



PRECISION CONTROL

719 W. ELM ST, PALMYRA, PA, U.S.A 17078-3029

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PHASE NOISE TEST STATION

The Phase Noise Test Station consists of the PC400 Phase Noise Test Rack with standard oscillators, a Phase Locking Baseband Test Set, and a Low Frequency Baseband Spectrum Analyzer. The output signal from the oscillator under test is measured by the analyzer and the phase noise curve is generated by the internal software.



Note: Only the PC400 Phase Noise Test Rack, Standard Oscillator Module, Unit Under Test Module are shown. The computer, baseband test set, and baseband spectrum analyzer, frequency counter, printer, and power supplies are not shown. See Equipment List below for detail of the complete PC400 System.

FEATURES

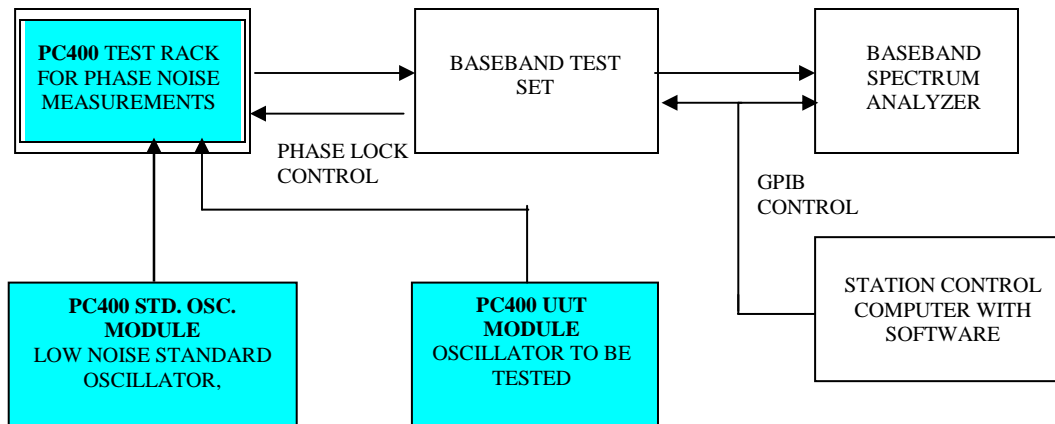
- * Measurement of Crystal, XO, TCXO, VCXO, and OCXO phase noise
- * Phase noise to jitter software program included
- * Self-contained test rack and modules for set-up and measurement of phase noise
- * System can be used to screen crystals for low offset frequency phase noise
- * Full manual use of the Phase Noise Equipment, power supplies, and frequency counter

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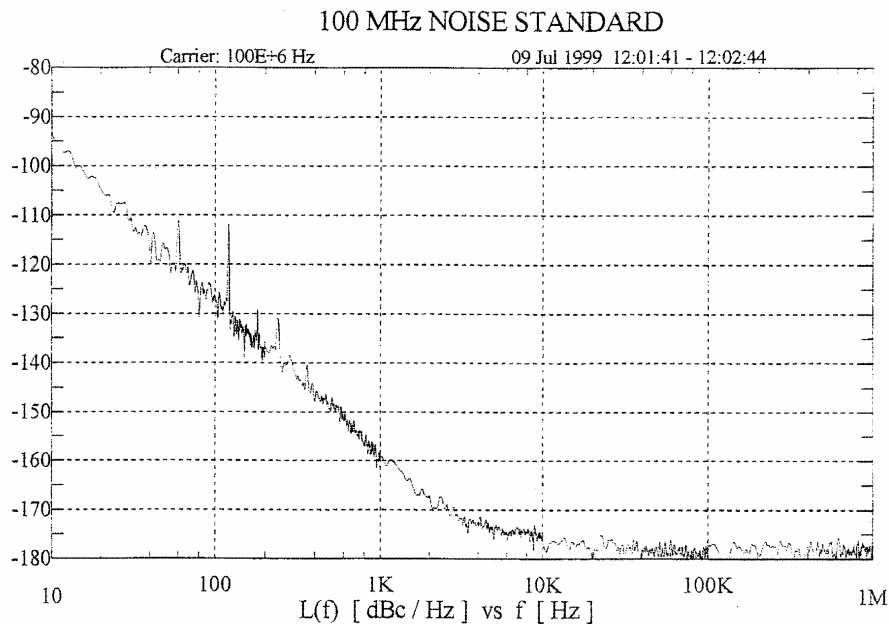
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PHASE NOISE TEST STATION BLOCK DIAGRAM



TYPICAL PHASE NOISE PLOT

This plot is of a low noise oscillator under test using an optional standard oscillator





