Model 7300 Series
Phase Noise Test System

7000 SERIES Signal Source Analyzer

- • Fully Integrated System
- • Cross-Correlation Signal Analysis
- • 5 MHz to 26.5 GHz
- • Additive or Absolute Phase Noise

BNC Berkeley Nucleonics
Test, Measurement and Nuclear Instrumentation since 1963

Introduction

The Model 7300 is an integrated solution that offers an indispensable set of measurement functions for evaluating signal sources ranging from VHF to microwave frequencies such as crystal oscillators, PLL synthesizers, clocks, phase-locked VCOs, DROs, and others.

The flexible instrument comprises a two-channel cross-correlation system with two internal tunable references sources and allows also measurements with external references.

The PNT provides a complete set of measurement such as

❖ absolute and additive phase noise measurements,
❖ direct access to the two channel 50 MHz FFT analyzer,
❖ transient measurements (frequency vs time, modulation domain analyzer)
❖ oscillator test bench (tuning, pushing, phase noise, current, power,..)
❖ spectrum monitoring
❖ or frequency counter function / power meter

Using proven cross-correlation measurement procedures and self-calibration routines, reproducible, and accurate measurements are obtained even under changing environmental conditions. Fully automated frequency acquisition and self-calibration greatly simplify use and applicability of the instrument, resulting in much faster measurement throughput and greater ease-of-use in actual operation.

It is a compact and powerful instrument available with LAN (VXI-11), USBTMC, or with GPIB (optionally) interfaces. Platform independent intuitive graphical user interface (GUI), API library, and powerful SCPI command language set is available.

Application   supported:

✓ Additive or absolute phase noise measurement
✓ Measure frequency droop on individual channels in frequency hopping systems
✓ Analyze chirp radar performance
✓ Calibrate frequency sweep signals.
✓ Calibrate intentional modulation (FM or FSK)
✓ Analyze PLL's and Frequency locked-loops
✓ Measure frequency settling times of VCO's
✓ Characterize start-up/warm-up of oscillators
✓ Spectrum and noise monitoring
✓ VCO characterization (tuning, supply pushing, power, current...)
✓ 50 MHz bandwidth FFT analyzer mode

Specifications

The specifications in the following pages describe the warranted performance of the instrument for 25 ± 5 °C after a 30 minute warm-up period. Typical specifications describe expected, but not warranted performance. Min and Max specifications are warranted.
Warranted performance. Specifications include guard-bands to account for the expected statistical performance distribution, measurement uncertainties, and changes in performance due to environmental conditions.

Parameter	Min.	Typ.	Max.	Note
Absolute Phase Noise Measurement 5 MHz to 26 GHz				
Measurement parameters	SSB phase noise [dBc/Hz], Spurious noise [dBc], Integrated rms phase deviation [deg, rad] or time jitter [s], Residual FM/PM [Hz rms]			
7300 RF Frequency Range	5 MHz 5 MHz		26 GHz 15 GHz	using internal references using external references
7070 RF Frequency Range	5 MHz 5 MHz		7 GHz 7 GHz	using internal references using external references
Input Power Range	-10 dBm	+5 dBm	+20 dBm +23 dBm	+26 dBm is damage level < 20000 MHz >20000 MHz
Input impedance VSWR		50 Ω 2		AC coupled, 10V DC max
Offset Analysis Range	0.1 Hz		50 MHz 20 MHz 5 MHz	for RF > 70 MHz for RF < 70 MHz RF < 25 MHz
Measurement Accuracy		±4 dB ±3 dB ±2 dB		< 10 Hz offset < 1 kHz offset > 1 kHz
System Phase Noise Floor 1 Hz 10 Hz 100 Hz 1 kHz 10 kHz 10 MHz		-140 dBc/Hz -150 dBc/Hz -160 dBc/Hz -175 dBc/Hz -180 dBc/Hz -180 dBc/Hz		(cross-correlation, external references)
Phase Noise Sensitivity	See plot for sensitivity of internal sources			
Measurement time				See Table "Measurement Time"
Internal References				Cross-correlation
Frequency Range	5 MHz 5 MHz		26 GHz 7 GHz	7300 7070
Phase Noise Sensitivity				See Plots "Sensitivity"
RF Tracking Range		±20 ppm / s ±0.5 %		PLL Mode Discriminator Mode

