	USERS GUIDE	NR2310D-R/O/G
	REVISION	P
	DATE	05/04/22

NR2310D-R/O/G

10MHz Rubidium Frequency Reference, GNSS-Locked, Low Noise, 10-Channel w/RS232, Display (Ethernet, SNMP – Optional)

Contents

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

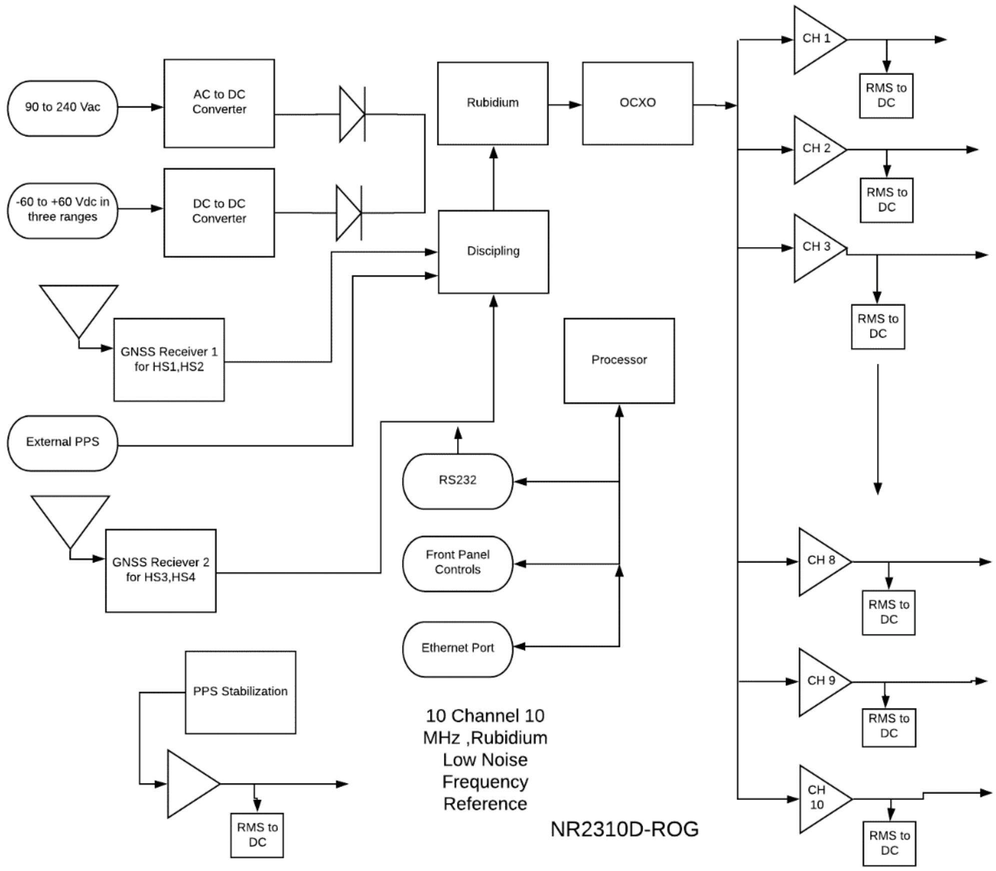
The equipment is meant to operate in a horizontal - top up configuration.

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 not 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.

Summary



The NR2310D-R/O/G is a high-performance ten channel, 10 MHz, GNSS-locked Rubidium frequency reference. The core time base is a Rubidium source that is disciplined with the timing information from the GNSS. The Rubidium source is followed by a low noise OCXO locked to the Rubidium. The ten channels provide a 13 dBm sine output that is transient, and fault protected. The unit also provides a single channel PPS output and a RS232 port. The RS232 port provides NMEA 0183 data as well as proprietary data streams for instrument status and control. The unit features a front panel display for equipment status and control. An optional Ethernet port allows remote access and control via SNMP. There are four levels of optional reference control for improved Allan Deviation performance and PPS accuracy and jitter. The platform also supports redundant power sources AC or DC. The unit may optionally be configured to lock to an external PPS signal.

The GNSS-Locked Reference

Novus offers four levels of GNSS locked reference performance:

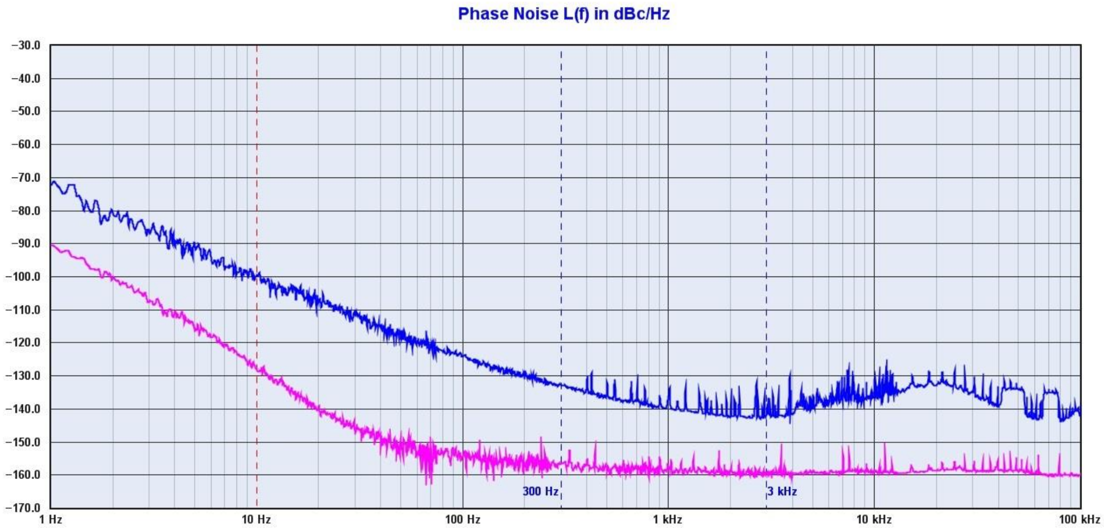
HS1 digital loop using basic radio
HS2 digital loop, basic radio, adding picosecond timing
HS3 digital loop, advanced radio, picosecond timing and thermal stabilization, Allan Deviation
HS4 digital loop, advanced radio, picosecond timing, thermal stabilization, Allan Deviation, and vibration isolation.

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, a 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 to allow the system designer to determine the level of performance required versus system cost constraints.

The Time Base

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 clean-up OCXO to achieve high stability and low phase noise. Following 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 compared to a typical OCXO ±50 ppb/year. The Rubidium source consists of a voltage-controlled crystal oscillator (VCXO) which is locked to a highly stable atomic transition in the ground state of the 85Rb isotope.

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

In addition to standard OCXO devices, Novus also uses double oven OCXOs as an alternative to a single oven OCXO. As can be imagined, a double oven OCXO offers improved temperature stability and is frequently a lower cost alternative to a Rubidium source.

