

LPRO-GPSDO
Economy Rubidium GPS Disciplined Oscillator
10 MHz Primary Time Standard
by Silicon Forest Solutions



Introduction

The LPRO-GPSDO combines the best economy performance technology of yesterday and today. By using a high-sensitivity GPS time receiver to provide long-term stability and a refurbished rubidium oven for low-jitter short-term stability, we can provide industry standard performance at a fraction of the price you'd expect. With guaranteed frequency accuracy of 5×10^{-11} or better (5×10^{-12} typical), and status indicators warning you when frequency goes out of spec, you can trust the LPRO-GPSDO to be your NIST-traceable time standard.

Disclaimer

We have made every effort to ensure that the information in this manual is correct. However, we are not responsible for errors this manual may contain. The warranty period covers repair or refund, our choice, up to the original purchase price of the LPRO-GPSDO not including shipping. Under no circumstances shall we be responsible for any damages beyond the original purchase price.

Features

- Guaranteed Accurate to $< 5 \times 10^{-11}$, **Traceable to NIST** when LED is green
- Typically accurate to $< 5 \times 10^{-12}$ in a stable operating environment
- Low phase noise 10 MHz, 50Ω BNC output at +7 dBm
- Includes power supply and high-gain GPS antenna
- Phase Lock mode for **absolute accuracy** over long time intervals
- Optional "periodic Adjust mode" for use in areas without GPS signal

Installation

Important note: Heat Dissipation and Ventilation

The LPRO-GPSDO generates approximately 12 watts of heat. To dissipate this heat, the LPRO-GPSDO must have free air flow around it, or be fastened to or placed on a sufficient heat sink. A good place to mount the LPRO-GPSDO is on the inside of your test equipment rack or to the top of your distribution amplifier.

Step 1: Verify that all of the contents are present:

- LPRO-GPS assembly
- AC to DC adapter, 100-240VAC in, +24V 1.7A out
- GPS antenna, SMA, high gain, magnetic mount, 3m cable
- Five (5), 4-40 x 1/4" mounting screws

Step 2: Mount or secure the LPRO-GPS module in your desired location, being mindful of heat dissipation requirements.

Step 3: Mount the GPS antenna into an area with good reception. Many locations indoors are acceptable, provided there is an outside window or non-metallic wall nearby. The antenna may be permanently mounted outdoors if desired.

Step 4: Attach the GPS antenna to the SMA connector on the side of the LPRO-GPS.

Step 5: Attach the BNC output from the LPRO-GPS to the "10 MHz IN" on your distribution amplifier (e.g. HP 5087A) or electronic test equipment.

Step 6: Plug the DC power supply jack into the LPRO-GPS. Plug it into AC power.

Step 7: Observe the status LED. You should see it flashing RED, indicating device is powered but not warmed up and without GPS lock.

Step 8: Wait 15-20 minutes. The LED should turn from flashing to solid indicating GPS signal acquisition, and begin alternating RED-GREEN, indicating rubidium atomic lock. If you do not see alternating RED-GREEN, your LPRO-GPS is defective and should be returned. If you do not see the LED turn solid (alternating colors), you do not have sufficient GPS signal strength. Mount your GPS antenna somewhere with better signal, or use the Periodic Adjust mode (less accurate).

Step 9: Wait 24 hours. The LED should turn solid GREEN, indicating operating frequency is within NIST-traceable specifications.

For improved accuracy, you may attach the LPRO-GPSDO to a thermally regulated baseplate and mount your GPS antenna in a location with a clear view of the sky.

Theory of Operation

The LPRO-GPS has two primary modes of operation, Phase Lock mode and Periodic Adjust mode. The best operating mode is automatically selected, depending on GPS signal availability.

Phase Lock Mode

When a continuous GPS signal is available, typically received through a nearby window or outdoor antenna, the LPRO-GPS activates its digital PLL, performing tiny corrections to the frequency (typically parts in 10^{-14}) every few seconds using a precision low-noise DAC. This keeps the LPRO-GPS phase locked to the GPS signal, keeping short-term frequency accuracy to better than 1×10^{-11} (typically 1×10^{-12}) and long-term frequency stability absolute. The time constant for the digital PLL is several hours, balancing the short-term accuracy of rubidium with the absolute error (± 62 ns) of GPS time.

Periodic Adjust Mode

When a continuous GPS signal is not available, the LPRO-GPS will remember the time of its last GPS synchronization and begin counting clock cycles. When it receives a valid GPS signal again (after at least two hours), it will compute the number of clock cycles off nominal and apply an offset to the precision low-noise DAC, correcting for the time-averaged error. **Continuous power to the LPRO-GPS is required. Two GPS time fixes, separated by at least two hours, are required for correction.**

Using Periodic Adjust Mode:

- If GPS signal is not available at your location, plan on using an extension cord or uninterruptible power supply (UPS) to periodically reach the GPS signal without interrupting power.
- Periodically (at least once a month), expose your LPRO-GPS to the GPS signal until the status LED changes from blinking to solid.

NIST Traceable Self-Calibration

The LPRO-GPS records a history of frequency corrections applied internally. Using a conservative internal calculation, the known accuracy is displayed on the STATUS LED. Guaranteed specifications are valid only if the user maintains an ambient temperature within +/- 5 °C and applies no strong external magnetic fields. User should check LED status immediately before use when a traceable standard is required.

Status LED Color(s)	Description	Accuracy
Solid Colors	GPS signal is available	See Below
Flashing Colors	No GPS signal available	
Red	Waiting for Rubidium Atomic Lock	--
Red-Green alternating	Successful Atomic Lock. Frequency accuracy unknown or not corrected.	$<5 \times 10^{-8}$
Green	Frequency Accuracy Corrected and stable	Solid: $<5 \times 10^{-11}$ Flashing: $<1 \times 10^{-10}$

Sales and Service Information

Please visit <http://www.TenMHz.com> for sales and service inquiries as well as contact information.