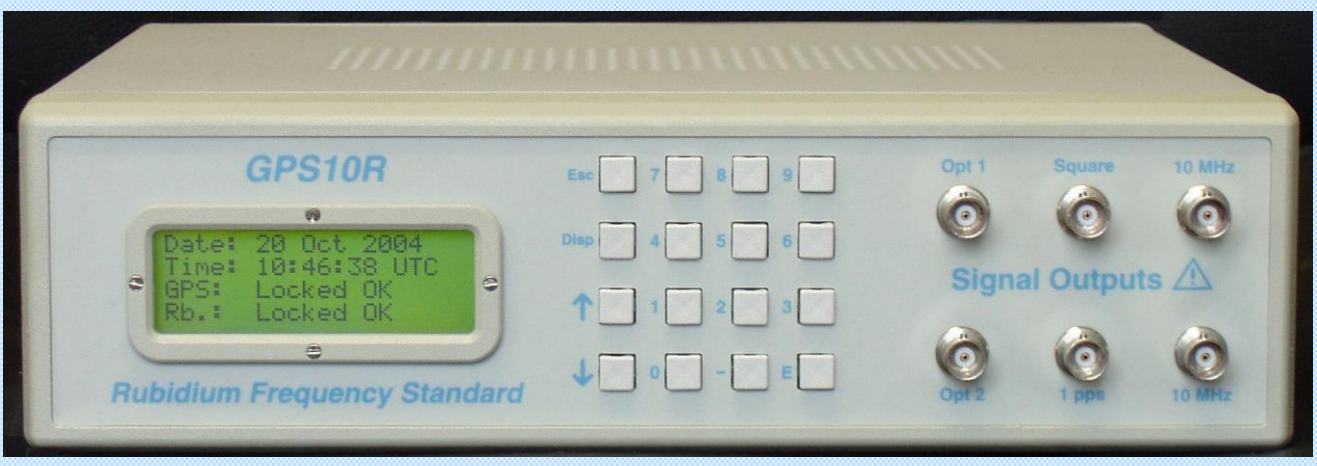
GPS10R - 10 MHz, GPS Disciplined, Rubidium Frequency Standards



Key Features

- Completely self-contained units. No extra P.C needed. Full information available via LCD.
- Rubidium Oscillator locked to GPS satellite signal. Accuracy to parts in 10^{-13} (Stratum 1 performance)
- Free run mode. Rubidium still gives an accurate output without a GPS satellite signal (Stratum 1)
- Two 1 pps time outputs. Typical error < 20 ns compared to UTC. Jitter < 300 ps
- Low Phase Noise, e.g. -120 dBc/Hz at 10Hz
- Multiple 10 MHz Outputs plus other outputs
- RS232 interface. Full control and interrogation of the GPS10R via RS232
- Very Low Microphonics
- Many options. See list of options in this brochure.
- Custom built options available upon request
- High quality design
- GPS10RBN 19" rack mount version also available

General Description

The GPS10R is a 10 MHz, GPS disciplined, rubidium frequency standards. It combines the short-term stability of an atomic rubidium oscillator with the long-term stability and traceability of the Global Positioning Service (GPS) set of satellites. The GPS10R achieves short and long-term frequency accuracy of parts in 10^{-13}. Thus the GPS10R exceeds the requirements of a Stratum 1 level frequency standard.

Options for the GPS10R include an antenna amplifier enabling the antenna to be placed up to 350 meters from the GPS10R, various fixed high frequency outputs, alarm relay outputs, redundancy, battery backup supply, time code outputs and a variable frequency output.

Rubidium for the price of an OXCO Oscillator

The GPS10R incorporates an atomic rubidium oscillator as the main frequency reference, but costs the same as some competitive units that use less accurate crystal oscillators. The rubidium used in the GPS10R is 30 times more stable than