A TCXO reference might be considered for a low-cost application. It offers an aging stability that is on the order of ±1000 ppb/year. Phase noise is typically not as good as that of an OCXO - but it is lower cost and consumes much less power.

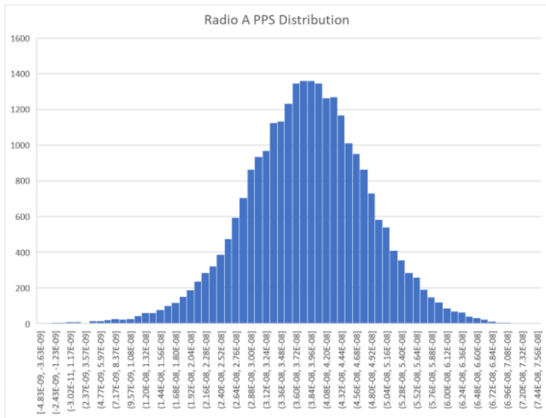
Timing Sources Comparison			
	Stability/Year	Temperature	Adev@1 sec
	ppb	ppb/ 0 to 70C	Seconds
TCXO	<+-1000	<+-1000	1.00E-09
OCXO	<+-50	<+-10	1.00E-10
Double OCXO	<+-10	<+-0.2	5.00E-12
Rubidium	<+-1	<+-0.1	5.00E-11

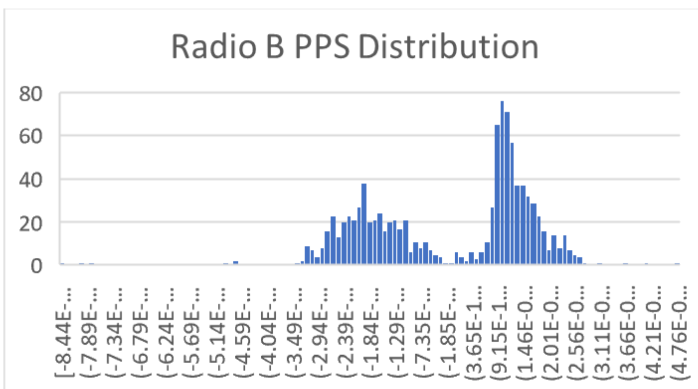
The GNSS Receiver

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. Following 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.

Novus uses two types GNSS receivers depending upon the stability options installed in the unit.

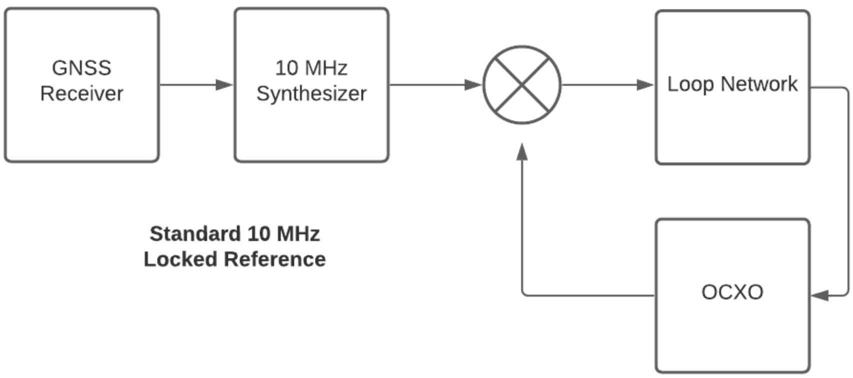
RADIO RECEIVER COMPARISON

		Standard	Advanced
Channels		26	184
Supported Channels			
GPS	L1C/A (1575.42 Mhz)	x	x
	L2C(1227.60 MHz)		x
GLONASS	L1OF(1602MHz)	x	x
	L20F(1246 MHz)		x
Galileo	E1-B/C(1575.42)	x	x
	E5-b(1207.140MHz)		x
BeiDou	B1l(1561.098MHz)		x
	B2l(1207.140Mhz)		x
Sensitvity			
GPS			
Tracking		-161	-167
Hot Start		-161	-157
Cold Start		-147	-148
Reacqusition		-161	-160
Glonass			
Tracking		-157	-167
Hot Start		-157	-157
Cold Start		-143	-148
Reacqusition		-157	-160

Stability Selection Types

Standard GNSS-Locked Reference – Analog Loop

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



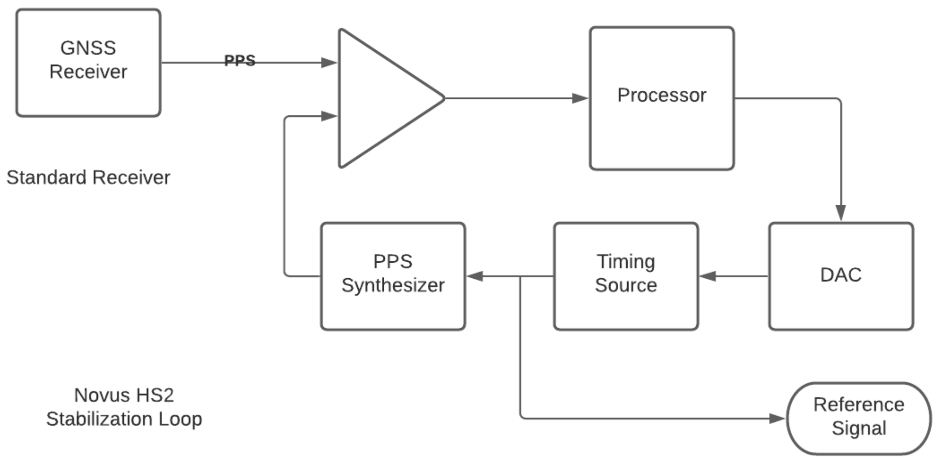
The standard loop does an outstanding job of controlling an OCXO. Components such as GaAs mixers provide excellent phase measurement performance, but close-in phase noise is difficult due to the size of the filtering components required and attendant leakage currents which are limited by the mixer drive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

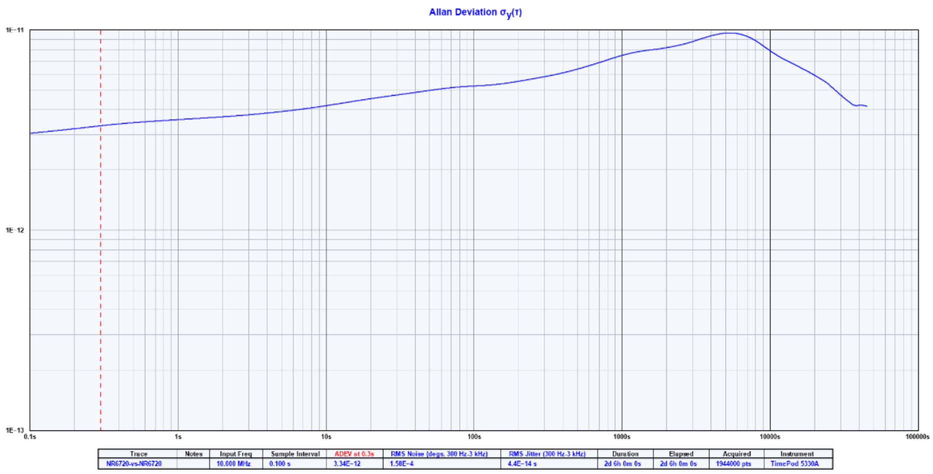
<u>Basic Digital Locking Loop (HS1)</u>

Though 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.