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PC400 PHASE NOISE TEST STATION SPECIFICATIONS

FREQUENCY RANGE:	4 MHz to 880 MHz with supplied standards, 50 kHz to 1.6 GHz with optional standards.
ACCEPTABLE OUTPUT OF UNIT UNDER TEST:	TTL, CMOS, LVDS, PECL. Sine with +5 dBm minimum output with supplied standards. Ultra low noise units under test, with noise floors better than -158 dBc/Hz, (up to -175 dBc/Hz is possible) using optional standards will require +15 dBm minimum output.
ACCURACY OF UNIT UNDER TEST:	Supplied Low Noise Standard Oscillator with purchaser supplied fundamental Crystals, +/-150 ppm; 3 rd Overtone Crystals, +/-50 ppm; 5 th Overtone Crystals, +/-20 ppm.
STD. PACKAGE CONFIGURATIONS OF UNIT UNDER TEST:	ZIP socket for Full, Half Size DIP oscillator. Optional adapters are available for a variety of SMD packages. Purchaser supplied SMD adapters can be inserted in the 14 Pin ZIP socket.
PHASE NOISE TO JITTER CONVERSION:	Software program allows manual conversion from phase noise to RMS jitter.
INPUT POWER:	120 V.A.C., 50 to 60 Hz (International voltages are available), an earth grounded single 15 amp single service is recommended.
PC400 TEST RACK SIZE:	5.25" High x 17.5" Wide x 20.0" Deep (including connectors and covers). The power supplies and frequency counter sits on top of the PC400 Test Rack and adds an additional 7.5" to the height for a total height of 12.75".
TWO PC400 MODULE SIZES:	3.5" High x 7.5" Wide x 5" Deep (including connectors and covers).

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RECOMMENDED BENCH AREA: 8' Long x 3' Deep for the PC400, Standard Oscillator Module, UUT Module, associated set-up test equipment, phase noise equipment, computer, printer, and work space

STANDARD OSCILLATOR AND CRYSTAL SCREENING OSCILLATOR:
 The testing of phase noise requires two oscillators, one is the unit under test. The other oscillator is one of eleven supplied voltage tunable standard oscillators that are characterized for low noise. Eleven screening oscillators are also supplied to screen crystals for the lowest noise. Each standard oscillator must contain a screened crystal of the same frequency as the unit under test for frequencies 220 MHz and below, and one fourth the frequency for extended range frequencies from 220 MHz to 880 MHz. The supplied voltage tunable standard oscillator's **typical** phase noise is shown below, and must be equal to or lower than the unit under test. The supplied standard oscillator plugs into the PC400 Standard Oscillator Module.

Crystals must be purchaser supplied for each specific frequency of the oscillator under test. These crystals are plugged into the supplied standard oscillator. The crystal mode (fundamental, 3rd, or 5th overtone) must be equal to or higher than the crystal used in the oscillator for frequencies 220 MHz and below, and one fourth the frequency for extended range frequencies from 220 MHz to 880 MHz. The accuracy of the oscillator or crystal under test must be tighter for higher overtone crystals. When crystals are ordered for each frequency tested, it is recommended that at least 3 crystals be ordered (5 recommended). The best two crystals must be selected using the supplied crystal screening oscillator and the supplied standard oscillator.

When the two lowest noise crystals are found, one crystal is placed in the standard oscillator for use when measuring phase noise of the unit under test. The other crystal and screening oscillator is not used when making phase noise measurements of the unit under test.

STANDARD OSC. PN	SCREENING OSC. PN	OSCILLATOR FREQUENCY RANGE (MHz)	USEABLE CRYSTAL MODES	EXTENDED FREQUENCY RANGE (MHz)
PC400-A1	PC400-B1	4.0 to 5.6	Fund	
PC400-A2	PC400-B2	>5.6 to 8.0	Fund	
PC400-A3	PC400-B3	>8.0 to 12.0	Fund	
PC400-A4	PC400-B4	>12.0 to 18.0	Fund	
PC400-A5	PC400-B5	>18.0 to 26.0	Fund	
PC400-A6	PC400-B6	>26.0 to 38.4	Fund, 3 rd	
PC400-A7	PC400-B7	>38.4 to 56.0	Fund, 3 rd	>220.0 to 224.0 MHz
PC400-A8	PC400-B8	>56.0 to 80.0	Fund, 3 rd	>224.0 to 320.0 MHz
PC400-A9	PC400-B9	>80.0 to 120.0	Fund, 3 rd , 5 th	>320.0 to 480.0 MHz
PC400-A10	PC400-B10	>120.0 to 180.0	Fund, 3 rd , 5 th	>480.0 to 720.0 MHz
PC400-A11	PC400-B11	>180.0 to 220.0	Fund, 3 rd , 5 th	>720.0 to 880.0 MHz



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Two covers are provided and may be used to cover the low noise standard and/or screening oscillator and the unit under test. These covers are recommended for phase noise measurements at 1 Hz and 10 Hz if the oscillator is not enclosed. They also can be used to reduce radiated spurious signals from outside sources. If these covers are used, the maximum size of the oscillator under test is 3.25" x 3.25" x 1.25" (L x W x H). Optional motherboards can be provided for non-standard sizes. A stand-alone under test oscillator of any size can be used and wired into the PC400 ZIP socket.

