	USERS GUIDE	NR2310D-O-G
	REVISION	M
	DATE	031021

NR2310D-OG

10 Channel GNSS Locked Frequency Reference with RS232, Display and optional Ethernet-SNMP

Contents

Summary

1.1 Summary of Configuration Options

A multi-channel reference for very demanding telecommunications, precision scientific research and calibration. The multi-use platform can be configured with several performance options:

1. A range of stability options.
2. High reliability (full redundancy is offered with the new NR2300 line).
3. Display and user interface.
4. Local and remote monitoring via RS232.
5. Ethernet port to allow remote monitoring and control

Safety

This product has been designed and manufactured to recognized safety standards and rules. The product is a sophisticated electronic instrument that should be installed and operated by highly trained professionals.

Installation of this equipment should comply with all local electrical codes.

Utilization of this equipment in a manner inconsistent with the operating instructions can be dangerous.

DANGER

There are no user serviceable parts within the unit. Removal of the cover to access interior parts will expose the user to dangerous voltages.

DANGER

The unit may be powered from more than one power source. Care must be taken to be certain all power sources are removed before installation or during removal of the equipment.

DANGER

The unit must be operated with a secure earth ground to the chassis. The electrical path for earth ground is through the power connector. The power switching device that controls power to the equipment must never interrupt the chassis ground connection.

The equipment contains complex electronic components that can be damaged by electrostatic discharge. Observe all recognize standards for the handling of complex electronic devices to avoid high voltage discharge to the equipment. Be certain the equipment chassis and operator are at equipotential before handling the equipment.

Mounting

The equipment is meant to operate in a horizontal - top up configuration.

The equipment is meant to mounted into a 19 inch standard NEMA cabinet. The unit occupies a single “1ru”. Mounting spaces above and below the equipment may be used as required.

Please observe the operating temperature range for the equipment. If mounted into a closed rack, be certain that the total heat load in the cabinet does result in an interior operating temperature that exceeds the equipment maximum rated temperature.

If cooling must be used, care should be given to prevent cooling mechanical vibration from the coupling into the equipment. Mechanical shock and vibration may introduce noise into the electronic signals inside the equipment that may degrade the performance of the equipment. For applications where there is significant shock and vibration, Novus offers equipment with interior mechanical design features to minimize the effects of vibration and shock on the equipment performance.

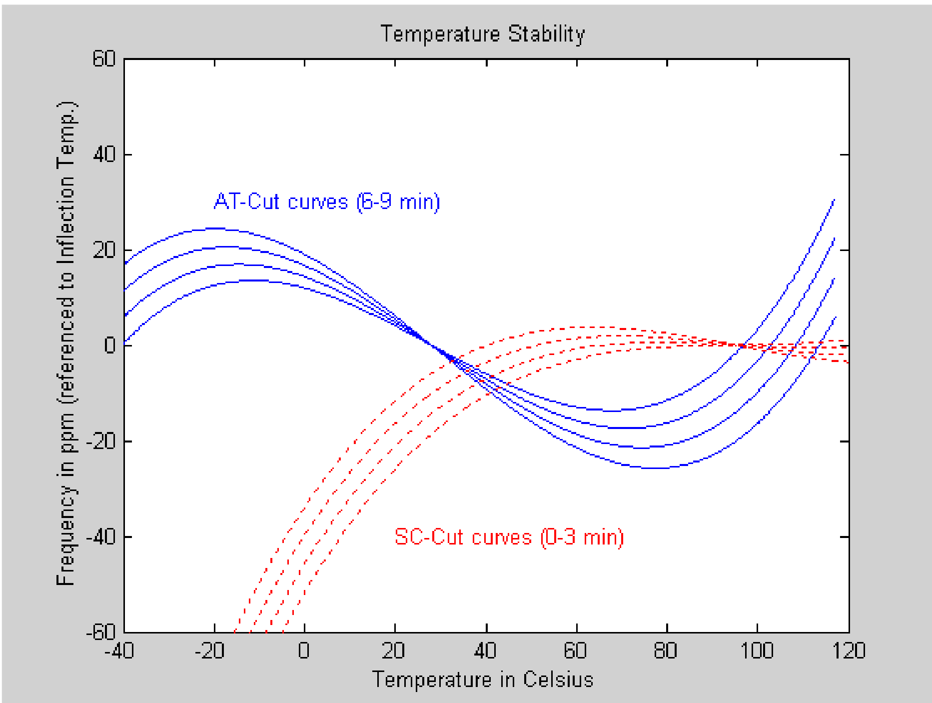
The Time Base

Novus crystal-based frequency reference products are based upon either TCXO or OCXO technology. Temperature compensated crystal oscillators will normally use an AT cut crystal and electronically compensate the device with temperature. An OCXO device uses a SC (stress compensated) crystal and the part is held at a fixed temperature to minimize temperature drift.

Temperature Compensated Crystal Oscillator (TCXO)

The TCXO implementation results in a temperature stable reference in the single digit parts per million.

Comparison of AT vs SC Cut Crystal



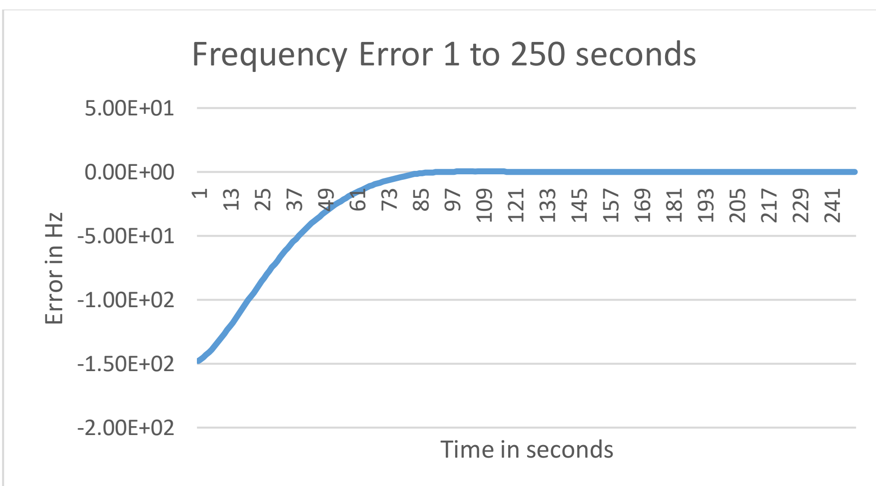
Over a broad temperature range, an AT cut crystal performs very well and much easier to compensate electronically. It is also a simpler crystal to manufacture than a SC cut device. For applications where a stability of a few ppm is acceptable, a TCXO can be a cost-effective alternative.

The SC cut results in a much higher Q device and achieves much lower phase noise than the AT cut. The device is also more sensitive to pressure and temperature variation and is therefore mounted in a temperature-controlled hermetic chamber.

Oven-Controlled Crystal Oscillator

An OCXO device affords a reference that is almost two orders of magnitude more stable than the TCXO. OCXO oven temperature is in the range of 90°C. The devices heat-up and become stable within ~ 5 minutes.

OCXO Frequency Error from Cold Start



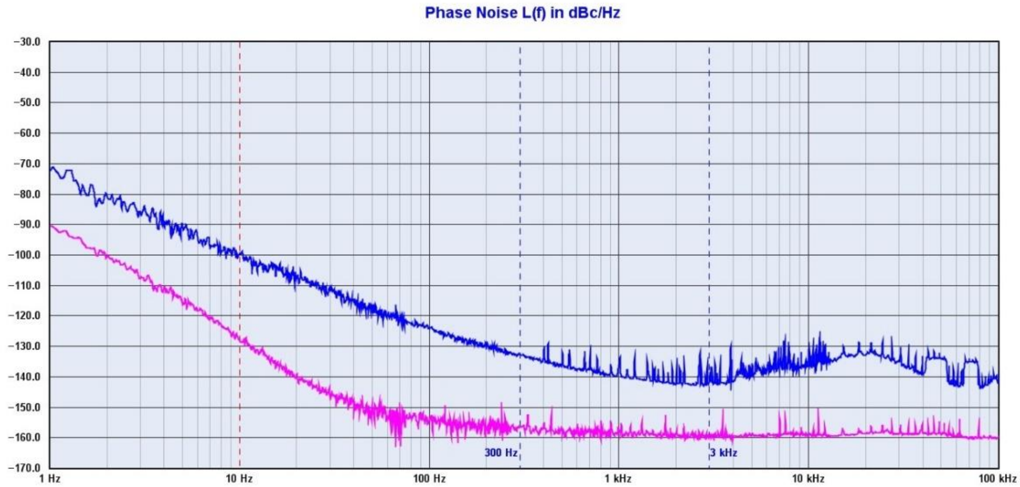
Typical OCXO

Atomic Oscillator

Another type of time base is an atomic reference. These devices use a change in atomic state of an isotope of Cesium or Rubidium for stability. Instead of a stability of ±50 ppb/year for a typical OCXO - stability of ±1 ppb/year is very common.

Atomic sources are very complex and while a very stable source, phase noise performance may not be acceptable for many applications.

RUBIDIUM SOURCE TYPICAL PHASE NOISE PERFORMANCE



Trace	Notes	Input Freq	Input Amplitude	dBc/Hz at 10 Hz	RMS Noise (degs)	RMS Jitter	Duration	Acquired
NR8403-R		10.000 MHz	7.3 dBm	−99.6	4.81E−4	1.3E−13 s	3m 0s	180 pts
NR8403-RO		10.000 MHz	8.1 dBm	−128.0	4.98E−5	1.4E−14 s	10m 0s	600 pts

For applications requiring the stability of an atomic source but also requiring low phase noise, a low phase noise OCXO is disciplined to an atomic source. The phase noise for the NR2110-R/O has phase noise improved by well over 20 dB by this technique.

GNSS/GPS Disciplined Oscillator (GPSDO)

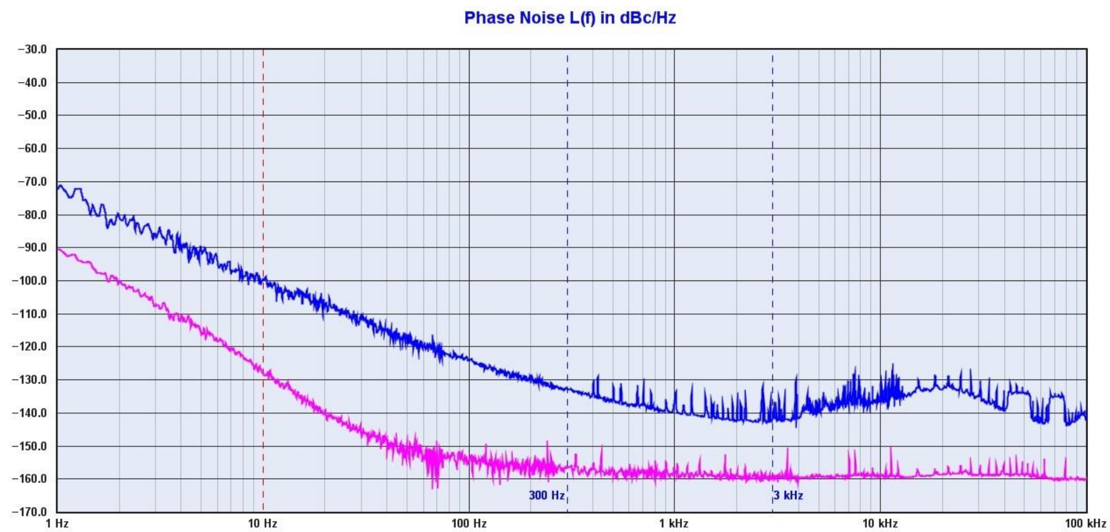
Novus offers four levels of GNSS locked reference performance:

HS1 Digital loop using basic radio
HS2 Digital loop, basic radio, adding picosecond timing
HS3 Digital loop, Gaussian radio, picosecond timing and thermal stabilization, Allan Deviation
HS4 Digital loop, Gaussian radio, picosecond timing, thermal stabilization, Allan Deviation, and vibration isolation.

Method	Option	GNSS Locked PLL	Pulse Stabilization	Temperature Control	ADEV (1s)	ADEV (100s)	ADEV (1ks)	ADEV(100ks)
Analog Loop PLL	Standard	✔			3.00E-10	5.00E-10	8.00E-12	
Digital Loop PLL	HS1	✔			3.00E-12	2.00E-11	5.00E-12	5.00E-12
	HS2	✔	✔		3.00E-12	1.00E-11	4.00E-12	9.00E-13
	HS3	✔	✔	✔	3.00E-12	7.00E-12	4.00E-12	7.00E-14

Novus offers a range of locked reference performance options. Timing information from the GNSS is very much a function of the receiver used, the processing of the received timing information and how the timing source- be it an OCXO- Rubidium or some other device- is controlled. Environmental factors such as temperature, shock and vibration all impact the overall system. Over the years, Novus has invested heavily in the design of locked references and can offer four levels of GNSS locking performance. Each level of performance is discussed in what follows to allow the system designer to determine the level of performance required versus system cost constraints.

