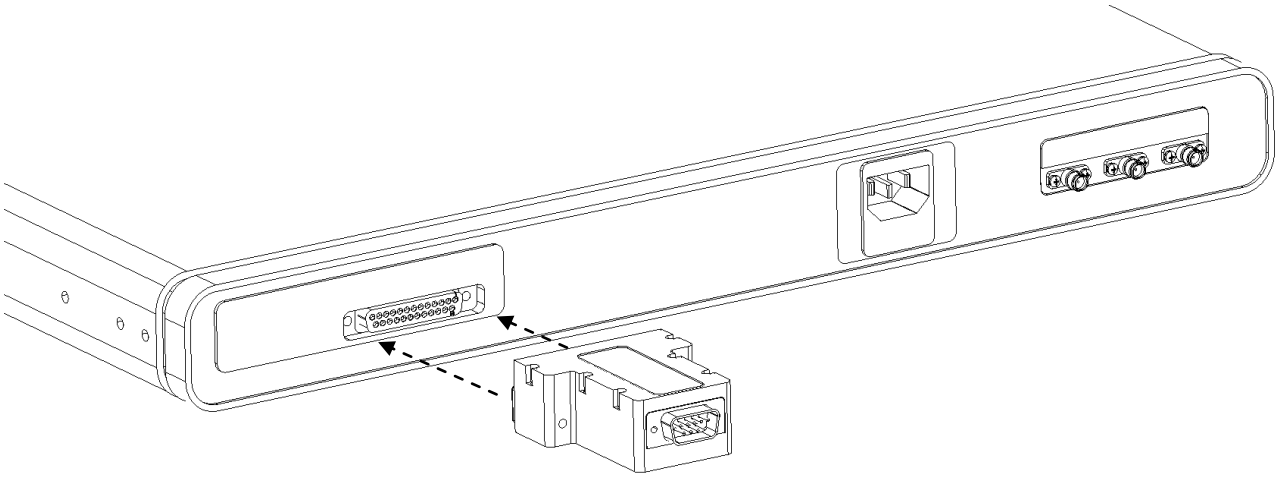
NOTE 2: For direct PC connection via Ethernet (non-networked) a cross over Ethernet cable is required.

7.2.3 RS-232 Hardware

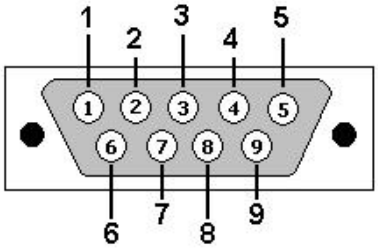
The HCM10 communication module can be used to control the HS9000 Series synthesizer using RS-232 communication standard.

RS-232 HARDWARE INSTALLATION

1. Connect the HCM10 module to the Data I/O port on the back of the HS9000 chassis.
2. Connect to the HCM10 using a DB9 cable with female connector or female DB9 adapter.



RS-232 HARDWARE SPECIFICATIONS



1. Connector: DB9 Male Shrouded.
2. Logic Level: ±5V
3. Baud Rate: 38.4k FIXED.
4. Bit Structure: 8 Data Bits, 1 Stop Bit, No Parity, No Flow Control
5. Carriage Return: Carriage return (ASCII Code 13)

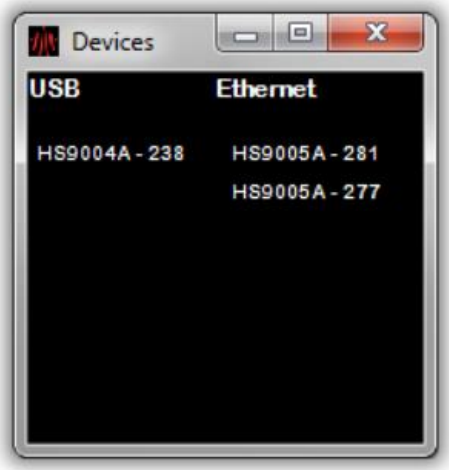
PINOUT

PIN	Label	PIN	Label	PIN	Label
1	N/C	**4**	N/C	**7**	N/C
2	**TX (Response Output from HCM10)**	**5**	**GND**	**8**	N/C
3	**RX (Instruction Input[1] into HCM10)**	**6**	N/C	**9**	N/C

Please refer to Appendix B for the complete instruction set.

7.3 DEVICE CONNECTION

The same GUI is used for both USB and Ethernet control of the device. Refer to the appendices of this document for alternate control methods. Due to the potential for having multiple synthesizer units connected to the same PC, making a connection is a manual operation. To locate and connect to the device, press the LOCATE DEVICE button located at the top center of the GUI window.



Pressing the LOCATE DEVICE button initiates the Devices popup window that will list all Holzworth multi-channel synthesizer devices that are available to the PC.

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

USB and Ethernet devices are listed separately. NOTE that once the HCM5 Ethernet hardware is installed onto the HS9000 Series synthesizer, USB communications is completely disabled and vice versa.

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

The device name protocol is by part number, followed by serial number. The unique part number/serial number can be located at the rear and front panel of each device. NOTE that the GUI does not specifically identify each channel frequency range, but the frequency limits of those channels are auto-detected and set for each channel.

The selected device will appear in the SELECTED DEVICE indicator, located at the top of the GUI application window. The unit is now connected and ready to be put to work.

NOTE: When connecting to devices located on a network (Ethernet), the GUI will not make a connection with any device that is already connected to an alternate application or PC.

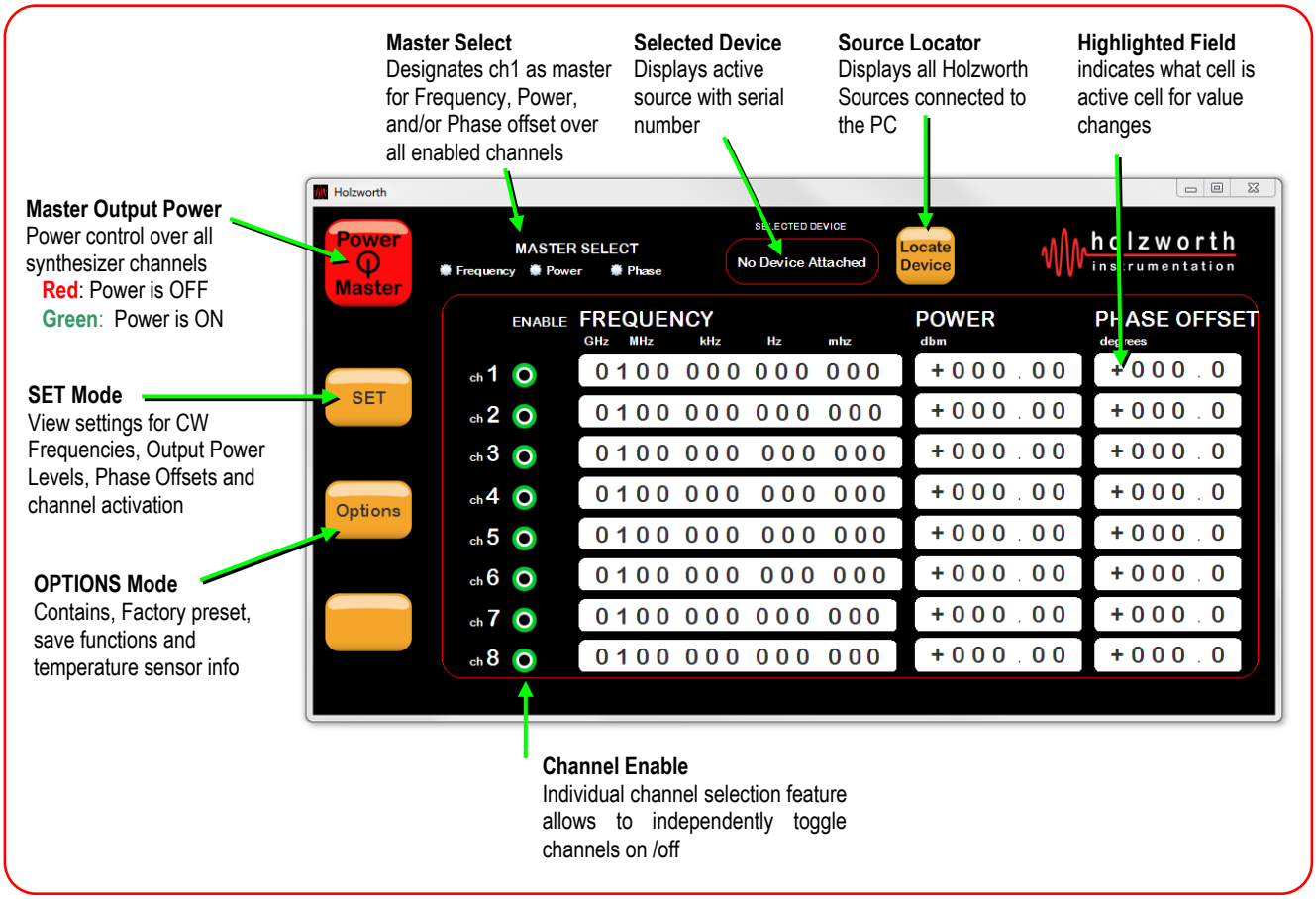
8.0 APPLICATION GUI / OPERATION

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

This section defines the basic operation of the standard application GUI that is provided for the multi-channel synthesizer 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 GLOBAL FUNCTIONS

The Global functions apply to all operating modes of the synthesizer.