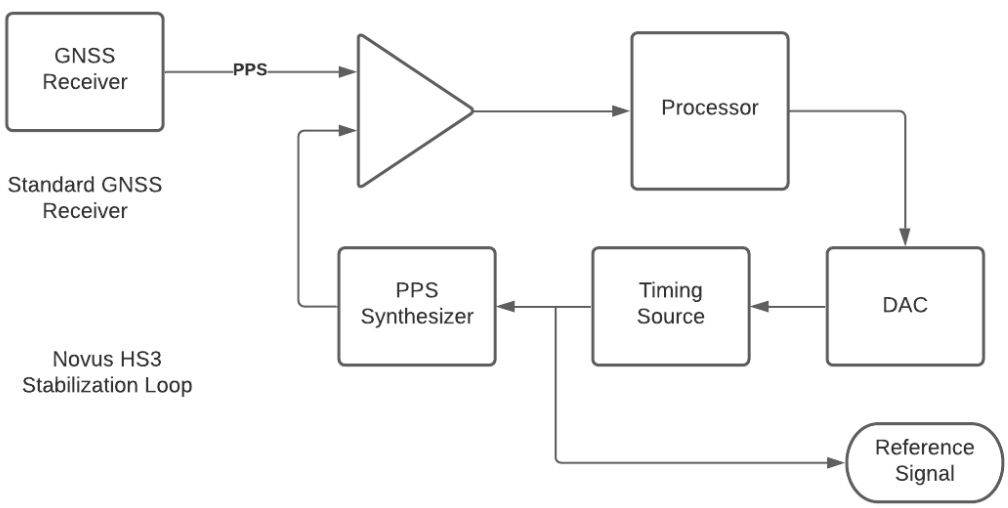
The HS1 improves Allan Deviation by an order of magnitude and close-in phase noise by 10 dB.

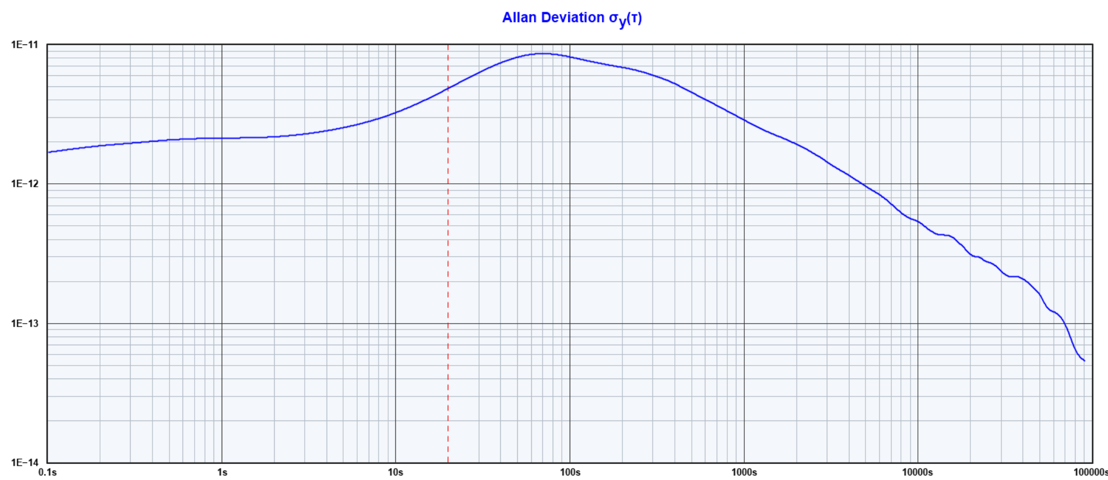
Trace	Input Freq	Input Amplitude	dBc/Hz at 0.01 Hz	RMS Jitter	Duration	Acquired	Instrument
NR3620 (Unsaved)	10.000 MHz	12.7 dBm	−4.9	5.2E−14 s	28m 41s	17214 pts	TimePod 5330A
NR6720–HS (Unsaved)	10.000 MHz	6.9 dBm	−33.7	2.8E−14 s	30m 0s	18000 pts	TimePod 5330A



<u>Advanced GNSS-Locked Reference (HS2)</u>

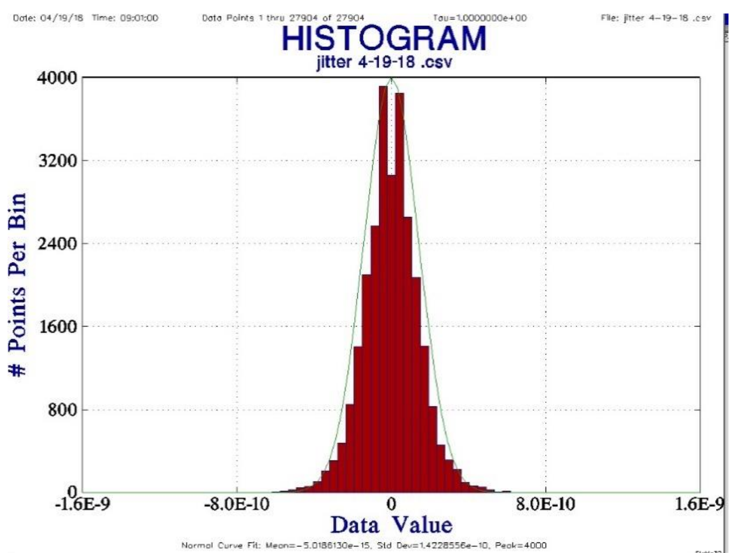
Our most advanced designs address long time constants digitally. High performance picosecond measurement techniques provide greater timing resolution. Advanced algorithms coupled with precise analog designs that are thermally controlled, and vibration-isolated allow Allan Deviation performance approaching 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

