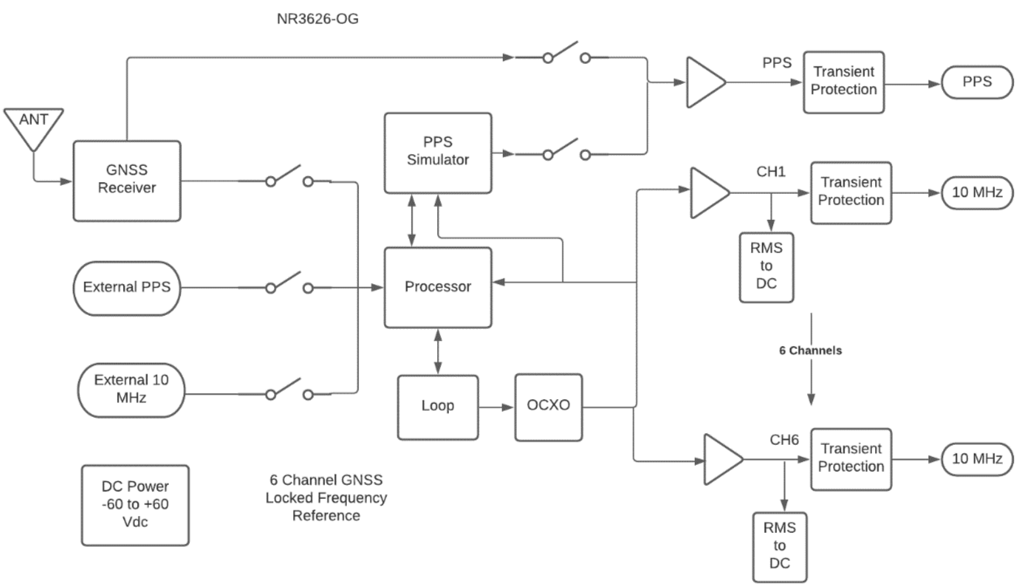
NR3626-O/G

10MHz Frequency Reference, OCXO, GNSS-Locked, Six-Channel, Auto-Cal

Contents

Overview



The NR3626-O/G is a high performance 10 MHz frequency reference that is driven by a low phase noise SC cut OCXO disciplined by a 26 channel GNSS receiver. The 10 MHz outputs are 13 dBm while the PPS output can be 3.3V or 5.0V logic levels with the capability of driving a 50 Ohm load.

The disciplining loop for the 10 MHz OCXO features an algorithm that affords very low close in phase noise. The bandwidth is such that many of the low frequency artifacts of the transmission path are successfully attenuated. Default settings of the frequency loop can be adjusted, as outlined in the Programmer's Guide.

The 26 channel GNSS receiver offers improved robustness with concurrent reception of GPS and GLONASS. Supports GPS, GLONASS, SBAS and QZSS.

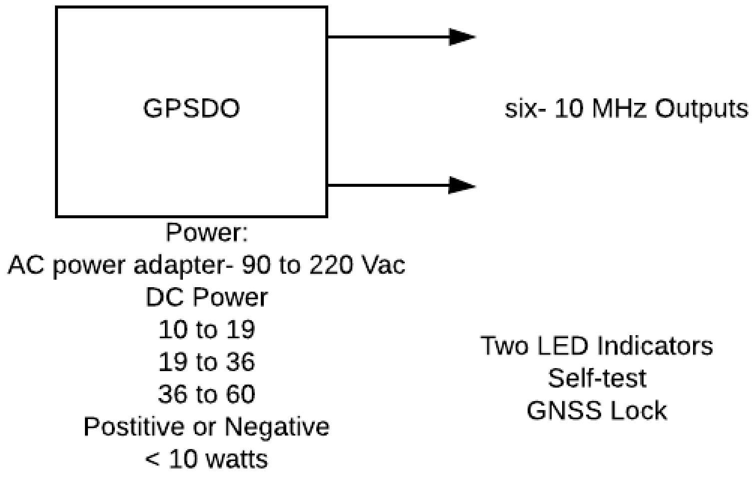
The PPS signal is available as received or as a synthesized PPS – locked to the received PPS but with pulse-to-pulse jitter reduced well below 2 ns.