STANDARD OSCILLATOR AND SCREENING OSCILLATOR CRYSTALS:

The user must order crystals to plug into the standard oscillator and the screening oscillator. A crystal specification is provided. Using the PC400, the phase noise test equipment, and with the supplied standard and screening oscillators, the operator selects the best crystal to be used in the standard oscillator. **A screened crystal of the same frequency must be used in the supplied standard oscillator for each specific frequency of the oscillator under test for frequencies 220 MHz and below, and one fourth the frequency for frequencies from 220 MHz to 880 MHz.**

PURCHASER SUPPLIED OR PURCHASED STANDARD OSCILLATOR:

Using the optional adapter, the supplied standard oscillator can be substituted by a purchaser supplied or purchased VCXO. When this is done, crystals do not need to be purchased for each new frequency. **Note, the frequency of the substituted standard and screening oscillators must be the same as the frequency of the oscillator under test. The phase noise of the VCXO must be equal to or better than the best oscillator under test.** Using the PC400 and the phase noise test equipment, the best VCXO is selected and used as the standard oscillator to test the phase noise of the oscillator under test.



PRECISION CONTROL

TYPICAL SYSTEM SSB PHASE NOISE
WITH SUPPLIED STD. OSCILLATORS
AT THE HIGHEST FREQUENCY IN EACH
BAND:

**With Fundamental Crystals
4.00 MHz to 10.00 MHz**

10 Hz	-93 dBc/Hz
100 Hz	-120 dBc/Hz
1 kHz	-143 dBc/Hz
10 kHz	-158 dBc/Hz
100 kHz	-162 dBc/Hz
1 MHz	-162 dBc/Hz

CALCULATED TYPICAL JITTER

AT 10 MHz

10 Hz to 1 MHz	0.81 pS
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**With Fundamental Crystals
>10.00 MHz to 40.00 MHz**

10 Hz	-85 dBc/Hz
100 Hz	-112 dBc/Hz
1 kHz	-139 dBc/Hz
10 kHz	-156 dBc/Hz
100 kHz	-162 dBc/Hz
1 MHz	-162 dBc/Hz

CALCULATED TYPICAL JITTER

AT 40 MHz

10 Hz to 1 MHz	0.50 pS
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**With 3rd Overtone Crystal
>40.00 MHz to 120.00 MHz**

10 Hz	-80 dBc/Hz
100 Hz	-110 dBc/Hz
1 kHz	-136 dBc/Hz
10 kHz	-153 dBc/Hz
100 kHz	-155 dBc/Hz
1 MHz	-162 dBc/Hz
20 MHz	-162 dBc/Hz

CALCULATED TYPICAL JITTER

AT 120 MHz

10 Hz to 1 MHz	0.29 pS
12 kHz to 20 MHz	0.04 pS

**Extended Range with 3rd
Overtone Crystal at one fourth
the output frequency
>220.00 MHz to 480.00 MHz**

10 Hz	-67 dBc/Hz
100 Hz	-97 dBc/Hz
1 kHz	-123 dBc/Hz
10 kHz	-140 dBc/Hz
100 kHz	-142 dBc/Hz
1 MHz	-149 dBc/Hz
20 MHz	-149 dBc/Hz

CALCULATED TYPICAL JITTER

AT 480 MHz

10 Hz to 1 MHz	0.33pS
12 kHz to 20 MHz	0.10pS



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With 3rd Overtone Crystals >120.00 MHz to 170.00 MHz

10 Hz	-75 dBc/Hz
100 Hz	-105 dBc/Hz
1 kHz	-135 dBc/Hz
10 kHz	-153 dBc/Hz
100 kHz	-155 dBc/Hz
1 MHz	-162 dBc/Hz
20 MHz	-162 dBc/Hz

CALCULATED TYPICAL JITTER AT 170 MHz

10 Hz to 1 MHz	0.37 pS
12 kHz to 20 MHz	0.03 pS

With Fundamental Crystals >170.00 MHz to 220.00 MHz

10 Hz	-65 dBc/Hz
100 Hz	-95 dBc/Hz
1 kHz	-125 dBc/Hz
10 kHz	-142 dBc/Hz
100 kHz	-155 dBc/Hz
1 MHz	-162 dBc/Hz
20 MHz	-162 dBc/Hz

