



# GPS10RBN - 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 GPS10RBN via RS232
- 19" 2U high rack mountable case (GPS10RBN) or bench mount unit (GPS10R)
- Very Low Microphonics
- Many options. See list of options in this brochure.
- Custom built options available upon request
- High quality design

## General Description

The GPS10RBN 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 GPS10RBN achieves short and long-term frequency accuracy of parts in  $10^{-13}$ . Thus the GPS10RBN exceeds the requirements of a Stratum 1 level frequency standard.

Options for the GPS10RBN include 5, 10 or 15 isolated sinewave outputs, an antenna amplifier enabling the antenna to be placed up to 350 meters from the GPS10RBN, 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

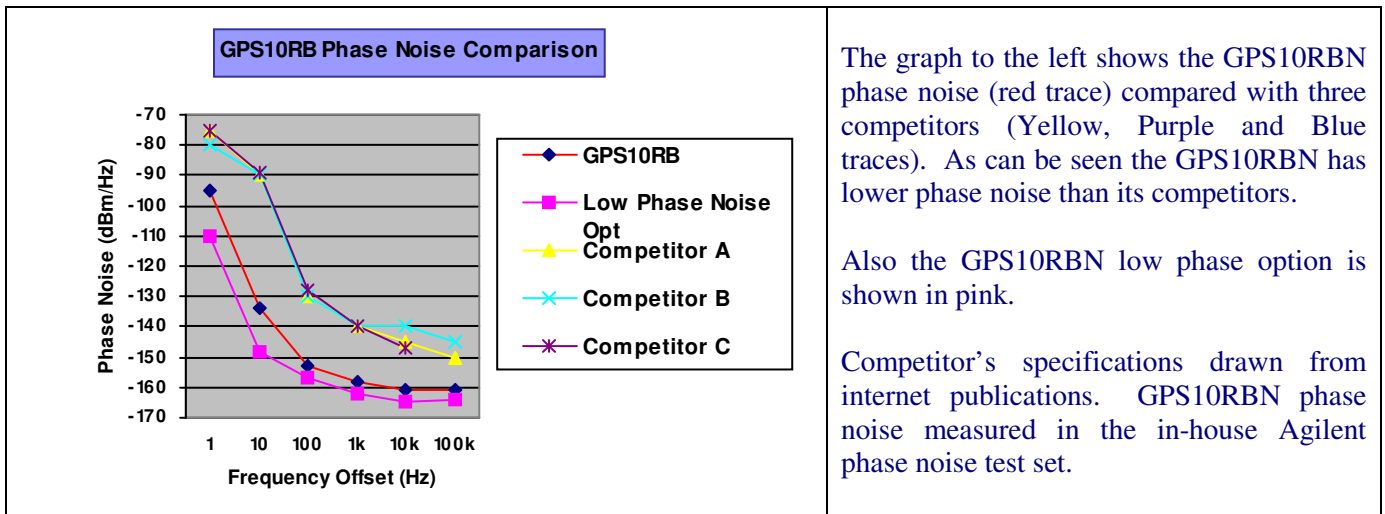
The GPS10RBN incorporates an atomic rubidium oscillator as the main frequency reference, but costs the same as some competitive units that use less accurate crystal oscillators. The rubidium used in the GPS10RBN is 30 times more stable than any OXCO available. Therefore the GPS10RBN achieves a frequency stability of typically  $7 \times 10^{-13}$  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 GPS10RBN 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 GPS10RBN 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.

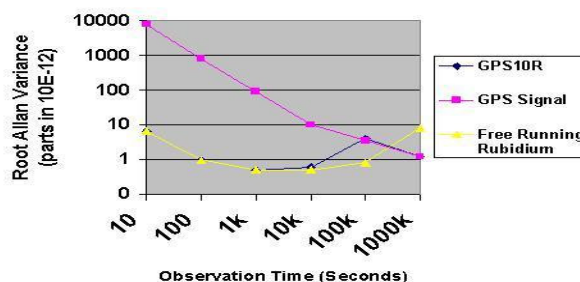


## Keyboard Control and LCD Display

A 16-way keyboard is used to interface to three microprocessors that control the GPS10RBN. 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 Variance Plot of the GPS10RBN and the GPS signal