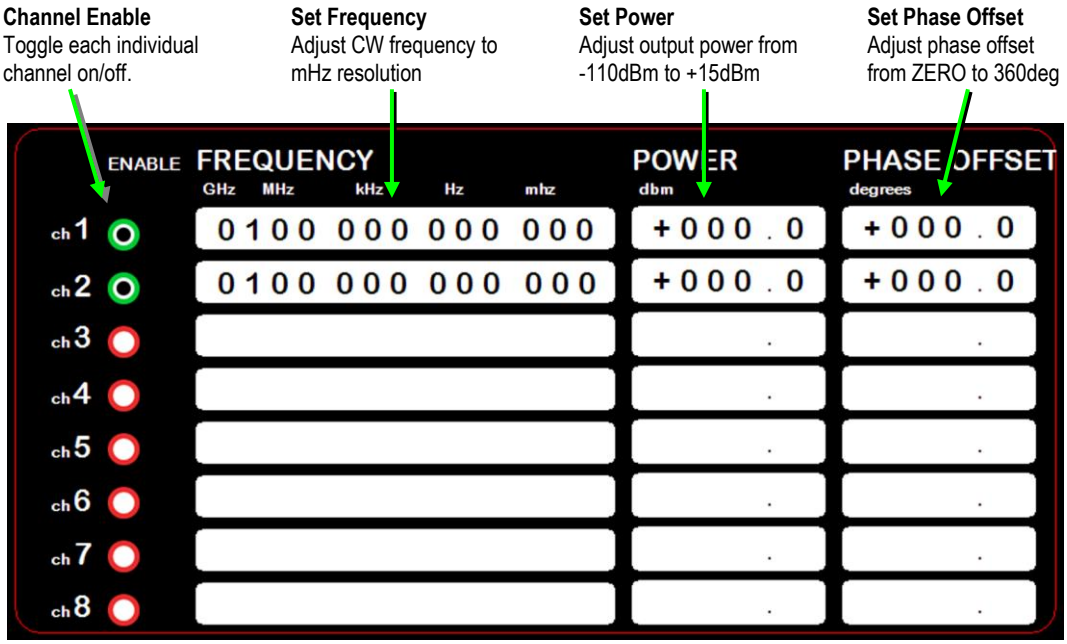
8.1.1 Keyboard and Mouse Functions

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 "SET" WINDOW

The Set Mode allows for independently setting the output characteristics of each channel. Available independent settings include: Channel enable (on/off), CW frequency, Output Power, and Phase Offset. The set window also allows for a master channel to be selected to control all active channels



NOTE that the GUI does not specifically identify each channel frequency range, but the frequency limits of each loaded channel is auto-detected and hard set for each channel.

Unavailable Channels

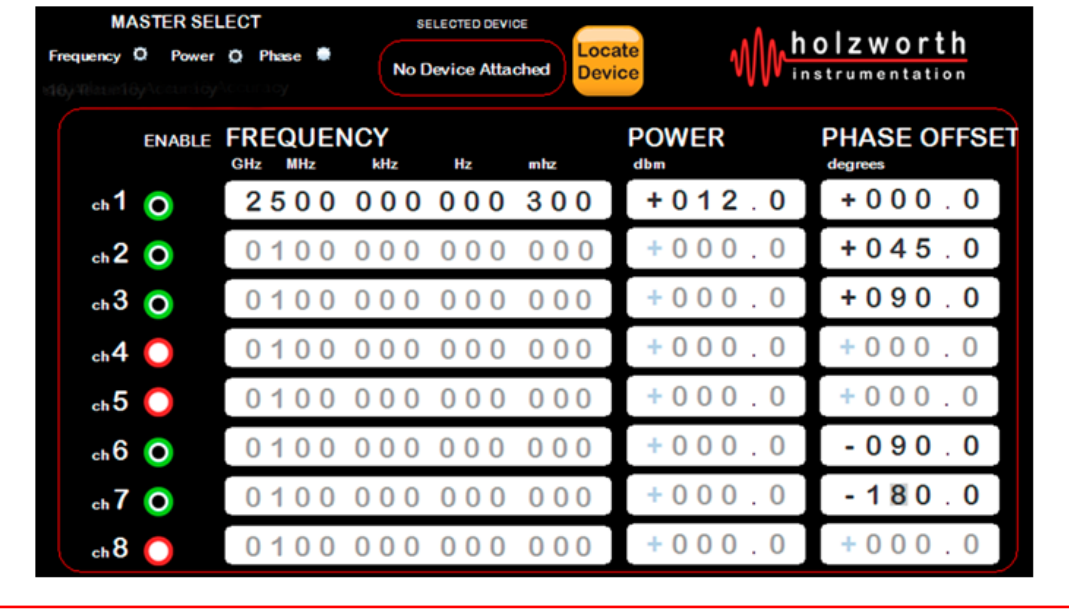
The example above demonstrates an instance where the GUI is connected to an HS9002A synthesizer (2 channel model). In the case of operating a synthesizer equipped with less than 8 channels, only channels 1 though N will be available for control.

8.2.1 Channel Enable Function

The channel enable function allows the user to select which channels are operating. By toggling the radio button next to the channel number, a user can independently turn each channel on or off. The example below shows how the GUI locks out those channels which have been toggled off (even numbered channels are "off" in this example).

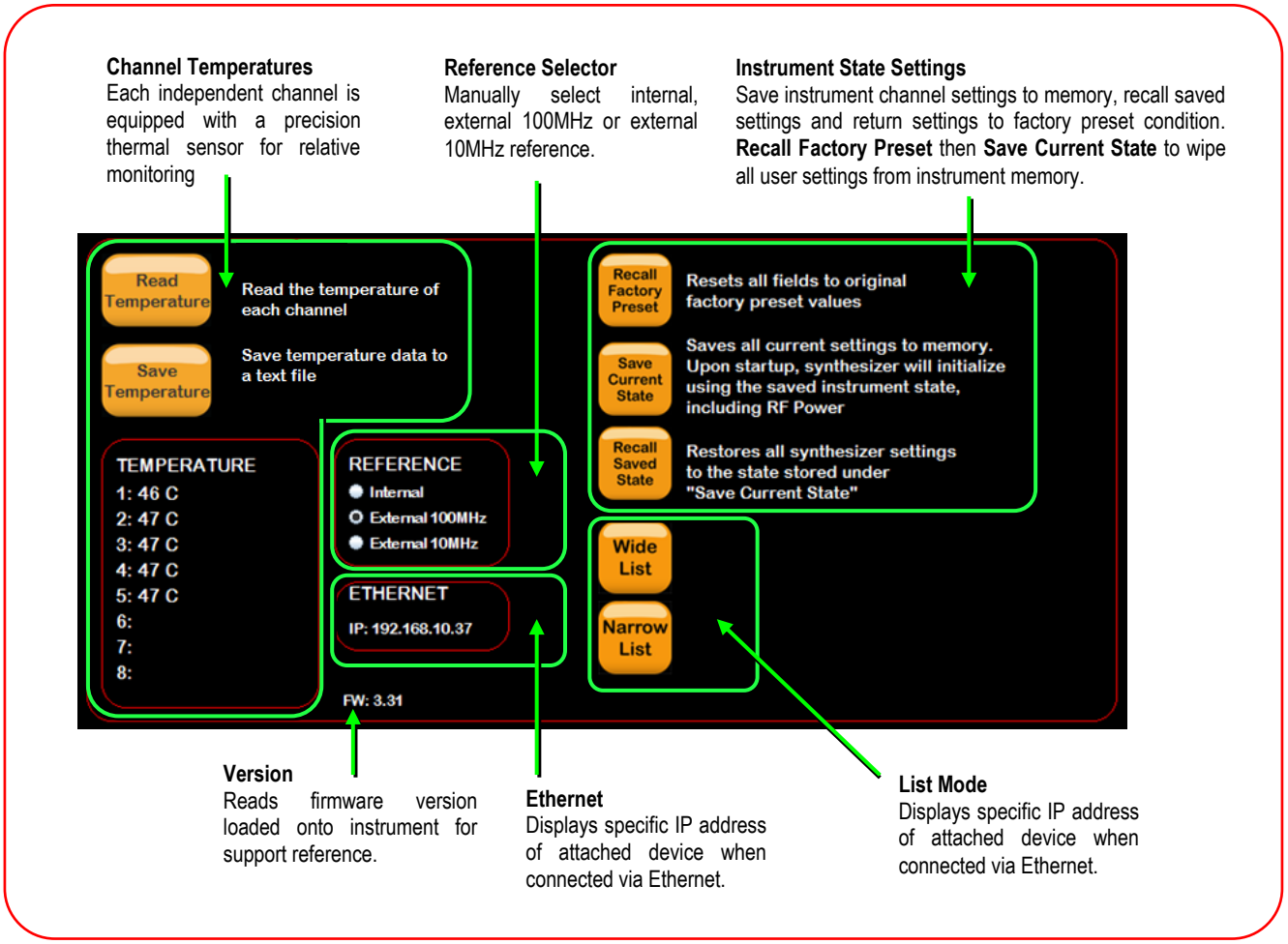
8.2.2 Master Select Function

The Master Select function allows for the user to select channel 1 as being the master control for any enabled channel. Under this flexible function, channel 1 will always be enabled. The user can select any combination of Frequency, Power and/or Phase Offset to be controlled via the master (channel 1). The example below demonstrates selection of master control over channels 1, 2, 3, 6 and 7 for Frequency and Power output, but leaving Phase Offset available for independent adjustment.