The heart of the system is the reference. Novus offers OCXO and Rubidium based references. Because of the relatively poor phase noise performance of Rubidium many of our customers select a Rubidium with a cleanup OCXO to achieve high stability and low phase noise. Below is a plot of the phase noise of a Rubidium reference and a Rubidium reference followed by a clean-up OCXO



Trace	Notes	Input Freq	Input Amplitude	dBc/Hz at 10 Hz	RMS Noise (degs)	RMS Jitter	Duration	Acquired
NR8403-R		10.000 MHz	7.3 dBm	−99.6	4.81E−4	1.3E−13 s	3m 0s	180 pts
NR8403-RO		10.000 MHz	8.1 dBm	−128.0	4.98E−5	1.4E−14 s	10m 0s	600 pts

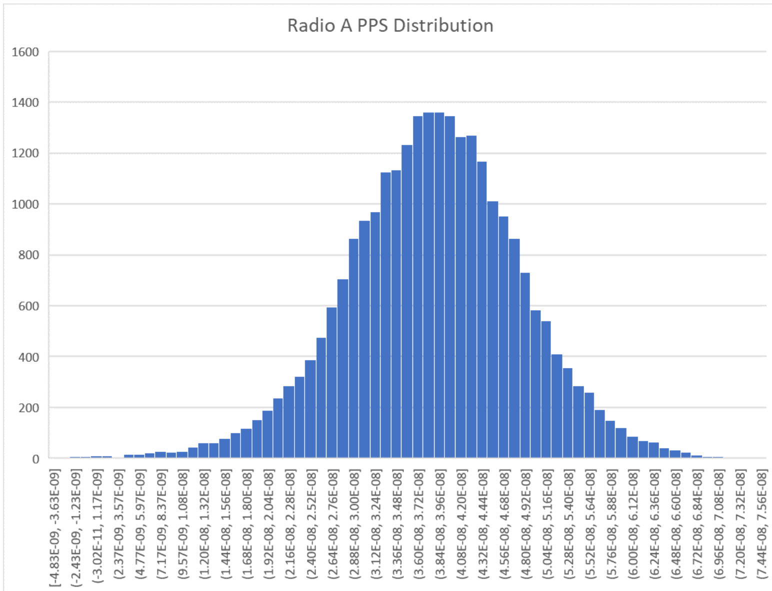
Our Rubidium references offer a stability of < 1 ppb/year.

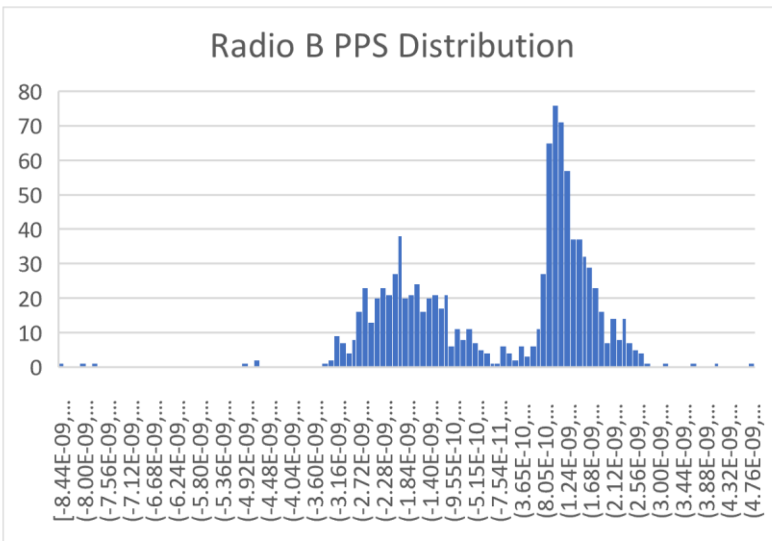
Novus uses several vendors for the OCXO. The OCXO selected based on required phase noise, stability, and cost. There are other secondary considerations such as size, power consumption etc.

Disciplining a reference, a 10 MHz timing signal to a master reference with all the noise due to atmospheric conditions, multipath and doppler effects is a tremendous challenge.

There are likely hundreds of GNSS receivers available with a range of functionality. Novus uses a few that are selected to meet the needs of our reference and PPS (pulse per second) sources. PPS stability and accuracy varies with each radio and cost rises with performance.

A significant part of the problem is the PPS being generated by the radio. No two radio designs are the same and the algorithms that generate the PPS vary widely. Below are two histograms for two different radios and their PPS performance. One is Gaussian and the other is not. Also, the spectral content of the PPS can vary greatly- often with low frequency content that adds to the close in phase noise of the reference.

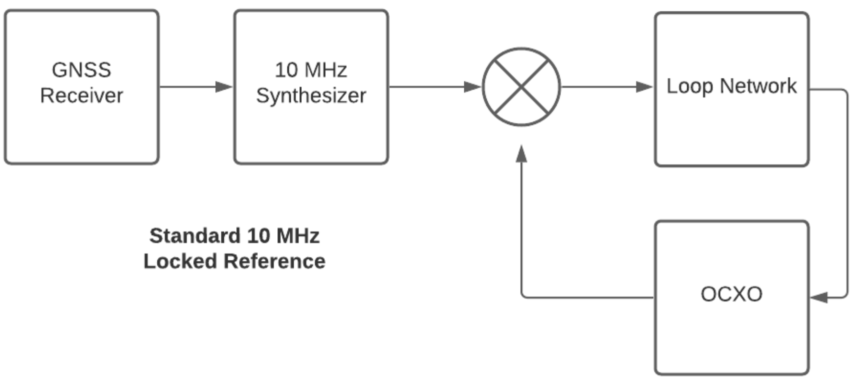




Depending upon the locking algorithm, the radio PPS variation can contribute directly to phase noise and uncertainty.

Standard GNSS locked Reference (HS1)

In the case of a basic reference, which is acceptable for many applications, the OCXO is controlled using a loop as indicated below:



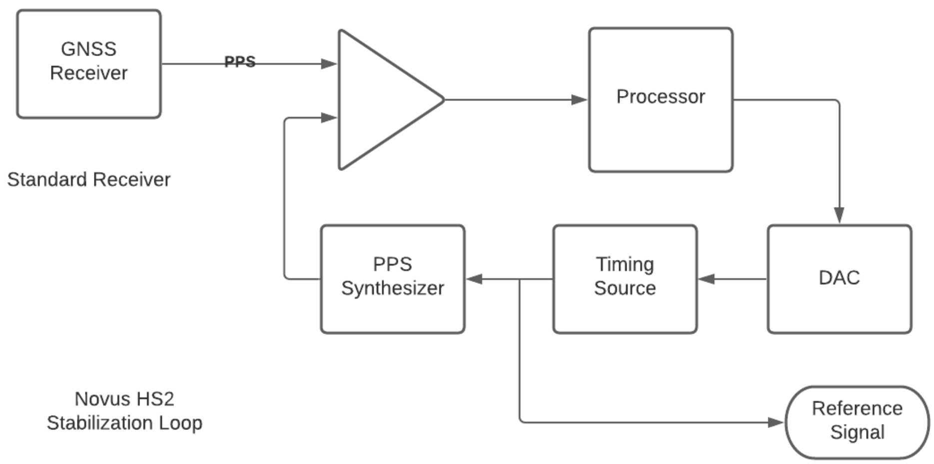
The standard loop does an outstanding job of controlling an OCXO. Components such as GaAs mixers provide excellent phase measurement performance, but close-in phase noise is difficult due to the size of the filtering components required and attendant leakage currents which are limited by the mixer drive currents.

Typical Allan Deviation performance for a standard loop is:

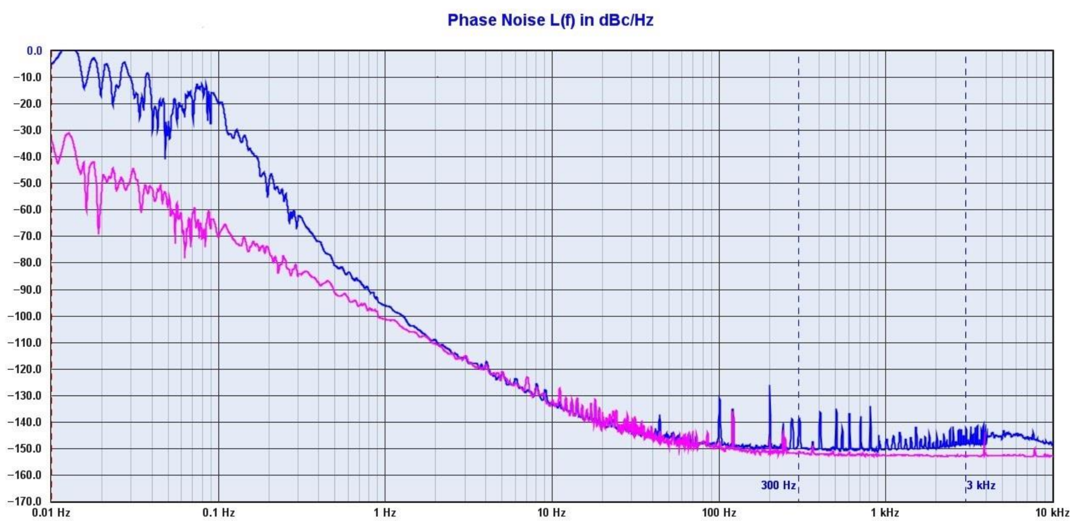
Trace	Input Freq	Input Amplitude	ADEV at 2000s	RMS Jitter (300 Hz-3 kHz)	Duration	Acquired	Instrument
NR3620-	10.000 MHz	13.8 dBm	5.36E−12	5.0E−14 s	2h 27m 41s	88612 pts	TimePod 5330A

Basic Digital Locking Loop(HS2)

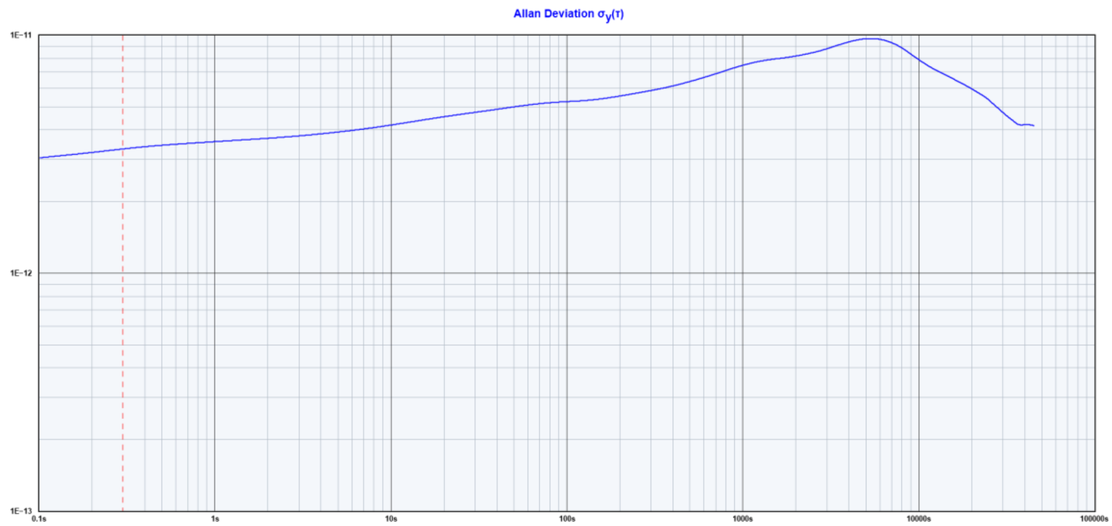
The analog loop is acceptable for many applications, the devices within the loop present barriers that are difficult to overcome. Achieving very long time constants requires larger and larger capacitors which present leakage current issues. A digital platform allows time constants that are unconstrained by a device and more flexibility to handle control loop performance.



The HS2 improves Allan Deviation by an order of magnitude and close-in phase noise by 10 dB.



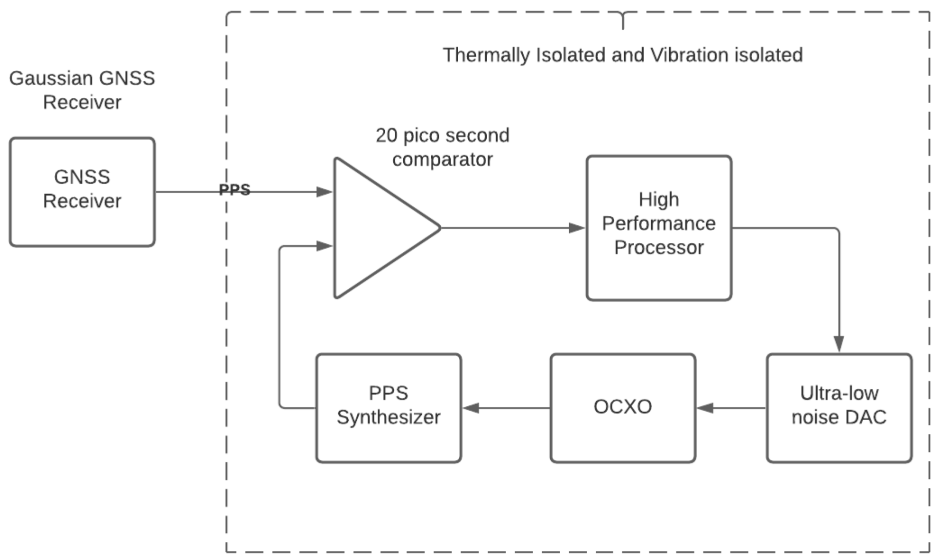
Trace	Input Freq	Input Amplitude	dBc/Hz at 0.01 Hz	RMS Jitter	Duration	Acquired	Instrument
NR3620 (Unsaved)	10.000 MHz	12.7 dBm	−4.9	5.2E−14 s	28m 41s	17214 pts	TimePod 5330A
NR6720--HS (Unsaved)	10.000 MHz	6.9 dBm	−33.7	2.8E−14 s	30m 0s	18000 pts	TimePod 5330A