Parameter	Min.	Typ.	Max.	Note
External References				One or Cross-correlation
Frequency Range	5 MHz		15 GHz 7 GHz	7300 7070
Reference Level Range	+13 dBm	+15 dBm	+ 23 dBm	
Tuning Voltage Range	0 V		+20 V	adjustable
Output current			10 mA	

Additive Phase Noise Measurement 5 MHz to 18 GHz

Measurement parameters	SSB phase noise [dBc/Hz], Spurious noise [dBc], Integrated rms phase deviation [deg, rad] or time jitter [s], Residual FM/PM [Hz rms]			
RF Frequency Range	5 MHz		15 GHz 7 GHz	**7300** **7070**
Input Power Range (RF port) **(REF ports)**	3 dBm 13 dBm		+23 dBm +23 dBm	
Offset Analysis Range	0.1 Hz 0.1 Hz 0.1 Hz		50 MHz 20 MHz 5 MHz	0.01 Hz via SCPI control for RF < 70 MHz RF < 25 MHz
Measurement Accuracy		±3 dB ±3 dB ±2 dB		< 10 Hz offset < 1 kHz offset > 1 kHz
Residual Phase Noise Floor 1 Hz 10 Hz 100 Hz 1 kHz 10 kHz 10 MHz		-140 dBc/Hz -150 dBc/Hz -160 dBc/Hz -175 dBc/Hz -185 dBc/Hz -185 dBc/Hz		(cross-correlation engine)

Transient Measurements

Measurement parameters	Frequency, Phase (narrowband)			
Frequency range	5 MHz 500 MHz 1 GHz 2 GHz		2.5 GHz 6 GHz 12 GHz 20 GHz	4 bands
Measurement bandwidth				See table
Frequency resolution				See table
Phase resolution				See table
Measurement time	50 us		10 s	
Time resolution	16 ns		500 ms	

Parameter	Min.	Typ.	Max.	Note
Trigger mode		Free-run, Internal, external		**5**

Spectrum Monitoring

Measurement parameters	dBm, dBm/Hz, dBc/Hz			
Frequency range	5 MHz		26 GHz	
Monitoring bandwidth	1 kHz		20 MHz	
Resolution bandwidth (RBW)	1.8 Hz		1 MHz	
Absolute measurement uncertainty		± 2 dB		Pin = 0 dBm
Relative measurement uncertainty		± 1.5 dB		
Residual noise floor		tbd		RBW =
Trigger mode		Free-run, Internal		

FFT Analyzer

Input Connectors	2 BNC female (rear panel), AC coupled			
Measurement parameters	dBV/Hz, dBm/Hz, nV/√Hz			
DC Voltage Range Input Impedance	-12 V	1 kΩ	+ 12 V	DC
AC Voltage Range			+ 10 dBm	
Frequency Range	1 Hz		50 MHz	
Input Noise Density		< 1 nV/√Hz		10 kHz offset

VCO Characterization

Measurement parameters	Frequency (Hz), Tuning sensitivity (Δf/ΔVc) (Hz/V), Frequency Pushing (Hz/V), RF power level [dBm], DC supply current [mA]			
Sweep parameters DC Supply Voltage Tuning Voltage	0 to 15 V / max 500 mA 0 to 20 V / max 20 mA			adjustable
RF frequency uncertainty	5 MHz	0.5 ppm	26 GHz	
RF Power uncertainty	-10 dBm	1 dB	20 dBm	

DC current measurement range uncertainty	0	1%	500 mA	
Output settling time		20 ms		
Trigger		Start, Software		