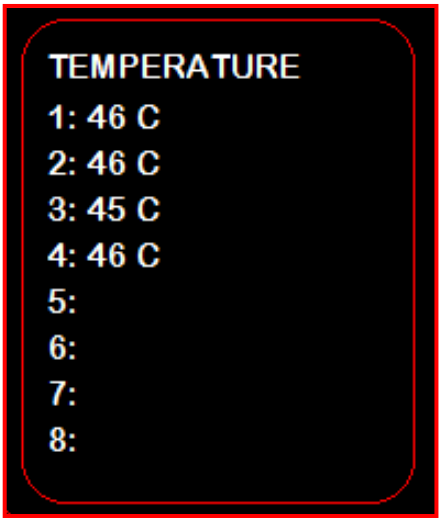


8.3 "OPTIONS" WINDOW

The Options Window is home to many auxiliary features. Some features require additional hardware, as with modulation. Features that are only available via additionally specified (loaded) options will either not be displayed or simply will not be accessible (when selected, a popup window will indicate if a feature is not available without a hardware upgrade).



8.3.1 Channel Temperature Sensors



The HS9000 Series synthesizers are equipped with channel dedicated temperature sensors for accurate monitoring of relative channel-to-channel temperature changes to within ±0.5C.

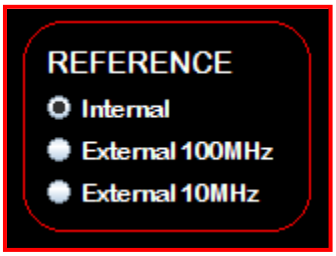
The non-PLL architecture of Holzworth synthesizers create a phase coherently relationship between loaded channels with extremely low channel-to-channel phase drift. The fanless design leverages thermal mass to help maintain optimal channel-to-channel stability. The greatest influence on channel-to-channel phase drift is temperature variations in the support electronics of each channel. Inclusion of the temperature sensors provides a means to monitor relative temperature changes between the loaded channels.

Selecting the *Read Temperature* button will capture the temperature at that instance and display them in the Temperature readout zone.

Selecting the *Save Temperature* button will simply open a Save window for the user to name a text file and save to a user designated location on the PC, network, *etc.*

NOTE that the steady state operating temperature of any unit may exceed 50C after several hours of ambient room temperature operation without a cooling fan. This is acceptable as the synthesizer channels have an actual MTBF of greater than 200,000 hours, rated at 75C.

8.3.2 Reference Selection



The signal reference must be manually selected to be internal (free running), external 100MHz or external 10MHz. Select the radio button next to the type of reference to be used.

Refer to section 9.2 for additional details for using internal or external references with the HS9000 Series synthesizers.

8.3.3 Instrument State Settings

The HS9000 Series units will erase all instrument settings if it is AC power cycled unless the settings have been saved. There are essentially three options for the instrument state:

1. *Recall Factory Preset*: Resets the entire instrument to factory default settings. There is no memory of any prior settings unless they were specifically saved.

2. *Save Current State*: All instrument settings will be saved to the internal memory of the synthesizer. Selecting this option could take up to 15 seconds for the save to finalize.

3. *Recall Saved State*: Restores all settings that were saved to the internal memory.

8.3.4 List Mode (NOTE: Currently only available on channels up to 6.4GHz)

Free running list mode is available on all units. **NOTE** that triggered list mode is only available on units that are equipped with the external modulation option, as OPT-EXTMOD provides an external stimulus input port for a trigger signal. Refer to section 8.3 for triggered list mode.

List mode allows for up to 3201 points (command lines) to be stored for each independent channel. Each command line allows for modification of any or all of the following parameters: *Frequency* and/or *Amplitude,* and *Dwell* time in between points, if desired.

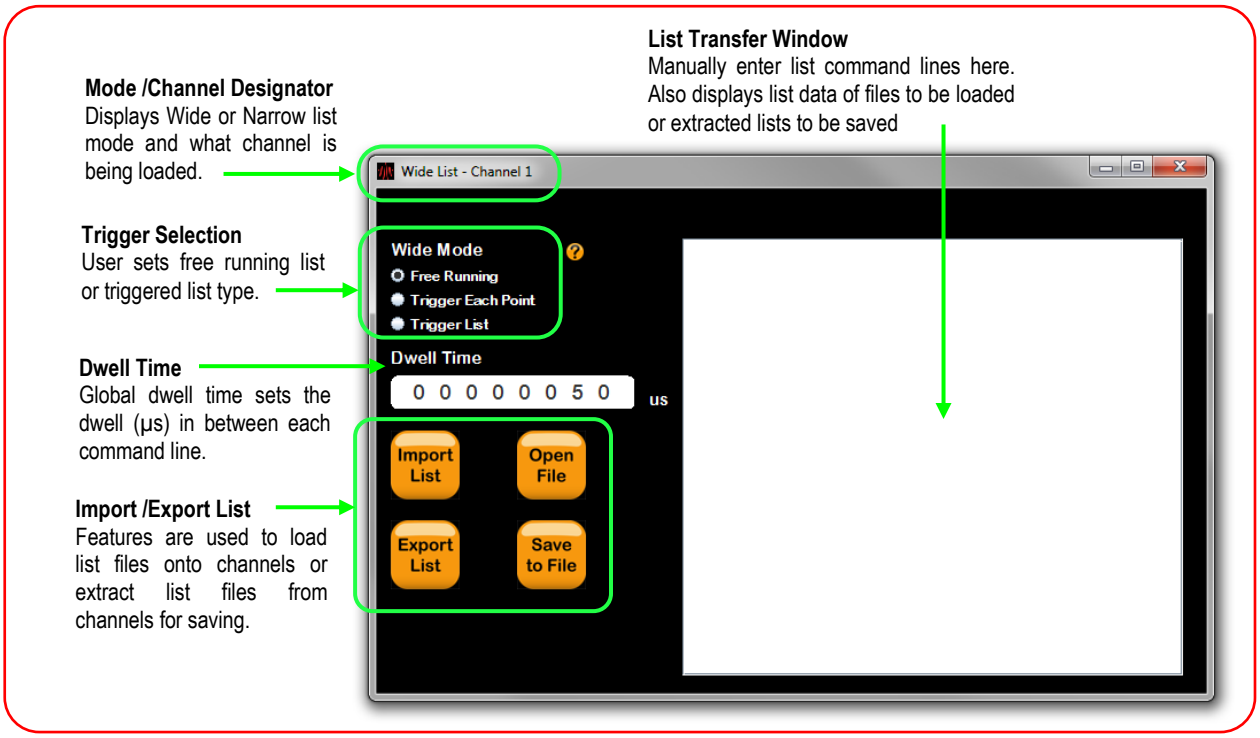
Wide List and *Narrow List* modes use identical load commands with limitations in the Narrow List settings, which are noted further into this section.

Selecting either *List* button will initiate a popup window with the available channels highlighted (a 2 channel unit is represented in the example below). Select the channel to be programmed for either list mode.

SELECT CHANNEL: Select the channel for which list mode will be installed.

SELECT FILE: Once the channel has been selected, an Open file window will open for the user to select and load a preconfigured, comma delimited list file. Selecting a file or pressing the *Cancel* button will then initiate the *List Mode Control Panel* as shown below.

LIST MODE CONTROL PANEL:



WIDE LIST COMMAND LINE FORMAT: A,B,C,D,E,F Comma separated (.csv).

A = Frequency value (non-restricted number of decimal places)
B = Frequency units (Hz, kHz, MHz, or GHz)
C = Amplitude value (up to 2 decimal places)
D = Amplitude units (dBm)
E = Dwell Time for each point (up to 6 decimal places)
F = Dwell Time units (s, ms, µs)

NOTE that setting any dwell time (E) inside the loaded list mode file, will cause the global dwell time setting (at List Mode Control Panel) to be ignored.

NARROW LIST COMMAND LINE FORMAT: A,B,E,F Comma separated (.csv).

A = Frequency value (non-restricted number of decimal places)
B = Frequency units (Hz, kHz, MHz, or GHz)
E = Dwell Time for each point (up to 6 decimal places)
F = Dwell Time units (s, ms, µs)

NOTE 1: As with the *Wide List Mode* command line format, setting any dwell time (E) inside the loaded list mode file, will cause the global dwell time setting (at List Mode Control Panel) to be ignored.

NOTE 2: *Narrow List Mode* list does not allow for amplitude control.

NOTE 3: The 5% frequency range limitation for *Narrow List Mode* is defined as: the center frequency (f_c) ± 2.5%.

IMPORT /EXPORT LIST BUTTONS

This feature set is used for list file management. The function of each button is defined as follows.

OPEN FILE: The *Open File* button is used to open a pre-formatted .csv file, if a file was not initially selected. Opening a file will load it into the *List Transfer Window*, but not onto the channel. **NOTE** that the file will still need to be imported to the synthesizer channel.

IMPORT LIST: Once a series of list command lines have either been manually entered into the *List Transfer Window* or via loading a preconfigured .csv file, the Import List button must be selected to finalize the loading of the list onto the synthesizer channel.