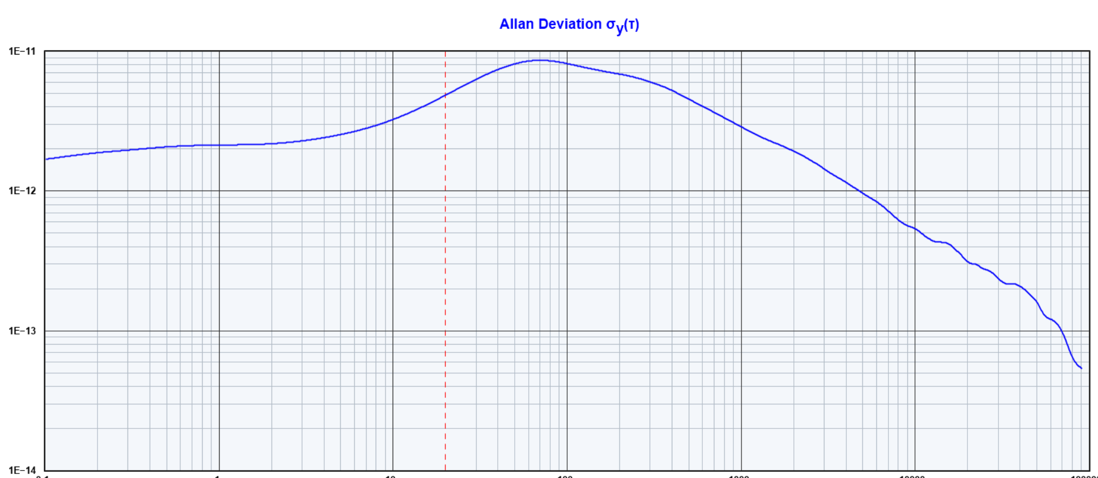


Trace	Notes	Input Freq	Sample Interval	ADEV at 0.3s	RMS Noise (degs, 300 Hz-3 kHz)	RMS Jitter (300 Hz-3 kHz)	Duration	Elapsed	Acquired	Instrument
NR6720-vs-NR6720		10.000 MHz	0.100 s	3.34E−12	1.58E−4	4.4E−14 s	2d 6h 0m 0s	2d 6h 0m 0s	1944000 pts	TimePod 5330A

Advanced GNSS Locked Reference (HS3)

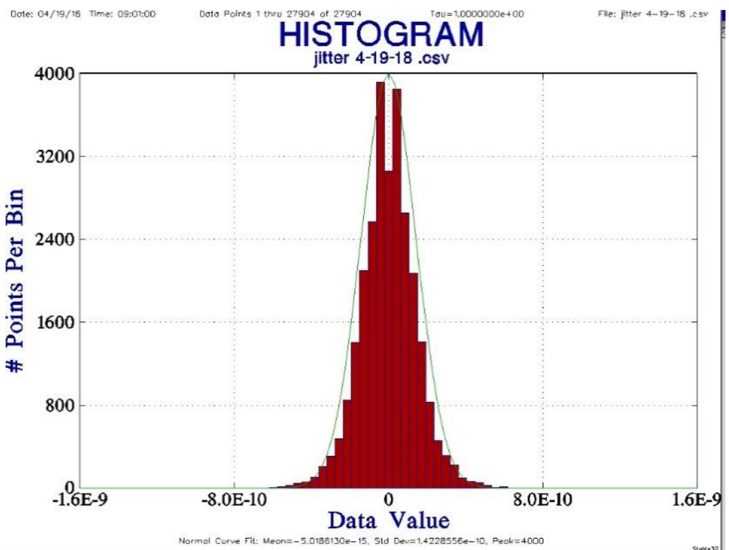
Our most advanced designs address long time constants digitally. High performance picosecond measurement techniques provide greater timing resolution, advanced algorithms coupled precise analog designs that are thermally controlled, and vibration isolated allow Allan Deviation performance approaching E-14. Performance over a standard loop is improved by almost two orders of magnitude.





Trace	Notes	Input Freq	Sample Interval	ADEV at 20s	RMS Noise (degs, 300 Hz-3 kHz)	RMS Jitter (300 Hz-3 kHz)	Duration	Elapsed	Acquired	Instrument
PCB78		10.0 MHz	0.100 s	4.93E−12	5.59E−5	1.6E−14 s	4d 14h 56m 50s	4d 14h 56m 50s	3994098 pts	Microchip 53100A

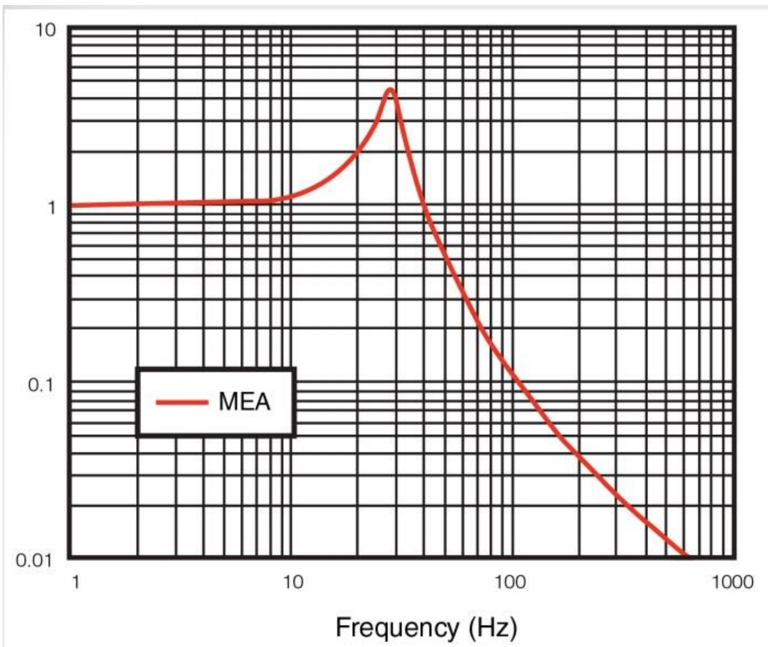
Our algorithms process the radio information to achieve a more stable reference. The curve below is a plot of timing jitter after processing:



The standard deviation improved from 17 ns to approximately 400 pico seconds. The most advanced loop reports calculated Allan Deviation on real time basis locally on a display and/or a selected comm port. Allan Deviation can also be set up as an alert such that if there is a defined variation from the base line Allan Deviation, an error will be reported. This level of monitoring will quickly detect a reference variation far in advance of a complete failure avoiding system outages. No one in the industry -that we are aware of- provides this level of monitoring.

Environmentally Isolated Reference (HS4)

To further enhance performance Novus offers thermal and vibration isolation. The thermally isolated unit adds a thermal plate held at a fixed temperature and an additional case around the reference to provide insulation. The vibration option adds vibration isolators to attenuate shock and vibration coming from the environment. Below is an attenuation curve for the option.



Dual-Time Base Frequency Verification (option)

GNSS locked references find application in laboratories where the integrity of the source must be beyond question. With a GNSS locked source, there could be a source malfunction that could cause the source to be in error. To be able to detect a problem, the dual-time base literally adds a second GNSS receiver and an embedded frequency counter to measure the accuracy of the primary reference. In some applications, a second antenna is installed, or a splitter can be used to drive both time-base references from a single antenna.

The average frequency of each gate can be monitored at this screen, allowing the user to see the most recent sample from the 1, 10, and 100 second gate.

GNSS Receiver (HS1,HS2 and Dual Time Base)

The 26 channel GNSS receiver and companion elements generate the GNSS PPS and NMEA serial link. The serial link conforms to NMEA 0183 protocol.

GPS, GLONASS, QZSS, SBAS, Active Anti-Jamming and Advanced Multipath Mitigation Functions.

Supports concurrent GPS, GLONASS, SBAS and QZSS. Galileo Ready.

Sensitivity

GPS
Tracking: -161 dBm
Hot Start: -161 dBm
Warm Start: -147 dBm
Cold Start: -147 dBm
Reacquisition: -161 dBm

GLONASS
Tracking: -157 dBm
Hot Start: -157 dBm
Warm Start: -143 dBm
Cold Start: -143 dBm
Reacquisition: -157 dBm

TTFF (Time to First Fix)

Hot Start: <5 sec (@-130 dBm)
Warm Start: 35 sec (@-130 dBm)
Cold Start: 40 sec (@-130 dBm)

- Active Anti-Jamming
- Advanced Multipath Mitigation

The receiver needs at least four satellite vehicles (SVs) visible to obtain an accurate 3-D position fix. When travelling in a valley, or built-up area, or under heavy tree cover, you will experience difficulty acquiring and maintaining a coherent satellite lock. Complete satellite lock may be lost, or only enough satellites (3) tracked to be able to compute a 2-D position fix, or a poor 3D fix due to insufficient satellite geometry (i.e. poor DOP). It may not be possible to update a position fix inside a building or beneath a bridge. The receiver can operate in 2-D mode if it goes down to seeing only three satellites by assuming its height remains constant. But this assumption can lead to very large errors, especially when a change in height does occur. A 2-D position fix is not considered a good or accurate fix; it is simply “better than nothing”.

The receiver’s antenna must have a clear view of the sky to acquire satellite lock. Remember, it is the location of the antenna that will be given as the position fix. If the antenna is mounted on a vehicle, survey pole, or backpack, allowance for this must be made when using the solution. The GNSS receiver provides power for the LNA in the antenna. The unit was designed to provide 3.5 Vdc < 40 mA of current.

To measure the range from the satellite to the receiver, two criteria are required: signal transmission time and signal reception time. All GPS satellites have several atomic clocks that keep precise time and are used to time-tag the message (i.e. code the transmission time onto the signal) and to control the transmission sequence of the coded signal. The receiver has an internal clock to precisely identify the arrival time of the signal. Transit speed of the signal is a known constant (the speed of light), therefore: time x speed of light = distance.

Once the receiver calculates the range to a satellite, it knows that it lies somewhere on an imaginary sphere whose radius is equal to this range. If a second satellite is then found, a second sphere can again be calculated from this range information. The receiver will now know that it lies somewhere on the circle of points produced where these two spheres intersect.

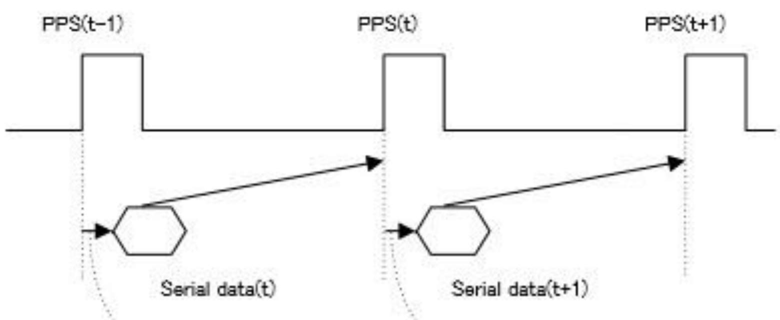
When a third satellite is detected and a range determined, a third sphere intersects the area formed by the other two. This intersection occurs at just two points. A fourth satellite is then used to synchronize the receiver clock to the satellite clocks.

In practice, just four satellite measurements are sufficient for the receiver to determine a position, as one of the two points will be totally unreasonable (possibly many kilometers out into space). This assumes the satellite and receiver timing to be identical. In reality, when the receiver compares the incoming signal with its own internal copy of the code and clock, the two will no longer be synchronized. Timing error in the satellite clocks, the receiver, and other anomalies mean that the measurement of the signal transit time is in error. This, effectively, is a constant for all satellites since each measurement is made simultaneously on parallel tracking channels. Because of this, the resulting ranges calculated are known as “pseudo-ranges”.

To overcome these errors, the receiver then matches or “skews” its own code to become synchronous with the satellite signal. This is repeated for all satellites in turn, thus measuring the relative transit times of individual signals. By accurately knowing all satellite positions and measuring the signal transit times, the user’s position can be accurately determined.

PPS

The PPS (one Pulse Per Second) relationship with the NMEA data is shown below:



The serial data timing is for the next rising edge of the PPS pulse.

There are a number of attributes for the PPS that can be controlled via the RS232 port with the radio. However when the Rubidium option is chosen, the PPS generated by the Rubidium is used and can’t be programmed.

PPS Availability

There is a TCXO that is used to maintain the PPS in the event of GNSS loss. The radio can be programmed to either have the PPS stop when GNSS lock occurs or continue with the stability of the internal TCXO. The TCXO has a stability shown below.

Electric characteristics	Condition	Description	Unit	Notes
frequency stability vs. Temperature	-30 to +85°C	Max. +/-0.5	ppm	Reference temperature: +25+/-2°C
	-40 to -30°C	Max. +/-2.0	ppm	
Frequency stability vs. Power supply	+1.8 V +10/-5%	Max. +/- 0.2	ppm	
Frequency stability vs. Load	(5.19 kΩ // 6.21 pF) +/-10 %	Max. +/- 0.2	ppm	
Frequency tolerance	+25+/-2 °C, # of reflow:4	Max. +/-2.0	ppm	Reference frequency: Standard
Frequency stability vs. Aging	One year	Max. +/-1.0	ppm	
	Five years	Max. +/-3.0	ppm	
	Ten years	Max. +/-5.0	ppm	
Waveform symmetry	DC Decupling	50 +/-10	%	Reference: Ground
Harmonic distortion		Max. -5	dBc	
Short term stability	τ=50 to 200ms	Max. 0.5	ppb	Reference: Allan variance

For applications requiring a more stable PPS – a source such as an OCXO or atomic reference should be considered. The PPS can also be enabled or disabled based upon a calculated accuracy.

Cable Delays

The unit can be programmed to compensate for PPS errors due to cable length. A compensation factor of +/-100000 ns can be used.

Pulse Width

The pulse width can be programmed from 1 to 500ms.

Factory Default Settings

PPS on when estimated accuracy is within 1 usec.
Pulse width is 200ms.