On startup, the OCXO derived PPS is the default PPS, and is actively disciplined by the GNSS receiver if the receiver is locked. If the unit is set for stable mode on warmup, the unit will enter PPS stability mode when lock has been achieved, and the loop frequency variance is below the threshold outlined in the Programmer's Guide.

Primary power can be in the range of -60 to plus 60Vdc (in three ranges) or a power adapter is available.

Available as a unit or as a kit with antenna, power supply and cable.

Equipment Setup



Power

The equipment will need a power source of approximately 10 watts. Power can be from an AC power adapter or a DC source. The DC power required is specified at the time of ordering to be within 1 of three ranges:

12VDC (10 to 15VDC)
24VDC (20 to 30VDC)
48VDC (40 to 60VDC)

The unit has reverse polarity protection and will operate within any given range positive or negative.

Power consumption is highest at turn-on as the crystal is warming up or if it is a very cold environment. Under normal conditions, warm is less than five minutes.

Antenna

The unit is designed to use a GNSS antenna with an embedded LNA. Amplifier power is provided over the center conductor of the antenna cable. The antenna power is 3.5 Vdc @ < 25 ma. Total antenna cable losses should be kept to under 10 dB. Novus sells antenna and cabling to assist with your installation.

Outputs

The 10 MHz signal is typically a 13 dBm sine. The PPS can be a 3.3 or 5V pulse capable of driving 50 Ohms. Each channel is monitored, and a faulted condition will cause the indicator near the connector to flash. Low loss cable with shield should be used. For long-runs or high electromagnetic environments, consider using a fiber optic link. Novus has many products to facilitate a fiber optic link.

As difficult as distributing a sine wave - a pulse is even more challenging. If not properly impedance matched, ringing and frequency shaping can cause significant timing errors. Consider twisted pairs or LVDS for longer runs.

GNSS Receiver

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 have trouble 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.

GPS Receiver LOCK LED

The GNSS Lock LED illuminates green when the unit is locked to the GNSS, and the frequency stability is within the threshold variance (as set by $PSVAR command). If the LED is flashing red twice, the unit is operating on the OCXO holdover, as the GPS is not locked. If the LED is flashing red once, the unit has GPS Lock, but the frequency error is outside the specified variance, or has not yet warmed up, at startup, for example. The frequency loop becomes active after a 10 minute warmup period.

The GNSS lock status is available via the serial output on the RS232 as well.

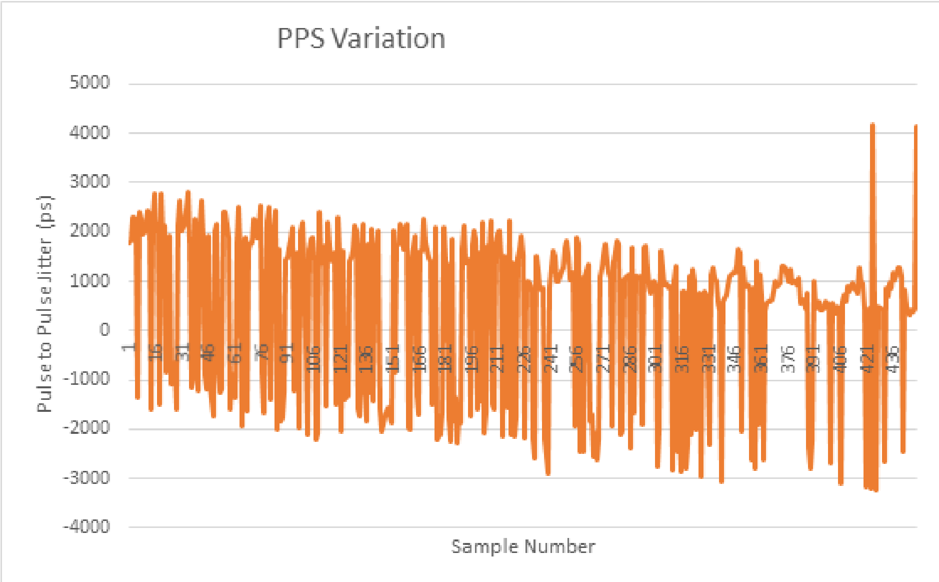
If the GNSS indicator remains flashing red for an extended period of time, it could be an indication of an antenna, cabling or unit malfunction. Confirm the antenna is still connected and has not become obstructed from a clear view of the sky. To check the unit, an alternate antenna can be tried in order to isolate the malfunction. For further support, please contact the factory: 816-836-7446.