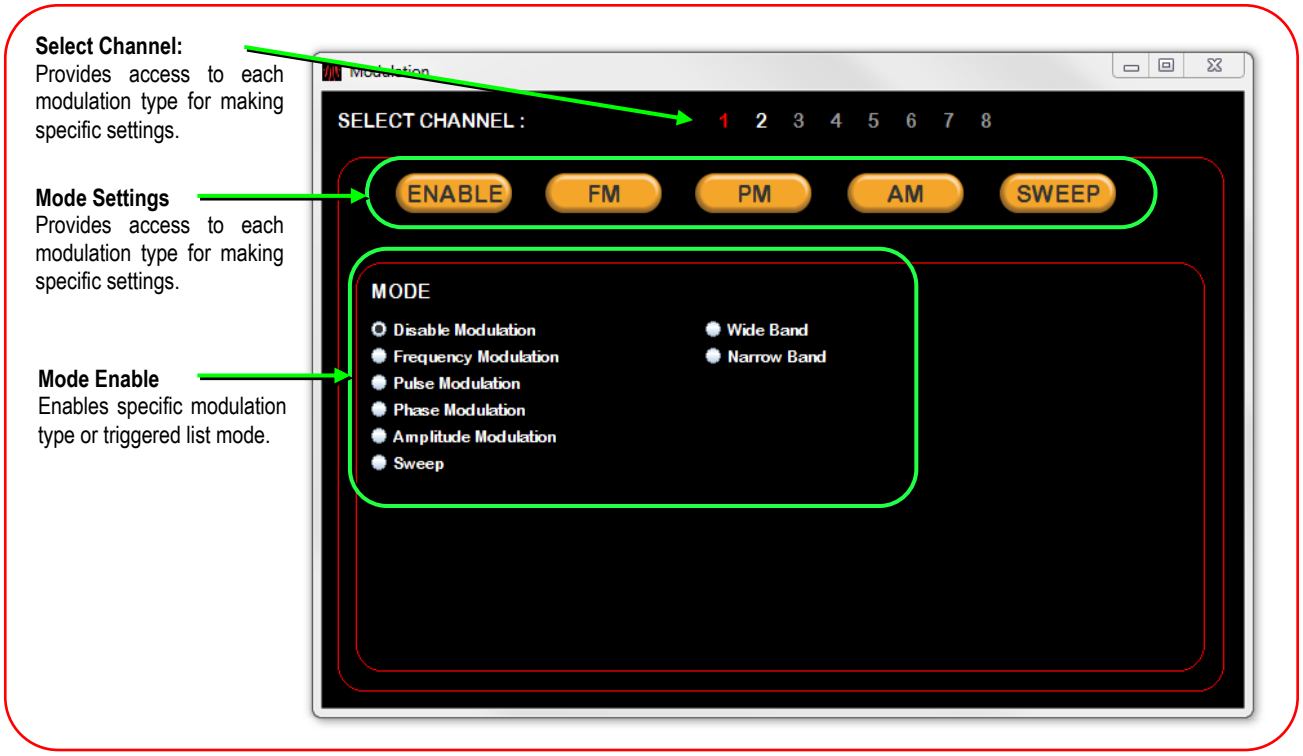
EXPORT LIST: This feature allows a user to export a list file from a synthesizer channel, into the *List Transfer Window*. It is useful for verifying that a specific list is loaded onto the channel.

SAVE TO FILE: The Save to File feature is used to save a .csv file of whatever list command line data is currently loaded in the *List Transfer Window*.

8.4 "MODULATE" WINDOW

The Modulation Window provides access to the modulation capabilities of the internally loaded synthesizer channels. If the unit is equipped with the external modulation option (OPT-EXTMOD), then all modulation functions are available. Without this option, only internal pulse modulation is available.

Selecting the Modulate button will initiate a popup window for enabling the various modulation capabilities including triggered list mode for both Wide Band and Narrow Band list modes.



8.4.1 Channel Select

Each channel that is available for modulation, sweep, or triggered list mode control will be highlighted here. Each available channel can be independently set for a different mode type. The selected channel to be set will be displayed in red font color.

8.4.2 Enable Mode Set

The *Enable* mode set button displays the screen as pictured above. In this mode the highlighted channel's modulation mode, sweep mode, or list mode type is selected via radio buttons. The specific details of the mode that is selected are described in sections 8.4.3 through 8.4.7.

NOTE that the *List Mode* settings are described in section 8.2.4. The Wide Band and Narrow Band radio buttons in this window are used to enable *triggered* list mode.

8.4.3 FM Mode Set

The *FM* mode set button allows the user to set the frequency modulation deviation to within the specified limits (in Hz).

8.4.4 PM Mode Set

The *PM* mode set button allows the user to set the phase modulation deviation to within the specified limits (in degrees).

8.4.5 AM Mode Set

The *AM* mode set button allows the user to set the amplitude modulation deviation to within the specified limits.

8.4.6 Pulse Mode Set

The *PULSE* mode set button gives the user access to the pulse control panel. This allows for setting external pulse modulation, internal pulse modulation, or internal pulse modulation with trigger. Additional settings related to internal pulse modulation include: the pulse repetition rate, the pulse width, and the number of pulses.

REPETITION RATE: The pulse rep rate allows the user to set the time between rising edges of a pulse. This setting does not apply when using external pulse modulation.

WIDTH: The pulse width allows the user to set the time interval between the leading edge and trailing edge of a pulse. This setting does not apply when using external pulse modulation.

NUMBER OF PULSES: The number of pulses allows the user to specify the number of output pulses. This setting only applies when using internal pulse modulation with trigger. A trigger signal at the modulation input port will start the output pulsing and the counter to track the number of pulses.

8.4.7 SWEEP Mode Set

The *SWEEP* mode set button gives the user access to the sweep function control panel. The control panel allows for setting the start/stop frequencies, dwell time (µs) between points, and the number of points to use within the sweep range. The user can also set the sweep direction up/down, and set the trigger sweep mode.

DWELL TIME: The *DWELL TIME* setting is for controlling the delay time (in microseconds) in between each point in the sweep bandwidth.

Number of *POINTS:* The maximum number of points allowable for any sweep is 65535. Note that the number of points may be limited depending on the sweep bandwidth selected.

TRIGGER SWEEP *Free Running*: Selecting *Free Running* sweep mode will initiate the entire set bandwidth sweep to begin at the moment the *Sweep* radio button is selected under the *ENABLE* mode.

TRIGGER SWEEP *Ramp*: Selecting the *Ramp* sweep mode will initiate an entire set bandwidth sweep with a trigger signal at the modulation input port.

TRIGGER SWEEP *Point*: Selecting the *Point* sweep mode will initiate each individual point step in the sweep bandwidth at each trigger signal.

NOTE that once sweep mode is initiated, it will loop (restart) continuously until the routine is manually interrupted.

9.0 HARDWARE

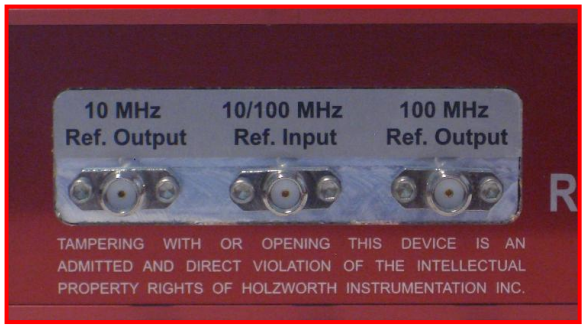
The HS9000 Series Multi-Channel RF Synthesizers are CW work horses. They are designed to do a very good job of providing highly stable, phase coherent signals with pure spectrums and highly accurate output power amplitude control.

9.1 RF OUTPUT

The RF Output ports are labeled and positioned sequentially from left to right on the front panel of the instrument. The RF Output ports are protected against reflected power with a maximum damage threshold of $25V_{DC}$ (+10dBm or 10mW).

9.2 REFERENCE INPUT / OUTPUTS

The reference input and output ports are located on the right side of the rear panel.



NOTE that the internal reference distribution subsystem must be manually set for the type of reference being used (internal, external 10MHz, or external 100MHz) per section 8.2.2. The factory default setting is for the *internal* reference (free running).

9.2.1 100MHz External Reference

When a 100MHz External Reference is applied to the synthesizer module and "External 100MHz" is selected from the OPTIONS sub-menu (Section 8.3.2), the internal OCXO switches off and the external reference is used exclusively for frequency generation. Under this scenario, the stability, phase noise performance, *etc.* of the synthesizer module is dependent on the integrity of the external reference signal. The Reference Output signals will be derived from the 100MHz external reference. The module was designed this way so that the channels of any slave synthesizers connected to a master synthesizer unit would maintain phase coherency with the channels of the master unit.

9.2.2 10MHz External Reference

When a 10MHz External Reference signal is applied and "External 10MHz" is selected from the OPTIONS sub-menu (Section 8.3.2), a 20Hz digital PLL phase locks the internal OCXO to the external reference signal. The internal OCXO remains operating in this scenario to maintain optimal phase noise levels at >20Hz offset. The performance of the synthesized channel output signals as well as the fixed 10MHz and 100MHz Reference Output signals are based on the 10MHz external reference for offsets of <20Hz; performance is based on the integrity of the 100MHz internal OCXO at offsets of >20Hz.

This architecture is often used in laboratories and systems as a cleanup loop for 10MHz Rubidium, Cesium, GPS disciplined, *etc*. references; as it provides an optimal reference signal for the internal channels as well as both the 10MHz and 100MHz reference outputs.

9.2.3 Reference Output

Holzworth multi-channel synthesizer modules supply very clean 10MHz and 100MHz Reference Outputs under all operating conditions.

