

NOVATECH INSTRUMENTS, INC. Model 1450A Rubidium Frequency Standard

INSTRUCTION MANUAL

SECTION 1- INTRODUCTION AND SPECIFICATIONS

1.0 The Model 1450A Rubidium Frequency Standard provides three simultaneous outputs of 10 MHz, 1 MHz, and 100 kHz for applications requiring a fixed precision frequency standard.

In addition to these standard outputs, up to seven TTL-level outputs and eight Sine-level outputs can be provided. These outputs can be one of the standard frequencies or a frequency factory-settable to 40 MHz in 0.025 Hz steps (all TTL-level outputs must be the same frequency and all Sine-level outputs must be the same frequency). See Table 2 for standard configurations.

All outputs are provided on the rear panel using BNC connectors. Front panel indicators show status of line power (POWER OK) and rubidium oscillator lock (RUBIDIUM LOCK). The Rubidium Lock signal is available on the rear panel BNC connector as a TTL-Level Signal for system use.

1.1 Specifications.

1.1.1 Frequency Stability (±)

Short Term:	$\tau=1s$	$<2.5 \times 10^{-11}$
	$\tau=10s$	$<0.8 \times 10^{-11}$
	$\tau=100s$	$<0.3 \times 10^{-11}$
Aging:	Monthly	$<5 \times 10^{-11}$ (after 1 month)
	Yearly	$<5 \times 10^{-10}$ (after 1 month)
Temperature:	+5 to +40C	$<4 \times 10^{-10}$
Line Voltage (±10%):		$<0.4 \times 10^{-11}$

1.1.2 Frequency Accuracy

At shipment: $\leq \pm 5 \times 10^{-11}$ at 25C internal baseplate temperature.
Retrace: $\leq \pm 4 \times 10^{-11}$ of previous frequency (constant temperature) after 24 hours ON and up to 48 hours OFF.

1.1.3 Sinewave Outputs

Standard: 10 MHz, 1 MHz and 100 kHz simultaneously plus four auxiliary outputs of one of the standard frequencies.
Optional: Up to 8 sinewave auxiliary outputs. These can be factory set to any one of the standard values or to a synthesized value. Synthesized values can be from 100 Hz to 40 MHz in 0.025 Hz steps and are locked to the internal rubidium oscillator.

Connectors: Rear mounted BNC Female

1.1.4 TTL Outputs

Standard: Four of one of the standard frequencies
Optional: Up to seven of the standard frequencies or a synthesized frequency.

1.1.5 Output Amplitude

Approximately 1 Vrms into 50 ohms (10 MHz, 1 MHz, 100 kHz)
Approximately 0.5 Vrms into 50 ohms (auxiliary outputs)
TTL: $V_{OL} \leq 0.5V$, $V_{OH} \geq 2.5V$, 30 pF load.

1.1.6 Output Impedance

50 ohms ±10%.

1.1.7 Size

3.47" H, 16.73" W, 12.0" D excluding rack handles and connectors. (Standard 3.5" high, 19" rack)

1.1.8 Spectral Purity (10 MHz, 1MHz, 100 kHz outputs)

All outputs (typ.): Harmonic: <-40dBc, Non-Harmonic: <-70dBc.

1.1.9 Phase Noise

10 MHz output, typical (dBc/Hz).

Freq. Offset	
1 Hz	-75
10 Hz	-89
100 Hz	-128
1 kHz	-140
10kHz	-147

1.1.10 Environmental

Temperature: 5 to 40C operating
Humidity: 80% to 31C, decreasing linearly to 50% at 40C.

1.1.11 Line Power

120/240 VAC ±10%, 50/60 Hz. 50VA (70VA during warm-up, ≤10 Minutes). Rear panel power switch.

1.1.12 Status Indicators

POWER OK. Front panel LED indicates power is on.
RUBIDIUM LOCK. Front panel LED and rear panel TTL level signal indicate that the Rubidium Oscillator is locked.

SECTION 2 - OPERATING INSTRUCTIONS

2.0 Introduction. This section of the manual contains information about connecting and operating the 1450A and should be read completely before using the instrument.

WARNING

This product is grounded through the grounding conductor of the power source. Before connecting anything to the instrument, be sure to plug the power cord into a properly wired power receptacle that is connected to a high quality earth ground. It is necessary to ground the 1450A in this way in order to avoid electrical shock and to assure safe operation.

WARNING

Although a chassis ground screw is provided, it should not be used to replace the connection made through the power receptacle. It is provided for system grounding purposes only.

2.1 Input Power. The 1450A is factory wired for 120V $\pm 10\%$ or 230V/240V $\pm 10\%$, 50/60Hz. Verify that the correct power is available before plugging in the instrument. The factory wired line voltage is indicated on the rear panel.

2.2 Fuse Replacement. The 1450A is protected by two AC line input fuses located on the left portion of the power receptacle. Use a small screwdriver to apply pressure at the side of the fuseholder and the fuseholder will snap out.

WARNING

The 1450A must be disconnected from line power before attempting to replace the fuses.

CAUTION

For continued fire protection, replace fuses only with slow fuses rated for 250V and the current rating shown on the rear panel (0.5 amperes for 120V and 0.25 amperes for 230V/240V).

NOTE

Either 5x20mm or 1/4" x 1 1/4" fuses may be used. 5x20mm are recommended.

2.3 Power Up. Connect the 1450A to the proper power source and switch the rear panel switch to ON. The POWER OK light should illuminate. After a maximum of 10 minutes (typically < 4 minutes), the RUBIDIUM LOCK light should illuminate and both the 1 MHz and 100 kHz outputs will be enabled.