Secondary/Aux Output Channel

The unit may be ordered with an optional secondary channel that can be programmed from 1 Hz to 20 MHz. The unit can be programmed from the serial port with the $AUXFR command. Recommended frequencies are even divisors of 200MHz. This circuitry is a PLL based synthesizer that uses the primary GNSS locked 10 MHz for its reference. Therefore, this secondary frequency is also GNSS locked. The output is a 3.3 V CMOS signal that is fault and transient protected with a 220 Ohm output impedance.

PPS Stabilizer

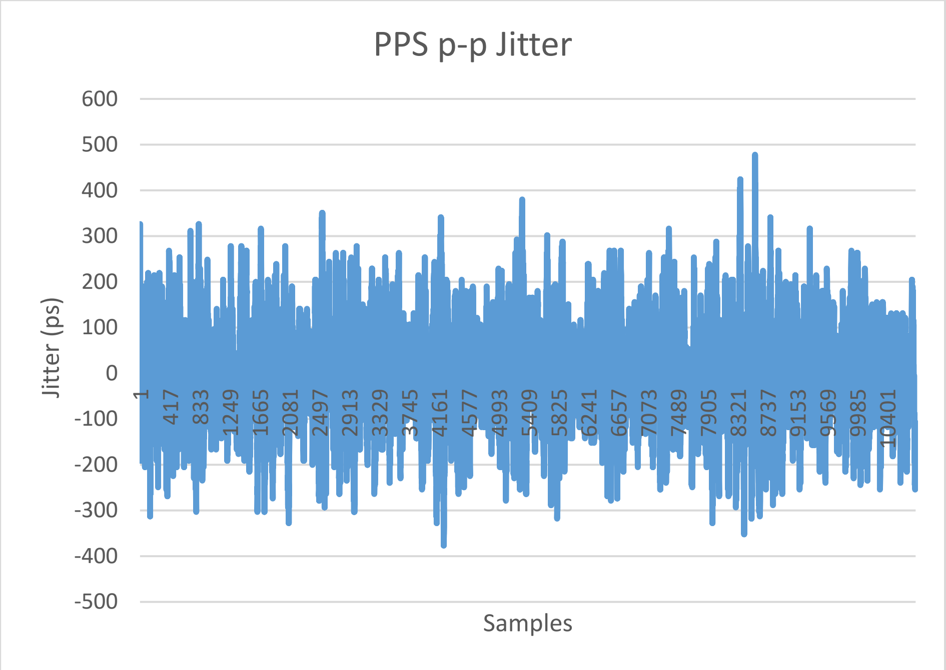
The PPS generated by the GNSS receiver is accurate to 25 ns rms. The pulse-to-pulse jitter is directly impacted by many external effects such as multi-path, reflections, etc. GNSS receiver pulse-to-pulse jitter is on the order of 6000ps, A measurement is GNSS receiver generated PPS pulse to pulse jitter is shown below:



GNSS Receiver PPS pulse to pulse jitter

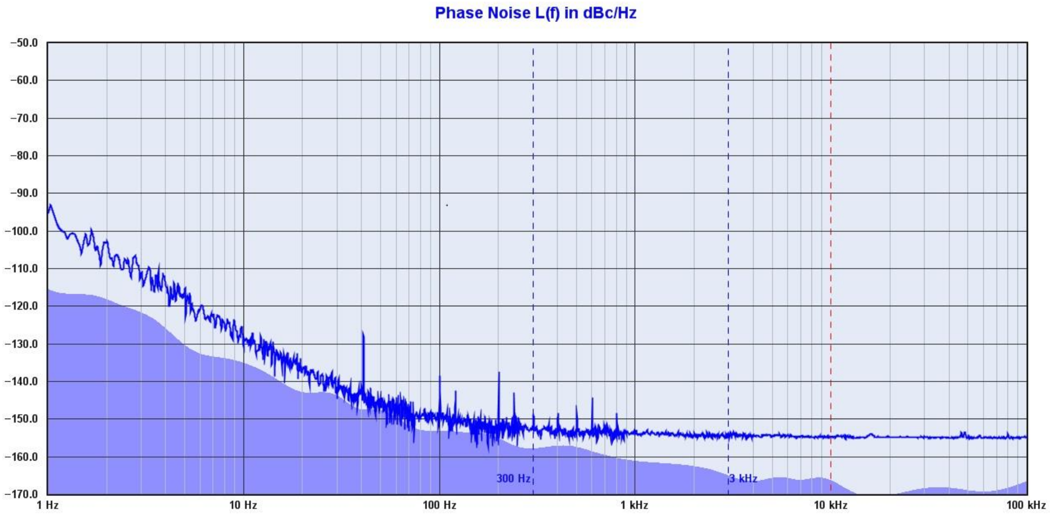
The NR3626 offers an option to dramatically reduce PPS jitter. The unit derives its stabilized PPS from a OCXO based counter that counts down the 10 MHz to 1 Hz. In addition, a unique feedback filter is added to modulate the loop to compensate for long-term loops disturbances. The result is jitter that is 600ps compared to 6000ps when in stabilized PPS Mode. This mode can be enabled/disabled from the serial port RS232 by the command $STBLM.

Once the PPS is accurately aligned to the GPS PPS to within 50ns and the oscillator frequency has stabilized, the unit will stop forced synchronization to the GPS, and will begin manipulation of the OCXO frequency to maintain PPS alignment. Parameters for a forced synchronization can be adjusted via RS232. For best results, allow the unit to run for one hour with GPS lock before enabling PPS Stabilizer.



Stabilized OCXO PPS pulse to pulse jitter

Phase Noise



Trace	Input Freq	Input Amplitude	dBc/Hz at 10 kHz	RMS Noise (degs)	RMS Jitter	Duration	Acquired	Instrument
NR3625-10181106	10.000 MHz	12.7 dBm	−154.7	8.51E−5	2.4E−14 s	2m 0s	1200 pts	TimePod 5330A

Programming Guide (RS232 Port)

The NR3626-O/G can accept user commands which will provide specific status and performance feedback, and which may be customized by the user. Many of the settings can be saved in non-volatile flash memory.

Commands that are handled by the GPS receiver are passed through to the GPS, and the responses returned. This allows the user to make all adjustments to the unit via a single serial port.

If the user makes changes which are intended to be kept between power-off cycles, the command "$SAVEFLASH*51 <CR><LF>" will update flash to reflect all current settings.

Table 1 shows a complete list of input commands and descriptions that are handled by the internal processor. In general, a command may be input without "=" or an additional value, and the unit will respond with the current setting's value. If the input is not understood, the microcontroller will return the value "$?*3F<CR><LF>"

NOTE: All commands should be prefixed with "$", and followed by <cr><lf>. Checksum can be enabled which requires the command to be followed by an asterisk (*) and a two digit hex value.

Example: $<*COMMAND*>*XX<cr><lf>.

The checksum can be required for all input commands and the requirement for a checksum can be enabled or disabled (default setting is disabled). The checksum method is the two-hexadecimal character representation of an XOR of all characters in the sentence between, but not including, the $ and the * character.

Example: $NVS1=1*76

The Status and control output of the NR3626 can be found in a separate document from the “Downloads” section of the website.

$GPNVS_STRING_DEFINITIONS

The NR3626 may use the following status strings, in addition to the NMEA data.

