

# NOVATECH INSTRUMENTS, INC.

## Model 2960AX Disciplined Quartz Frequency Standard



2960AX

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## 1.0 DESCRIPTION

1.1 The Models 2960AX is an ovenized quartz frequency standard which can be disciplined to an external 1pps (one pulse per second) reference signal. This 1pps is commonly derived from primary, or other standards, such as GPS (global positioning satellite). When disciplined to 1pps, the 2960AX provides primary standard accuracy and stability.

1.2 The 2960AX provides three fixed frequency outputs of 10MHz, 10MHz and 5MHz. All outputs have a nominal amplitude of 1V<sub>rms</sub> into 50Ω.

1.3 The most recent version of this manual can be found on Novatech Instruments, Inc. web site.

## 2.0 SPECIFICATIONS

### 2.1 FREQUENCY STABILITY (10MHz output)

Short Term:  $\tau = 1\text{s to } 100\text{s}$   $< \pm 2 \times 10^{-11}$

Aging: Daily  $< \pm 1 \times 10^{-10}$  after 3 months

Holdover (24 Hours,  $\pm 2^\circ\text{C}$ ):  $< \pm 10\mu\text{s}$  after  $> 10 \times$  1pps time constant learning phase

Temperature:  $+5$  to  $+45^\circ\text{C}$   $< \pm 5 \times 10^{-10}$

Line Voltage:  $\pm 10\%$   $< \pm 5 \times 10^{-11}$

### 2.2 FREQUENCY ACCURACY

Tracking 1pps:  $< \pm 5 \times 10^{-11}$  after 24 hours in constant environment (using Model GPS1).

Retrace:  $< \pm 2 \times 10^{-8}$  from last frequency after 1 hour ON and 24 hours OFF (constant environment).

Warm up:  $< \pm 5 \times 10^{-8}$  of final frequency after 20 min.

### 2.3 FIXED SINE OUTPUTS

Two 10MHz and one 5MHz, 1V<sub>RMS</sub>  $\pm 0.25$ V<sub>RMS</sub> into 50Ω.

### 2.4 SPECTRAL PURITY (10MHz outputs)

Harmonic  $< -25\text{dBc}$

Spurious, Non-Harmonic, Sub-Harmonic:  $< -45\text{dBc}$ .

### 2.5 PHASE NOISE (Typical, 10MHz output)

Frequency Offset dBc

1Hz -85

10Hz -115

100Hz -130

1kHz -140

10kHz -145

### 2.6 1pps IN and OUT

1pps IN, DC-coupled, accepts TTL/CMOS levels.

1pps OUT TTL, 100μs positive going pulse width.

### 2.7 ENVIRONMENTAL

Temperature:  $+0^\circ\text{C}$  to  $+50^\circ\text{C}$  operating.

Humidity: 80% to 31%  $^\circ\text{C}$ , decreasing linearly to 50% at 40%  $^\circ\text{C}$ .

### 2.8 SIZE

6.4cm H, 18.5cm W, 24.1cm L, excluding bail and feet.

### 2.9 CONNECTORS

BNCs on front panel for sine outputs. BNCs on rear panel for 1pps I/O.

### 2.10 LINE POWER

120/240VAC  $\pm 10\%$ , 50/60Hz. 25VA (35VA max during warm up  $< 20$ minutes).

### 2.11 FRONT PANEL INDICATORS

POWER OK: AC power is applied.

OVEN OK: Crystal Oven on.

1PPS LOCK: Locked to and tracking a 1pps input.

### 2.12 ACCESSORY

GPS1: Matching GPS smart antenna system.

## 3.0 INSTALLATION

### WARNING:

*The 2960AX line power input receptacle is provided with a 3-wire cord. Do not defeat the grounded conductor.*

3.1 **Power Connection.** Verify that the rear panel indicates your line power (120VAC or 240VAC 50Hz/60Hz). Connect the provided 3-wire line cord to your power source. The power switch is built-in

to the input module on the rear panel. Line voltage is selected by an internal switch and set at the factory.

**3.2 2960AX Installation.** The 2960AX requires no user setup beyond the application of line power and connection to your application. Connect your 50Ω coaxial cables to the appropriate front panel BNC. See below for 1pps connections and use.

**NOTE:**

*If you plan to use your 2960AX as part of a calibration system or house standard, it is suggested that it be powered from an uninterruptable power supply (UPS) (along with your 1pps source, if used).*

**3.3 Signal Outputs.** The 2960AX has three front panel outputs of 10MHz, 10MHz and 5MHz. Each has a nominal amplitude of 1V<sub>rms</sub> ±0.25V<sub>rms</sub> into 50Ω.