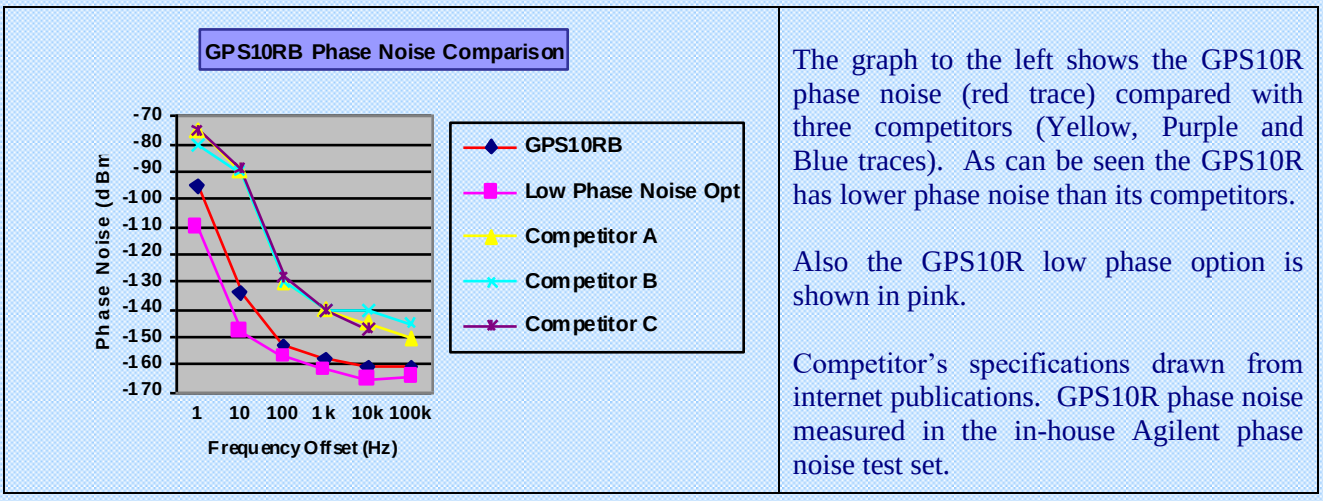
any OXCO available. Therefore the GPS10R achieves a frequency stability of typically 7 x 10^{-13} in 1000 sec. Frequency Standards that use a crystal oscillator as the main reference can only achieve this stability when measurements are averaged over one week or one month. This enables the GPS10R to be used as a frequency reference for frequency counters etc and measurements can be made in seconds, not days or weeks as is the case for crystal oscillator based units.

Accurate Timing Outputs

There are two 1 pps (pulse per second) outputs that are derived from the GPS receiver or the rubidium oscillator. The 1 pps signal from the GPS receiver is aligned to UTC with less than 20 ns error. The 1 pps from the rubidium is also aligned to UTC but has the advantage of less than 300 ps jitter (typically < 150 ps). Most other frequency standards quote 50-100 ns.

Very Low Phase Noise

The GPS10R is one of the lowest phase noise frequency standards available, at any price! Phase noise is often overlooked, but is one of the most important specifications of a frequency standard. Many of today's high performance signal generators, for example, have very low phase noise outputs. These signal generators have their own internal, low phase noise, crystal oscillator. However, if this type of instrument is used with an external frequency source, it is essential that the external frequency source has an equally low phase noise output as the internal oscillator. Otherwise the signal generators phase noise will be impaired. Of course it's not only signal generators that could suffer, but also any other type of instrument that relies on a low phase noise frequency source, to operate correctly.



The graph to the left shows the GPS10R phase noise (red trace) compared with three competitors (Yellow, Purple and Blue traces). As can be seen the GPS10R has lower phase noise than its competitors.

Also the GPS10R low phase option is shown in pink.

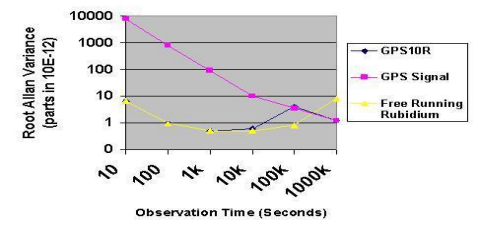
Competitor's specifications drawn from internet publications. GPS10R phase noise measured in the in-house Agilent phase noise test set.

Keyboard Control and LCD Display

A 16-way keyboard is used to interface to three microprocessors that control the GPS10R. The LCD display's over 50 different menus. These menus show all the relevant information including time, position (longitude, latitude, height), number of satellite tracked, health of each satellite and the status of the rubidium oscillator.

Allan Deviation Plot of the GPS10R and the GPS signal

The diagram below shows the Allan deviation of a typical GPS signal (pink), the Allan deviation of the GPS10R's rubidium oscillator when free running (not locked to the GPS signal) (yellow) and the actual output of the GPS10R when locked to the GPS signal (blue). As can be seen, the GPS10R combines the short-term stability of the rubidium oscillator with the long-term stability of the GPS signal to achieve short and long term stability of its frequency output signal.