$GPNVS,7…
$GPNVS,8…
$GPNVS,9…
$GPNVS,10…

Setting	Command	Response	Description
DAC VOLTAGE	$DAC	$DAC=N.NNNNN	This command will force the DAC Control Voltage to a specific value. This value is modified perpetually by the GPS loop, and saved to flash memory. Do not modify this value except to test or calibrate unit.
PPS OUTPUT SELECTION	$PPS	$PPS=0	Select PPS output between the GPS PPS or the OCXO derived low-jitter synthesized PPS. Default is the OCXO PPS. 1 = GPS PPS 0 = OCXO PPS
PPS STABILIZATION MODE	$STBLM	$STBLM=1	Enable PPS Stabilization Mode. When Frequency variance decreases to within the margin of PSVAR, and PPS is aligned, the PPS will be manipulated by frequency assist to remain in GPS alignment, but with low jitter. Returns a 0 value if not ready. Also enables/disables “$STBWU”. 1 = Enable PPS stabilization if ready. 0 = Disable
ENABLE PPS STABILIZATION ON WARMUP	$STBWU	$STBWU=1	Enable PPS Stabilization mode when warmup and GNSS lock is complete. This value is saved to flash and allows the unit to recover PPS Stabilization mode after power cycle when ready. 1 = Enable PPS stabilization when ready 0 = Disable
FORCE PPS DISCIPLINE (PPS STABILIZATION OFF)	$DSC	$DSC=1	Enable PPS discipline to align the synthesized PPS to the GPS PPS within 50ns. The synthesized PPS will remain available even with loss of GPS lock. If PPS stabilization is enabled, the output will remain as the OCXO derived PPS. 1 = Enable discipline of synthesized PPS 2 = Disable discipline
PPS PULL ACTION TIMER	$PACT	$PACT=2	Sets frequency of PPS Pull application to frequency loop in seconds. Lower value is more aggressive. (0-9 seconds)

FREQUENCY VARIANCE THRESHOLD FOR ACTIVATION OF PPS STABILIZATION MODE	$PSVAR	$PSVAR=20	In PPS stabilization mode, this threshold determines the number of bits of frequency correction below which the PPS is determined to be steerable. If the variance in frequency is below this threshold, and PPS stabilization is enabled, the PPS will be manipulated by frequency to maintain low jitter. If the PPS Stabilization is off, this value is the threshold by which frequency “lock” is determined. (<=100) [cycles]

PPS DRIFT THRESHOLD	$PSDIF	$PSDIF=100	In PPS stabilization mode, this threshold determines the number of nanoseconds from the true PPS, below which the Synth PPS will be steered by frequency, avoiding a hard synchronization. This value is measured from a 4 cycle (20ns) delay from the GPS PPS to the Synth PPS, ensuring center exactly at point of discipline. To move the PPS pulse, either advance or delay, use the receiver command “$PERDAPI,PPS,…” from Appendix A. Note: While frequency variance is greater than PSVAR, PPS will still be forced to synchronization. (<=250) [ns]
PPS DRIFT CALIBRATION FACTOR	$PSCAL	$PSCAL=0.5	In PPS stabilization mode, this Cal Factor determines how much the proportional PPS difference is applied to the frequency adjustment. Higher is more aggressive. 0.1 to 10.0

Setting	Command	Response	Description
AUXILIARY FREQUENCY OUTPUT	$AUXFR=<INTEGER>	$AUXFR=<INTEGER>	Sets the auxiliary frequency output. Even integer devisors of 200,000,000 are recommended. Remainders of the calculation 200,000,000/AUXFR are truncated. Enter $AUXFR=0 to disable output. If disabled, allow 10 seconds for an enabled output to restart.
PPS PULSEWIDTH	$PULSW=<INTEGER>	$PULSW=<INTEGER>	Sets or returns the current PPS pulsewidth in ms. Range: 1 to 500 [ms]

Setting	Command	Response	Description
FREQUENCY LOOP LENGTH	$MLLEN	$MLLEN=15	Sets the integration loop period for the frequency measurement and correction cycle. A longer period allows more accurate frequency measurement, but reduces correction speed. (1-100 seconds)
FREQUENCY LOOP LINEAR CAL FACTOR	$MLCAL	$MLCAL=1.5	Sets the overall linear calibration coefficient which weights the frequency correction as it is applied. Higher values are more aggressive. (0.0 to 10.0)
FREQUENCY LOOP EXPONENTIAL CAL FACTOR	$MLPOW=2	$MLPOW=2	Sets the overall exponential calibration coefficient which weights the frequency correction as it is applied. Higher values are more aggressive. (0 to 6)
INPUT PRIORITY SELECTION	$INPREF	$INPREF=0	Sets the preferred locking source for the OCXO. The default order is: 0 – GNSS 1 – 10MHz input 2 – Optical input The priority will cycle in this order, starting with the source selected by $INPREF.

Antenna

Antenna - SMA
SMA female antenna connection. Provides internal 3.5VDC power at <40mA max. The Novus NA103 pole mount antennas or the Novus NA106 magnetic mount antenna are recommended for optimal performance.