3.4 See section 5.0 for the rear panel 1pps IN and OUT characteristics and use.

## 4.0 Operation

**4.1 Power on.** After power is applied, the 2960AX **POWER OK** LED will illuminate green. This indicates that the applied line power is within tolerance and the unit is functioning.

4.2 Proper operation in stand-alone mode, without a 1pps connection, is indicated by a green **POWER OK** LED and a green **OVEN OK** LED. The 1pps LED will remain off.

**NOTE:**

*The 2960AX will meet its specified accuracy within a few hours after power-up. For applications requiring verification of long-term stability, the periods shown in the specifications will have to be met.*

4.3 See the section “1pps Operation,” below, for details on 1pps connections and operation.

## 5.0 1pps Operation

**5.1 1pps In and Out.** The 2960AX is equipped with rear panel BNC receptacles which accept a

1pps input and provide a 1pps output. Use of 1pps allows synchronization of multiple 2960AX as well as providing a means of auto-calibration.

5.2 The 2960AX will accept a long-term stable 1pps signal, typically derived from a GPS (global positioning system) receiver or from another frequency standard. The unit will auto-adapt to the supplied 1pps and adjust the internal ovenized Quartz Oscillator to match the long term average frequency derived from the 1pps. The auto-adaptive algorithm selects the best tuning time constant based upon the stability of your supplied 1pps.

5.3 For low-jitter 1pps inputs (<20ns), the approximate tuning time constant will be 1,000 seconds. A typical timing receiver system, such as the GPS1 (with approximately 100ns peak-peak 1pps jitter), requires a time constant of approximately 10,000 seconds (about 3 hours) for optimum tracking.

5.4 For noisier 1pps inputs, such as those from standard GPS receivers not intended for timing applications, the time constant may increase to 100,000 seconds. If the input is too noisy, as determined by the auto-adaptive algorithm, the **1 PPS LOCK** light will not illuminate.

