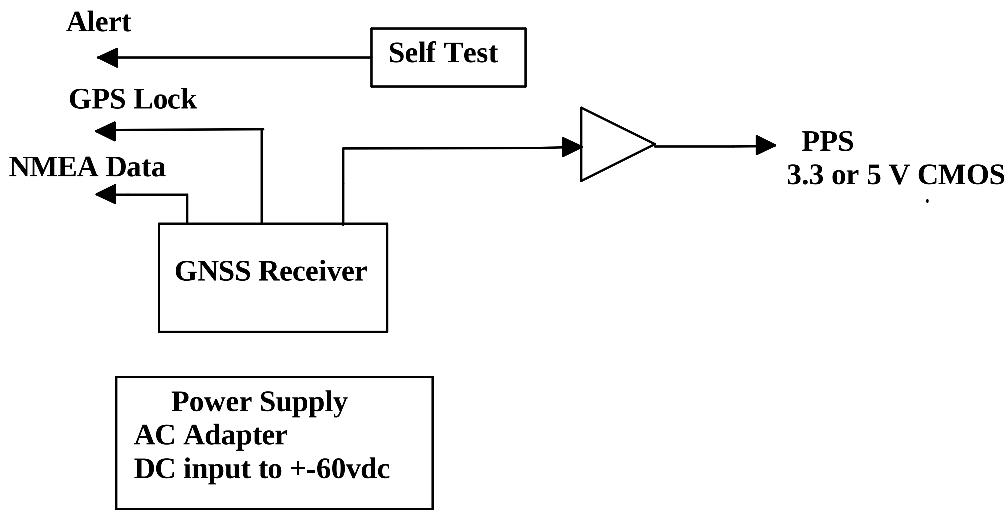
NR3700-G-PPS

NMEA-PPS Source

Contents

1.0 Overview



The NR3700-G-PPS is a GNSS locked PPS/NMEA source. Ideal for critical timing applications. The NMEA data is configurable as to the NMEA strings to be provided. PPS cable compensation is also possible through the RS232 port. The PPS can be supplied at either 3.3 or 5 Vdc CMOS.

The RS232 interface provides access to the NMEA-0183 data from the GPS at a baud rate of 38.4K. The baud rate can be changed through the RS232 port.

The unit operates from power in the voltage range of -60 to +60 VDC in three power supply ranges that must be specified at purchase. There is also an AC power adapter available.

PPS pulse is a LVCMOS signal and is also short and transient protected. The PPS has an accuracy of 30 ns rms and is available on the front panel as an option with a SMA connector

The NR3700-G-PPS also incorporates built-in test to monitor critical parameters such as the power supplies and other functions. The built-in test drives a front panel indicator.

The GNSS lock status is provided by a front panel indicator. An unlocked state can be detected via the RS232 port. Many systems will use this signal to detect a long-term GNSS loss of lock state which may be caused by an antenna or cabling issue.

Less than 5 Watts of power from a 12 VDC nominal source is consumed. An AC power adapter is available to allow direct operation from standard AC power. Also, Novus offers related NR3700 products that can operate anywhere from –60 to +60 VDC. Contact the factory for further details. There is a PCB assembly version of this product (NR4400) which offers essentially the same functionality and can be directly embedded in a system - smaller size and lower cost.

The output is transient and fault protected.

GNSS Receiver

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.

Antenna

Antenna - SMA
SMA female antenna connection. Provides internal 3.3VDC power at 20mA max. The Novus NA103 Pole Mount Antenna or the Novus NA106 Magnetic Mount Antenna are recommended for optimal performance.

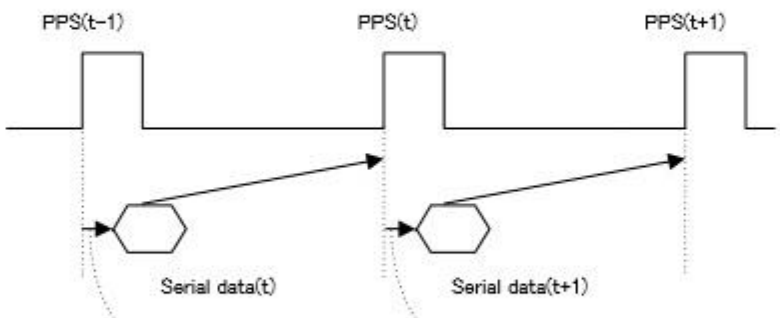
The receiver and companion elements generate the PPS and NMEA serial link. The serial link conforms to NMEA 0183 protocol. The 26 channel high-sensitivity, high-accuracy Multi-GNSS receiver supports TRAIM, GPS, GLONASS, QZSS, SBAS, Active Anti-Jamming and Advanced Multipath Mitigation Functions.

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	20mA (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.

There are a number of attributes for the PPS that can be controlled via the RS232 port with the radio:

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

The PPS pulse is a CMOS drive capable of providing 30 ma. The unit is available with either 3.3 or 5 Vdc logic levels.

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. 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 60 ps.