Num	Contents	Range	Default	Remark
1	PPS	-	-	Command Name
2	type	LEGACY GCLK	LEGACY	PPS type
3	mode	0 to 4	4	PPS mode 0: Always stop 1: Always output 2: Output only during positioning more than one satellite 3: Output only when TRAIM is OK 4: Output only when estimated accuracy is less than estimated accuracy threshold which is 8th field on this command.
4	period	0 to 1	0	PPS output interval 0: 1PPS (A pulse is output per second) 1: PP2S (A pulse is output per two seconds)
5	pulse width	1 to 500	200	PPS pulse width (ms)
6	cable delay	-100000 to 100000	0	PPS cable delay (ns) Plus brings delay PPS. Minus brings forward PPS.
7	polarity	0 to 1	0	PPS polarity (LEGACY PPS is rising edge only) 0 : rising edge 1 : falling edge
8	PPS accuracy threshold	5 to 9999	1000	PPS estimated accuracy threshold This threshold is used for mode 4. ⚠4

Output Drive

Connecting a PPS to a load is problematic at best. Connecting a 10 MHz sine to many devices is routine and the understanding of matching load and cable impedances is well understood. The problems arise when connecting a PPS to a load in the same manner as a simple sine wave. A CMOS device will not drive a 50 Ohm load to required voltage levels. A PPS pulse with a rise and fall time of 5 ns is a much greater problem for a cable than a simple sine wave at 10 MHz. The 5ns edge requires almost an order of magnitude more bandwidth than a 10 MHz signal even though most consider the PPS to be a 1 Hz signal.

Novus PPS drive is configurable at the factory for 5 or 3.3 VDC CMOS logic levels with drive capability to handle up to a 50 ohm load. The PPS drive must be established at the time ordering.

PPS Accuracy

15ns(1σ) (@-130 dBm)
50ns(1σ) (@-150 dBm)

The nominal accuracy of a PPS signal that is directly from the radio is on the order of 25 ns rms. The signal will also have ~5 ns of jitter. The jitter is due to the characteristics of the transmission channel - multi-path and other radio effects. The long-term accuracy of the PPS is excellent. There are numerous reference documents produced by NIST that define accuracy.

For those applications where the 5 ns of jitter is unacceptable, there is a more stable source. To solve the jitter problem, a stable oscillator is locked to the PPS and the output of the oscillator is then counted down to 1 Hz to have jitter level that is dominated by the oscillator and associated electronics. Normally, a Kalman Filter is used to discipline the oscillator and the resulting performance is a function of the design and the quality of the oscillator. PPS jitter can be improved from the 5 ns range to less than 250 ps.

The PPS source is software selectable to be the GNSS radio source or the Synthesized PPS.

PPS Holdover

PPS holdover is concerned with the stability of the PPS when GNSS lock is lost. The circuitry discussed to improve jitter also improves holdover. If the oscillator is an OCXO - then a PPS drift of 5 to 10 ppb/day is achievable (< 1ms). A Rubidium source can be used to achieve drift rate well over an order of magnitude better than the OCXO.

NMEA - RS232

The serial NMEA data is provided on the DB9 connector.

The baud rate for the NMEA port is selectable. Communication speed can be changed into 4800, 9600, 19200, 38400, 57600 or 115200 bps. In case of using low baud rate, please adjust size of output sentence by NMEAOUT command and CROUT command to output all sentence within one second.

Format:

$PERDCFG	,	UART1	,	baud	*hh	<CR>	<LF>
		1		2			

Num	Contents	Range	Default	Remark
1	UART1	-	-	Command Name
2	baud	4800, 9600, 19200, 38400, 57600 or 115200	38400	Baud rate (bps)

Example:
$PERDCFG,UART1,115200*65
Baud rate: 115200 bps

What information is sent from the radio and how often, can be selected. The NMEA sentence format:

Format:

$	<address field>	,	<data field>	...	*<checksum field>	<CR>	<LF>

5 bytes

Field	Description
$	Start-of Sentence marker
<address field>	5-byte fixed length. First 2 bytes represent a talker ID, and the remaining 3 bytes do a sentence formatter. All output sentences must begin with a "$" followed by a TalkerID. The relevant Talker IDs are GP for GPS, GN for GNSS, GL for GLONASS and GA for Galileo. For the sentences received from external equipment, the GT-87 accepts any talker ID. Talker ID "XX" found on the succeeding pages is a wildcard meaning "any valid talker ID".
<data field>	Variable or fixed-length fields preceded by delimiter ","(comma). Comma(s) are required even when valid field data are not available i.e. null fields. Ex. ",,,,," In a numeric field with fixed field length, fill unused leading digits with zeroes.
*<checksum field>	8 bits data between "$" and "*" (excluding "$" and "*") are XORed, and the resultant value is converted to 2bytes of hexadecimal letters. Note that two hexadecimal letters must be preceded by "*", and delimiter "," is not required before *<checksum>. All output sentences have checksum. For input sentences, the resultant value is checked and if it is not correct, the sentence is treated invalid.
<CR><LF>	End-of-Sentence marker

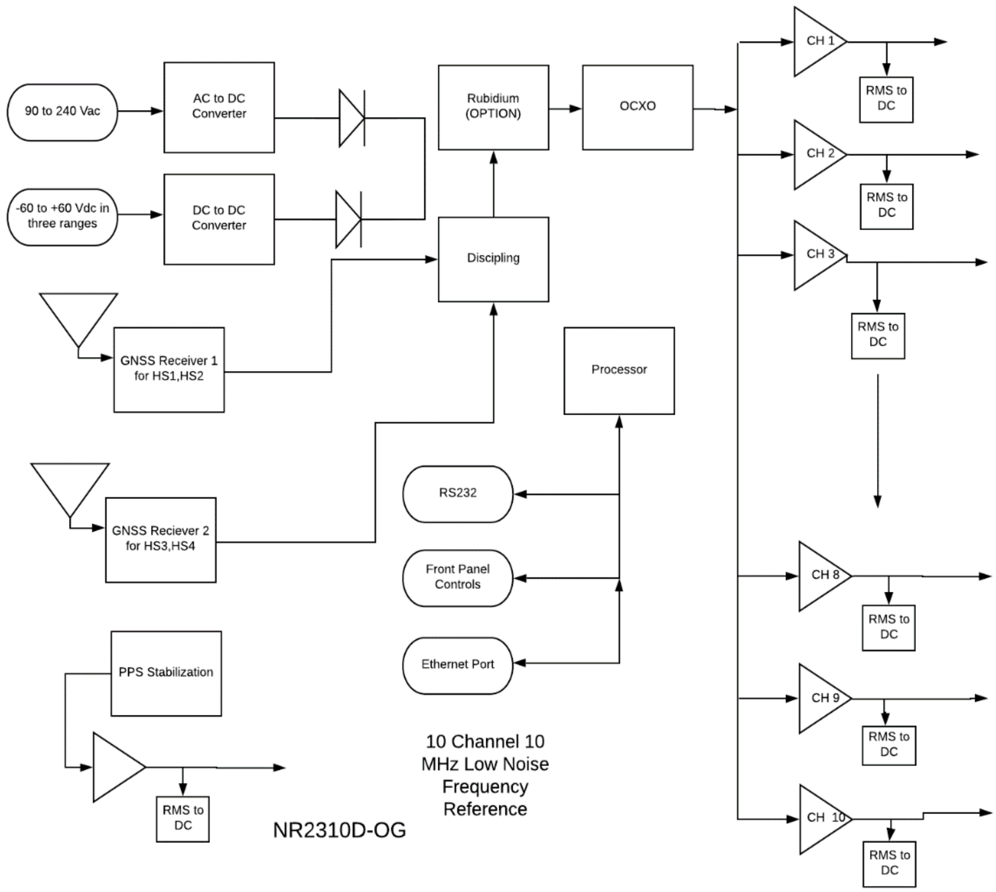
The receiver supports eight standard NMEA output sentences (GGA, GLL, GNS, GSA, GSV, RMC, VTG and ZDA) per NMEA standard 0183 Version 4.10 (June, 2012). By default, the RMC, GNS, GSA, ZDA, GSV and TPS sentences will be output every second. The sentences can be independently enabled and disabled using the $PERDCFG,NMEAOUT and/or $PERDAPI,CROUT command described later in this document, as well as using differing transmission rates.

The NMEA sentence descriptions throughout the document are for reference only. The sentence formats are defined exclusively by the copyrighted document from NMEA.

There is considerable detail available from the Novus website download page:

Receiver Control Information.

Base Unit Block Diagram



There is built-in test circuitry throughout the design. Power supplies, signal present are monitored and are used to drive a status relay as well as indicators on the front panel and optional serial and Internet communications paths.

To further improve long-term stability, the unit is disciplined to the GPS/GNSS by either having an internal GNSS receiver or supplying the unit a PPS pulse from an external receiver (option).

The unit display allows local monitoring and remote monitoring via an RS232 serial link or ethernet port.

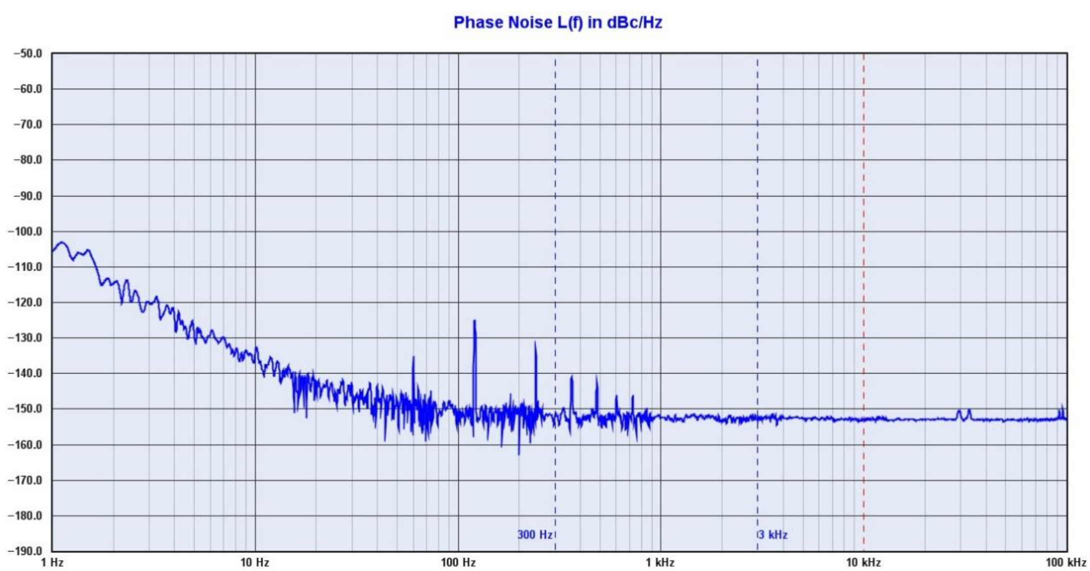
The ten-channel amplifier is designed for ultra-low noise to preserve the low noise performance of the reference. This multi-channel design frequently results in the elimination of a system distribution amplifier and consequently lower system noise performance while reducing the system cost and rack space requirement.

Basic timing information is derived from the GNSS with an embedded 26 channel receiver. The receiver supports GPS, GLONASS, QZSS, SBAS, 1PPS accuracy of less than 15 ns with a single satellite (PPS hold mode).

Phase Noise Performance

Typical phase noise performance is indicated below. The phase noise performance is dominated by the OCXO and the noise contribution of the ten-channel distribution amplifier. The amplifier was designed to minimize phase noise contribution through the use of low noise power sources and high-performance amplifiers. The OCXO performance is determined by the device used and there are a range of options available. Contact the factory for performance levels available.

Typical phase noise performance



Trace	Input Freq	Input Amplitude	dBc/Hz at 10 kHz	RMS Noise (degs)	RMS Jitter	SSB C/N dB	Duration
NR2310-PN (Unsaved)	10.000 MHz	5.0 dBm	−153.2	1.04E−4	2.9E−14 s	−117.8	2m 0s

Controls and indicators

Channel Status- Front panel LED's

For the base unit, three LEDs indicate status of the unit, monitoring for channel faults, Oven Status (and GPS Lock Status), and System Status. The optional Display provides the user with GPS lock information, time, and Channel Status as detailed in the screens that follow.

There are a number of critical circuits in the unit. These are monitored and a failure of any of these will initiate an Alert condition. The ALERT led on the front panel will go from green to flashing red and the Alert relay will open. The alert relay is accessed by a BNC connector on the rear panel. The normal operating state is the relay will be closed.

Oven- LED front Panel

Green indicates that the Oven is operational, and that GPS lock has been acquired for NR2310 with GPS Locked option. A red color indicates that the oven associated with the OCVCXO has failed.

Since the NR2310-ROG is a GPS locked reference, during power-on, the OVEN LED will flash during tracking, and until a GPS Lock status is achieved. This can take up to 30 minutes – typically < 10 minutes.

Digital Display (Optional)

The NR2310D-OG OLED Display gives a number of useful indicators about the frequency reference. Each menu available at the display can be reached by pressing NEXT to advance through the available menus.

Time/Date/Lock Status

On power up, the NR2310-ROG will display the Time and Date as well as the current status of the GNSS receiver.

GNSS: The GNSS status indication allows the user to observe the Lock status of the receivers, and the number of GNSS satellites in view. Before GNSS lock is acquired, the status will be “Tracking” and the number of satellites will be shown. When GNSS lock is acquired, the status will change to “Lock.”

Time and Date: The time zone will be UTC by default, but the hour can be offset to the local time in the UTC Offset menu. Changes to UTC offset and Hour mode will be reflected on this screen.

GNSS/GPS Status

The GNSS Status Menu gives the user a quick reference for the quality of the GNSS satellite signal and length of time that each receiver has been locked.

To toggle between each receiver, press the SELECT button. The screen will display which receiver status is being viewed.

The user can then see number of GNSS satellites are in view, number of GLONASS satellites in view, and the UTC time and date that lock occurred on the selected receiver.