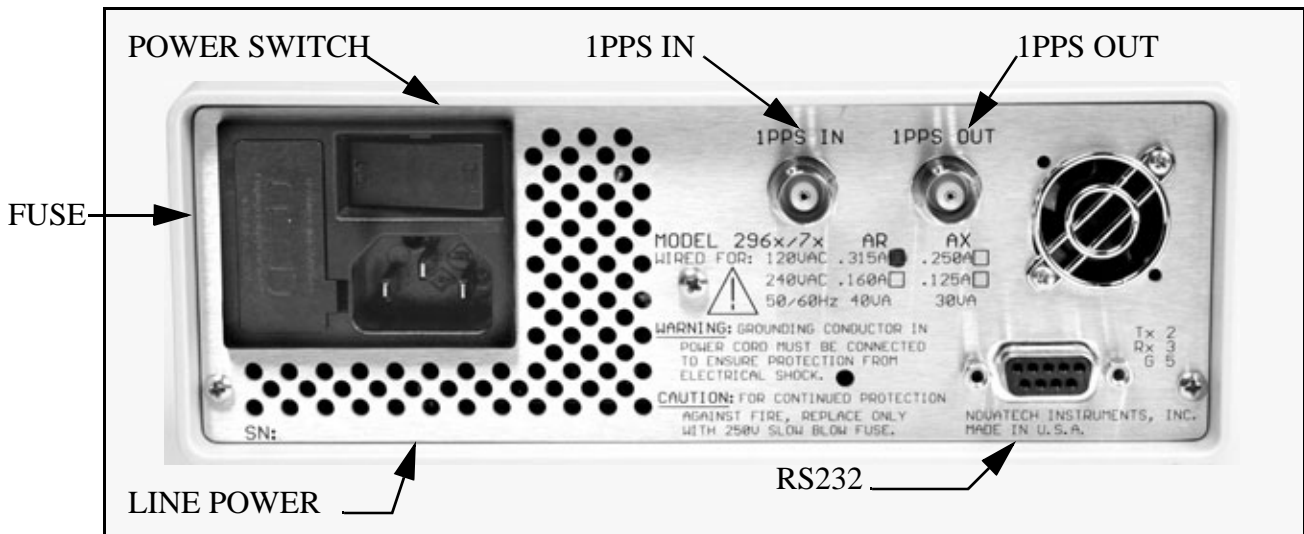
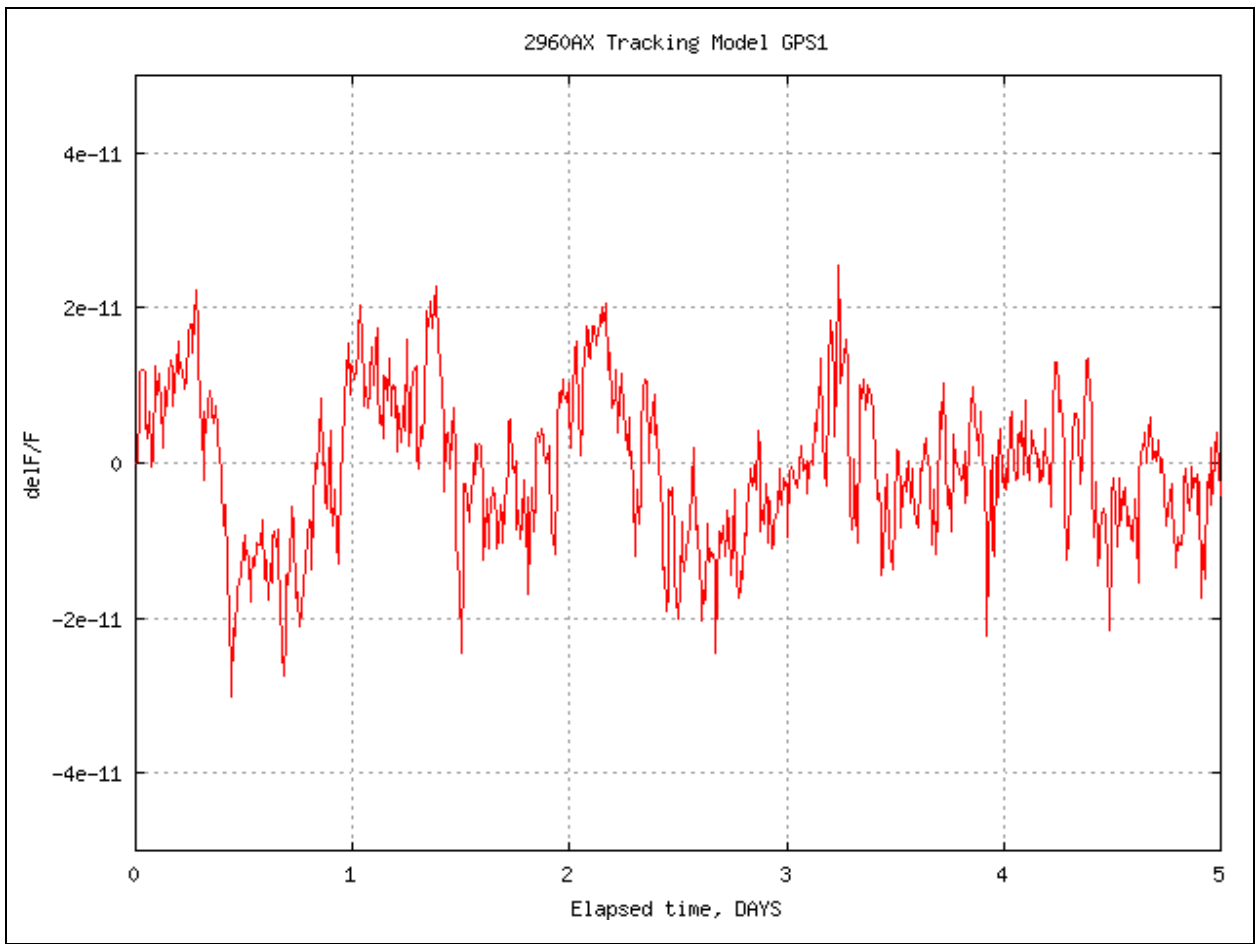
5.5 Proper operation when tracking a 1pps signal is indicated by all three front panel LEDs illuminated green.

**NOTE:**

*Due to these long time constants necessary to track a 1pps input, temperature variations can cause fluctuations in the relative phase of the 10MHz output and the 1pps output.*

**NOTE:**

*The Δf/f tracking range of the internal Quartz oscillator is approximately ±1x10<sup>-7</sup>. If your 1pps source is in error, but within these limits, the 2960AX will adjust to your source. This allows multiple units to be synchronized even in the absence of an absolute reference.*



2960AX Rear Panel

**CAUTION:**

*Do not connect the 1pps input and 1pps output on a single instrument together. This will force the instrument to track a moving value and reach its adjustment limit.*

5.6 The 2960AX is factory configured for automatic self-calibration. When continuously connected to a stable 1pps source, it will auto-save the disciplined frequency value into non-volatile calibration memory every 24 hours. The last-saved value will be used at next power on or when 1pps is lost. The 1pps output of a calibrated and tracking 2960AX has lower jitter than a typical GPS receiver making it suitable for use as a master reference for further 1pps systems.