The diagram below shows the Allan variance of a typical GPS signal (pink), the Allan variance of the GPS10RBN's rubidium oscillator when free running (not locked to the GPS signal) (yellow) and the actual output of the GPS10RBN when locked to the GPS signal (blue). As can be seen, the GPS10RBN 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 GPS10RBN 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 130 dB and channel to channel isolation is 90 dB. Five outputs as standard. Up to 15 outputs can be optionally installed. Optional output level to +20 dBm available.
- Optional square wave output that can drive TTL levels into a 50  $\Omega$  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  $\pm$  20 ns. The Rb 1 pps output signal has very low jitter of < 300 ps. These outputs can drive TTL levels into a 50  $\Omega$  load impedance.
- A slave 10 MHz output is available to connect more distribution amplifiers, such as the DA1-100-10 to the GPS10RBN. 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 as 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 GPS10RBN to produce a sinewave or squarewave output that is locked to the GPS10RBN. The frequency range of this output is 1  $\mu$ Hz to 80 MHz (1  $\mu$ Hz steps) or 10 $\mu$ Hz to 1640 MHz (10  $\mu$ Hz 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  $\mu$ Hz to 80 MHz or 10  $\mu$ Hz 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 GPS10RBN 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 GPS10RBN will automatically switch over to free run mode. In this mode, the GPS10RBN's Rubidium Oscillator still achieves Stratum 1 performance over a 72 hour period. Also the GPS10RBN can be used for portable applications where a satellite signal is not available, or the time required to lock the GPS10RBN is not available. When the GPS10RBN 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 GPS10RBN. An optional USB adapter allows the GPS10RBN to be controlled via the USB port of the PC.

## **Options**

The GPS10RBN has many options enabling it to work in varied applications. Not all options can be installed at the same time. Some options require a separate case. Some of the options are listed below:

### **Option 01: Second Frequency Output, 0 to 500 MHz spot frequency**

This option gives a second frequency output. The frequency is fixed and cannot be changed. The spot frequency must be advised by the customer prior to manufacture. The frequency can be in the range 0 to 500 MHz. For example, option 01A gives a 100 MHz output.

### **Option 02: Second Frequency Output, 500 to 1000 MHz spot frequency**

This option gives a second frequency output. The frequency is fixed and cannot be changed. The spot frequency must be advised by the customer prior to manufacture. The frequency can be in the range 500 to 1000 MHz.

### **Option 02A: Second Variable Frequency Output, 780 to 820 MHz**

This option gives a second frequency output. The frequency is variable and can be changed from 780 MHz to 820 MHz in 100 kHz steps. The frequency output has good phase noise and low spurious.

### **Option 03: Second Frequency Output, 1 GHz to 3.2 GHz spot frequency**

This option gives a second frequency output. The frequency is fixed and cannot be changed. The spot frequency must be advised by the customer prior to manufacture. The frequency can be in the range 1 GHz to 3.2 GHz.

### **Option 03A: Second Variable Frequency Output, 2.25 GHz to 2.65 GHz**

This option gives a second frequency output. The frequency is variable and can be changed from 2.25 GHz to 2.65 GHz in 100 kHz steps. The frequency output has good phase noise and low spurious.

### **Option 04: Antenna Amplifier**

The GPS35 is a GPS Antenna Amplifier. When used with low loss cable, antenna lengths of over 300 m (1000 feet) can be achieved, making installation in large buildings or basements possible.

### **Option 05, 05 and 05B: DDS Signal Generator**

Option 05 adds a DDS (direct digital synthesis) signal output to the GPS10RBN. The DDS output has a squarewave and sinewave output. The frequency of this output is adjustable from 1  $\mu$ Hz to 80 MHz in steps of 1  $\mu$ Hz. Thus this option can be used to generate the popular 2048 kHz and 13 MHz outputs often needed in Telecommunication systems. The DDS output is locked to the main 10 MHz rubidium frequency oscillator. Option 05A gives a higher output. Option 05B adds a Sine and Cosine outputs (in place of squarewave output).

### **Option 06: RS232 Cable**

The RS232 cable connects the GPS10RBN to a PC enabling control and interrogation of the GPS10RBN by the PC.

### **Option 07 and 07A: Alarm Relay Output**

This option adds a dual changeover relay that is activated in the event of an alarm. Each relay contact is rated at 30 VDC and 1 Amp. Option 07A increases relay current to 30 V at 5 amps.

### **Option 08: Redundancy**

Option 08 adds redundancy. With this option, two GPS10RBN's can be configured into a redundancy set-up with five main 10 MHz outputs (up to 15 outputs optionally available). Normally one unit will supply the 10 MHz outputs (locked to the GPS satellite). In the event of failure of this unit, the 10 MHz outputs will be automatically switched to the second GPS10RBN unit. The second GPS10RBN unit will then supply the 10 MHz outputs, locked to the GPS system. Even if both GPS antennas are disconnected, and one unit completely fails, there will still be a 10 MHz from the second unit running from the rubidium oscillator. Both units are identical; there is no master or slave. Simply, whatever unit is

healthy will supply the 10 MHz output. System status is available via the RS232 interface. This option is ideal for applications that require extra security. Extra 10 MHz outputs can be added if required.