An outline of the reference input vs. output configuration is captured as follows:

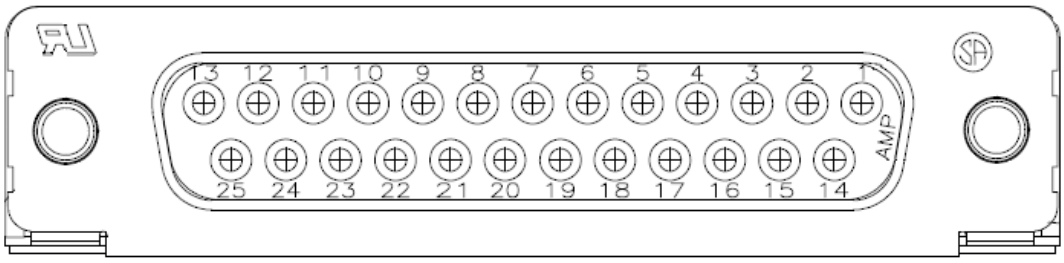
Reference Input	Internal 100MHz OCXO	100MHz Reference Out	10MHz Reference Out
None (free running)	ACTIVE	Matches Internal 100MHz OCXO	Divided from internal 100MHz OCXO.
10MHz Signal applied	ACTIVE	Based on: Internal 100MHz OCXO (>20Hz OS) External 10MHz (<20Hz OS)	Divided from: Internal 100MHz OCXO (>20Hz OS) External 10MHz (<20Hz OS)
100MHz Signal applied	OFF	Based on External Reference Signal	Divided from external reference

9.2.4 External DB25 Connector

The HS9000 Series is equipped with a rear-mounted DB25 connector that can be used to communicate with the instrument over SPI (See Appendix D for more information).

Module Connector Part Number:

Thru-Hole, Right Angle: TE Connectivity 5745783-2



PIN	Label	PIN	Label
1	GND	14	/CS-CH0-REF
2	SDI	15	/CS-CH1
3	SDO	16	/CS-CH2
4	SCLK	17	/CS-CH3
5	PWRGOOD	18	/CS-CH4
6	READY	19	/CS-CH5
7	/ERROR	20	/CS-CH6
8	NC	21	/CS-CH7
9	/CH-RESET	22	/CS-CH8
10	/SPI_EN	23	NC
11	NC	24	NC
12	NC	25	+5V
13	GND		

Pin Definitions:

+5V	5V DC Output
SDI	Serial Data Input (synthesizer module/slave data out). High-Z input on module. 3.3V logic levels, 5V tolerant. 47k pulldown.
SDO	Serial Data Output (synthesizer module/slave data out. High-Z input on module. 3.3V logic levels, 5V tolerant. 47k pulldown.
SCLK	SPI Clock (slave clock input). Idle low, active high. Data is transitioned into the module on a rising low to high transition. Data is transitioned out on the same edge and is valid on the falling edge of SCLK. 3.3V logic levels, 5V tolerant. 47k pulldown.
PWRGOOD	Open collector output, 47k pullup to 3.3V. When high, power is healthy. When low, either voltages or currents are problematic. Modules may not operate correctly. There is a 0.5 second delay from when power is applied to a valid PWRGOOD. Actual PWRGOOD may take up to 2 seconds to go high due to some very stable internal references that require settling.
READY	Open collector output, 47k pullup to 3.3V. Nominally high. After an SPI communication, if a command has been issued then READY will go active low. Duting this time no communication may occur and SPI bus will be asleep.
/ERROR	Open collector output, 47k pullup to 3.3V. nominally high. If an error condition ovvurs, such as a PLL unlock or un-leveled condition, this will go active low.
/CH-RESET	Active low on this pin puts the module in reset, releasing it returns to reset operation. Module is ready 2-3 seconds after /RESET is released. 47k pullup to 3.3V in parallel to 0.01uF cap to ground.
/SPI_EN	Disables the USB communication that has control of the bus. Only when driven low should the user apply any signal to the lines.
/CS	Communications chip select, active low. 47k pullup on this line. /CS must be low for any communication to occur. Allows for multiple synthesizer modules on a single SPI bus. 3.3V lgic levels, 5V tolerant.
NC	These are reserved lines. Should be left floating.

10.0 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: Multi-Channel API

The Multi-Channel API is an API which allows users to write high-level and easy to use scripts to communicate with the Holzworth Instrumentation Multi-channel synthesizers over USB.
This Multi-Channel API runs on the Microsoft Windows platform. This release is designed for users of any application software which is capable of communicating with a dynamic link library(DLL). Programming examples can be provided for C/C++, MATLAB, and LabVIEW users upon request.
Contact the Holzworth factory for information related to connectivity on the Linux platform.

Installing the Multi-Channel API

Windows

The Multi-Channel API is easy to install. Simply copy the DLL (HolzworthMulti.dll) and the header file (HolzworthMulti.h) to your machine. The DLL must reside in the path or in the same directory as the executable. Depending on the type of software application, the header file should reside in your compiler's header path.

General Functions

All general functions require the serial number as input. This refers to the unique serial number for each channel. For almost all functions, the format for the serial number string is: <device name>-<serial number>-<channel number>
For example, if you have an HS9002A with serial number 009, then the unique serial number for channel 2 would be, 'HS9002A-009-2'. If the channel number is excluded from the serial number string, then the function will fail to execute the command.
If the format of the serial number varies from the specifications above, then it will be noted below each function.
Each of the functions described below will initiate a connection to the device

openDevice
int openDevice(const char *serialnum)

The format for serialnum is described above.
The return value will be greater than zero if a connection could be establish with the specified channel, and a -1 or 0 otherwise.

deviceAttached
int deviceAttached(const char *serialnum)

The format for serialnum is described above.
The return value will be a 1 if a connection could be establish with the specified channel, and a 0 otherwise.

getAttachedDevices
char *getAttachedDevices()

The return value is a comma delimited string with the list of serial numbers and channel numbers for all Holzworth multi-channel RF Synthesizers. An example of the return value, when one multi-channel synthesizer is attached is 'HS9002A-314-1,HS9002A-314-2'.
An empty string will be returned, if no synthesizers are attached.

usbCommWrite
char * usbCommWrite(const char *serialnum, const char *writeString)

The format for serialnum is described above.
The format for writeString should match the syntax of any of the available ASCII commands. The complete list of commands can be found in Appendix B.
Always preface the string with the channel number using the format ':CHX', where X is the channel number. For example, to set the frequency of channel 1 to 1.024 GHz, the value of writeString should be ":CH1:FREQ:1.024GHz"
The function will return a string. Refer to Appendix B for the syntax of the returned string.

Mandatory Function

It is important to make the call to this function when the application terminates or when communication is no longer required with any Holzworth Instrumentation Multi-channel synthesizers. If this function is not called, then another application may not be able to properly communicate with the Holzworth Instrumentation Multi-channel synthesizers.

close_all
void close_all()

There are no input parameters for this function.
This function will close all connections to any channels which were called by any of the general functions above.
There is no return value for this function.

APPENDIX B: PROGRAMMING COMMANDS

The Holzworth Instrumentation HS9000 Series Synthesizers allow users to communication with the instrument over USB or Ethernet using their own application software.

The programming commands are ASCII commands sent over USB or Ethernet. An internal USB communications module will forward the commands to the appropriate synthesizer channel. Optionally, an external HCM5 Ethernet Communications module is available for Ethernet communication. The ASCII commands begin with a colon (:) or asterisk (*).

If a command is not understood, the synthesizer will have in its buffer:

Invalid Command

The format for describing the command instruction is as follows:

:COMMAND:<value>[suffix]		A Description of the command here.
	<value>	Defined here, if any, queries typically have no value
	[suffix]	Units, i.e. Hz or dBm. If no suffix is included it is default to whatever is in brackets [Hz].
Example	TX:	Example ASCII sent in transmission
	RX:	Example ASCII received back

Decimal Places:

In general, any number of usable decimal places may be entered. For example, set frequency may have up to 12 decimal places if sent in GHz. A decimal does not have to be entered.
In general, any number of usable decimal places may be entered. For example, set frequency may have up to 12 decimal places if sent in GHz. A decimal does not have to be entered.

IMPORTANT – Channel Indicator

Preface each command with the syntax for the channel number,

:CHn

where "n" stands for the channel number.

For example, to read the frequency setting of channel 1, use the following syntax,

:CH1:FREQ?

Any commands on this page, related to the communications bus should NOT include the channel number indicator preceding the command.

USB Communication Bus Information

:COMM:READY? — Query if the communications bus is ready to receive additional commands

Example TX: :COMM:READY?

RX: Communications Bus Ready <OR> Communications Bus is Busy

:ATTACH? — Query the number of internal channels

Example TX: :ATTACH?

RX: :CH1:CH2 <OR> :CH1:CH2:CH3:CH4 <OR> etc

All commands on the following pages communicate with the synthesizer channels. The commands MUST BE prefaced with the appropriate channel indicator.