Frequency Counter

Measurement parameters	Frequency [Hz]			
Frequency Range	5 MHz		26 GHz	
Absolute Accuracy		300 ppb		
Sensitivity		-10 dBm		See typical sensitivity plot

Power Detector

Measurement parameters	Power mW ,dBm			
Frequency Range	5 MHz		13 GHz	
Accuracy		< 2 dB		
Power Range	-10 dBm		+23 dBm	

Dual Power Supply (option SUPPLY)

DC Voltage Range	0		15 V	
Setting Resolution		10 mV		
Setting Uncertainty		±10 mV		
Noise Level		< 10 nVrms/√Hz		> 20 kHz
Output Resistance		< 0.5 Ohm		
DC current meas. range	0		500 mA	Per channel
Uncertainty		< 100 uA		

Phase Noise Sensitivity (dBc /Hz)
Measurement time ~25 seconds, after first cross-correlation; further correlations will improve sensitivity by 5 dB by for 10, 10 dB for 100, and 15 dB for 1000 respective correlations performed.
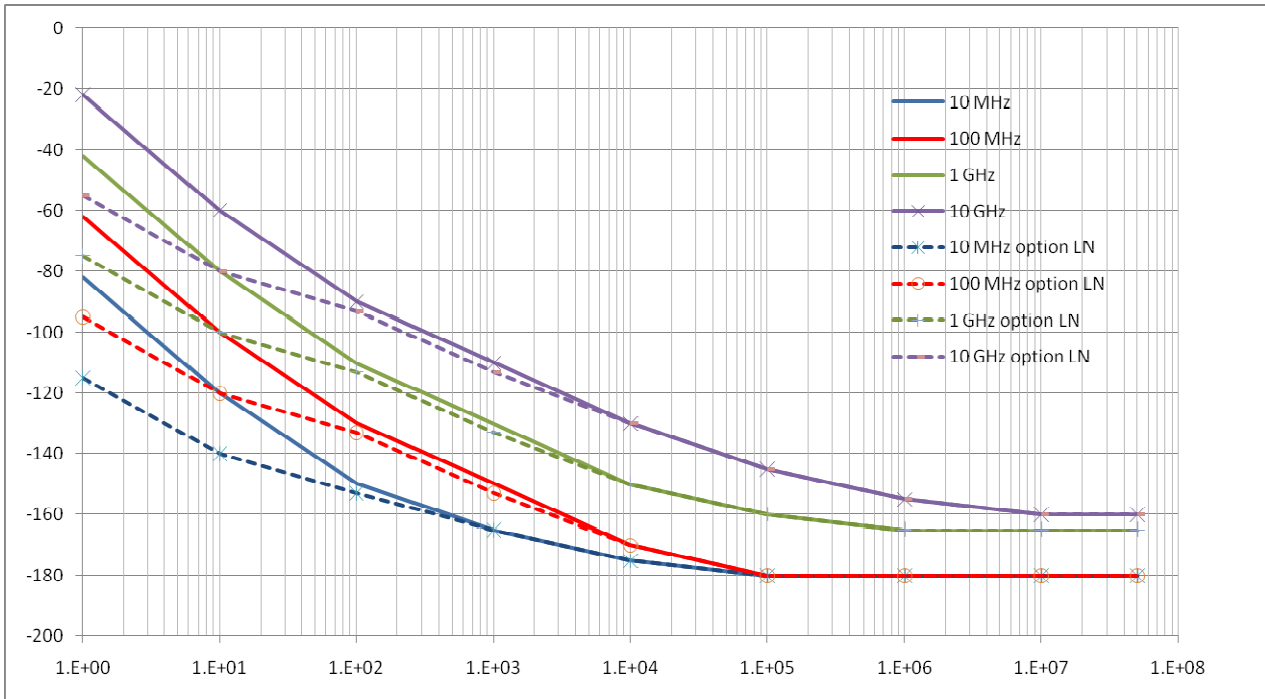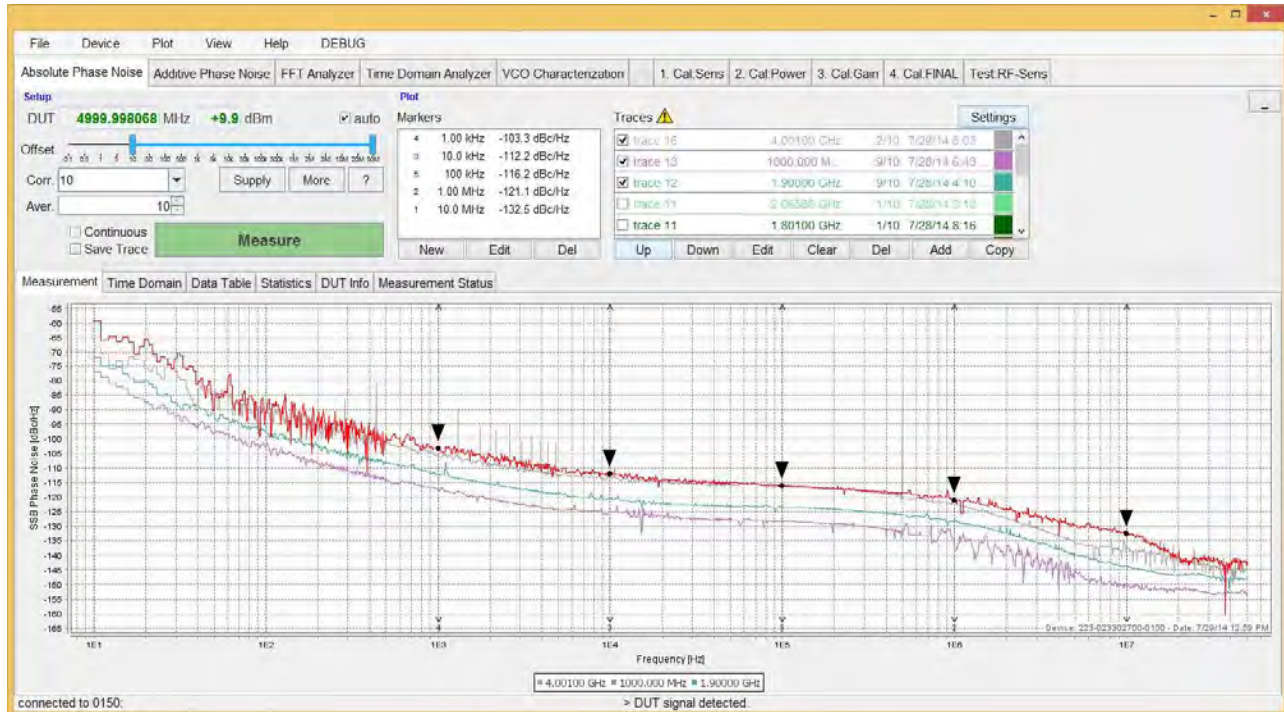