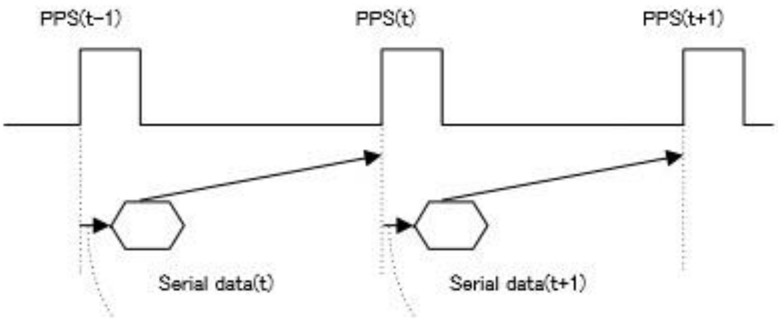
The receiver and companion elements generate the PPS and NMEA serial link. The serial link conforms to NMEA 0183 protocol. The 26 channel high-sensitivity, high-accuracy Multi-GNSS receiver supports TRAIM, GPS, GLONASS, QZSS, SBAS, Active Anti-Jamming and Advanced Multipath Mitigation Functions.

Typical Antenna Specs:

Frequency Band	1574 – 1607 MHz
Antenna Gain	2 dBic @ 90°
Amplifier Gain	@ 3.0Vdc: 26dB (typ)
Polarization	RHCP
Out-of-band Rejection	>60dBc @ f0 ± 50MHz
Impedance	50Ω
VSWR	2.0 Max
DC Input	2.8V - 6V
Noise Figure	<2.0dB
Power Consumption	25mA (typ)

PPS (Pulse Per Second)

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.

The PPS is selected by default from an internal synthesizer operated from the 10 MHz OCXO. This source is much more stable with pulse-to-pulse jitter below 1 ns while being within 100ns of the received PPS. If there is a need for the PPS directly from the receiver, the user can change the PPS output with the “$PPS” command as outlined in the Programmer’s Guide.

GNSS 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 a jitter level that is dominated by the oscillator and associated electronics. PPS jitter can be improved from the 5 ns range to less than 1 ns

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.

Factory Default Settings:

The PPS is, by default, the OCXO derived pulse which is disciplined to the GNSS PPS. The pulse-to-pulse jitter on the disciplined PPS is better than 15ns RMS. With stable mode applied, the OCXO PPS is no longer disciplined, but is steered, to maintain pulse-to-pulse jitter of less than 1 ns.

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

Pulse Width

The pulse width can be programmed from 1 to 500ms using the $PULSW command in the programming guide.

Output Drive

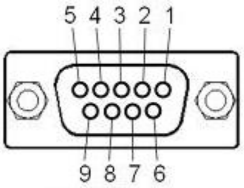
Connecting a PPS to a load is problematic at best. Connecting a 10 MHz sine to many devices is routine and the importance of matching load and cable impedances is well understood. The problems arise when connecting a PPS to a load in the same manner as a simple sine wave. A CMOS device will not drive 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. To address this problem, Novus offers PPS products with a configurable output drive section. Please discuss your drive requirements with a Novus Application Engineer.

Not all products offer all configurations. Selecting the right drive for your load characteristics will assure accurate timing and reliability. An incorrect match can cause ringing and/or damage a device.

RS232 / NMEA / Status / Command

The RS232 port (socket) provides the main NMEA-0183 data output, as well as input of command variables and flash settings.

The NMEA output is a combined structure of the GNSS receiver output and the onboard processor's status output. The commands from the Programmer's Guide are implemented on the RS232 port, as well as the receiver settings in attached Appendix A.



Female DB-9

Pin	Function	I/O
1	NC / Optional PPS	O
2	NMEA port / Command Port TX	O
3	NMEA Port / Command Port RX	I
4	NC	
5	GND	
6	NC	
7	NC	
8	NC	
9	Alert (3V3 CMOS)	O