UTC Mode

The user can select how the time is displayed on the screen by choosing between three formats: UTC, 24 hour mode, or 12 hour mode. Toggle through the modes by pressing the SELECT button.

If 24 hour mode or 12 hour mode is chosen, the GMT offset will be applied to the displayed time.

GMT offset

With 24 hour mode or 12 hour mode, the user can choose to align the displayed hour with their current time zone. Using the SELECT button, toggle to the desired offset. The offset will decrement through the 24 hour period, from UTC-11 to UTC +12, etc.

Adjusting the GMT offset will affect the displayed date. As the hour moves across the International Dateline, the displayed date will reflect the date in the selected time zone, and not necessarily the GMT date.

Channel Status

Each channel has an AC to DC converter that monitors the 10 MHz sine, square or PPS pulse. If a severe fault on the output is detected, the faulted channel status will be displayed and the status of all 10 channels is available via the RS232 port.

Next and Select Buttons

The NR2310 Display Menus can be navigated using the NEXT and SELECT buttons. In general, the NEXT button will advance through the menus, and the SELECT button will choose from options in a particular menu.

RS232 NMEA / Alert – DB9 Male (Optional)

RS232 Communication at 38400 baud. Flow Control: None.

NMEA/Frequency Data*:* Pins 2,3, and 5 provide communication with either GNSS receiver or the internal microcontroller.

Alert: Pins 8 and 9 are closed across a relay under normal operation. This allows the user to place any positive voltage up to 20VDC as a logic value across the relay connections. The relay opens in any of the following alert conditions: GNSS Lock is lost, OCXO Lock is lost, OCXO oven failure, or power failure. This Alert Option is not available with the Rubidium .

DB9 Male Connections:
Pin 2: Tx
Pin 3: Rx
Pin 5: GND
Pin 8: Alert +
Pin 9: Alert –

Rear Panel - Outputs

Channel 1 through 10 output connectors – BNC or SMA

The ten BNC or SMA connectors 10 MHz sine @ 50 Ohm load.

PPS – SMA (with GPS locking option)

PPS output: 5V, TTL, short and transient protected. The PPS has a pulse width of 100µs and an accuracy of 20 ns rms. The PPS is programmable in 1 usec steps

Alert – BNC-SMA

Connects to the status relay. Contacts rated at 20 VDC/VAC, 0.5 amps. Contacts are closed during normal operation. Alert status will cause relay to open. The BNC option eliminates one output port if selected.

Power In

Primary power input. The unit operates from 50 or 60 Hz, 88 to 250 VAC. The unit does automatic sensing of the input voltage and there are no actions that need to be taken to operate across the defined AC voltage range. Connector style IEC 320-C14. The is available with a DC power option that can range from -60 to +60 VDC in three ranges. The DC supply can be the primary or secondary back-up to the AC.

Antenna Connection (with GNSS option only-analog,HS1,HS2 stability options))

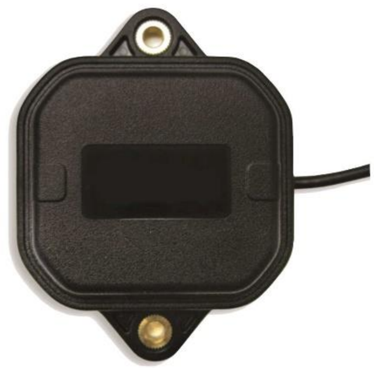
Antenna 1 and 2 - SMA
SMA female antenna connections. Provides internal 3.5VDC power at <20mA max. The Novus NA103 pole mount antennas or the Novus NA106 magnetic mount antenna are recommended for optimal performance.

The receiver and companion elements generate the PPS and NMEA serial link. The serial link conforms to NMEA 0183 protocol. The 26 channel high-sensitivity, high-accuracy Multi-GNSS receiver supports TRAIM, GPS, GLONASS, QZSS, SBAS, Active Anti-Jamming and Advanced Multipath Mitigation Functions.

NA101 Antenna Specifications	
Antenna	
Frequency	**1574-1607 MHz**
Impedance	50 Ohms
Gain	2 dBic @ Zenith
Polarization	RHCP
Out of Band Rejection	> 60 dBc@ +- 50 Mhz
Amplifier gain	26 dB @ 3 Vdc
Amplifier	
DC Supply	2.8 to 6 Vdc
Noise figure	< 2.0 dB
Power	< 25 ma

Antenna for HS3 and HS4.

NA0107



NA107 Antenna Specifications		
Antenna	**L1 Band**	**L2/E5b/B2i Band**
Frequency	1559-1606 MHz	1197-1249 MHz
Impedance	50	50
Gain	Typ. 3.5 dBic (Zenith)	Typ. 2.0 dBic (Zenith)
Axial Ratio	Max 2.0 dB (Zenith)	Max 2.0 dB (Zenith)
Polarization	RHCP	RHCP
Amplifier		
Frequency	1559-1606 MHz	1197-1249 MHz
Impedance	50	50
LNA Gain	Max 28 +- 3 dB	Max 28 +- 3 dB
LNA Noise Figure	Max 2.8 dB	Max 3.2 dB
Output VSWR	Max 2.0	Max 2.0
Cable Insertaion loss	Typ 6.6 dB	Typ 6.6 dB
Total Gain	Typ 21.4 dB	Typ 21.4 dB
Typ Out of Band Rejection	65dB<1459 MHz	50 dB< 1097 MHz
	70dB> 1706 MHz	75 dB> 1349 MHz
Enviromental		
Operating Temperature	-40 to 85 C	
Storage temperature	-40 to 85 C	
Ingress protection	IP67	
Humidity	95% RH, 60C, 96 Hrs	
Power supply	3 to 5 Vdc , 15 ma	
Mechanical		
Weight	173 g	
Size	82x60x22.5 mm	
Cable Length	RG174 5 m	

Functional Description (Base NR2310D-OG)

Outputs

Each output is fault and electrostatic discharge protected. Each output is independent, and any output can be faulted for an indefinite period of time with no permanent damage. Each output is connected to a monitor circuit that detects a local fault on the output. The fault status is indicated on the front panel via an LED or reported in the digital display. The fault status and the protection on each output facilitates installation. A channel fault will not activate an “ALERT” state and the status relay will not be opened.

The standard outputs are1.0 Vrms 10 MHz sine into 50 Ohm.

Built-in Test

The built-in test monitors the following:

Power Supplies - All power supplies are monitored. If a supply fails to meet test limits, an alert is generated.

Channel Faults - if a channel fault is detected, an indication is given but an alert is not generated.

Power Supplies

The unit is designed to accept power in the range of 90 to 264VAC, 50 to 60 Hz. This allows global application. The design is such that no action need be taken to operate from global power types. This feature avoids installation damage that occurs in designs that require an input power switch mode be used.

There is an EMI filter between the internal power supply and the available power being used. This filter minimizes the electrical noise from entering the circuitry and negatively impacting noise performance. Also, in most applications, the equipment that surrounds this unit is sensitive and the filter also reduces noise that could impact the performance of other equipment.

Specifications

Technical Specifications

Output	10 MHz 1 Vrms ±0.2, into 50 Ohms, 10 channels, Sine
Harmonic Distortion	< -30 dBc
Yearly Aging	± 50 ppb (unlocked)
Connectors	Available with either BNC or SMA connectors
Accuracy (Allan Deviation)	Analog, HS1,HS2
1 second	0.9E-10
10 second	0.9E-10
100 second	2.0E-11
1000 second	0.8E-12
Accuracy (Allan Deviation)	HS3,HS4
1 second	4E-12
10 second	6E-12
100 second	3E-12
1000 second	2E-12
10000 second	3E-13
PPS	
Amplitude for 1PPS	3.3 Vdc CMOS (5 Vdc option)
Pulse width for 1PPS	Programmable 1 to 500ms in 1 usec steps
Rise time for 1PPS	<5 ns
Accuracy @1 σ	
analog	15ns
HS1	15ns
HS2	15ns
HS3	5ns
HS4	5ns
Pulse to Pulse Jitter @ 1σ	
analog	10ns
HS1	10ns
HS2	GNSS-PPS <5ns SYTH-PPS< 200psec
HS3	GNSS-PPS <5ns SYTH-PPS< 200psec
HS4	GNSS-PPS <5ns SYTH-PPS< 200psec
PPS Holdover	
OCXO	< 1 ms

Rubidium	< 20 usec
Connector	SMA
Load Impedance	50 Ohm
Location	rear
Typical Phase Noise	
Offset	
1 Hz	-105 dBc/Hz
10 Hz	-130 dBc/Hz
100 Hz	-150 dBc/Hz
1kHz	-155dBc/Hz
10 kHz	-155 dBc/Hz
GNSS receiver -Analog, HS1,HS2	GPS L1 C/A, GLONASS L1OF, QZSS L1 C/A, SBAS L1 C/A (Ready): Galileo E1B/E1C, QZSS L1S
Channels	26 channels (GPS, GLONASS, QZSS, SBAS)
Sensitivity	
GPS	Tracking: -161 dBm
	Hot Start: -161 dBm
	Warm Start: -147 dBm
	Cold Start: -147 dBm
	Reacquisition: -161 dBm
GLONASS	
	Tracking: -157 dBm
	Hot Start: -157 dBm
	Warm Start: -143 dBm
	Cold Start: -143 dBm
	Reacquisition: -157 dBm
	With Novus recommended antenna
GNSS Receiver HS3,HS4	**184 Channels**
Systems supported	GPS, BeiDou, Galileo, and GLONASS reception
Cold Start Acquisition	< 30 seconds
Sensitivity	
Tracking	-167 dBm
Reacquisition	-160 dBm
Cold Start	-148 dBm
Hot Start	-157 dBm
Signals Supported	

GPS	L1C/A (1575.42 MHz), L2C (1227.60 MHz)	
GLONASS	L1OF (1602 MHz + k*562.5 kHz, k = –7,..., 5, 6), L2OF (1246 MHz + k*437.5 kHz, k = –7,..., 5, 6)	
Galileo	E1-B/C (1575.42 MHz), E5b (1207.140 MHz)	
BeiDou	B1I (1561.098 MHz), B2I (1207.140 MHz)	
Antenna with LNA 26 channel Analog, HS1,HS2	(Recommended)	
Antenna power	3.5 Vdc, < 20 ma (on center conductor) (factory configurable to 5 Vdc)	
Frequency	1574-1607 MHz	
Nominal Gain	2 dBic	
Amplifier gain	26 dB	
Noise Figure	< 2.0 dB	
Out of Band rejection	Fo±50MHz=60 dBc, Fo±60 MHz	
DC current	<25 ma@3.5 Vdc	
Antenna with LNA	**184 channel receiver**	
	L-1 Band	L2/ESb/B2i Band
Frequency	1559-1606	1197-1249 MHz
Impedance	50 Ohm	50 Ohm
Gain	Typ 3.5 dBic (Zenith)	Typ 0 to 2 dBic (Zenith)
Axial Rotation	Max 2 dB (Zenith)	Max 2 dB (Zenith)
Polarization	RHCP	RHCP
LNA Gain	Typ 28 +-3 dB	28 +- 3 dB
LNA Noise Figure	Max 2.8 dB	Max 3.2 dB
Output VSWR	Max 2.0	Max 2.0 dB
Cable Insertion Loss	Typ 6.6 dB	Typ 6.6 dB
Remote interface & control		
Protocol	RS232 NMEA-0183	
Connector	DB-9	
Location	Rear panel	
Protocol	Bit plus stop	
Standard Baud Rates	Selectable 4800, 9600, 19200, 38400, 57600 or 115200 bps	
SNMP (option)		
Remote monitoring & control	Internet	

Parameters monitored Locally – present on remote interface for monitoring	Output amplitude, all power supplies, GNSS lock status, number of satellites, Built-In test status,
Transaction/decodable commands	English format
Single monitoring command	Updated every second
Connector	RJ-45

Environmental and Mechanical

Operating Temperature	0 to 50°C non-condensing
Storage Temperature	-40 to 70°C
Height	1.73" (1 RU)
Width	19.0"
Depth	10.0"
Weight	5.5 lbs.
AC Input	90 to 264VAC, 50/60Hz

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User Manual **$GPNVS**

Appendix C: $GPNVS Status String Definitions

Contents

1.0 The $GPNVS Serial Status String

Novus products provide, in many cases, serial data output from a standard GNSS receiver matching the NMEA 0183 protocol. This is usually a direct connection to the receiver.

In addition to NMEA, Novus Products which provide an additional RS232 serial port for status monitoring, will be set up to meet the following protocols. These are designed to be standardized across different products, and easy to port and use via serial-to-ethernet connections.

Many products will have some, but not all, of the following strings, if configured for the optional status RS232.