Multiple Frequency Outputs

The GPS10R has many different output options. These outputs are:

- Buffered 10 MHz sinewave outputs. Each output is fully isolated from each other. The amplitude of each output can be individually adjusted from 0 dBm to +13 dBm. Reverse isolation of each output is 90 dB and channel to channel isolation is 45 dB. Five outputs as standard. Extra outputs can be obtained.

- Square wave output that can drive TTL levels into a 50 Ω load impedance. The frequency of the square wave can be set to 10, 5, 2, 1, 0.1 MHz and 1 pps via the front panel keyboard.

- Dual one pulse per second outputs. These 1 pps outputs are either derived from the GPS receiver, or from the rubidium receiver. The leading edge of the GPS 1 pps signal is aligned to UTC time ± 20 ns. The Rb 1 pps output signal has very low jitter of < 300 ps. These outputs can drive TTL levels into a 50 Ω load impedance.

- A slave 10 MHz output is available to connect more distribution amplifiers, such as the DA1-100-10 to the GPS10R. Thus it is possible to get multiple 10 MHz outputs that can be used to provide 10 MHz reference signals to an entire building or workshop, for example. Up to 1000 outputs can be realized.

- Optional high frequency outputs can be specified at the time of ordering. These fixed high frequency outputs can be as high at 10 GHz (higher frequencies available upon special request) and are phase locked to the main frequency reference. Note: this option only generates one fixed frequency.

- Optional DDS Output enables the GPS10R to produce a sinewave or squarewave output that is locked to the GPS10R. The frequency range of this output is 1 µHz to 80 MHz (1 µHz steps) or 10µHz to 1640 MHz (10 µHz steps). This option can be used to generate the popular 2048 kHz and 13 MHz frequencies as well as any frequency in the range 1 µHz to 80 MHz or 10 µHz to 1640 MHz.

- Optional Time Code Output. This option generates the industry standard IRIG-B, IRIG-E and ESE-TC90) time code formats. Also a 48 bit BCD time code can be generated with option 16.

Free Run Mode. Ideal for portable applications

The GPS10R is normally operated with the Rubidium oscillator's 10 MHz output, locked to the GPS satellite system. In the event of a failure of the GPS signal for any reason, the GPS10R will automatically switch over to free run mode. In this mode, the GPS10R's Rubidium Oscillator still achieves Stratum 1 performance over a 72 hour period.
Also the GPS10R can be used for portable applications where a satellite signal is not available, or the time required to lock the GPS10R is not available. When the GPS10R is powered up it can be set to the free run mode. The Rubidium Oscillator "remembers" the last known good frequency setting and adjusts itself to this frequency. Thus an accurate 10 MHz is available within a few minutes of switch on. This mode is ideal for setting up GSM base stations that require an accurate time base for frequency measurement.

RS232 and USB Interface

The RS232 interface allows complete control and interrogation of the GPS10R. An optional USB adapter allows the GPS10R to be controlled via the USB port of the PC.

Applications

Applications of the GPS10R include, but are not limited to, the following examples:

- Reference frequency source in a calibration or standards laboratory
- Portable frequency standard
- Calibration of GSM Base Station Clocks

- Reference Frequency and Time source for the electricity generating industry
- Synchronizing of telecommunication and computer networks
- Space Measurements.

High Quality of Construction

The GPS10R is made to the highest standards. A purpose built aluminum 19" rack mount case houses all the circuits inside the GPS10R. The GPS10R is CE marked for sale within the EEC.

Active Antenna Supplied as Standard

The GPS10R is supplied with an active antenna. This small unit can be easily fitted to buildings, roofs etc.