Preset / Save / Recall/ Identify

***RST** Recall Factory Preset

Example TX: :CHn*RST
RX: Instrument Preset

***RCL** Recall Saved State

Example TX: :CHn*RCL
RX: State Recalled

***SAV** Save Current State

Example TX: :CHn*SAV
RX: State Saved

:IDN? Identify

Example TX: :CHn:IDN?
RX: Holzworth,HSM6001A,M1009-001,FW3.31,HS9002A-112

(Manufacturer, Device Name, Board #, Firmware version, Instrument Serial #)

Read Temperature

:TEMP? Query the temperature of the channel

Example TX: :CHn:TEMP?
RX: Temp = 40C

Set Frequency

:FREQ:<value><suffix> Set Synthesizer RF Frequency

<value> Synthesizer Dependent
<suffix> Hz, kHz, MHz, GHz

Example TX: :CHn:FREQ:2.105GHz
RX: Frequency Set

:FREQ? Query Synthesizer RF Frequency

Example TX: :CHn:FREQ?
RX: 22.67 MHz

:FREQ:MAX? Query Synthesizer Maximum RF Set Frequency

Example TX: :CHn:FREQ:MAX?
RX: 1.024 MHz

:FREQ:MIN? Query Synthesizer Minimum RF Set Frequency

Example TX: :CHn:FREQ:MIN?
RX: 0.25 MHz

Set Power

:PWR:<value>[suffix] Set Synthesizer RF Power

<value> Synthesizer Dependent
[suffix] [dBm]

Example TX: :CHn:PWR:9.5dBm
RX: Power Set

:PWR? Query Synthesizer RF Power

Example TX: :CHn:PWR?
RX: 9.50

:PWR:MAX? Query Synthesizer Maximum RF Set Power

Example TX: :CHn:PWR:MAX?
RX: 10.00 dBm

:PWR:MIN? Query Synthesizer Minimum RF Set Power

Example TX: :CHn:PWR:MIN?
RX: -100.00 dbm

Set Phase

:PHASE:<value>[suffix] Set Synthesizer RF Phase Offset

<value> Synthesizer Dependent
[suffix] [deg]

Example TX: :CHn:PHASE:270.1deg
RX: Phase Set

:PHASE? Query Synthesizer RF Phase Offset

Example TX: :CHn:PHASE?
RX: 270.1

:PHASE:MAX? Query Synthesizer Maximum RF Phase Offset

Example TX: :CHn:PHASE:MAX?
RX: 359.9deg

:PHASE:MIN? Query Synthesizer Minimum RF Phase Offset

Example TX: :CHn:PHASE:MIN?
RX: 0.0deg

Set RF ON/OFF

:PWR:RF:<value> Set Synthesizer RF ON/OFF

<value> ON <or> OFF

Example TX: :CHn:PWR:RF:ON

RX: RF POWER ON

:PWR:RF? Query Synthesizer RF ON/OFF

Example TX: :CHn:PWR:RF?

RX: ON <or> OFF

Most commands on the following pages are in reference to Modulation Control. Modulation is only available on HS9000 Series synthesizers that have OPT-EXTMOD installed, which includes channel dedicated modulation ports at the front panel. Internal pulse modulation, pulse rep rate, and pulse width are available without OPT-EXTMOD.

Modulation Enable

:MOD? Query Modulation Enable Status

Example TX: :CHn:MOD?

RX: DIS <or> EXT

:MOD:MODE:<value> Set Modulation Mode

<value> OFF <or> PULSE <or> PULSE:SRC:EXT <or> PULSE:SRC:INT <or> PULSE:SRC:INT:TRIGGER <or> FM <or> AM <or> PM <or> SWEEP:FREQ <or> LOOKUP:NARROW <or> LOOKUP:WIDE

Example TX: :CHn:MOD:MODE:PULSE:SRC:EXT

RX: External Pulse Modulation Set

NOTE: In the value field above, PULSE or PULSE:SRC:EXT enable external pulse modulation.

:MOD:MODE? Query Modulation Mode Status

Example TX: :CHn:MOD:MODE?

RX: OFF <or> PULSE:EXT <or> PULSE:INT <or> PULSE:INT:TRIGGER <or> FM <or> AM <or> PM <or> SWEEP:FREQ <or> LOOKUP:NARROW <or> LOOKUP:WIDE

Set FM Deviation

:MOD:FM:DEV:<value>[suffix] Set Synthesizer FM Deviation

	<value>	Synthesizer Dependent
	[suffix]	Hz, kHz
Example	TX:	:CHn:MOD:FM:DEV:1.2kHz
	RX:	FM Deviation Set

:MOD:FM:DEV? Query Synthesizer FM Deviation

Example	TX:	:CHn:MOD:FM:DEV?
	RX:	0.500 kHz

:MOD:FM:DEV:MAX? Query Synthesizer Maximum FM Deviation

Example	TX:	:CHn:MOD:FM:DEV:MAX?
	RX:	100.000 kHz

Set AM Depth

:MOD:AM:DEPTH:<value>[suffix] Set Synthesizer AM Depth

	<value>	Synthesizer Dependent
	[suffix]	[percent]
Example	TX:	:CHn:MOD:AM:DEPTH:15 percent
	RX:	AM Depth Set

:MOD:AM:DEPTH? Query Synthesizer AM Depth

Example	TX:	:CHn:MOD:AM:DEPTH?
	RX:	60 percent

:MOD:AM:DEPTH:MAX? Query Synthesizer Maximum AM Depth

Example	TX:	:CHn:MOD:AM:DEPTH:MAX?
	RX:	75 percent

Set PM Deviation

:MOD:PM:DEV:<value>[suffix] Set Synthesizer PM Deviation

	<value>	Synthesizer Dependent
	[suffix]	[deg]
Example	TX:	:CHn:MOD:PM:DEV: 45 deg
	RX:	PM Deviation Set

:MOD:PM:DEV? Query Synthesizer PM Deviation

Example	TX:	:CHn:MOD:PM:DEV?
	RX:	10 deg

:MOD:PM:DEV:MAX? Query Synthesizer Maximum PM Deviation

Example	TX:	:CHn:MOD:PM:DEV:MAX?
	RX:	180 deg

Set Internal Pulse Repetition Rate

:MOD:PULSE:REP:<value><suffix> Set Internal Pulse Repetition Rate

<value> Synthesizer Dependent
<suffix> s, ms, [us]
Example TX: :CHn:MOD:PULSE:REP:45ms
RX: Pulse Rep Rate Set

:MOD:PULSE:REP? Query Internal Pulse Repetition Rate

Example TX: :CHn:MOD:PULSE:REP?
RX: 45000.0 us

:MOD:PULSE:REP:MAX? Query Maximum Internal Pulse Repetition Rate

Example TX: :CHn:MOD:PULSE:REP:MAX?
RX: 10000000.0 us

Set Internal Pulse Width

:MOD:PULSE:WIDTH:<value><suffix> Set Internal Pulse Width

	<value>	Synthesizer Dependent
	<suffix>	s, ms, [us]
Example	TX:	:CHn:MOD:PULSE:WIDTH:45ms
	RX:	Pulse Width Set

:MOD:PULSE:WIDTH? Query Internal Pulse Width

Example	TX:	:CHn:MOD:PULSE:WIDTH?
	RX:	45000.0 us

:MOD:PULSE:WIDTH:MAX? Query Maximum Internal Pulse Width

Example	TX:	:CHn:MOD:PULSE:WIDTH:MAX?
	RX:	10000000.0 us

Set Number of Output Pulses

:MOD:PULSE:NUM:<value> Set Number of Output Pulses for Internal Pulse Modulation

<value> Synthesizer Dependent

Example TX: :CHn:MOD:PULSE:NUM:10

RX: Number of Output Pulses set

:MOD:PULSE:NUM? Query Number of Output Pulses

Example TX: :CHn:MOD:PULSE:NUM?

RX: 10

:MOD:PULSE:NUM:MAX? Query Maximum Number of Output Pulses

Example TX: :CHn:MOD:PULSE:NUM:MAX?

RX: 65535

The number of output pulses only applies when using Internal Pulse Modulation with a Trigger.

Set Frequency Sweep Start Frequency*

:MOD:SWEEP:FREQ:START:<value><suffix> Set Synthesizer Sweep Start RF Frequency

<value> Synthesizer Dependent

<suffix> Hz, kHz, MHz, GHz

Example TX: :CHn:MOD:SWEEP:FREQ:START:100.1MHz

RX: Sweep Frequency Start Set

:MOD:SWEEP:FREQ:START? Query Synthesizer Sweep Start RF Frequency

Example TX: :CHn:MOD:SWEEP:FREQ:START?

RX: 100.1 MHz

* The maximum and minimum for the Sweep Start Frequency are the same as the corresponding values for the Set Frequency. Refer to the Set Frequency page for the maximum and minimum values.

Set Frequency Sweep Stop Frequency*

:MOD:SWEEP:FREQ:STOP:<value><suffix> Set Synthesizer Sweep Stop RF Frequency

<value> Synthesizer Dependent
<suffix> Hz, kHz, MHz, GHz

Example TX: :CHn:MOD:SWEEP:FREQ:STOP:200.1MHz
RX: Sweep Frequency Stop Set

:MOD:SWEEP:FREQ:STOP? Query Synthesizer Sweep Stop RF Frequency

Example TX: :CHn:MOD:SWEEP:FREQ:STOP?
RX: 200.1 MHz

* The maximum and minimum for the Sweep Stop Frequency are the same as the corresponding values for the Set Frequency. Refer to the Set Frequency page for the maximum and minimum values.

Set Frequency Sweep Trigger

:MOD:SWEEP:FREQ:TRIG:<value> Set Synthesizer Sweep Frequency Trigger

<value> FREE or RAMP or POINT

Example TX: :CHn:MOD:SWEEP:FREQ:TRIG:FREE

RX: Sweep Frequency Free Running Set

:MOD:SWEEP:FREQ:TRIG? Query Synthesizer Sweep Frequency Trigger

Example TX: :CHn:MOD:SWEEP:FREQ:TRIG?

RX: FREQ SWEEP TRIGGER FREE <or> FREQ SWEEP TRIGGER RAMP <or> FREQ SWEEP TRIGGER POINT

Set Frequency Sweep Direction

:MOD:SWEEP:FREQ:DIR:<value> Set Synthesizer Sweep Frequency Direction

<value> UP or DOWN

Example TX: :CHn:MOD:SWEEP:FREQ:DIR:UP

RX: FREQ SWEEP DIRECTION UP

:MOD:SWEEP:FREQ:DIR? Query Synthesizer Sweep Frequency Direction

Example TX: :CHn:MOD:SWEEP:FREQ:DIR?