**NOTE:**

*If the 1pps source is changed, it may be necessary to cycle power on the 2960AX. If 1pps lock is not obtained from a stable 1pps source after 24 hours, cycle power. Lock should be obtained within one hour.*

**6.0 PERFORMANCE TEST**

6.1 The performance test below verifies the functions of the 2960AX.

**NOTE:**

*Verification of the frequency and frequency stability of the 2960AX requires a laboratory environment of 23°C ±5°C.*

6.2 See Table 3 for a list of recommended test equipment to perform the following measurements.

**Table 3: Recommended Test Equipment**

<u>Item</u>	<u>Minimum Specification</u>	<u>Recommended</u>
Oscilloscope	300MHz, 50Ω termination	Tektronix TDS3032B
Frequency Counter	100MHz, 12-digits.	HP53132A

**Table 3: Recommended Test Equipment**

<u>Item</u>	<u>Minimum Specification</u>	<u>Recommended</u>
Counter Time Base	<±1x10 <sup>-11</sup>	Novatech Instruments, Inc. Model 2960AR with GPS1 smart antenna.

6.3 **Verify Frequency Accuracy.** To verify the frequency of the 2960AX, set the frequency counter to display 12-digits of resolution. The frequency counter must use an external time base of accuracy better than ±1x10<sup>-11</sup>.

6.4 Verify the correct frequency at each output. Allow the counter to average several readings. The error limits shown do not include time base or counter errors.

6.5 **Amplitude Verification.** Establish a measurement function of Volts RMS on the oscilloscope. Connect a 50Ω coaxial cable from the 2960AX to the oscilloscope (set to 50Ω termination) Verify an amplitude of 1.0V<sub>rms</sub>±0.25V<sub>rms</sub> on each output.

6.6 This concludes the verification of the 2960AX.

**7.0 CALIBRATION**

7.1 The 2960AX require no routine adjustments for typical operation.

**NOTE:**

*There are no periodic user adjustments required for operation of the 2960AX. When necessary, calibration is best performed “closed-case” using an external 1pps source.*

7.2 Closed-case calibration is obtained by connecting the instrument to a known stable and accurate 1pps source, such as a GPS1. (Faster tracking is obtained by using another 2960AX or 2960AR already tracking and stabilized to a 1pps source.)

7.3 Verify that the 1 PPS TRACKING light illuminates green. A stable 1pps source will allow this illumination within 15 minutes after connection.

7.4 Leave the unit tracking the 1pps in a stable environment for a minimum of 5 days. During this time, the internal auto-adaptive algorithm will measure and qualify the 1pps source adjusting the frequency to the long term average of the 1pps source.

**NOTE:**

*The unit under test or calibration must remain undisturbed during the calibration period. Changes in environmental conditions (temperature, electric field, magnetic field or physical orientation) affect the calibration. If possible, calibration should be performed at the application site.*

7.5 Best calibration performance is obtained in an environment stable to 23°C ±3°C or better.

**NOTE:**

*The auto-adaptive frequency adjustment has a resolution of  $\pm 5.12 \times 10^{-13}$ .*

7.6 Longer calibration periods are indicated for obtaining maximum performance from the 2960AX. Whenever possible, the units should remain connected to a stable 1pps source.

# WARRANTY

NOVATECH INSTRUMENTS, INC. warrants that all instruments it manufactures are free from defects in material and workmanship and agrees to replace or repair any instrument found defective during a period of one year from date of shipment to original purchaser.

This warranty is limited to replacing or repairing defective instruments that have been returned by purchaser, at the purchaser's expense, to NOVATECH INSTRUMENTS, INC. and that have not been subjected to misuse, neglect, improper installation, repair alteration or accident. NOVATECH INSTRUMENTS, INC. shall have the sole right to final determination regarding the existence and cause of a defect.

This warranty is in lieu of any other warranty, either expressed or implied, including but not limited to any warranty of merchantability or fitness for a particular purpose. In no event shall seller be liable for collateral or consequential damages. Some states do not allow limitations or exclusion of consequential damages so this limitation may not apply to you.

All instruments manufactured by NOVATECH INSTRUMENTS, INC. should be inspected as soon as they are received by the purchaser. If an instrument is damaged in shipment the purchaser should immediately file a claim with the transportation company. Any instrument returned to NOVATECH INSTRUMENTS, INC. should be shipped in its original shipping container or other rigid container and supported with adequate shock absorbing material.

This warranty constitutes the full understanding between NOVATECH INSTRUMENTS, INC. and the purchaser and no agreement extending or modifying it will be binding on NOVATECH INSTRUMENTS, INC. unless made in writing and signed by an authorized official of NOVATECH INSTRUMENTS, INC.

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