GPS10R Specifications

Description	Specification	Remarks
10 MHz Outputs		
Connector	Front & Rear panel BNC socket	
Frequency	10 MHz	
Accuracy	Refer to Allan Deviation section	
Signal Type / Amplitude	Sine wave @ 0 dBm to + 13 dBm	Internally adjustable
Harmonic Distortion / Spurious	-40 dBc / - 80 dBc	
Return Loss	> 20 dB @ 10 MHz	
Reverse Isolation	> 90 dB	
Channel to Channel Isolation	> 45 dB	
Squarewave Output		
Connector	Rear panel BNC socket	
Frequency	10, 5, 2, 1, 0.1 MHz and 1 pps	Selectable by keyboard
Accuracy	Refer to Allan Deviation section	
Signal Type	Square wave	
Amplitude (open circuit / 50 ohm)	0 to 5 V / 2.7 V , TTL Compatible	
1 PPS Outputs		
Connector	Rear panel BNC socket	
Frequency	1 pulse per second	
Signal Type	Pulse Output	
Amplitude (open circuit)	0 to 5 V, TTL Compatible	
Amplitude (50 ohm)	0 to > 2.5 V, TTL Compatible	
Accuracy to UTC time (GPS 1 pps output)	< 20 ns (6 sigma)	After cable delays taken into account
Jitter of Rubidium Osc. 1 pps output	< 300 ps	
Slave Output		
Connector	Rear panel BNC socket	
Frequency	10 MHz	
Accuracy	Refer to Allan Deviation section	
Signal Type	Sine wave	
Amplitude	> -10 dBm	Fixed level output
Harmonic Distortion	- 20 dBc	Typically -40 dBc
Allan Deviation when locked to GPS Satellites (typical)		
Observation Time 1 seconds	$< 2 \times 10^{-11}$	GPS10R in full lock for > 1 week. > 3 satellites in view. Ambient temperature 0 °C to +50 °C. Temperature change less than 3 °C per hour
Observation Time 10 seconds	$< 1 \times 10^{-11}$	
Observation Time 100 seconds	$< 3 \times 10^{-12}$	
Observation Time 1000 seconds	$< 1.5 \times 10^{-12}$	
Observation Time 10000 seconds	$< 6 \times 10^{-13}$	
Observation Time 100000 seconds	$< 7 \times 10^{-13}$	
Observation Time 1 week	$< 2 \times 10^{-13}$	

Rubidium Drift when GPS10R NOT Locked to GPS Satellites		
Drift due to aging	< 5 x 10^{-11} per month	After 30 days operation
Drift due to temperature	< 5 x 10^{-11}	0 °C to +50 °C
GPS Receiver		
Number of Channels	12 parallel	Simultaneous operation
Frequency	1575.42 MHz	L1 Frequency
Acquisition Time	< 50 s typical	With current position / time data.
Positioning Accuracy	< 25 m	1 sigma, pos hold mode
Jamming Immunity	-79 dBm @ 1575.42 MHz	Measured at active antenna input
Antenna	Active micro strip patch	Powered by GPS10R
Datum	WGS-84	
Miscellaneous		
Operating Temperature	0 °C to +50 °C	
Storage Temperature	-20 °C to +60°C	
Magnetic Field	< 2 x $10E^{-10}$ for 1 Gauss field reverse	
AC Power Inlet with switch	IEC320 power cord	Rear Panel
AC Voltage Range	115 VAC or 230 VAC ± 10%	
Power consumption	70 – 100 watts typ. (warm-up - operating)	Warm up period is < 10 minutes at +20 °C
Dimensions		
Width	303 mm	
Depth	370 mm	
Height	85 mm	
Weight	9 kg	
Supplied Accessories		
Antenna	Active type, 5V @ 20 mA	
Power cord	IEC320 type	
Instruction manual		
Option 05: DDS Generator Output		
Overall Frequency Range / Step Size	1 µHz to 80 MHz in 1 µHz steps	Usable to 90 MHz
Frequency Accuracy	± 300 µHz plus main 10 MHz error	Subject to jitter specification
Sinewave Frequency Range	10 kHz to 80 MHz	
Sinewave Output level	> 0 dBm into 50 Ω	
Spurious and Harmonic Output	-40 dBc and -20 dBc respectively	Option > +10 dBm available (opt 05A)
Squarewave Frequency Range	1 µHz to 50 MHz	
Squarewave Output Level	0V to 3V nominal into open circuit	Use 50 ohm termination above 1 MHz
Allan Deviation (100 second)	2.5 x 10^{-12}	> 0 dBm into 50 Ω (10 kHz – 80 MHz)
All other options		
Consult Precision Test Systems for further details of other options. Not all options can be fitted at the same time.		

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Full specifications available from www.ptsyst.com. Specifications and features subject to change without notice (101221)