NR3620-CAL

10MHz Frequency Reference, OCXO, GPS/GNSS-Locked
Single Channel, Auto-Cal

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1.0 Overview

The NR3620-CAL is a GPS locked OCXO 10 MHz frequency reference with PPS and RS232. The unit features Auto-Calibration so that the most recent coefficients to compensate the OCXO for drift due to aging and/or temperature are stored and applied to the OCXO during GPS loss of lock conditions. These coefficients are updated after eight hours of continuous GPS locked state. This effectively eliminates long-term OCXO changes.

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 using commands described in Appendix A (Output Format Section).

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.

The output is a 10 MHz sinewave at 13 dBm (1.0 Vrms). The output is short circuit and transient protected.

PPS pulse is a LVCMOS signal and is also short and transient protected. The PPS has an accuracy of 30 ns rms. The unit may be ordered with the PPS level at 3.3 or 5 VDC CMOS levels and is capable of driving a 50 Ohm load (units mfg. after March 2020).

The Global Positioning System (GPS) transmits a wealth of data. The information is routinely used for position and timing. This signal is what is used by all GPS disciplined oscillators for master timing.

The first part of the process is acquiring the GPS satellites and deriving what is called the PPS signal. This is a pulse that occurs once a second. Most GPS receivers will specify an accuracy for the leading edge in the range of ~20 ns rms. Due to atmospheric conditions, multi-path and other effects, there is considerable jitter on the pulse. This pulse, with exceptional long-term accuracy of ~E-12, is the starting point for the GPSDO.

The PPS is used to derive a 10MHz signal. As you can imagine, the algorithms for the generation of the 10MHz are very sophisticated. You are, in effect, creating a 10MHz waveform with frequency measured once a second by a waveform which has considerable jitter.

To get a useful frequency reference, the jitter (phase noise) of the frequency reference must be improved. A very low bandwidth phase locked loop is used to lock a high performance 10 MHz OCXO to the synthesized disciplined 10 MHz. By virtue of having a very low bandwidth, the high frequency jitter is dramatically reduced. There are numerous tradeoffs - speed of acquisition, phase error, stability, cost, etc. It is a complex feedback loop and as such, there are many solutions. Noise on the final output is also affected by the noise in the system. Noise from power supplies and other circuits can easily sum with the output signal. Care has been taken throughout the design to achieve a high quality signal.

The phase noise of the output is now largely dominated by the voltage controlled oscillator. The oscillator is typically a crystal oscillator and the quality of that device can vary significantly. The NR3620-CAL uses an oven-controlled oscillator to provide an unlocked stability of under 50 ppb/year.

The calibration feature continually monitors the correction coefficients developed through GPS timing information. These are sampled multiple times per day and stored in non-volatile memory and in the event of a GPS loss, the saved coefficients are applied to the OCXO. This effectively eliminates long-term crystal drift.

The NR3620-CAL also incorporates built-in test to monitor critical parameters such as the OCXO oven, power supplies and other functions. The built-in test drives a front panel indicator and a set of relay contacts accessible on the front panel DB-9 connector. The GPS lock status is provided by a front panel indicator and a signal accessible on the front panel DB-9. Many systems will use this signal to detect a long-term GPS loss-of-lock state which may be caused by an antenna or cabling issue.

The NR3620-CAL draws less than 10 Watts of power from a 12 VDC nominal source. An AC power adapter is available as an option to allow direct operation from standard AC power. Also, Novus offers related NR3620 products that can operate anywhere from – 60 to +60 VDC. Contact the factory for further details.

The output of the OCXO is buffered and amplified. The buffering is completely fault protected and is followed by ESD protection circuitry. The output is also monitored for signal presence and if a signal is not detected, the Alert LED is activated and the status relay is opened.