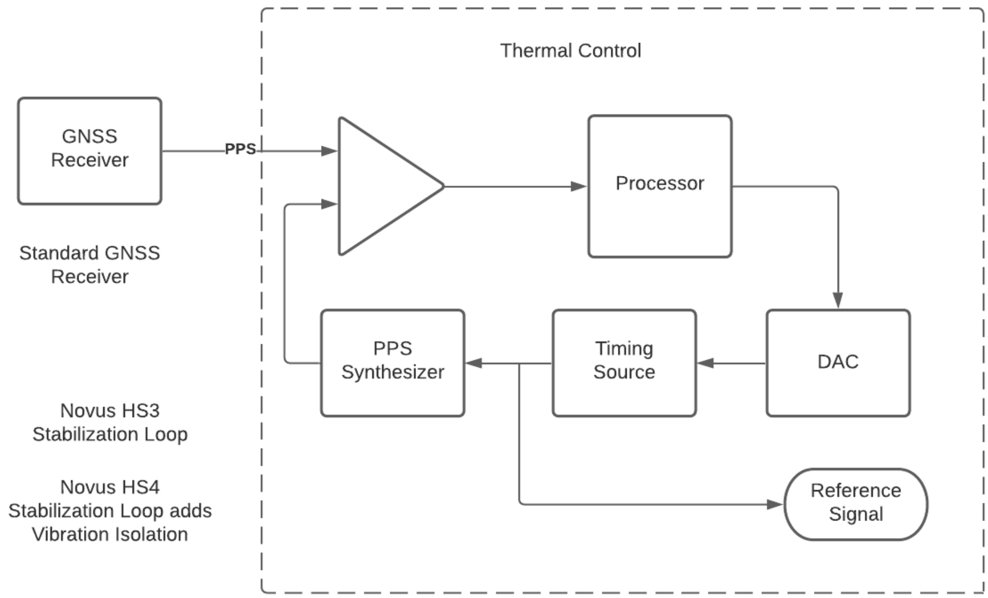
Our algorithms process the radio information to achieve a more stable reference. The curve below is a plot of timing jitter after processing:



The standard deviation improved from 17 ns to approximately 400 picoseconds. 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 so that if there is a defined variation from the baseline 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.

<u>Thermally Isolated Reference (HS3)</u>

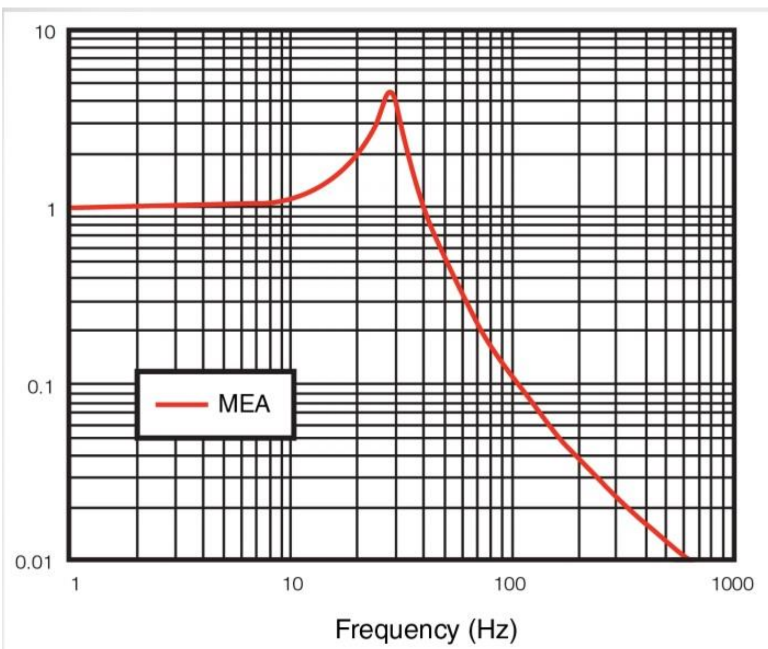


Thermally and Vibration Isolated Reference (HS4)

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.

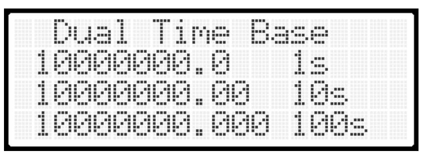
The vibration option adds vibration isolators to attenuate shock and vibration coming from the environment. Below is an attenuation curve for the option.



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.



External PPS Locking

The unit may be configured to lock to an external PPS signal. The signal must conform to 3.3 V CMOS into a 1000 Ohm load. Rise time must be less than 10ns and the pulse width must be greater than 10ms.

GNSS Antenna (recommended)-HS1,HS2

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. The GNSS receiver provides power for the LNA in the antenna. The unit was designed to provide 3.5 Vdc <25 mA of current.

Novus NA103A

Novus NA106

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)

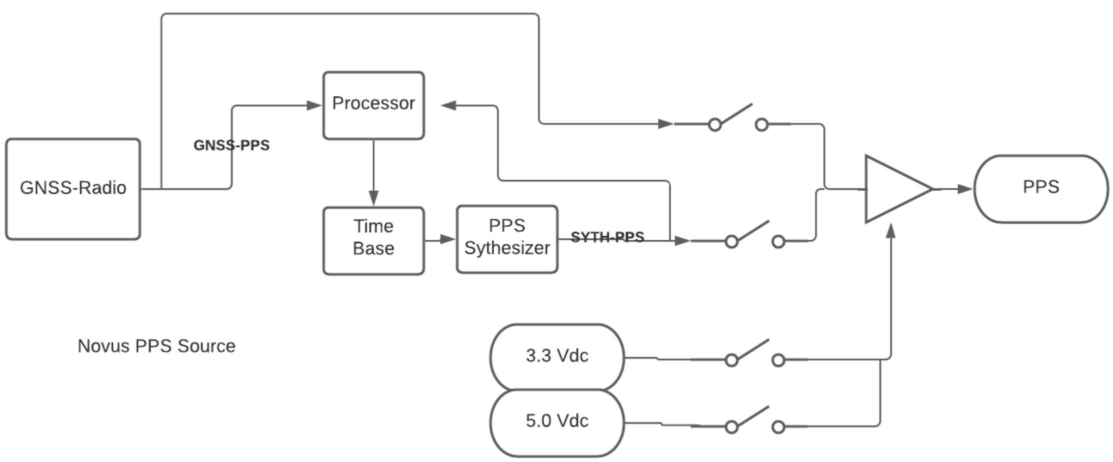
GNSS Antenna (recommended)-HS3,HS4

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	

PPS

The PPS signal is available on a rear panel SMA connector. There are numerous attributes that can be controlled via the serial port or were selected at the time the instrument was ordered.

- The PPS can be radio sourced or a synthesized PPS. User programmable.
- The PPS may be 5 or 3.3 V CMOS - Amplitude > 2.4 Volts into a 50 Ohm load. Default is 3.3 V CMOS. Selected at the time of ordering - factory configurable only.
- PPS pulse width is programmable- Radio PPS 1ms steps to 500ms, Synthesized programmable to 500ms in 20ns steps. User programmable - default is 200ms.
- Cable delays - compensates for the length of the cable in 1ns steps. User programmable. Default is 0.