Typical RF Sensitivity (dBm)
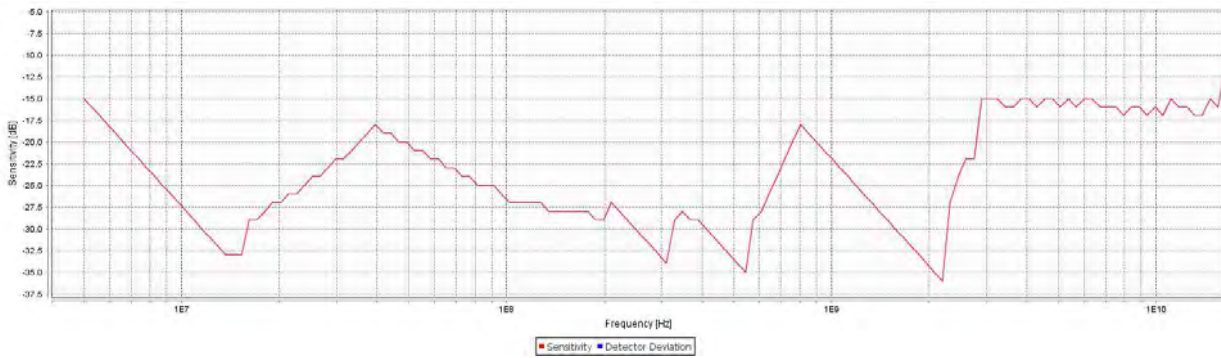
Measurement Time