### **Option 09: IRIG-B Output**

This option gives the industry standard IRIG-B or IRIG-E time code output. The output can be internally set to give an AM modulated signal or TTL output.

### **Option 11: Clock / Date Display Unit**

Option 11 provides a remote Clock / Date display. The display consists of a 6 digit 25 mm high digital LED display that can be read from a distance of 10 meters. The display can be located remotely from the GPS10RBN. The display requires a cable connection from the GPS10RBN although a wireless unit is available on special order.

### **Option 12: Additional sinewave outputs**

The GPS10RBN has five isolated 10 MHz sinewave outputs. Option 12 adds a further five making ten in total. Option 12C adds a further ten, making fifteen in total.

### **Option 12A: 10.23 MHz Outputs**

This option changes the five sinewave outputs to 10.23 MHz. A rear panel input connector allows the DDS option (option 05) to generate 10.230 MHz and be available on these five isolated outputs.

### **Option 13: Mute Sinewave Outputs in the event of an alarm**

This option disables all the sinewave outputs in the event of an alarm or error.

### **Option 14: Service manual**

The service manual has service information and realignment procedures.

### **Option 15: Windows Software**

This windows software operates on Windows XP. It allows all the main parameters of the GPS10RBN to be monitored and recorded by the PC.

### **Option 16: BCD Time Code Output**

This option gives a 48 bit BCD time code output. The time output is in the format HH:MM:SS.ssssss. The fractional seconds have a resolution of 100 ns. The output is updated every 100 ns and is accurate to UTC to within 200 ns.

### **Option 17: DDS Generator 0 to 400 MHz**

This option adds a DDS generator that can operate from 0 to 400 MHz in 0.1 Hz steps.

### **Option 18: Ethernet Port**

This option adds a Ethernet port. This allows the GPS10RBN to be controlled and monitored via an Ethernet network or internet.

### **Option 19: +24VDC Input**

This option allows the GPS10RBN to be externally powered by a +24 VDC supply at 5 amps. In the event of AC power being lost, the GPS10RBN will instantly switch over to the external +24 VDC supply (supply not included).



### **Option 20: 2.048 MHz G703:10 output**

This option gives the popular 2.048 MHz output. The output is a squarewave with amplitude of  $\pm 1.2$  V in 75  $\Omega$

### **Option 21: Lightning Protection**

This option adds lightning protection to the antenna input. The protection is placed close to the GPS antenna.

### **Option 22: 0 to 1640 MHz DDS Output**

This option adds a DDS output. The output can be set anywhere from 0 to 1640 MHz in 10  $\mu$ Hz steps.

### **Option 23: GSM Interface**

This option enables the GPS10RBN to send a SMS (short message service) or text to ten GSM mobile phones in the event of an error.

### **Option 24: Frequency Change to 5 MHz (also requires option 12 additional 5 outputs to be installed)**

This option changes all sinewave outputs to 5 MHz instead of 10 MHz. A 10 MHz output is still available.

### **Option 25: USB Adapter**

Allows GPS10RBN to be controlled from a USB port of a PC.

### **Option 26: Low Phase Noise Option**

This option gives a low phase noise output. Normally the frequency is 10 MHz, but any frequency from 1 to 100 MHz can be supplied. This output is phase locked to the main rubidium output.

### **Option 30: USB Adapter**

Squarewav Output. Gives a TTL output switchable in frequency to 10, 5, 2, 1, 0.1 MHz and 1 pps.

### **Applications**

Applications of the GPS10RBN 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 GPS10RBN is made to the highest standards. A purpose built aluminum 19" rack mount case houses all the circuits inside the GPS10RBN. The GPS10RBN is CE marked for sale within the EEC.

### **Active Antenna Supplied as Standard**

The GPS10RBN is supplied with an active antenna. This small unit can be easily fitted to buildings, roofs etc.

## GPS10RBN Specifications

The specifications for the GPS10RBN are shown below:

<b>Description</b>	<b>Specification</b>	<b>Remarks</b>
<b>10 MHz Outputs</b>		
Connector	Rear panel BNC socket	Internally adjustable
Frequency	10 MHz	
Accuracy	Refer to Allan Variance section	
Signal Type / Amplitude	Sine wave @ 0 dBm to + 13 dBm	
Harmonic Distortion / Spurious	-40 dBc / - 80 dBc	
Return Loss	> 20 dB @ 10 MHz	
Reverse Isolation	> 130 dB	
Channel to Channel Isolation	> 90 dB	
Phase Match of Outputs	< 500 ps within groups of five	
<b>Squarewave Output (Option 30 required)</b>		
Connector	Rear panel BNC socket	Selectable by keyboard
Frequency	10, 5, 2, 1, 0.1 MHz and 1 pps	
Accuracy	Refer to Allan Variance section	
Signal Type	Square wave	
Amplitude (open circuit / 50 ohm)	0 to 5 V / 2.7 V , TTL Compatible	
<b>1 PPS Outputs</b>		
Connector	Rear panel BNC socket	After cable delays taken into account
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)	
Jitter of Rubidium Osc. 1 pps output	< 300 ps	
<b>Slave Output</b>		
Connector	Rear panel BNC socket	Fixed level output Typically -40 dBc
Frequency	10 MHz	
Accuracy	Refer to Allan Variance section	
Signal Type	Sine wave	
Amplitude	> -10 dBm	
Harmonic Distortion	- 20 dBc	
<b>Phase Noise Response (Typical). 10 MHz Outputs</b>		
At 1 Hz Offset	-95 dBc/Hz	Optional to -110 dBc/Hz available Optional to -147 dBc/Hz available Optional to -157 dBc/Hz available Optional to -162 dBc/Hz available Optional to -164 dBc/Hz available
At 10 Hz Offset	-134 dBc/Hz	
At 100 Hz Offset	-153 dBc/Hz	
At 1 kHz Offset	-159 dBc/Hz	
At 10 kHz Offset	-161 dBc/Hz	
At 100 kHz Offset	-162 dBc/Hz	
At 1 MHz Offset	-165 dBc/Hz	
<b>Allan Variance when locked to GPS Satellites (typical)</b>		
Observation Time 1 seconds	< 2 x 10 <sup>-11</sup>	GPS10RBN 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 x 10 <sup>-11</sup>	
Observation Time 100 seconds	< 2 x 10 <sup>-12</sup>	
Observation Time 1000 seconds	< 7 x 10 <sup>-13</sup>	
Observation Time 10000 seconds	< 6 x 10 <sup>-13</sup>	
Observation Time 100000 seconds	< 7 x 10 <sup>-13</sup>	
Observation Time 1 week	< 2 x 10 <sup>-13</sup>	

<b>Rubidium Drift when GPS10RBN NOT Locked to GPS Satellites</b>			
Drift due to aging	< 5 x 10 <sup>-11</sup> per month	After 30 days operation	
Drift due to temperature	< 5 x 10 <sup>-11</sup>	0 °C to +50 °C	
<b>GPS Receiver</b>			
Number of Channels	12 parallel	Simultaneous operation	
Frequency	1575.42 MHz	L1 Frequency	
Acquisition Time	< 50 s typical	With current position / time data. No SA	
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 GPS10RBN	
Datum	WGS-84		
<b>Miscellaneous</b>			
Operating Temperature	0 °C to +50 °C	Rear Panel	
Storage Temperature	-20 °C to +60°C		
Magnetic Field	< 2 x 10E <sup>-10</sup> for 1 Gauss field reverse		
AC Power Inlet with switch	IEC320 power cord		
AC Voltage Range	100 - 240 VAC (usable 90-260 VAC)		
	100 watts max (warm up)		
Power consumption	70 watts typ (operating)		
Fuse rating	3.15A, 250 VAC slow blow type		
Dimensions			
Width	482.6 mm		
Depth	330 mm	Warm up period is < 10 minutes at +20 °C	
Height	88 mm		
Weight	7 kg		
Supplied Accessories			
Antenna	Active type, 5V @ 20 mA		
Power cord	IEC320 type		
Instruction manual			
<b>Option 05: DDS Generator Output</b>			
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 variance (100 second)	2.5 x 10 <sup>-12</sup>	> 0 dBm into 50 Ω (10 kHz – 80 MHz)	
<b>Output 09: IRIG Time Code Output</b>			
Output types	IRIG-B or IRIG-E or ESE TC-90	Internally selectable	
Mark – Space Ratio (IRIG-B)	3.3 to 1		
Output type (IRIG-B) / Impedance	TTL or AM. 2.7 V p-p / 600 Ω	Internally selectable	
<b>All other options</b>			
Consult Precision Test Systems for further details of other options. Not all options can be fitted at the same time.			

<b>Head Office - UK</b>	<b>South Africa</b>	<b>USA</b>
Precision Test Systems LTD 40 Holkham Avenue, South Woodham Ferrers Essex, CM3 7AU, England Tel: +44 (0) 845 052 0920 Fax: +44 (0) 1245 330030 Email: uksales@ptsyst.com Web: www.ptsyst.com	Precision Test Systems cc P.O Box 1344 Witkoppen, 2068 Gauteng South Africa Tel: +27 (0) 11 464 3778 Email: sasales@ptsyst.com Web: www.ptsyst.com	Precision Test Systems 14781 Memorial Dr, Suite # 981 Houston Texas, 77079, USA Tel: 1 888 876 4804 Fax: 1 760 923 6354 Email: usasales@ptsyst.com Web: www.ptsyst.com

Specifications and features subject to change without notice (090108)