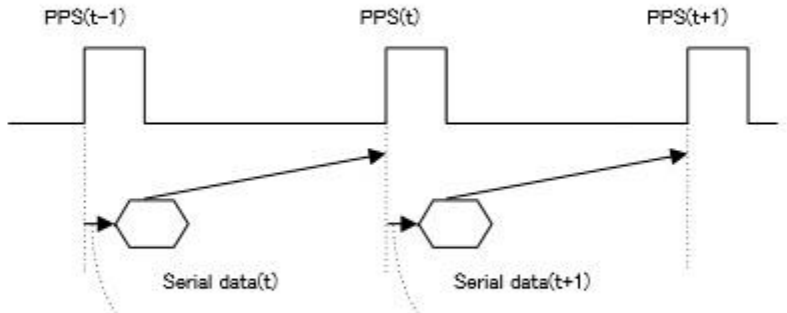


Novus PPS Source

PPS Source

Depending upon the stability option purchased, the PPS has different performance levels. The accuracy of the PPS changes and the pulse-to-pulse jitter varies. Also, the PPS may be selected to be sourced from a synthesizer or the receiver:

The rising edge of the PPS is the start of the second for the NMEA data just received.

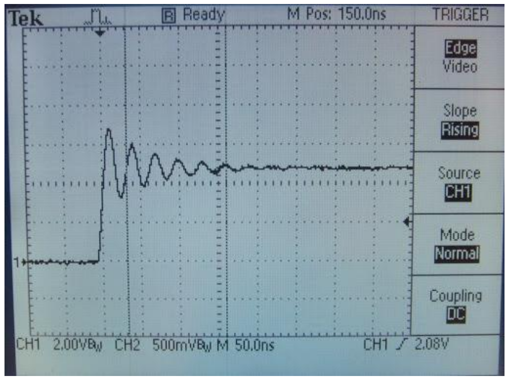


PPS	
Amplitude for 1PPS	3.3 Vdc CMOS (5 Vdc option)
Pulse width for 1PPS	Programmable 1 to 500ms in 1 usec steps
Rise time for 1PPS	<5 ns
Accuracy @1 σ	
analog	15ns
HS1	15ns
HS2	15ns
HS3	5ns
HS4	5ns
Pulse to Pulse Jitter @ 1 σ	
analog	5ns
HS1	5ns
HS2	GNSS-PPS <5ns SYTH-PPS< 200psec
HS3	GNSS-PPS <5ns SYTH-PPS< 200psec
HS4	GNSS-PPS <5ns SYTH-PPS< 200psec

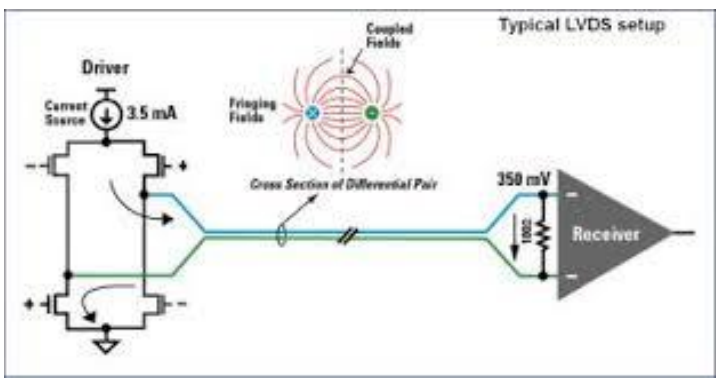
PPS Cabling

Connecting a PPS to a system is a subtle challenge. It is a pulse and as such, connecting a pulse to a distant point is not simple. Firstly, the very name PPS implies that you are dealing with a 1 Hz signal. Nothing could be further from the truth. Most PPS pulse signals have a rise and fall time that is on the order of 5ns – this is more like a 200MHz signal than a 1 Hz signal. In addition, while many loads look like a CMOS high-impedance load, attempts to connect with 50 Ohm cable frequently end up with ringing that may cause an edge to become ill-defined.

PPS Ringing

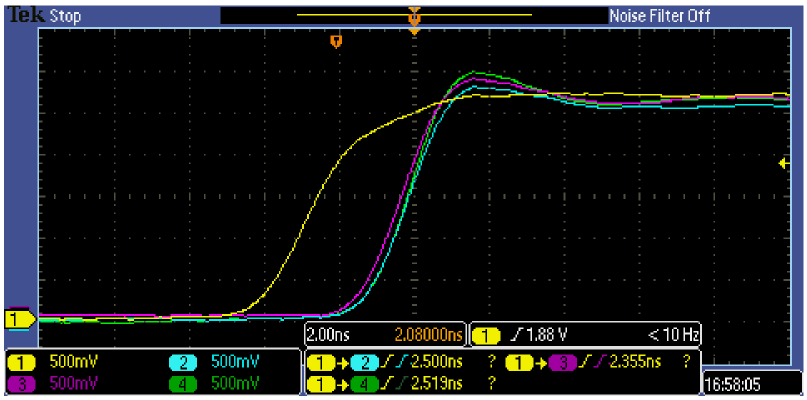


If properly terminated – a 50 Ohm cable can be used, but most CMOS drivers will not drive a 50 Ohm load. If the load is 5 Vdc CMOS at 50 Ohms, then the drive current is approaching 100 mA. This high drive current also compounds the short circuit protection that is essential in any complex system. Short run, high impedance cabling can work if done so carefully. Other options include LVDS. LVDS works very well < 20 meters and is offered on several references.

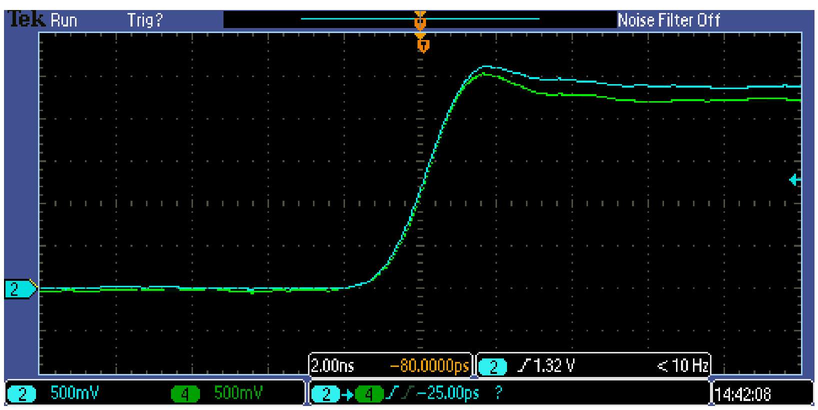


In applications where there is more than one client, a PPS distribution amplifier should be considered. A distribution amplifier will add latency (~25 ns) and skewing. Skewing in the 100 psec range is possible but must be carefully specified.