Total measurement time consists of setup time, transfer time plus the number of performed correlations times the time per correlation

	Typical setup time (sec)	Time per average (sec)	Nr. of points
0.1 Hz to 50 MHz	2	80	~ 1800
1 Hz to 50 MHz	2	10	~ 1700
10 Hz to 50 MHz	2	1.5	~ 1500
100 Hz to 50 MHz	2	0.5	~ 1300
1 kHz to 50 MHz	<2	0.2	~ 1050
10 kHz to 50 MHz	<2	<0.1	~ 800

GUI Interface (Absolute Phase Noise)

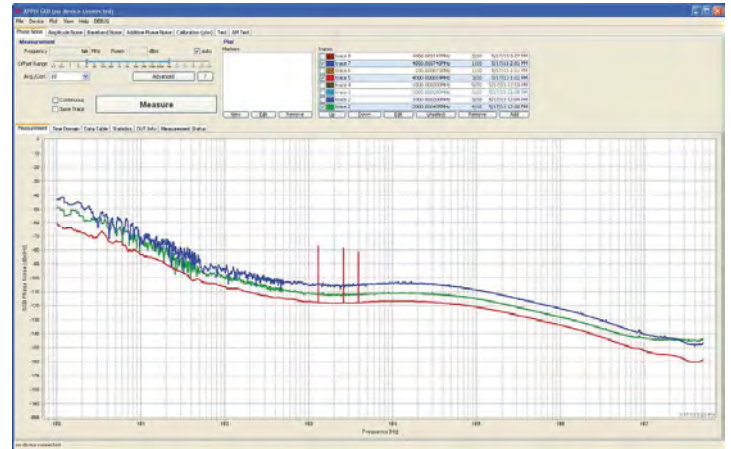| Display Functions	Phase Noise, Time Domain, Data Table, Residual, Statistics

Trace Functions
 	
   Data Traces
 	
   Math
 	
   Title
 	
Auto-Scale
 	
   Statistics
	
	Display current measurement and/or multiple memory data (up to 16 traces)
	
	Addition, subtraction, multiplication, or division of trace data, offset corrections
	
	Add customized title to each measurement window
	
	Automatically selects scale resolution and reference value to vertically center the trace.
	
	Calculates and displays mean, standard deviation, and peak-to-peak deviation of the trace.