RX: FREQ SWEEP DIRECTION UP or FREQ SWEEP DIRECTION DOWN

Set Frequency Sweep Dwell Time

:MOD:SWEEP:FREQ:DWL:<value> Set Synthesizer Sweep Dwell Time

	<value>	Synthesizer Dependent
	[suffix]	ms, [us]
Example	TX:	:CHn:MOD:SWEEP:FREQ:DWL:1ms
	RX:	Sweep Frequency Dwell Time Set

:MOD:SWEEP:FREQ:DWL? Query Synthesizer Sweep Dwell Time

Example	TX:	:CHn:MOD:SWEEP:FREQ:DWL?
	RX:	700 us

:MOD:SWEEP:FREQ:DWL:MAX? Query Synthesizer Maximum Sweep Dwell Time

Example	TX:	:CHn:MOD:SWEEP:FREQ:DWL:MAX?
	RX:	10000000 us

:MOD:SWEEP:FREQ:DWL:MIN? Query Synthesizer Minimum Sweep Dwell Time

Example	TX:	:CHn:MOD:SWEEP:FREQ:DWL:MIN?
	RX:	100 us

Set Frequency Sweep Number of Points

:MOD:SWEEP:FREQ:PTS:<value> Set Synthesizer Sweep Number of Points

<value> Synthesizer Dependent

Example TX: :CHn:MOD:SWEEP:FREQ:PTS:50

RX: Sweep Frequency Points Set

:MOD:SWEEP:FREQ:PTS? Query Synthesizer Sweep Points

Example TX: :CHn:MOD:SWEEP:FREQ:PTS?

RX: 50

:MOD:SWEEP:FREQ:PTS:MAX? Query Synthesizer Maximum Sweep Points

Example TX: :CHn:MOD:SWEEP:FREQ:PTS:MAX?

RX: 65535

Set Wide Band List Number of Points

:MOD:LIST:WIDE:PTS:<value> Set Wide Band List Number of Points

<value> Synthesizer Dependent

Example TX: :CHn:MOD:LIST:WIDE:PTS:500

RX: Wide Band Points Set

:MOD:LIST:WIDE:PTS? Query Wide Band List Points

Example TX: :CHn:MOD:LIST:WIDE:PTS?

RX: 500

:MOD:LIST:WIDE:PTS:MAX? Query Maximum Wide Band Points

Example TX: :CHn:MOD:LIST:WIDE:PTS:MAX?

RX: 3232

Set Wide Band List Values*

:MOD:LIST:WIDE:<point>,<freq><freq suffix>,<power>[power suffix],[dwell time][dwell suffix] — Set Wide Band List Value (for the given point)

	<point>	Point location. Cannot be greater than the value set using :MOD:LIST:WIDE:PTS:
	<freq>	Synthesizer Dependent
	<freq suffix>	GHz,MHz, kHz, Hz
	<power>	Synthesizer Dependent
	[power suffix]	[dBm]
	[dwell time]	Synthesizer Dependent OPTIONAL
	[dwell suffix]	ms, [us] OPTIONAL
Example	TX:	:CHn:MOD:LIST:WIDE:1,100.1MHz,-1.0dBm,3.4ms
	RX:	Stored frequency, power, and dwell time for point 1 <or> Invalid point

:MOD:LIST:WIDE?<point> — Query Wide Band List Value (for the given point)

	<point>	Point location. Cannot be greater than the value set using :MOD:LIST:WIDE:PTS:
Example	TX:	:CHn:MOD:LIST:WIDE?1
	RX:	1001.000 MHz,-1.00,3400 us <or> Invalid Point

*NOTE: If a dwell time is not specified with each point, then the value used for dwell time will be the value set using the Set Wide Band Dwell Time command.

The list of dwell times is not saved to the device. If the synthesizer is power cycled, then the complete list with dwell times must be reloaded.

Set Wide Band Trigger

:MOD:MODE:LIST:WIDE:<value> Set Wide Band Trigger

<value> FREE or LIST or POINT

Example TX: :CHn:MOD:MODE:LIST:WIDE:FREE

RX: Wide Band Free Running Set

:MOD:MODE:LIST:WIDE? Query Wide Band Trigger

Example TX: :CHn:MOD:MODE:LIST:WIDE?

RX: WIDE LIST MODE TRIGGER FREE <or> WIDE LIST MODE TRIGGER LIST <or> WIDE LIST MODE TRIGGER POINT

Set Wide Band Dwell Time*

:MOD:LIST:WIDE:DWL:<value> Set Wide Band Dwell Time

	<value>	Synthesizer Dependent
	[suffix]	ms, [us]
Example	TX:	:CHn:MOD:LIST:WIDE:1ms
	RX:	Wide Band Dwell Time Set

:MOD:LIST:WIDE:DWL? Query Wide Band Dwell Time

Example	TX:	:CHn:MOD:LIST:WIDE:DWL?
	RX:	1000 us

:MOD:LIST:WIDE:DWL:MAX? Query Maximum Wide Band Dwell Time

Example	TX:	:CHn:MOD:LIST:WIDE:DWL:MAX?
	RX:	10000000 us

:MOD:LIST:WIDE:DWL:MIN? Query Minimum Wide Band Dwell Time

Example	TX:	:CHn:MOD:LIST:WIDE:DWL:MIN?
	RX:	100 us

*NOTE: If a dwell time is loaded with each point in Set Wide Band List Values, then the value for Set Wide Band Dwell Time will be ignored.

Set Narrow Band List Number of Points

:MOD:LIST:NARROW:PTS:<value> Set Narrow Band List Number of Points

<value> Synthesizer Dependent

Example TX: :CHn:MOD:LIST:NARROWPTS:300

RX: Narrow Band Points Set

:MOD:LIST:NARROW:PTS? Query Narrow Band List Points

Example TX: :CHn:MOD:LIST:NARROW:PTS?

RX: 300

:MOD:LIST:NARROW:PTS:MAX? Query Maximum Narrow Band Points

Example TX: :CHn:MOD:LIST:NARROW:PTS:MAX?

RX: 3232

Set Narrow Band List Values*

:MOD:LIST:NARROW:<point>,<freq><freq suffix>,[dwell time][dwell suffix]	Set Narrow Band List Value (for the given point)

	<point>	Point location. Cannot be greater than the value set using :MOD:LIST:NARROW:PTS:
	<freq>	Synthesizer Dependent. All frequency values must be less than the first frequency point plus 5 percent.
	<freq suffix>	GHz,MHz, kHz, Hz
	[dwell time]	Synthesizer Dependent OPTIONAL
	[dwell suffix]	ms, [us] OPTIONAL
Example	TX:	:CHn:MOD:LIST:NARROW:2,996MHz,10us
	RX:	Stored frequency and dwell time for point 2 <or> Invalid point

:MOD:LIST:NARROW?<point>	Query Narrow Band List Value (for the given point)

	<point>	Point location. Cannot be greater than the value set using :MOD:LIST:NARROW:PTS:
Example	TX:	:CHn:MOD:LIST:NARROW?2
	RX:	996.0000000 MHz,10us <or> Invalid point

*NOTE: If a dwell time is not specified with each point, then the value used for dwell time will be the value set using the Set Narrow Band Dwell Time command.

The list of dwell times is not saved to the device. If the synthesizer is power cycled, then the complete list with dwell times must be reloaded.

Set Narrow Band Trigger

:MOD:MODE:LIST:NARROW:<value> Set Narrow Band Trigger

	<value>	FREE or LIST or POINT
Example	TX:	:CHn:MOD:MODE:LIST:NARROW:FREE
	RX:	Narrow Band Free Running Set

:MOD:MODE:LIST:NARROW? Query Narrow Band Trigger

Example	TX:	:CHn:MOD:MODE:LIST:NARROW?
	RX:	NARROW LIST MODE TRIGGER FREE <or> NARROW LIST MODE TRIGGER LIST <or> NARROW LIST MODE TRIGGER POINT

Set Narrow Band Dwell Time*

:MOD:LIST:NARROW:DWL:<value> Set Narrow Band Dwell Time

	<value>	Synthesizer Dependent
	[suffix]	ms, [us]
Example	TX:	:CHn:MOD:LIST:NARROW:700us
	RX:	Narrow Band Dwell Time Set

:MOD:LIST:NARROW:DWL? Query Narrow Band Dwell Time

Example	TX:	:CHn:MOD:LIST:NARROW:DWL?
	RX:	700 us

:MOD:LIST:NARROW:DWL:MAX? Query Maximum Narrow Band Dwell Time

Example	TX:	:CHn:MOD:LIST:NARROW:DWL:MAX?
	RX:	10000000 us

:MOD:LIST:NARROW:DWL:MIN? Query Minimum Narrow Band Dwell Time

Example	TX:	:CHn:MOD:LIST:NARROW:DWL:MIN?
	RX:	6 us

*NOTE: If a dwell time is loaded with each point in Set Narrow Band List Values, then the value for Set Narrow Band Dwell Time will be ignored.

The following commands are only for communication with the :REF channel
The channel designator is required.

Reference Distribution Module Commands

:INT:100MHz Set internal 100MHz reference

Example TX: :REF:INT:100MHz
RX: Reference Set to 100MHz Internal, PLL Disabled

:EXT:10MHz Set external 10MHz reference

Example TX: :REF:EXT:10MHz
RX: Reference Set to 10MHz External, PLL Enabled

:EXT:100MHz Set external 100MHz reference

Example TX: :REF:EXT:100MHz
RX: Reference Set to 100MHz External, Internal 100MHz Disabled

---

:STATUS? Query reference status

Example TX: :REF:STATUS?
RX: Internal 100MHz <or> External 10MHz <or> External 100MHz

:PLL? Query PLL Lock Status

Example TX: :REF:PLL?
RX: 1 PLL Locked <or> 0 PLL Unlocked <or>
0 PLL Disabled, External 100MHz <or>
0 PLL Disabled, Internal 100MHz

When using an external 10MHz reference, the response will be **'1 PLL Locked'** or **'0 PLL Unlocked'**

APPENDIX C: ETHERNET PROGRAMMING COMMANDS

Ethernet programming requires installation of accessory part number: HCM5 (Ethernet Communications Module). The Holzworth HCM5 Ethernet module enables communication with the Holzworth HS9000 Series Multi-channel RF synthesizers connected to a network.