The following products comply with this document:

1. ND0115
2. NR2310-OG
3. NR2315
4. NR2110-O
5. NR2110-OG (Separate Status Port)
6. NR2110-OG (Combined NMEA/Status Port)
7. NR6720
8. NR2304

Note: The NR2110-OG with combined NMEA and Status Port complies with section 2.0 "Combined NMEA/Status RS232"

1.1 Status String ($GPNVS,1) Fault Bytes

$GPNVS	1	hhmmss	mmddyy	A	A	nn	nn	0x0000	0x00	0x00	n	n	*	XX
1	2	3	4	5	6	7	8	9	10	11	12	13		14

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	1
3.	Time (UTC)	hhmmss
4.	Date	mmddyy
5.	GPS 1 Lock (Valid)	"A" = Valid, "V" = Not Valid, "N" = N/A
6.	GPS 2 Lock (Valid)	"A" = Valid, "V" = Not Valid, "N" = N/A
7.	# of Sats in View (1)	Greater of GPS or GNSS count, "N" = N/A
8.	# of Sats in View (2)	Greater of GPS or GNSS count, "N" = N/A
9.	Channel Fault Byte	0x0000 to 0xFFFF (Hex OR'd value)
10.	Power Supply Fault Byte	0x00 to 0xFF (Hex OR'd value)
11.	Error Message Byte	0x00 to 0xFF (Hex OR'd value)
12.	Antenna 1	"0" = Ok, "1" = Error, "N" = N/A
13.	Antenna 2	"0" = Ok, "1" = Error, "N" = N/A
14.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,1,233518,092516,A,A,10,11,0x0000,0x00,0x00,0,0*23

1.2 Status String ($GPNVS,2) Channel Values 1-8

$GPNVS	2	hhmmss	ddmmyy	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	*	XX
1	2	3	4	5	6	7	8	9	10	11	12		13

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	2
3.	Time (UTC)	hhmmss
4.	Date	mmddyy
5.	Channel 1 Vrms	0.00 to 3.30 [V]
6.	Channel 2 Vrms	0.00 to 3.30 [V]
7.	Channel 3 Vrms	0.00 to 3.30 [V]
8.	Channel 4 Vrms	0.00 to 3.30 [V]
9.	Channel 5 Vrms	0.00 to 3.30 [V]
10.	Channel 6 Vrms	0.00 to 3.30 [V]
11.	Channel 7 Vrms	0.00 to 3.30 [V]
12.	Channel 8 Vrms	0.00 to 3.30 [V]
13.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,2,233518,092516,2.56,2.48,2.51,2.60,2.44,2.53, 2.51,2.60*6C

Note: For units with fewer than the number of channels listed, a null value will be present.

1.3 Status String ($GPNVS,3) Power Supply Values

$GPNVS	3	hhmmss	ddmmyy	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n	nn	*	XX
1	2	3	4	5	6	7	8	9	10	11	12	13	14		15

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	3
3.	Time (UTC)	hhmmss
4.	Date	mmddyy
5.	Power Supply 1	-30.0 to 30.0 [V]
6.	Power Supply 2	-30.0 to 30.0 [V]
7.	Power Supply 3	-30.0 to 30.0 [V]
8.	Power Supply 4	-30.0 to 30.0 [V]
9.	Power Supply 5	-30.0 to 30.0 [V]
10.	Power Supply 6	-30.0 to 30.0 [V]
11.	Power Supply 7	-30.0 to 30.0 [V]
12.	Power Supply 8	-30.0 to 30.0 [V]
13.	Built in Test (BIT)	0 = Ok, 1 = Fail
14.	Temperature (C)	-40 to 99
15.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,3,233518,092516,-7.84,7.93,-11.8,12.1,0.00,0.00,0.00,1.92,0,
26*62

Note: Depending on configuration, Power Supply values will be defined differently, and some Power Supply values may not be present.

1.4 Status String ($GPNVS,4) Channel Values 9-16

$GPNVS	4	hhmmss	ddmmyy	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	*	XX
1	2	3	4	5	6	7	8	9	10	11	12		13

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	4
3.	Time (UTC)	hhmmss
4.	Date	mmddyy
5.	Channel 9 Vrms	0.00 to 3.30 [V]
6.	Channel 10 Vrms	0.00 to 3.30 [V]
7.	Channel 11 Vrms	0.00 to 3.30 [V]
8.	Channel 12 Vrms	0.00 to 3.30 [V]
9.	Channel 13 Vrms	0.00 to 3.30 [V]
10.	Channel 14 Vrms	0.00 to 3.30 [V]
11.	Channel 15 Vrms	0.00 to 3.30 [V]
12.	Channel 16 Vrms	0.00 to 3.30 [V]
13.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,4,233518,092516,2.56,2.48,2.51,2.60,2.44,2.53,2.51,2.60*6A

Note: For units with fewer than the number of channels listed, a null value will be present.

1.5 Status String ($GPNVS,5) Sensors

$GPNVS	5	hhmmss	ddmmyy	nnn	nn	±nn	*	XX
1	2	3	4	5	6	7		8

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	5
3.	Time (UTC)	hhmmss
4.	Date	mmddyy
5.	Potentiometer	Hex Value 000 to FFF
6.	Fan PWM %	0 to 90
7.	Temperature	-40 to 99 [C]
8.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,5,233518,092516,45,00,25*70

1.6 Status String ($GPNVS,6) Status Bytes

There are two different Status Strings; one for everything except the NR2304 and one for the NR2304.

1.6.1 Status String ($GPNVS,6) Status Bytes; Standard

$GPNVS	6	0	A	0	0x0000	0x00	0x00	0x00	0	0x0000	0x0000	0x0000	*	XX
1	2	3	4	5	6	7	8	9	10	11	12	13		14

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	6
3.	Active PCB Assembly	0 or 1
4.	GNSS Lock	A = Locked, V = Unlocked
5.	Input Error	0 = Ok, 1 = A Error, 2 = B error
6.	Channel Status Word	0x0000 to 0xFFFF
7.	Primary PS Status	0x00 to 0xFF
8.	Secondary PS Status	0x00 to 0xFF
9.	Active PCB Status	0x00 to 0xFF
10.	Checksum Status	00 to 999
11.	Channel Fault Bin	0x0000 to 0xFFFF
12.	Primary PCB Amp Status	0x0000 to 0xFFFF
13.	Backup PCB Amp Status	0x0000 to 0xFFFF
14.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,6,0,A,0,0x0000,0x40,0x40,0x00,00,0x0000,0x0000,0x0000*63

See Status Byte Table for details.

1.6.2 Status String ($GPNVS,6) Status Bytes; Rubidium

$GPNVS	6	nnn	0x0000	nnn	0/1	*	XX
1	2	3	4	5	6		7

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	6
3.	Heat Sink Temperature	0-255
4.	Heater Current Voltage	0x0000-0x0136
5.	Measured Voltage in Heater	0-255
6.	Rb Locked	0 = Unlocked 1= Locked
7.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,9,136,0x002A,90,1*7E

1.7 Status String ($GPNVS,7) Status Bytes

$GPNVS	7	nnnnnn	nnnnnn	A	nn	0x00	0	0	0	nnnnnn	n.nn	n.nn	*	XX
1	2	3	4	5	6	7	8	9	10	11	12	13		14

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	7
3.	Time	hhmmss
4.	Date	mmddyy
5.	GPS Lock	"A" = Valid, "V" = Not Valid
6.	# of Sats in View (1)	Greater of GPS or GNSS count, "N" = N/A
7.	Error Byte	0x00 to 0xFF
8.	Freq Diff	±999 (last count, clock cycles)
9.	PPS Diff	±999 (last count, clock cycles)
10.	Freq Correction Slice	±999 (DAC bits, per second)
11.	DAC Value	Integer Representation, n x 1/(2^20)
12.	Power Supply	Vdc
13.	Power Supply	Vdc
14.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,7,161505,081617,A,12,0x00,-1,-2,0,505610,+5.05,-4.66*58

1.8 Event String ($GPNVS,8) Event Status

$GPNVS	8	0	0	0	0	0	0	0	nnnnnn	0	*	XX
1	2	3	4	5	6	7	8	9	10	11		12

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	8
3.	Discipline Counter	0 = Off, 1 = Disciplined to Synthetic PPS
4.	User Enabled	0 = Off, 1 = On
5.	Event Enabled (System)	0 = Events Disabled, 1 = Events Enabled
6.	GPS Lock Achieved	0 = No Lock, 2 = Locked or previously locked
7.	Event Index	0-512, Current count of events in RAM
8.	Event Errors (RAM)	0
9.	Event Index	0-512, Current count of events in Flash
10.	Event Errors (Flash)	0
11.	Event Time Alignmet	2 = LS applied, 1 = GPS, 0 = RTC
12.	Estimated Accuracy	0-999999 [ns]
13.	Edge Detect Direction	0 = Falling Edge, 1 = Rising Edge
14.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:

$GPNVS,8,1,1,1,2,0,0,2,000005,0*60

1.9 Status String ($GPNVS,9) Frequency Measurement

The frequency measurement string has two versions, one standard version, and one for the NR6720.

1.9.1 Standard Frequency Measurement String

$GPNVS	9	hhmmss	ddmmyy	(n)nnnnnnn.nnn	nnn	(-)nn	*	XX
1	2	3	4	5	6	7		8

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	9
3.	Time (UTC)	hhmmss
4.	Date	mmddyy
5.	Measured Frequency	9999900.000 to 10000100.000
6.	Frequency Alert Range	0 – 240 (units of 0.0083 Hz)
7.	Temperature	-40 to 99 [C]
8.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,9,233518,092516,10000000.003,240,25*70

1.9.2 NR6720-HS Frequency Measurement String

$GPNVS	9	nnnnnnn.nnn	n.nnnnn	nnnnnnnn.nn	0	±n.nn	±n.nn	*	XX
1	2	3	4	5	6	7	8		9

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	9
3.	Frequency (Loop Period)	10000000.000
4.	DAC Voltage (Double)	2.00000
5.	Frequency (per second)	10000000.0
6.	Loop Period	0-99
7.	Antenna Current Mon	0.00 to 3.30V
8.	Sine Output RMS	0.00 to 3.30V
9.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,9,+10000000.003,+1.97493,+10000000.0,15,+1.03,+1.30*4A

1.10 PPS Alignment String ($GPNVS,10) PPS Status

$GPNVS	10	0	0	0	±n	±n	n	n	n.n	n	n	n	0	±n	n.n	n	*	XX
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		18

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	10
3.	PPS Stability Enabled	0 = Off, 1 = On
4.	PPS Disciplining to GPS	0 = Off, 1 = Actively Synchronized
5.	PPS Output Type	0 = Synthetic PPS, 1 = GPS PPS
6.	PPS Difference	±250 [ns]
7.	PPS Avg Difference	±250 [ns]
8.	PPS Avg Count	1-20
9.	PPS Synch Threshold	1-250
10.	PPS pull Cal Factor	0.1 to 10.0
11.	PPS active Time Cal Factor	0 to 9
12.	Frequency Variance	0-9999 (clock cycles per Loop period)
13.	Frequency Var Threshold	0-100 (clock cycles per Loop period)
14.	PPS Stabile Mode Post-Warm up	0 = Off, 1 = On
15.	PPS Slope Indicator	±250 (clock cycles per second)
16.	PPS Slope Cal Factor	0.1 to 10.0
17.	PPS Slope Distance	14 to 60 (seconds)
18.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,10,1,0,0,+0,+0,2,100,0.5,3,2,10,1,0,1.0*46

1.12 PPS Alignment String ($GPNVS,9) PPS Status

$GPNVS	9	nnn	0x0000	nnn	0/1	*	XX
1	2	3	4	5	6		7

#	Description	Range
8.	Identifier	$GPNVS
9.	String ID	9
10.	Heat Sink Temperature	0-255
11.	Heater Current Voltage	0x0000-0x0136
12.	Measured Voltage in Heater	0-255
13.	Rb Locked	0 = Unlocked 1= Locked
14.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,9,136,0x002A,90,1*7E

1.11 Response String ($GPNVS,R)

$GPNVS	R	n	<response>	*	XX
1	2	3	4		5

#	Description	Range
1.	Identifier	$GPNVS
2.	Response ID	R
3.	Command Success	1 = Success, 0 = Fail
4.	Response	<see example responses>
5.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,R,SET01=1.00*6F

1.12 Discipline Selection String ($GPNVS,13)

$GPNVS,	13,	n,	n,	n,	n,	n,	,	,	*	XX
1	2	3	4	5	6	7	8	9		10

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	13
3.	Priority Discipline Source	0 = GNSS, 1 = 10MHz input, 2 = Optical input
4.	Current Discipline Source	0 = GNSS, 1 = 10MHz, 2 = Optical, 3 = Holdover
5.	GNSS Lock	0 to 3, 0 = Unlocked, 3 = Fully Locked
6.	RF Present	0 = No RF source, 1 = RF Source found
7.	Opto Present	0 = No Optical source, 1 = Optical Source Found
8.	Loop Lock	1 = Lock, 0 = Loop acquiring lock
9.	Reserved	
10.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,13,0,0,3,0,0,1,*5C

2.0 Combined NMEA/Status RS232

NR2110-OG Combined NMEA?Status Port

2.1 Status String ($GPNVS,1) Fault Bytes

$GPNVS	1	hhmmss	mmddyy	A	nn	0x00	0x00	0x00	*	XX
1	2	3	4	5	6	7	8	9		10

# Description	Range
15. Identifier	$GPNVS
16. String ID	1
17. Time (UTC)	hhmmss
18. Date	mmddyy
19. GPS Lock (Valid)	“A” = Valid, “V” = Not Valid
20. # of Sats in View	Greater of GPS or GNSS count
21. Channel Fault Byte	0x00 to 0x3F (Hex OR’d value)
22. Power Supply Fault Byte	0x00 to 0x1F (Hex OR’d value)
23. Error Message Byte	0x00 to 0x0F (Hex OR’d value)
24. NMEA Checksum	*XX (xor’d value of bytes between $ and *)

Example:
$GPNVS,1,233518,092516,A,10,0x00,0x00,0x00*62
Time: 23:35:18; Sep. 25, 2016, GPS locked; 10 Satellites in view; No channel faults; No power supply faults; No error messages.