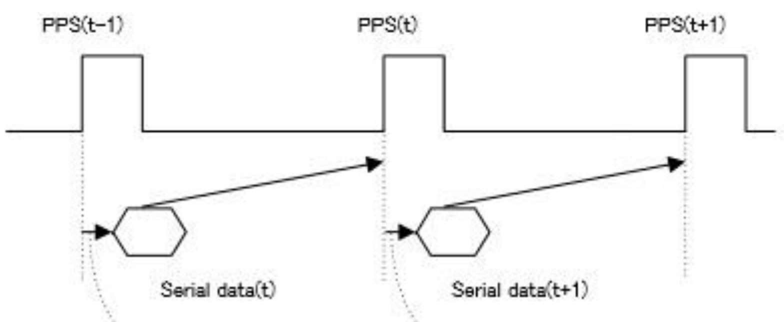
Novus PPS Distribution Amplifier Latency



Novus PPS Distribution Amplifier Skewing



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.

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. See Appendix C for status strings.

Pulse Width

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

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

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

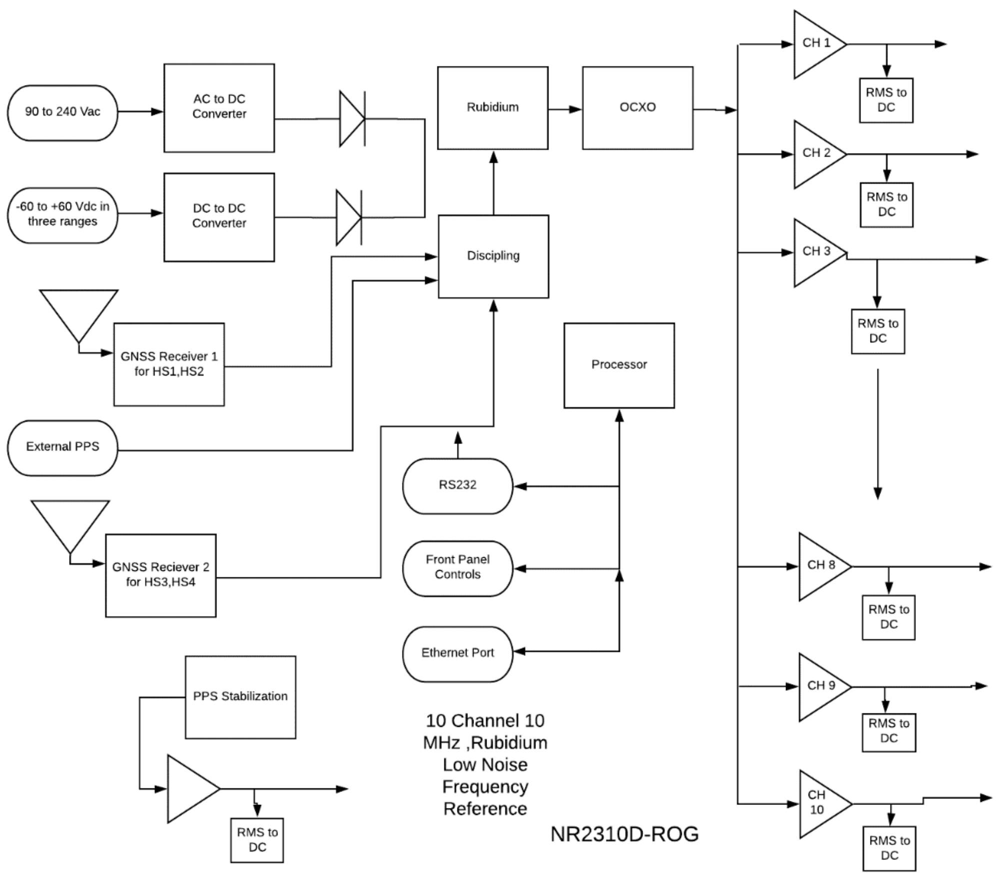
The receiver supports eight standard NMEA output sentences (GGA, GLL, GNS, GSA, GSV, RMC, VTG and ZDA) per NMEA standard 0183 Version 4.10 (June 2012). By default, the RMC, GNS, GSA, ZDA, GSV and TPS sentences will be output every second. The sentences can be independently enabled and disabled using 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).

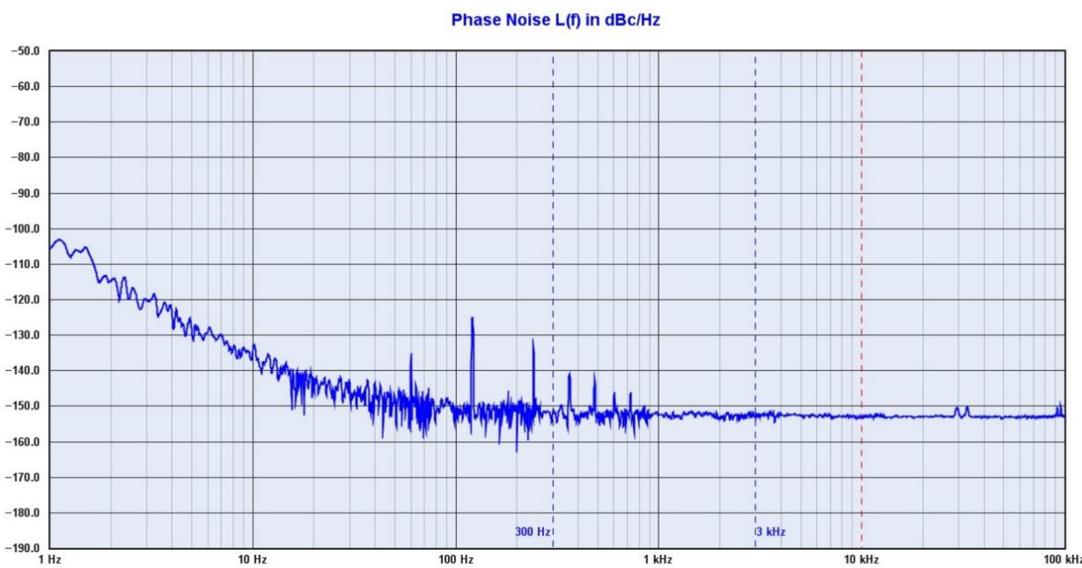
The unit display allows local monitoring and remote monitoring via an RS232 serial link or Ethernet port.

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.

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 LEDs

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. The alert condition is diagnosable by parsing the status strings on the serial port.

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.

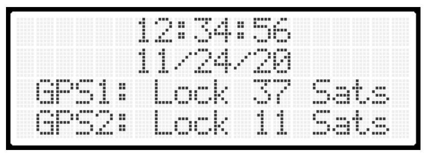
Since the NR2310D-R/O/G is a GPS-locked reference, during power-on, the OVEN LED will flash during tracking, and until a GPS-lock status is achieved. This can take up to 30 minutes – typically < 10 minutes.