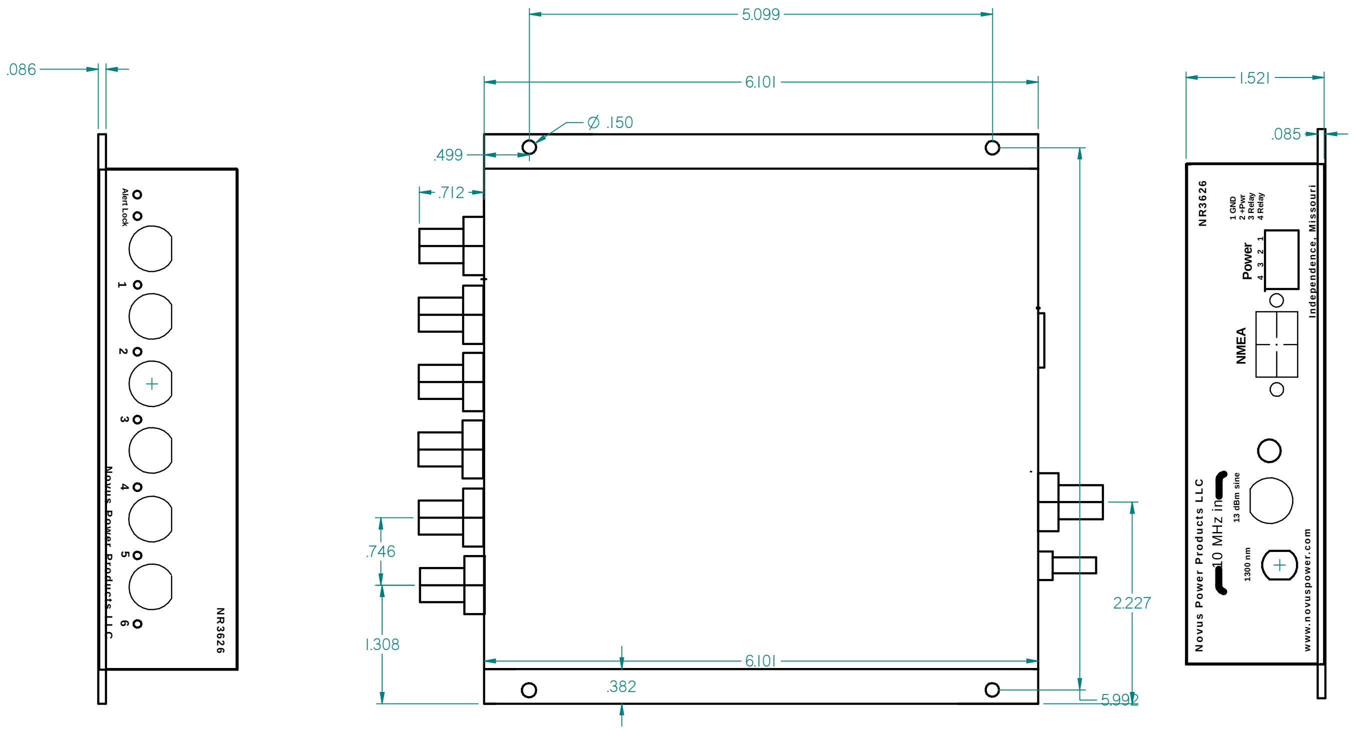
Note: Routing the PPS through the DB9 is offered as an option that might ease system integration.

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.

See attached Appendix A

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

Mechanical



The power connector is a four pin terminal block connector (Phoenix Contact part #1844236 or ON-Shore Tech Part# OSTOQ041251) and the unit ships with its mate (Phoenix Contact part #1840382 or ON-Shore OSTTJ0411530) pictured below. Wires are installed and secured with a slotted screwdriver.

Pin assignments:

1. + positive power
2. - power return
3. Status Relay 1
4 Status Relay 2

Typical Phase Noise/Allan Deviation

The typical phase noise is as indicated below. The low end phase noise is to be noted.

10MHz Sine - Primary Output

Offset Frequency (Hz)	Typical (dBc / Hz)
0.01	-35
0.1	-65
1	-95
10	-140
100	-145
1000	-150

There are optional phase noise performance levels available - contact factory.

Alerts-Function Relay

There are many critical circuits in the unit. These are monitored and a failure of any of these will initiate an ALERT condition. Alert is indicated by the front panel LED and the opening of the relay contacts on pins 3 & 4 of the power connector.