Installation

Connect the HCM5 module to the back of the HS9000 synthesizer via the SPI port as described in section 7.2.2. Power cycle the HS9000 synthesizer via the master power switch on the front panel. **NOTE** that for direct PC connection via Ethernet (non-networked) a “cross over” Ethernet cable is required.

Host Software

A variety of host software can be used to communicate with the HCM5 Ethernet module:

Holzworth GUI – The Holzworth provided Multi-Channel application GUI has been modified to detect HS9000 synthesizers connected to the HCM5 module.

Terminal programs – Any terminal emulation program can be used to communicate with the HCM5 module

Custom applications – Any programming language or environment which provides network access can be used to communicate with the HCM5 module.

Network Configuration

The HCM5 module supports static IP address and DHCP. The default setup is DHCP. The network parameters can be configured using the Holzworth Ethernet Configuration GUI or the commands listed in the instruction set on the following pages.

In the event the static IP network parameters are incorrectly set and the module cannot be found on the network, turn off the power to the HS9000 synthesizer. Use a pin to depress the internal reset button located below the Ethernet port on the HCM5 module. Turn on the power to the HS9000 synthesizer while keeping the pin in place for at least three seconds. The HCM5 module will come online with a DHCP assigned address.

UDP Discovery packets are accepted over port 30303. Send the request “Discovery: Who is out there?” to receive a list of Holzworth devices on the network.

The HCM5 module accepts TCP requests over port 9760. All instructions to the synthesizers or the HCM5 module should be sent via a TCP socket connection.

TCP data communication can be established using the device IP address or the device host name. When the HCM5 module is attached to a HS9000 synthesizer, the host name is the complete serial number of the HS9000 synthesizer. An example host name is HS9005A-309.

HCM5 Programming Commands

All commands are ASCII commands. One command at a time may be issued over TCP. The ASCII commands begin with a colon (:) or asterisk (*).

The TCP buffer size is 100 bytes, but the default should be 64 bytes. Bytes sent beyond 64 will be ignored.

The commands on the following pages relate to the settings on the HCM5 module. To send commands to the HS9000 synthesizer channels, refer to Appendix B. The same ASCII commands sent over USB can also be sent over TCP.

If a command is not understood, the module will have in its buffer:

Invalid Command

The format for describing the command instruction is as follows:

:COMMAND:<value>		A Description of the command here.
	<value>	Defined here, if any, queries typically have no value
Example	TX:	Example ASCII sent in transmission
	RX:	Example ASCII received back, if a receive transmission is made

Network Configuration Commands

:IP:STATUS:<value> Set IP status to Static IP or DHCP

<value> STATIC <or> DHCP

Example TX: :IP:STATUS:STATIC

RX: DHCP status changed. Restart Device

:IP:STATUS? Query IP status

Example TX: :IP:STATUS?

RX: Static IP Address <or> DHCP

:IP:ADDR:<value> Set Static IP Address

<value> IP Address

Example TX: :IP:ADDR:192.168.10.11

RX: Static IP address changed

:IP:ADDR? Query Static IP Address

Example TX: :IP:ADDR?

RX: 192.168.10.11

:IP:GATEWAY:<value> Set Gateway IP Address for Static IP

<value> Gateway IP Address

Example TX: :IP:GATEWAY:192.160.10.1

RX: Gateway address changed.

Network Configuration Commands (continued)

:IP:GATEWAY? Query Gateway Address

Example TX: :IP:GATEWAY?
RX: 192.160.10.1

:IP:SUBNET:<value> Set Subnet for Static IP Address

<value> IP Address
Example TX: :IP:SUBNET:255.255.0.0
RX: Subnet address changed

:IP:SUBNET? Query Subnet Address

Example TX: :IP:SUNET?
RX: 255.255.0.0

Debug Command

:ECHO: Echo command for debug

Example TX: :ECHO:ABCD
RX: :ECHO:ABCD

Synthesizer Status Commands

:COMM:READY? Query if the communications bus is ready to receive additional commands

Example TX: :COMM:READY?

RX: Communications Bus Ready <or> Communications Bus is Busy

:ATTACH? Query the number of internal channels

Example TX: :ATTACH?

RX: :REF:CH1:CH2 <or> :REF:CH1:CH2:CH3 <or> etc.

APPENDIX D: SPI Communication

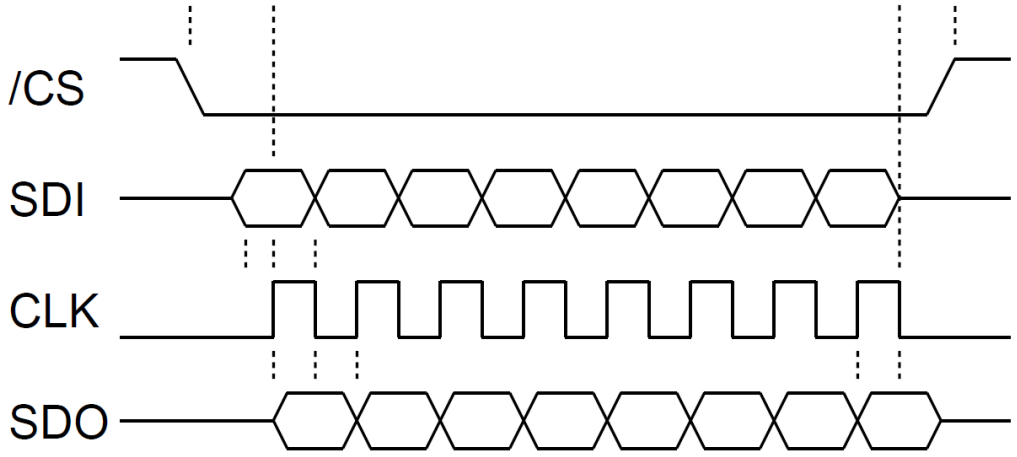
Bus Overview:

The SPI bus is a byte oriented bus, sending 8bits at a time. Any number of bytes may be sent, from 1 byte to 64 bytes while chip select is low. Bytes sent beyond 64 bytes will be ignored. The data is held in a buffer until chip select goes high, initiating the parsing of the data and execution of the commands. The maximum tested speed of the bus is 10Mbits/s. Data may be written to the module and data may be received from the module. After a command is sent requesting data, the next transfer sends this data out on SDO. During the read, a new command may be sent and will be parsed when chip select goes high. A read is always followed by a write with a read request.

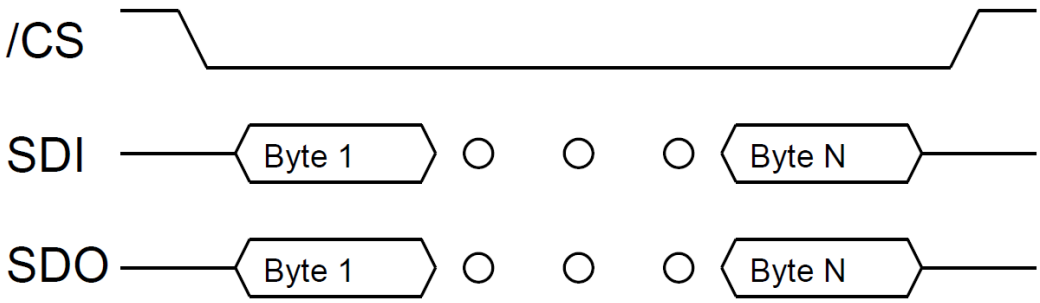
Bus Hardware Protocol:

Data is clocked into the module on the rising edge of SCLK. Data is clocked out of the module on this same edge. Data output is valid on the falling edge of SCLK. Data is only transferred when chip select is low. When chip select goes high, this initiates the parsing and execution of data.

SPI Timing



Bit level timing demonstrating where data is sampled into and out of the module on the rising edge of SCLK. Data out is valid on the falling edge of SCLK.



Byte level communications. Any number of bytes may be sent. After /CS goes high, the data is parsed and executed. If no data is sent, the SPI communications module simply resets itself and no parsing or execution of data occurs. If /CS goes high in the middle of a byte transfer (1-7 bits are sent instead of 8) this byte is ignored.

Binary Programming Commands

Three commands are supported in binary mode over the SPI bus. One command at a time may be issued between chip selects and the module responding with an active ready.

Command	B1 Instruction (Hex)	B2 (MSB)	B3	B4	B5	B6	B7
Set Frequency (mHz)	01h	Unsigned Integer - 48Bits					
Set Power (0.01dBm)	02h	Signed Integer					
Set Phase Offset (0.1 deg)	03h	Unsigned Integer					

Always send MSB in the second byte. Position of LSB depends on the size of the integer.

Examples:

To set the RF frequency to 1.56GHz, send 01h in the first byte followed by the unsigned integer value of 1560000000000. MSB in the second byte and LSB in the seventh byte.

To set the RF power to 10.12dBm, send 02h in the first byte followed by the signed integer value of 1012. MSB in the second byte and LSB in the third byte.

To set the phase offset to 165.1 degrees, send 03h in the first byte followed by the unsigned integer value of 1651. MSB in the second byte and LSB in the third byte

USER NOTES

USER NOTES

USER NOTES

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