Digital Display (optional)

The NR2310D-R/O/G 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 NR2310D-R/O/G will display the time and date as well as the current status of the GNSS receiver.

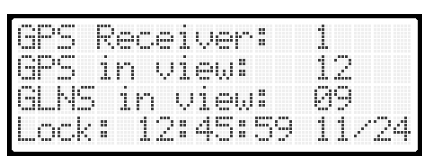


GNSS: The GNSS status indication allows the user to observe the lock status of the receivers, and the number of GNSS satellites in view. Before GNSS-lock is acquired, the status will be “Tracking” and the number of satellites will be shown. When GNSS-lock is acquired, the status will change to “Lock.”

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. (There are two GNSS receivers when the unit has the Dual Time Base option.)

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

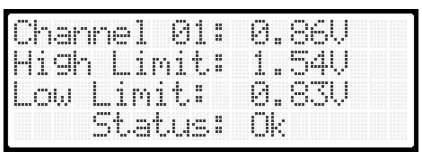
Channel Status

The channel status can be determined by reading the actual RMS value on the output of each stage. This is compared to a threshold limit that is set by the user as a percentage variation from a saved value. The default variation value is set at ±25% percent from the current state of the amplifier and is user programmable in 5% increments from ±10% to ±60%.

The range of acceptable channel amplitude can be narrowed around a connected balanced line, such that a channel status below the alert threshold indicates a shorted line, while a channel status above the alert threshold window indicates a potential disconnected cable.

The threshold value at which a channel alert is triggered can be programmed on the alert threshold screen, or programmed via the RS232 port. Once set, the unit would continue to monitor each channel and a deviation beyond the set limits would be reported as a failure on the front panel and via RS232.

The channel status feature can quickly detect a cabling failure. Any change in the load impedance will change the output voltage with respect to the divider formed by the output impedance of the amplifier and the load impedance. Failing cables and connectors can be detected early.

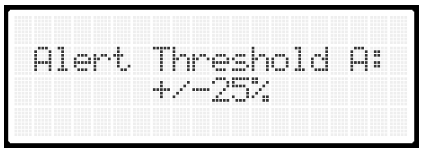


The current threshold limits are displayed in addition to the actual measured value. These values reflect the percentage threshold defined in the alert threshold settings. If the output value is too low to give a valid reading, the display will read “LOW.”

The status is displayed on the front panel and is accessible over the RS232 serial bus via DB9.

Alert Threshold

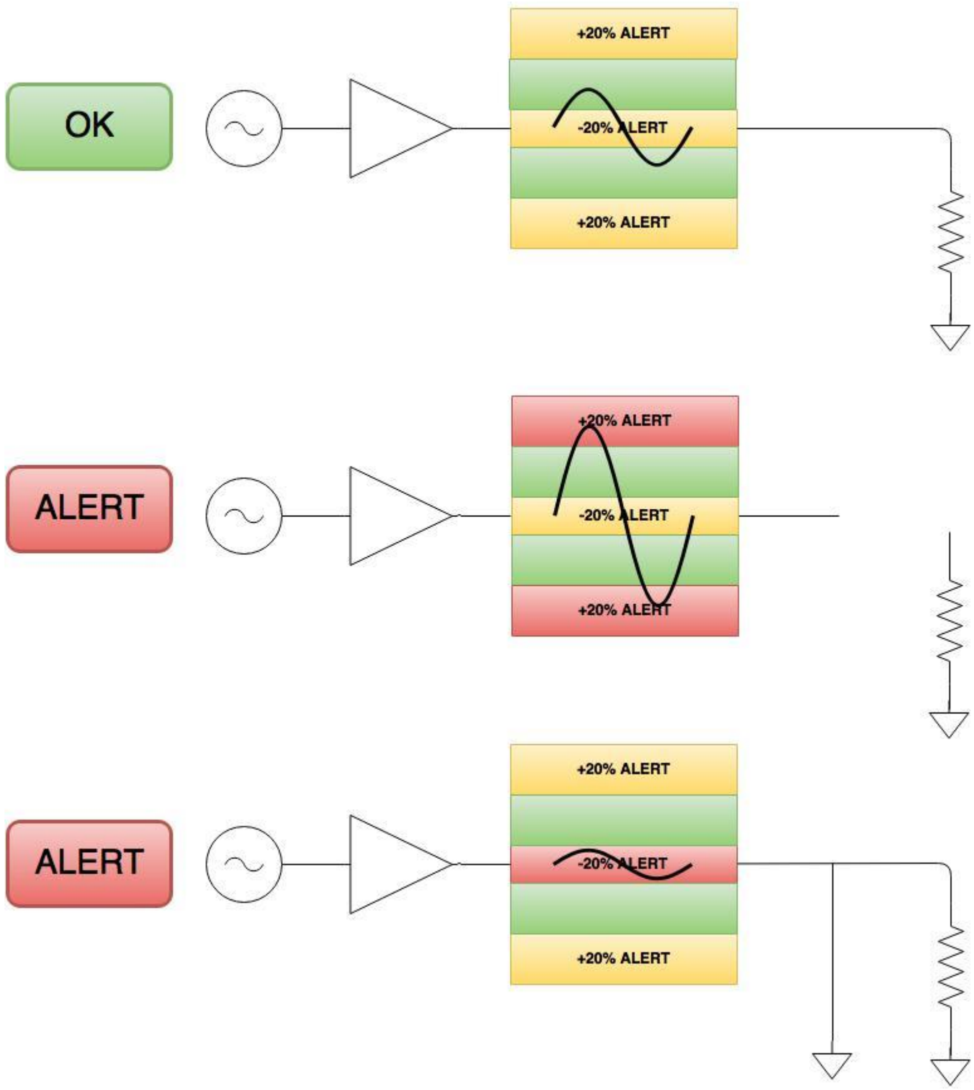
The alert threshold screen allows the user to adjust the tolerance from the reference voltage which, if exceeded in either direction, the output channel will report a fault status. The default threshold value is set at ±25% percent from the current state of the amplifier and is user-programmable in 5% increments, from ±10% to ±60%.



The output channel has a reference voltage which can be set by latching the channel's current value in the Latch Channel Average Screen. The output reference voltage can be set individually by writing the value serially with the $SET command. After saving the current configuration on a channel, any subsequent deviation on that channel which exceeds the alert threshold percentage will trigger an alert.

Steps to ensure correct alert configuration:

- connect distribution cabling to the 10MHz output
- set alert threshold to desired range
- save current channel voltage with the Latch Channel Values screen
- save current settings on the Save Configuration screen



The alert threshold can be optimized so that a channel short or an impedance change will cause an alert.