GNSS Indicators and Signals

The GNSS Lock LED illuminates green when the unit is locked to the GNSS, and the frequency stability is within the threshold variance (as set by $PSVAR command).. If the LED is flashing red twice, the unit is operating on the OCXO holdover, as the GPS is not locked. If the LED is flashing red once, the unit has GPS Lock, but the frequency error is outside the specified variance, or has not yet warmed up, at startup, for example. The frequency loop becomes active after a six minute warmup period.

The GNSS lock status is available via the serial output on the RS232 as well.

If the GNSS indicator remains flashing red for an extended period of time, it could be an indication of an antenna, cabling or unit malfunction. Confirm the antenna is still connected and has not become obstructed from a clear view of the sky. To check the unit, an alternate antenna can be tried in order to isolate the malfunction. For further support, please contact the factory 816-836-7446.

Specifications

Performance

10MHz sine	13 ±2 dBm, 50 Ohm - BNC
Harmonics	Less than -30 dBc
Locked stability	<~E-12 @ 100s (see Allan Deviation curve) After 30 mins (Post GNSS lock + Crystal Warmup 10 mins)
First year frequency stability	±50 ppb (long-term unlocked)
Temperature stability	±10 ppb (long-term unlocked)
Yearly aging	±50ppb (long-term unlocked)
PPS accuracy	15ns(1σ) (@-130 dBm) 50ns(1σ) (@-150 dBm)
Receiver sensitivity	-155dBm antenna power 3.3 Vdc<30 mA
PPS	15ns(1σ) (@-130 dBm) 50ns(1σ) (@-150 dBm) RMS accuracy, 3.3V logic, output impedance CMOS (±20mA) P-P jitter< 20 ns
PPS stabilizer	100 ns RMS accuracy, pulse-to-pulse jitter < 1000 ps
GNSS receiver	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
Antenna with LNA	
Antenna power	3.5 Vdc, < 35 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

Power requirements	Standard configuration is 12Vdc (9 to 15Vdc) Options- ±24Vdc (20 to 30Vdc), ±48Vdc (40 to 60Vdc) AC adapter available 100 to 240Vac, 50/60Hz
Connectors	BNC 10 MHz output
	BNC 10 MHz input
	BNC PPS (3.3 Vdc CMOS) (assigned when ordered)
Power connector	4-pin power connector - power-in. Mates with On-Shore Technology P/N OSTTJ0411530.

Environmental and Mechanical

Operating temperature	0 to 50°C non-condensing (extended temperature range available)
Storage temperature	-40 to 70°C
Width	6.0”
Depth	6.0” (exclusive of connectors)
Height	1.58”
Weight	~16 oz.

LIMITED HARDWARE WARRANTY

Novus Power Products (hereinafter Novus) warrants its products to the original end user ("original purchaser") and warranty is not transferrable. Novus guarantees that the NOVUS hardware products that you have purchased from NOVUS are free from defects in materials or workmanship under normal use during the LIMITED WARRANTY PERIOD. The LIMITED WARRANTY PERIOD starts on the date of shipment and for the period of 1 (one) year to be free from defects caused by faulty materials or poor workmanship, provided:
(a) NOVUS is notified in writing by Buyer of such defect prior to the expiration of the warranty period, and
(b) after receiving return authorization –RMA- from NOVUS, the defective item is returned with transportation prepaid to NOVUS, Independence,, Missouri, with transportation charges prepaid by Buyer …see RMA policy in Terms and conditions, and
(c) NOVUSs' examination of such unit shall disclose to its satisfaction that such defect(s) exist and have not been caused by misuse, neglect, improper installation, improper storage, unauthorized modifications, inadequate maintenance, operation outside the environmental specifications for the product, repair alteration, or accident. NOVUS assumes no risk or liability for results of the use of products purchased from it, including but without limiting the generality of the foregoing: (1) the use in combination with any electrical or electronic components, circuits, systems, assemblies or any other materials or substances; (2) unsuitability of any product for use in any circuit or assembly. Removal or tampering with tamper-proof label on merchandise will void warranty coverage unless with the written authorization from NOVUS
(d) an evaluation fee will be charged to Buyer to cover inspection and testing costs for any item returned by Buyer under this paragraph which is found to be within specifications and/or otherwise not the responsibility of NOVUS under the terms and conditions of this paragraph or any other part of this Agreement..
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Appendix A: NMEA, GPS Radio Control and Status

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
9.

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