Marker Functions	16 independent markers

GUI Interface (Transient)
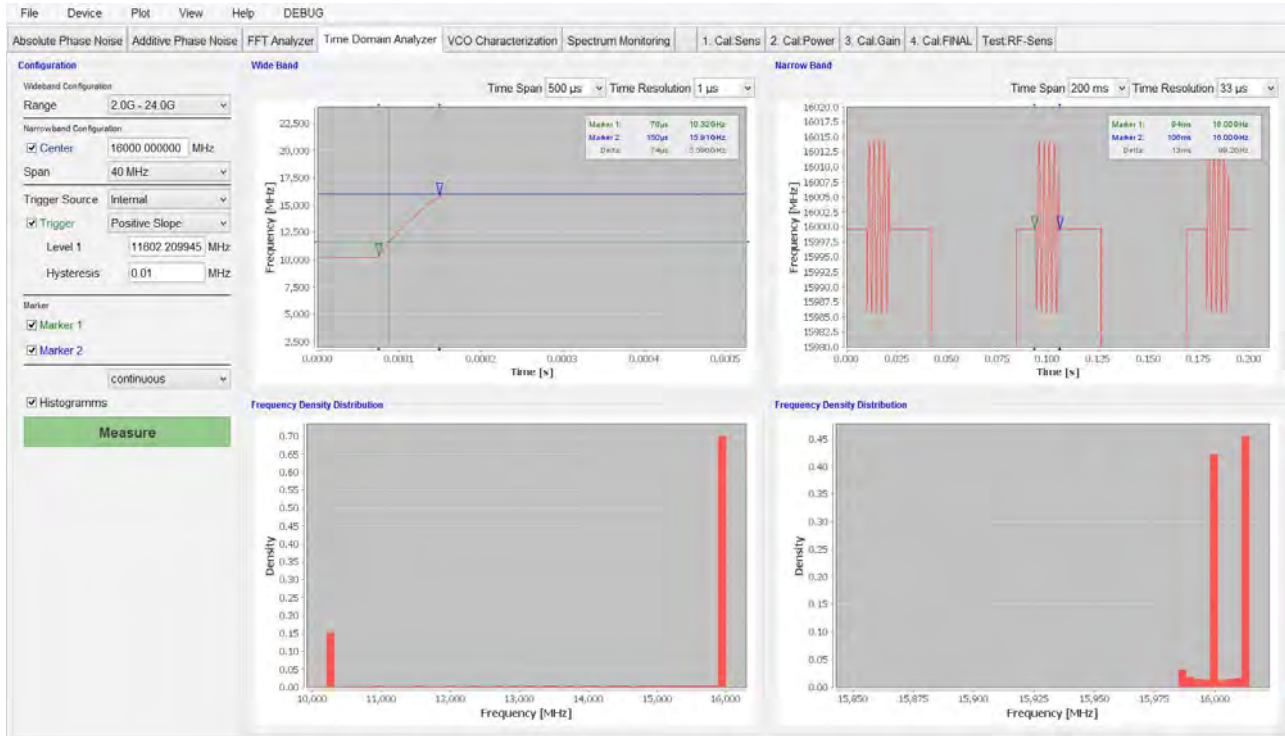
GUI Interface (VCO Characterization)
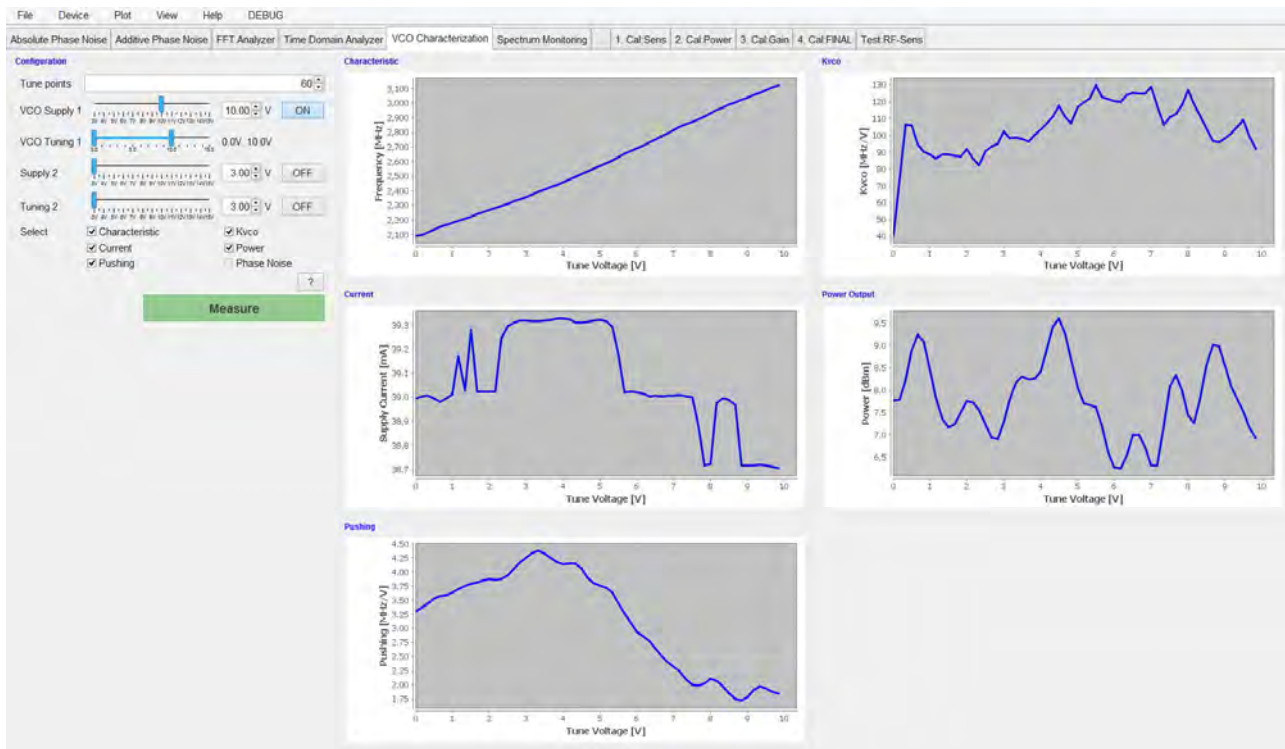
Data Processing Capabilities