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

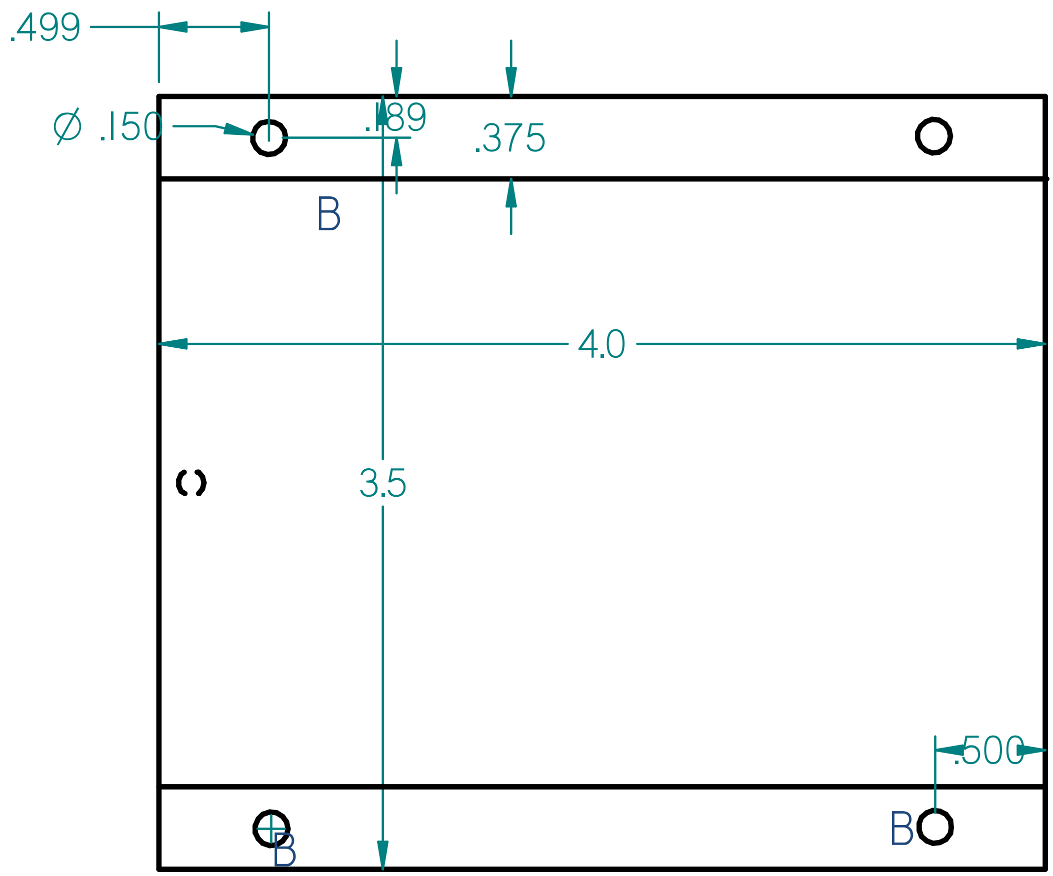
The receiver supports eight standard NMEA output sentences (GGA, GLL, GNS, GSA, GSV, RMC, VTG and ZDA) per NMEA standard 0183 Version 4.10 (June, 2012). By default, the RMC, GNS, GSA, ZDA, GSV and TPS sentences will be output every second. The sentences can be independently enabled and disabled using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

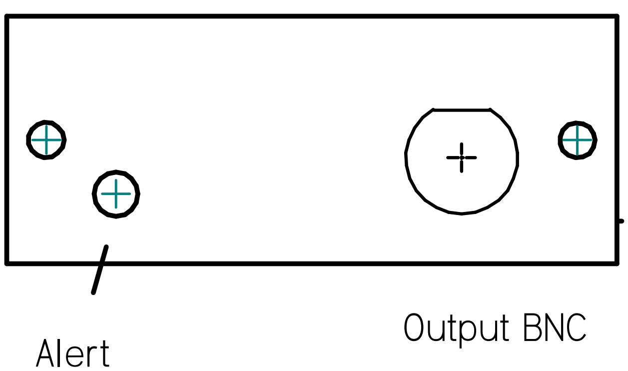
There is considerable detail available from the Novus website download page:

Receiver Control Information.

Input/Output Connectors/Mechanical



Front Panel



GNSS Ant - SMA connects to the GPS ant - provides 3.3 VDC 45mA max

PPS - SMA or BNC one pulse per second

RS232 - standard NMEA output NMEA-0183

Power Connector

The power connector is a 2 pin terminal block connector that mates to (ON-Shore Tech Part# OSTTJ0211530). Wires are installed and secured with a slotted screwdriver.

Pin assignments

1. power ground
2. power positive

The unit is designed to operate from 12 VDC nominal power and is reverse polarity protected.

Pin 1 is designated on the panel and is the far-right pin as directly viewed.

Pin	
1	N/C
2	NMEA – Tx
3	NMEA- Rx
4	no connection
5	GND
6	N/C
7	N/C
8	N/C
9	N/C

Contact closure occurs in the normal operating state for Alert.

Alerts-Function

There are numerous critical circuits in the unit. These are monitored and a failure of any of these will initiate an ALERT condition. The ALERT LED will flash red.

Technical Specification

Locked Stability	<~E-11 after 100 seconds	
RS232	NMEA 0183 at full RS232 levels default is 38.4K Baud	
Antenna power	3.5 Vdc < 40 ma	
Receiver Sensitivity	-155dBm	
PPS	15ns(1σ) (@-130 dBm) 50ns(1σ) (@-150 dBm) RMS accuracy, 3.3 volt logic(5 vdc logic option), output impedance CMOS (±20mA)	
Power Requirements	9 to 15 VDC @ 1.0 amps max (10 Watts) (Voltage range -60 to +60 available - contact Factory.	
Connectors	BNC 10 MHz output	
	SMA PPS 3.3 VDC CMOS	
Power mate	2 pin Digikey ED10554-ND	

10.0 Environmental and Mechanical

Operating Temperature	0 to 50°C non-condensing (extended temperature range available)	
Storage Temperature	-40 to 70°C	
Width	4.0” (exclusive of connectors)	
Depth	5.0”	
Height	1.5”	
Weight	~16 oz.	

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Appendix: GNSS Command Reference