WARNING

The 1450A requires a free flow of air from the rear panel and from its exhaust on the bottom right hand side. When mounted in its rack, verify that this flow is unimpeded. If bench testing a 1450A is necessary, provision must be made for this flow.

2.4 Rubidium Lock. The "Rb OK" BNC signal will go low when the internal rubidium oscillator has achieved lock. This indicates that the signal is within approximately $\pm 5 \times 10^{-8}$ of absolute frequency offset.

2.5 Operation. The 1450A has no operator controls and no operator interaction is required for normal use. Connect the appropriate coaxial cables to the BNC output connectors on the 1450A. All outputs can be used simultaneously up to their maximum loads. The BNC shells are at chassis potential and are common connected.

2.6 Accuracy. The 1450A will stabilize to $< \pm 1 \times 10^{-9}$ within 10 minutes (typically < 6 minutes @ 25C), and reach its full rated accuracy within 24 hours.

NOTE

The 1450A should be left powered on at all times for maximum accuracy and stability.

SECTION 3 - PERFORMANCE TEST AND MAINTENANCE

WARNING

To avoid personal injury do not remove the panel or covers and do not operate the 1450A unless the panel and covers are properly installed.

3.0 Introduction. The 1450A Rubidium Frequency Standard requires no periodic calibration or maintenance. It is recommended that the performance test of paragraph 3.1 be performed periodically to verify that the instrument is functioning properly.

Regularly scheduled maintenance cycles are required in those cases where tighter control of the output accuracy is necessary. For example, a user desiring a maximum frequency error of 5 parts in 10^{10} will need to test the 1450A at least once a year after an initial 30 days stabilization.

3.1 Performance test. Refer to Table 1 for a listing of recommended test equipment. This test assumes that the 1450A has warmed up for at least one hour in a stable environment of 18-28C.

3.1.1 Output Verification. This test quickly verifies the basic operation of the 1450A. Refer to paragraph 3.1.2 for detailed accuracy verification.

a) Connect the frequency counter to the 10 MHz, 1 MHz and 100 kHz outputs. Verify that the measured frequency is approximately correct. Displayed frequency should be in error no more than the time base accuracy of the counter $\pm 1 \times 10^{-8}$.

b) Verify that the auxiliary outputs are within $\pm 1 \times 10^{-8}$ of factory set frequency.

c) Connect the RF probe to the digital multimeter. Measure the 10 MHz, 1 MHz and 100 kHz outputs through a 50-ohm feed-through termination. Verify approximately 1 Vrms. Auxiliary sine outputs should be approximately 0.5 Vrms

d) Connect an oscilloscope to the TTL auxiliary outputs. Verify $V_{OL} \leq 0.5$ and $V_{OH} \geq 2.4$.

3.1.2 Frequency Accuracy Verification and Calibration. This test should only be performed if a highly accurate standard is available and the 1450A has been ON continuously for at least 30 days.

a) Connect the 10 MHz output from the recommended standard to one channel of the oscilloscope. Trigger the oscilloscope from this input.

b) Connect the 10 MHz output from the 1450A to another channel of the oscilloscope. If this waveform drifts to the left, the 1450A output is higher than the standard. If to the right, it is lower.

c) Using a stop watch, measure the time it takes for one cycle of the 1450A waveform to drift. Compare this time to those shown below:

Drift Time	Accuracy
1 sec	1×10^{-7}
10 sec	1×10^{-8}
100 sec	1×10^{-9}
1000 sec	1×10^{-10}

The fractional frequency error is given by:

$$\frac{\Delta f}{f} = \frac{\Delta T}{t}$$

Where ΔT is one period (100 ns for 10 MHz) and t is the time for one cycle to drift.

d) You may also use a frequency comparator or receiver. Consult the manual supplied with that instrument for operating instructions.

e) If your desired accuracy is not met, the internal Rubidium Oscillator must be adjusted. This is not recommended for most users. Adjustment of the internal oscillator requires extreme care and specialized equipment. Please consult NOVATECH INSTRUMENTS, INC. for detailed procedures.

**TABLE 1
RECOMMENDED TEST EQUIPMENT**

<u>Test Instrument</u>	<u>Minimum Specifications</u>	<u>Example Instrument</u>
Frequency Standard	10x better than 1450A	HP5071A Cesium Standard
Frequency Counter	10 digits, oven time base	HP53131A Opt 012 (or connected to external standard)
Oscilloscope	Dual Trace	Tektronix, TAS465
Termination	50 Ohm $\pm 2\%$	Tektronix 011-0049-01
RF Probe	100 kHz to 5 MHz	HP34301A, Tektronix P6420
Digital Multimeter	3.5 digits minimum	HP34401A
Stopwatch		

**TABLE 2
1450A STANDARD CONFIGURATIONS**

<u>Model</u>	<u>Description</u>
1450A	Standard outputs plus 4-Sine outputs and 4-TTL outputs. The Sine and TTL outputs must be one of the standard frequencies.
1450A/01	Standard outputs plus 4-Sine and 4-TTL outputs. The Sine or TTL outputs are factory settable to 40 MHz in 0.025 Hz steps.
1450A/02	Standard outputs plus up to 8-Sine and 7-TTL outputs. The Sine or TTL outputs are factory settable to 40 MHz in 0.025 Hz steps.

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.

NOVATECH INSTRUMENTS, INC.