CALCULATED TYPICAL JITTER AT 220 MHz

10 Hz to 1 MHz	0.91 pS
12 kHz to 20 MHz	0.05 pS

Extended Range with 3rd Overtone Crystal at one fourth the output frequency >480 MHz to 680 MHz

10 Hz	-62 dBc/Hz
100 Hz	-92 dBc/Hz
1 kHz	-122 dBc/Hz
10 kHz	-140 dBc/Hz
100 kHz	-142 dBc/Hz
1 MHz	-149 dBc/Hz
20 MHz	-149 dBc/Hz

CALCULATED TYPICAL JITTER AT 680 MHz

10 Hz to 1 MHz	0.42 pS
12 kHz to 20 MHz	0.07 pS

Extended Range with Fundamental Crystal at one fourth the output frequency >680 MHz to 880 MHz

10 Hz	-52 dBc/Hz
100 Hz	-82 dBc/Hz
1 kHz	-112 dBc/Hz
10 kHz	-129 dBc/Hz
100 kHz	-142 dBc/Hz
1 MHz	-149 dBc/Hz
20 MHz	-149 dBc/Hz

CALCULATED TYPICAL JITTER AT 880 MHz

10 Hz to 1 MHz	1.02 pS
12 kHz to 20 MHz	0.06 pS

NOTE: Improved system phase noise can be achieved with optional or purchased standard oscillators at specific frequencies. NO OSCILLATOR UNDER TEST CAN BE MEASURED BETTER THAN -3 dB FROM THE ABOVE VALUES USING THE SUPPLIED STANDARD OSCILLATORS AND PURCHASED CRYSTALS. IF FUNDAMENTAL OR LESSER OVERTONE CRYSTALS, THAN NOTED ABOVE, ARE USED IN THE SUPPLIED STANDARD



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OSCILLATOR, THE NOISE <100 kHz WILL BE DEGRADED FROM THE TYPICAL VALUES ABOVE. TYPICAL VALUES ABOVE WILL VARY DEPENDING ON THE QUALITY OF THE CRYSTALS PURCHASED. HIGHER OVERTONE CRYSTALS CAN BE USED TO ACHIEVE LOWER PHASE NOISE AT A SPECIFIC FREQUENCY. WITH HIGHER OVERTONE CRYSTALS, THE SETTING ACCURACY OF THE UNIT UNDER TEST MUST BE GREATER.

PC400 Equipment supplied or required

EQUIPMENT SUPPLIED

Qty	Description
1	PC400 Phase Noise Test Rack
1	PC400 Unit Under Test (UUT) Module
1	PC400 Unit Low Noise Standard Module
1	PC400 Accessory Kit Includes:
11	PC400 Standard Oscillator
11	PC400 Screening Oscillator
1	PC400 Full and Half Size DIP Oscillator Adapter
20	PC400 Band Pass Filters
54	Variable Coils
2	X2 Multipliers for extended frequency range
1	PC400 Cable Set
1	PC400 Manual Set
1	*Agilent Technologies E5501B Phase Noise Test System with FFT analyzer, Spectrum analyzer, Test Set, and Computer/Monitor
2	*Agilent Technologies E3610A Power Supply
1	*Agilent Technologies 53131A 225 MHz Frequency Counter
1	* Color Printer

*** Quoted separately or purchased as part of a complete system**

COMPONENTS AND EQUIPMENT REQUIRED

Qty	Description
3 TO 5	**Crystals for the supplied standard and screening oscillators for each specific frequency of the unit under test for frequencies 220 MHz and below and one fourth the frequency for frequencies from 220 MHz to 880 MHz

**** Quoted separately or purchaser supplied**



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PC400 Optional Equipment Available

PC400 Full and Half Size DIP Oscillator Adapter with band pass filters to be used with a purchased or supplied VCXO as the Standard Oscillator.

Adapters for a surface mounted oscillators to be used as the standard oscillator, screening oscillator or for the oscillator under test.

Lower noise standard oscillators to measure ultra low noise XOs, TCXOs, and OCXOs, with a noise floor up to -170 dBc/Hz.

Higher overtone crystals for the supplied reference oscillators to measure better close-in phase noise of the UUT.

Higher frequency standard oscillators up to 1.6 GHz to measure oscillators under test with frequencies greater than 880 MHz.

Motherboards for custom or purchased standard and screening oscillators.

Motherboards for odd size units to be tested for phase noise.