2.2 Status String ($GPNVS,2) Channel Values

$GPNVS	1	hhmmss	mmddyy	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	*	XX
1	2	3	4	5	6	7	8	9	10		11

# Description	Range
14. Identifier	$GPNVS
15. String ID	2
16. Time (UTC)	hhmmss
17. Date	mmddyy
18. Channel 1 Vrms	0.00 to 6.60 [V]
19. Channel 2 Vrms	0.00 to 6.60 [V]
20. Channel 3 Vrms	0.00 to 6.60 [V]
21. Channel 4 Vrms	0.00 to 6.60 [V]
22. Channel 5 Vrms	0.00 to 6.60 [V]
23. Channel 6 Vrms	0.00 to 6.60 [V]
24. NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,2,233518,092516,0.99,1.01,1.06,0.97,1.52,1.54*4E

2.3 Status String ($GPNVS,3) Power Supply Values

$GPNVS	3	hhmmss	mmddyy	n.nn	n.nn	n.nn	n.nn	n.nn	*	XX
1	2	3	4	5	6	7	8	9		10

# Description	Range
15. Identifier	$GPNVS
16. String ID	2
17. Time (UTC)	hhmmss
18. Date	mmddyy
19. -5Vdc Power Supply(opt)	-30.0 to 30.0 [V]
20. +5Vdc Power Supply	-30.0 to 30.0 [V]
21. 10kΩ Thermistor(opt)	0.00 to 3.30 [V]
22. +5Vdc Power Supply(opt)	-30.0 to 30.0 [V]
23. OCXO Control Voltage	0.00 to 3.30 [V]
24. NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,3,233518,092516,-4.84,4.93,1.45,4.90,2.12*42

3.0 Status Byte Key

	Hex Value (OR'd)	Channel ID	Channel Status Word
Channel Status Byte	0x1<<0	Channel 1 Fault	General Channel Fault
	0x1<<1	Channel 2 Fault	
	0x1<<2	Channel 3 Fault	
	0x1<<3	Channel 4 Fault	
	0x1<<4	Channel 5 Fault	
	0x1<<5	Channel 6 Fault	
	0x1<<6	Channel 7 Fault	
	0x1<<7	Channel 8 Fault	
	0x1<<8	Channel 9 Fault	
	0x1<<9	Channel 10 Fault	
	0x1<<10	Channel 11 Fault	
	0x1<<11	Channel 12 Fault	
	0x1<<12	Channel 13 Fault	
	0x1<<13	Channel 14 Fault	
	0x1<<14	Channel 15 Fault	

	Hex Value (OR'd)	Channel ID	Channel Fault Bin
Channel Fault Bin	0x1<<0	Channel 1 Fault	External Fault: The ND0100 has completed an internal amplifier gain test and both primary and backup assemblies are functional. The fault is external to the ND0100 (cabling, short, etc) Amp Gain Test for Alert is enabled with $AMP=1 command via RS232
	0x1<<1	Channel 2 Fault	
	0x1<<2	Channel 3 Fault	
	0x1<<3	Channel 4 Fault	
	0x1<<4	Channel 5 Fault	
	0x1<<5	Channel 6 Fault	
	0x1<<6	Channel 7 Fault	
	0x1<<7	Channel 8 Fault	
	0x1<<8	Channel 9 Fault	
	0x1<<9	Channel 10 Fault	
	0x1<<10	Channel 11 Fault	
	0x1<<11	Channel 12 Fault	
	0x1<<12	Channel 13 Fault	
	0x1<<13	Channel 14 Fault	
	0x1<<14	Channel 15 Fault	

	Hex Value (OR'd)	Channel ID	Primary PCB Amp Status
Primary PCB Amp Status	0x1<<0	Channel 1 Fault	Internal Fault Primary Assembly: The channel has failed an internal gain test on the primary PCB assembly, and the channel is not functional on the primary board. Amp Gain Test for Alert is enabled with $AMP=1 command via RS232
	0x1<<1	Channel 2 Fault	
	0x1<<2	Channel 3 Fault	
	0x1<<3	Channel 4 Fault	
	0x1<<4	Channel 5 Fault	
	0x1<<5	Channel 6 Fault	
	0x1<<6	Channel 7 Fault	
	0x1<<7	Channel 8 Fault	
	0x1<<8	Channel 9 Fault	
	0x1<<9	Channel 10 Fault	
	0x1<<10	Channel 11 Fault	
	0x1<<11	Channel 12 Fault	
	0x1<<12	Channel 13 Fault	
	0x1<<13	Channel 14 Fault	
	0x1<<14	Channel 15 Fault	

	Hex Value (OR'd)	Channel ID	Backup PCB Amp Status
Backup PCB Amp Status	0x1<<0	Channel 1 Fault	Internal Fault Backup Assembly: The channel has failed an internal gain test on the backup PCB assembly, and the channel is not functional on the secondary board. Amp Gain Test for Alert is enabled with $AMP=1 command via RS232
	0x1<<1	Channel 2 Fault	
	0x1<<2	Channel 3 Fault	
	0x1<<3	Channel 4 Fault	
	0x1<<4	Channel 5 Fault	
	0x1<<5	Channel 6 Fault	
	0x1<<6	Channel 7 Fault	
	0x1<<7	Channel 8 Fault	
	0x1<<8	Channel 9 Fault	
	0x1<<9	Channel 10 Fault	
	0x1<<10	Channel 11 Fault	
	0x1<<11	Channel 12 Fault	
	0x1<<12	Channel 13 Fault	
	0x1<<13	Channel 14 Fault	
	0x1<<14	Channel 15 Fault	

	Hex Value (OR'd)	Status Message
Active Board Status	0x1<<0	Flash Read Boot Error (Deprecated)
	0x1<<1	Potentiometer Read/Set Fail
	0x1<<2	Reserved
	0x1<<3	Reserved
	0x1<<4	PCB Assembly Input A/B Select Fail
	0x1<<5	Reserved
	0x1<<6	Reserved
	0x1<<7	Reserved

	Hex Value (OR'd)	Status Message
Primary and Secondary Power Supply Status	0x1<<0	PS 1 Fault
	0x1<<1	PS 2 Fault
	0x1<<2	PS 3 Fault
	0x1<<3	PS 4 Fault
	0x1<<4	PS 5 Fault
	0x1<<5	PS 6 Fault
	0x1<<6	PS 7 Fault
	0x1<<7	PS 8 Fault

	Hex Value (OR'd)	Status Message
Error Status	0x1<<0	FLASH_NOT_FOUND
	0x1<<1	FLASH_NOT_SAVED
	0x1<<2	LOOP_VOLT_ERROR
	0x1<<3	ANTENNA_VOLT_ERROR
	0x1<<4	GPS_FAILURE
	0x1<<5	POTENTIOMETER_ERROR
	0x1<<6	RAM_MEMORY_ERROR
	0x1<<7	Reserved

User Manual **$GPNVS**

Appendix C: $GPNVS Status String Definitions

Contents

1.0 The $GPNVS Serial Status String

Novus products provide, in many cases, serial data output from a standard GNSS receiver matching the NMEA 0183 protocol. This is usually a direct connection to the receiver.

In addition to NMEA, Novus Products which provide an additional RS232 serial port for status monitoring, will be set up to meet the following protocols. These are designed to be standardized across different products, and easy to port and use via serial-to-ethernet connections.

Many products will have some, but not all, of the following strings, if configured for the optional status RS232.

The following products comply with this document:

1. ND0115
2. NR2310-OG
3. NR2315
4. NR2110-O
5. NR2110-OG (Separate Status Port)
6. NR2110-OG (Combined NMEA/Status Port)
7. NR6720
8. NR2304

Note: The NR2110-OG with combined NMEA and Status Port complies with section 2.0 "Combined NMEA/Status RS232"

1.1 Status String ($GPNVS,1) Fault Bytes

$GPNVS	1	hhmmss	mmddyy	A	A	nn	nn	0x0000	0x00	0x00	n	n	*	XX
1	2	3	4	5	6	7	8	9	10	11	12	13		14

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	1
3.	Time (UTC)	hhmmss
4.	Date	mmddyy
5.	GPS 1 Lock (Valid)	"A" = Valid, "V" = Not Valid, "N" = N/A
6.	GPS 2 Lock (Valid)	"A" = Valid, "V" = Not Valid, "N" = N/A
7.	# of Sats in View (1)	Greater of GPS or GNSS count, "N" = N/A
8.	# of Sats in View (2)	Greater of GPS or GNSS count, "N" = N/A
9.	Channel Fault Byte	0x0000 to 0xFFFF (Hex OR'd value)
10.	Power Supply Fault Byte	0x00 to 0xFF (Hex OR'd value)
11.	Error Message Byte	0x00 to 0xFF (Hex OR'd value)
12.	Antenna 1	"0" = Ok, "1" = Error, "N" = N/A
13.	Antenna 2	"0" = Ok, "1" = Error, "N" = N/A
14.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,1,233518,092516,A,A,10,11,0x0000,0x00,0x00,0,0*23

1.2 Status String ($GPNVS,2) Channel Values 1-8

$GPNVS	2	hhmmss	ddmmyy	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	*	XX
1	2	3	4	5	6	7	8	9	10	11	12		13

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	2
3.	Time (UTC)	hhmmss
4.	Date	mmddyy
5.	Channel 1 Vrms	0.00 to 3.30 [V]
6.	Channel 2 Vrms	0.00 to 3.30 [V]
7.	Channel 3 Vrms	0.00 to 3.30 [V]
8.	Channel 4 Vrms	0.00 to 3.30 [V]
9.	Channel 5 Vrms	0.00 to 3.30 [V]
10.	Channel 6 Vrms	0.00 to 3.30 [V]
11.	Channel 7 Vrms	0.00 to 3.30 [V]
12.	Channel 8 Vrms	0.00 to 3.30 [V]
13.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,2,233518,092516,2.56,2.48,2.51,2.60,2.44,2.53, 2.51,2.60*6C

Note: For units with fewer than the number of channels listed, a null value will be present.

1.3 Status String ($GPNVS,3) Power Supply Values

$GPNVS	3	hhmmss	ddmmyy	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n	nn	*	XX
1	2	3	4	5	6	7	8	9	10	11	12	13	14		15

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	3
3.	Time (UTC)	hhmmss
4.	Date	mmddyy
5.	Power Supply 1	-30.0 to 30.0 [V]
6.	Power Supply 2	-30.0 to 30.0 [V]
7.	Power Supply 3	-30.0 to 30.0 [V]
8.	Power Supply 4	-30.0 to 30.0 [V]
9.	Power Supply 5	-30.0 to 30.0 [V]
10.	Power Supply 6	-30.0 to 30.0 [V]
11.	Power Supply 7	-30.0 to 30.0 [V]
12.	Power Supply 8	-30.0 to 30.0 [V]
13.	Built in Test (BIT)	0 = Ok, 1 = Fail
14.	Temperature (C)	-40 to 99
15.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,3,233518,092516,-7.84,7.93,-11.8,12.1,0.00,0.00,0.00,1.92,0,
26*62

Note: Depending on configuration, Power Supply values will be defined differently, and some Power Supply values may not be present.

1.4 Status String ($GPNVS,4) Channel Values 9-16

$GPNVS	4	hhmmss	ddmmyy	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	*	XX
1	2	3	4	5	6	7	8	9	10	11	12		13

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	4
3.	Time (UTC)	hhmmss
4.	Date	mmddyy
5.	Channel 9 Vrms	0.00 to 3.30 [V]
6.	Channel 10 Vrms	0.00 to 3.30 [V]
7.	Channel 11 Vrms	0.00 to 3.30 [V]
8.	Channel 12 Vrms	0.00 to 3.30 [V]
9.	Channel 13 Vrms	0.00 to 3.30 [V]
10.	Channel 14 Vrms	0.00 to 3.30 [V]
11.	Channel 15 Vrms	0.00 to 3.30 [V]
12.	Channel 16 Vrms	0.00 to 3.30 [V]
13.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,4,233518,092516,2.56,2.48,2.51,2.60,2.44,2.53,2.51,2.60*6A

Note: For units with fewer than the number of channels listed, a null value will be present.

1.5 Status String ($GPNVS,5) Sensors

$GPNVS	5	hhmmss	ddmmyy	nnn	nn	±nn	*	XX
1	2	3	4	5	6	7		8

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	5
3.	Time (UTC)	hhmmss
4.	Date	mmddyy
5.	Potentiometer	Hex Value 000 to FFF
6.	Fan PWM %	0 to 90
7.	Temperature	-40 to 99 [C]
8.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,5,233518,092516,45,00,25*70

1.6 Status String ($GPNVS,6) Status Bytes

There are two different Status Strings; one for everything except the NR2304 and one for the NR2304.

1.6.1 Status String ($GPNVS,6) Status Bytes; Standard

$GPNVS	6	0	A	0	0x0000	0x00	0x00	0x00	0	0x0000	0x0000	0x0000	*	XX
1	2	3	4	5	6	7	8	9	10	11	12	13		14

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	6
3.	Active PCB Assembly	0 or 1
4.	GNSS Lock	A = Locked, V = Unlocked
5.	Input Error	0 = Ok, 1 = A Error, 2 = B error
6.	Channel Status Word	0x0000 to 0xFFFF
7.	Primary PS Status	0x00 to 0xFF
8.	Secondary PS Status	0x00 to 0xFF
9.	Active PCB Status	0x00 to 0xFF
10.	Checksum Status	00 to 999
11.	Channel Fault Bin	0x0000 to 0xFFFF
12.	Primary PCB Amp Status	0x0000 to 0xFFFF
13.	Backup PCB Amp Status	0x0000 to 0xFFFF
14.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,6,0,A,0,0x0000,0x40,0x40,0x00,00,0x0000,0x0000,0x0000*63

See Status Byte Table for details.