Graphical user interface: The analyzer employs a graphical user interface based on Windows OS.

GUI Interface

Display Functions	Phase Noise, Time Domain, Data Table, Residual, Statistics
Trace Functions / Data Traces	Display current measurement and/or multiple memory data (up to 16 traces)
Math	Addition, subtraction, multiplication, or division of trace data, offset corrections
Title	Add customized title to each measurement window
Auto-Scale	Automatically selects scale resolution and reference value to vertically center the trace.
Statistics	Calculates and displays mean, standard deviation, and peak-to-peak deviation of the trace.
Marker Functions	16 independent markers

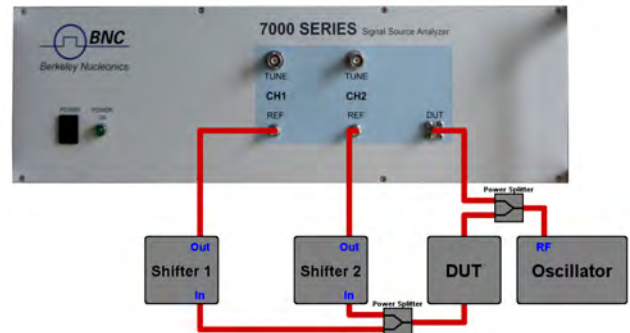# Connectors

7000 Series Front Panel

- Front Panel
1. RF inputs: RF IN, REFIN1, REFIN2, REFOUT1, REFOUT2 : SMA female
2. Tuning outputs: Tune1, Tune2 : BNC female
3. DC power switch

- Rear Panel
1. Baseband inputs: BBIN1, BBIN2) BNC female
2. LAN connection: RJ-45
3. USB 2.0 host and device
4. DC Power plug (6V, 2.5A)

7000 Series Rear Panel

General Characteristics

Remote programming interfaces
- Ethernet 100BaseT LAN interface,
- USB 2.0 host & device
- GPIB (IEEE-488.2,1987) with listen and talk (optional)
- Control language SCPI Version 1999.0

Power requirements: 6 VDC; 24 W maximum
Mains adapter supplied: 100-240 VAC in/ 6V, 6A DC out
Operating temperature range: 0 to 45 °C
Storage temperature range: –40 to 70 °C
Operating and storage altitude up to 15,000 feet

CE notice
Safety/EMC Certified
Weight - 4kg (9 lbs) net
Options - GPIB: IEEE-488.2

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