Example:

The output of channel 1 is connected to a high impedance input and reports 1.25Vrms at the output.

Alert threshold is set to +/-20%.

The current state is saved in the Save Configuration screen.

The Channel 1 alert will report when:

- *The Channel 1 output is higher than 1.50Vrms*
- *The Channel 1 output is lower than 1.00Vrms*

To adjust the alert threshold from the front panel, hold the NEXT and SELECT buttons down simultaneously for two seconds. The percentage value will begin flashing. To increase the value, press the SELECT button. To decrease the value, press the NEXT button.

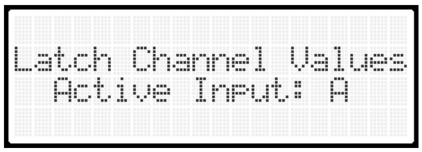
When the desired value is reached, press the NEXT and SELECT button simultaneously to leave the settings mode.

The alert threshold settings can be modified via the RS232 serial port with the $FLTTHR command.

For details on the alert threshold, see Programmer's Guide.

Latch Channel Value

The Latch Channel Values screen allows the user to save the current channel output value for use as the reference value for alert settings.

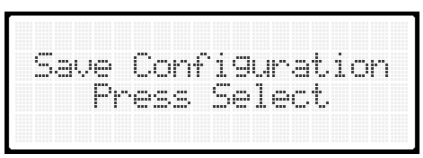


A channel alert is triggered when the channel output voltage exceeds or falls below a percentage of the reference value. This reference value is 1.10Vrms as a default, but can be set by the user.

There are two ways to set the reference voltage. The RS232 serial port allows for setting an individual channel's reference voltage with the $SET command. The user can also use the Latch Channel Values to take a snapshot of all current outputs and use these as the reference values.

Save Configuration

The Save Configuration screen allows the user to save the current settings for alert threshold, input threshold, attenuation, input select, reference voltage and any other settings that have been modified via the RS232 port.



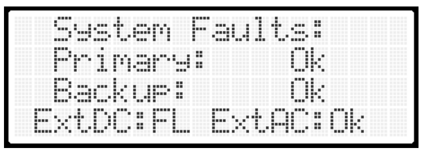
To save the current settings, press the SELECT button twice.

The Save Configuration action is equivalent to the $SAVEFL command on the serial port.

Fault Status

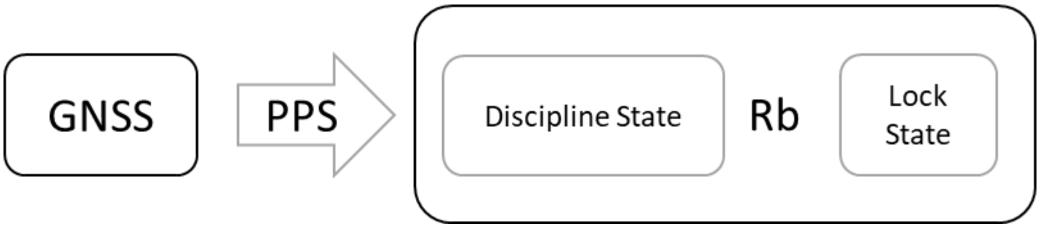
The fault status screen allows a quick overview of any channel faults from the front panel.

Press SELECT to advance to the System Fault Screen.



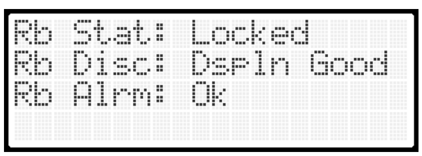
The System Fault screen indicates any failures in the primary system or the redundant backup system. All internal power supplies are monitored (12 V, +5V, -5V, 5Vlogic) on both the primary and backup systems. A failure on one of these supplies will be indicated with a “PS FAIL” fail warning for either system. A communication failure would be indicated by a “Com FAIL” indicator. Either of these fault statuses will result in the change of the primary to the backup system. The individual statuses of the internal power supplies are also available via the RS232 serial port.

The presence of a valid DC input voltage is indicated on this screen, as well as a valid AC power input. If either of these supplies are not present, a “FL” indication will be shown next to the appropriate input.



Rubidium Status – Lock State

The Rb status screen provides a snapshot of the current Rubidium status and its relationship to the GNSS PPS input.



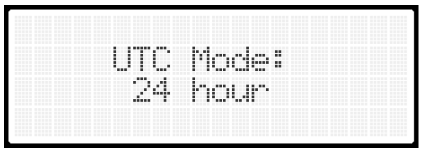
The Rb status screen will report both discipline state and lock state as reported by the Rubidium module. The default status for the PPS input discipline is Holdover, until a valid PPS is detected. The lock state will progress through stages:

Upon power up, the Rubidium enters a heating and initialization period, during which the Rb status is “Heat/Init”. Laser-lock is followed by full lock state.

When GNSS is present and providing a PPS to the Rubidium module, the Rubidium will enter the discipline state. If the Rb is currently still disciplining, but has not reached the specifications required for holdover, the screen will report “Dspln Wait”. Once the disciplining process has provided enough samples for holdover, the screen will report “Dspln Good.”

UTC Mode

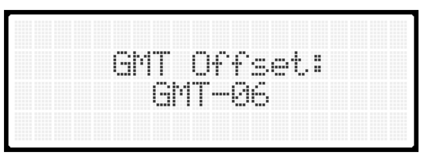
The user can select how the time is displayed on the screen by choosing between three formats: UTC, 24-hour mode, or 12-hour mode. Toggle through the modes by pressing the SELECT button.



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.

RS232 NMEA / Alert – DB9 Male (optional)

RS232 Communication at 38400/115200 baud, 8 bit, no parity. Flow Control: None.

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

DB9 Male Connections

Pin 2: Tx
Pin 3: Rx
Pin 5: GND

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

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.

Functional Description (Base NR2310D-R/O/G)

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, indicated in the serial output, and 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 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.

Redundant Power

The unit may have an external secondary power source. It may be AC or DC.

Specifications

Technical Specifications

Output	10 MHz 1 Vrms ±0.2, into 50 Ohms, 10 channels, Sine
Harmonic Distortion	< -30 dBc
Connectors	available with either BNC or SMA connectors
Rubidium Atomic	
Accuracy at shipment	+/-5.0E-11
Warm-up time	<15 minutes
Time of lock	<5 minutes
Time to achieve accuracy	<±1E-9<20 minutes
Aging - monthly	<±5E-11
Retrace	<±1.0E-10 after 1 hour
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) > 2.5 Vdc @ 50 Ohms
Pulse width for 1PPS	Programmable 1 to 500ms in 1 usec steps
Holdover	Rubidium < 20 usec/day
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
Connector	SMA
Load impedance	50 Ohm
Location	rear
Typical Phase Noise	
Offset	
1 Hz	-95 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	(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
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-with SNMP option)

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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