1.6.2 Status String ($GPNVS,6) Status Bytes; Rubidium

$GPNVS	6	nnn	0x0000	nnn	0/1	*	XX
1	2	3	4	5	6		7

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	6
3.	Heat Sink Temperature	0-255
4.	Heater Current Voltage	0x0000-0x0136
5.	Measured Voltage in Heater	0-255
6.	Rb Locked	0 = Unlocked 1= Locked
7.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,9,136,0x002A,90,1*7E

1.7 Status String ($GPNVS,7) Status Bytes

$GPNVS	7	nnnnnn	nnnnnn	A	nn	0x00	0	0	0	nnnnnn	n.nn	n.nn	*	XX
1	2	3	4	5	6	7	8	9	10	11	12	13		14

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	7
3.	Time	hhmmss
4.	Date	mmddyy
5.	GPS Lock	"A" = Valid, "V" = Not Valid
6.	# of Sats in View (1)	Greater of GPS or GNSS count, "N" = N/A
7.	Error Byte	0x00 to 0xFF
8.	Freq Diff	±999 (last count, clock cycles)
9.	PPS Diff	±999 (last count, clock cycles)
10.	Freq Correction Slice	±999 (DAC bits, per second)
11.	DAC Value	Integer Representation, n x 1/(2^20)
12.	Power Supply	Vdc
13.	Power Supply	Vdc
14.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,7,161505,081617,A,12,0x00,-1,-2,0,505610,+5.05,-4.66*58

1.8 Event String ($GPNVS,8) Event Status

$GPNVS	8	0	0	0	0	0	0	0	nnnnnn	0	*	XX
1	2	3	4	5	6	7	8	9	10	11		12

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	8
3.	Discipline Counter	0 = Off, 1 = Disciplined to Synthetic PPS
4.	User Enabled	0 = Off, 1 = On
5.	Event Enabled (System)	0 = Events Disabled, 1 = Events Enabled
6.	GPS Lock Achieved	0 = No Lock, 2 = Locked or previously locked
7.	Event Index	0-512, Current count of events in RAM
8.	Event Errors (RAM)	0
9.	Event Index	0-512, Current count of events in Flash
10.	Event Errors (Flash)	0
11.	Event Time Alignmet	2 = LS applied, 1 = GPS, 0 = RTC
12.	Estimated Accuracy	0-999999 [ns]
13.	Edge Detect Direction	0 = Falling Edge, 1 = Rising Edge
14.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,8,1,1,1,2,0,0,2,000005,0*60

1.9 Status String ($GPNVS,9) Frequency Measurement

The frequency measurement string has two versions, one standard version, and one for the NR6720.

1.9.1 Standard Frequency Measurement String

$GPNVS	9	hhmmss	ddmmyy	(n)nnnnnnn.nnn	nnn	(-)nn	*	XX
1	2	3	4	5	6	7		8

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	9
3.	Time (UTC)	hhmmss
4.	Date	mmddyy
5.	Measured Frequency	9999900.000 to 10000100.000
6.	Frequency Alert Range	0 – 240 (units of 0.0083 Hz)
7.	Temperature	-40 to 99 [C]
8.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,9,233518,092516,10000000.003,240,25*70

1.9.2 NR6720-HS Frequency Measurement String

$GPNVS	9	nnnnnnn.nnn	n.nnnnn	nnnnnnnn.nn	0	±n.nn	±n.nn	*	XX
1	2	3	4	5	6	7	8		9

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	9
3.	Frequency (Loop Period)	10000000.000
4.	DAC Voltage (Double)	2.00000
5.	Frequency (per second)	10000000.0
6.	Loop Period	0-99
7.	Antenna Current Mon	0.00 to 3.30V
8.	Sine Output RMS	0.00 to 3.30V
9.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,9,+10000000.003,+1.97493,+10000000.0,15,+1.03,+1.30*4A

1.10 PPS Alignment String ($GPNVS,10) PPS Status

$GPNVS	10	0	0	0	±n	±n	n	n	n.n	n	n	n	0	±n	n.n	n	*	XX
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		18

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	10
3.	PPS Stability Enabled	0 = Off, 1 = On
4.	PPS Disciplining to GPS	0 = Off, 1 = Actively Synchronized
5.	PPS Output Type	0 = Synthetic PPS, 1 = GPS PPS
6.	PPS Difference	±250 [ns]
7.	PPS Avg Difference	±250 [ns]
8.	PPS Avg Count	1-20
9.	PPS Synch Threshold	1-250
10.	PPS pull Cal Factor	0.1 to 10.0
11.	PPS active Time Cal Factor	0 to 9
12.	Frequency Variance	0-9999 (clock cycles per Loop period)
13.	Frequency Var Threshold	0-100 (clock cycles per Loop period)
14.	PPS Stabile Mode Post-Warm up	0 = Off, 1 = On
15.	PPS Slope Indicator	±250 (clock cycles per second)
16.	PPS Slope Cal Factor	0.1 to 10.0
17.	PPS Slope Distance	14 to 60 (seconds)
18.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,10,1,0,0,+0,+0,2,100,0.5,3,2,10,1,0,1.0*46

1.12 PPS Alignment String ($GPNVS,9) PPS Status

$GPNVS	9	nnn	0x0000	nnn	0/1	*	XX
1	2	3	4	5	6		7

#	Description	Range
8.	Identifier	$GPNVS
9.	String ID	9
10.	Heat Sink Temperature	0-255
11.	Heater Current Voltage	0x0000-0x0136
12.	Measured Voltage in Heater	0-255
13.	Rb Locked	0 = Unlocked 1= Locked
14.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,9,136,0x002A,90,1*7E

1.11 Response String ($GPNVS,R)

$GPNVS	R	n	<response>	*	XX
1	2	3	4		5

#	Description	Range
1.	Identifier	$GPNVS
2.	Response ID	R
3.	Command Success	1 = Success, 0 = Fail
4.	Response	<see example responses>
5.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,R,SET01=1.00*6F

1.12 Discipline Selection String ($GPNVS,13)

$GPNVS,	13,	n,	n,	n,	n,	n,	,	,	*	XX
1	2	3	4	5	6	7	8	9		10

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	13
3.	Priority Discipline Source	0 = GNSS, 1 = 10MHz input, 2 = Optical input
4.	Current Discipline Source	0 = GNSS, 1 = 10MHz, 2 = Optical, 3 = Holdover
5.	GNSS Lock	0 to 3, 0 = Unlocked, 3 = Fully Locked
6.	RF Present	0 = No RF source, 1 = RF Source found
7.	Opto Present	0 = No Optical source, 1 = Optical Source Found
8.	Loop Lock	1 = Lock, 0 = Loop acquiring lock
9.	Reserved	
10.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,13,0,0,3,0,0,1,*5C

2.0 Combined NMEA/Status RS232

NR2110-OG Combined NMEA?Status Port

2.1 Status String ($GPNVS,1) Fault Bytes

$GPNVS	1	hhmmss	mmddyy	A	nn	0x00	0x00	0x00	*	XX
1	2	3	4	5	6	7	8	9		10

# Description	Range
15. Identifier	$GPNVS
16. String ID	1
17. Time (UTC)	hhmmss
18. Date	mmddyy
19. GPS Lock (Valid)	"A" = Valid, "V" = Not Valid
20. # of Sats in View	Greater of GPS or GNSS count
21. Channel Fault Byte	0x00 to 0x3F (Hex OR'd value)
22. Power Supply Fault Byte	0x00 to 0x1F (Hex OR'd value)
23. Error Message Byte	0x00 to 0x0F (Hex OR'd value)
24. NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,1,233518,092516,A,10,0x00,0x00,0x00*62
Time: 23:35:18; Sep. 25, 2016, GPS locked; 10 Satellites in view; No channel faults; No power supply faults; No error messages.

2.2 Status String ($GPNVS,2) Channel Values

$GPNVS	1	hhmmss	mmddyy	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	*	XX
1	2	3	4	5	6	7	8	9	10		11

# Description	Range
14. Identifier	$GPNVS
15. String ID	2
16. Time (UTC)	hhmmss
17. Date	mmddyy
18. Channel 1 Vrms	0.00 to 6.60 [V]
19. Channel 2 Vrms	0.00 to 6.60 [V]
20. Channel 3 Vrms	0.00 to 6.60 [V]
21. Channel 4 Vrms	0.00 to 6.60 [V]
22. Channel 5 Vrms	0.00 to 6.60 [V]
23. Channel 6 Vrms	0.00 to 6.60 [V]
24. NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,2,233518,092516,0.99,1.01,1.06,0.97,1.52,1.54*4E

2.3 Status String ($GPNVS,3) Power Supply Values

$GPNVS	3	hhmmss	mmddyy	n.nn	n.nn	n.nn	n.nn	n.nn	*	XX
1	2	3	4	5	6	7	8	9		10

# Description	Range
15. Identifier	$GPNVS
16. String ID	2
17. Time (UTC)	hhmmss
18. Date	mmddyy
19. -5Vdc Power Supply(opt)	-30.0 to 30.0 [V]
20. +5Vdc Power Supply	-30.0 to 30.0 [V]
21. 10kΩ Thermistor(opt)	0.00 to 3.30 [V]
22. +5Vdc Power Supply(opt)	-30.0 to 30.0 [V]
23. OCXO Control Voltage	0.00 to 3.30 [V]
24. NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,3,233518,092516,-4.84,4.93,1.45,4.90,2.12*42

3.0 Status Byte Key

	Hex Value (OR'd)	Channel ID	Channel Status Word
Channel Status Byte	0x1<<0	Channel 1 Fault	General Channel Fault
	0x1<<1	Channel 2 Fault	
	0x1<<2	Channel 3 Fault	
	0x1<<3	Channel 4 Fault	
	0x1<<4	Channel 5 Fault	
	0x1<<5	Channel 6 Fault	
	0x1<<6	Channel 7 Fault	
	0x1<<7	Channel 8 Fault	
	0x1<<8	Channel 9 Fault	
	0x1<<9	Channel 10 Fault	
	0x1<<10	Channel 11 Fault	
	0x1<<11	Channel 12 Fault	
	0x1<<12	Channel 13 Fault	
	0x1<<13	Channel 14 Fault	
	0x1<<14	Channel 15 Fault	

	Hex Value (OR'd)	Channel ID	Channel Fault Bin
Channel Fault Bin	0x1<<0	Channel 1 Fault	External Fault: The ND0100 has completed an internal amplifier gain test and both primary and backup assemblies are functional. The fault is external to the ND0100 (cabling, short, etc) Amp Gain Test for Alert is enabled with $AMP=1 command via RS232
	0x1<<1	Channel 2 Fault	
	0x1<<2	Channel 3 Fault	
	0x1<<3	Channel 4 Fault	
	0x1<<4	Channel 5 Fault	
	0x1<<5	Channel 6 Fault	
	0x1<<6	Channel 7 Fault	
	0x1<<7	Channel 8 Fault	
	0x1<<8	Channel 9 Fault	
	0x1<<9	Channel 10 Fault	
	0x1<<10	Channel 11 Fault	
	0x1<<11	Channel 12 Fault	
	0x1<<12	Channel 13 Fault	
	0x1<<13	Channel 14 Fault	
	0x1<<14	Channel 15 Fault	

	Hex Value (OR'd)	Channel ID	Primary PCB Amp Status
Primary PCB Amp Status	0x1<<0	Channel 1 Fault	Internal Fault Primary Assembly: The channel has failed an internal gain test on the primary PCB assembly, and the channel is not functional on the primary board. Amp Gain Test for Alert is enabled with $AMP=1 command via RS232
	0x1<<1	Channel 2 Fault	
	0x1<<2	Channel 3 Fault	
	0x1<<3	Channel 4 Fault	
	0x1<<4	Channel 5 Fault	
	0x1<<5	Channel 6 Fault	
	0x1<<6	Channel 7 Fault	
	0x1<<7	Channel 8 Fault	
	0x1<<8	Channel 9 Fault	
	0x1<<9	Channel 10 Fault	
	0x1<<10	Channel 11 Fault	
	0x1<<11	Channel 12 Fault	
	0x1<<12	Channel 13 Fault	
	0x1<<13	Channel 14 Fault	
	0x1<<14	Channel 15 Fault	

	Hex Value (OR'd)	Channel ID	Backup PCB Amp Status
Backup PCB Amp Status	0x1<<0	Channel 1 Fault	Internal Fault Backup Assembly: The channel has failed an internal gain test on the backup PCB assembly, and the channel is not functional on the secondary board. Amp Gain Test for Alert is enabled with $AMP=1 command via RS232
	0x1<<1	Channel 2 Fault	
	0x1<<2	Channel 3 Fault	
	0x1<<3	Channel 4 Fault	
	0x1<<4	Channel 5 Fault	
	0x1<<5	Channel 6 Fault	
	0x1<<6	Channel 7 Fault	
	0x1<<7	Channel 8 Fault	
	0x1<<8	Channel 9 Fault	
	0x1<<9	Channel 10 Fault	
	0x1<<10	Channel 11 Fault	
	0x1<<11	Channel 12 Fault	
	0x1<<12	Channel 13 Fault	
	0x1<<13	Channel 14 Fault	
	0x1<<14	Channel 15 Fault	

	Hex Value (OR'd)	Status Message
Active Board Status	0x1<<0	Flash Read Boot Error (Deprecated)
	0x1<<1	Potentiometer Read/Set Fail
	0x1<<2	Reserved
	0x1<<3	Reserved
	0x1<<4	PCB Assembly Input A/B Select Fail
	0x1<<5	Reserved
	0x1<<6	Reserved
	0x1<<7	Reserved

	Hex Value (OR'd)	Status Message
Primary and Secondary Power Supply Status	0x1<<0	PS 1 Fault
	0x1<<1	PS 2 Fault
	0x1<<2	PS 3 Fault
	0x1<<3	PS 4 Fault
	0x1<<4	PS 5 Fault
	0x1<<5	PS 6 Fault
	0x1<<6	PS 7 Fault
	0x1<<7	PS 8 Fault

	Hex Value (OR'd)	Status Message
Error Status	0x1<<0	FLASH_NOT_FOUND
	0x1<<1	FLASH_NOT_SAVED
	0x1<<2	LOOP_VOLT_ERROR
	0x1<<3	ANTENNA_VOLT_ERROR
	0x1<<4	GPS_FAILURE
	0x1<<5	POTENTIOMETER_ERROR
	0x1<<6	RAM_MEMORY_ERROR
	0x1<<7	Reserved