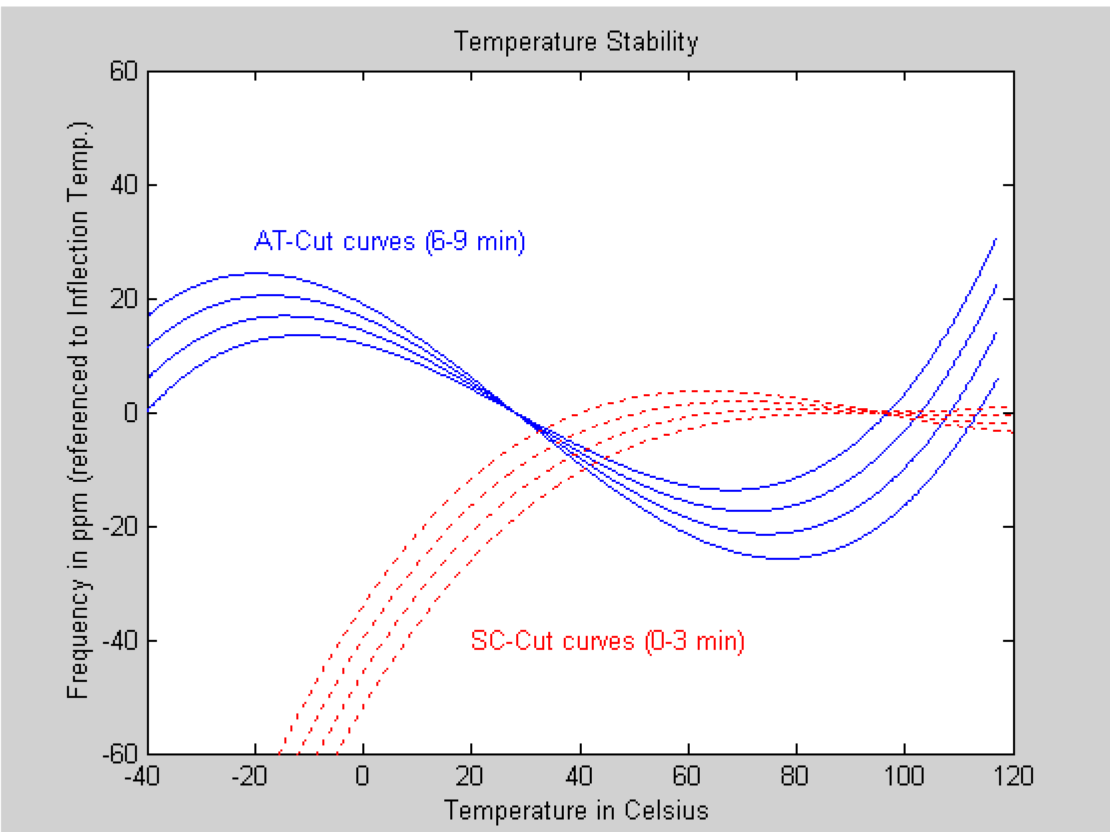
In addition to the signal presence built-in test, there is circuitry to determine if the oven within the OCXO has failed. This is a very subtle failure as there would appear to be a sine wave but without a functional oven, the temperature stability would be poor. If a failure is detected, the Alert LED will be activated and the status relay will be opened. During the first fifteen minutes of operation, an Alert may occur as the oven brings the crystal up to temperature. This is normal and will stop after approximately fifteen to thirty minutes of operation.

2.0 Crystal

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

The TCXO implementation results in a temperature stable reference in the single digit parts per million. An OCXO device affords a reference that is almost 2 orders of magnitude more stable than the TCXO.

COMPARISON OF AT vs SC CUT CRYSTAL

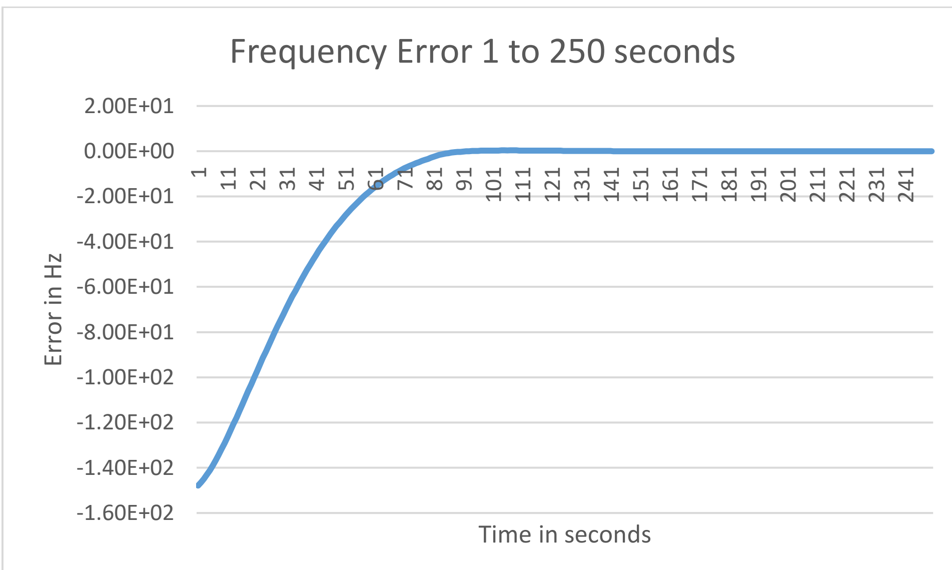


Over a broad temperature range, an AT performs very well and much easier to compensate electronically. It is also a simpler crystal to manufacture than a SC cut device. For applications where a stability of a few ppm is acceptable, a TCXO can be a cost-effective alternative.

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

OCXO oven temperature is in the range of 90°C. The devices heat-up and become stable within ~ 5 minutes.

OCXO FREQUENCY ERROR FROM COLD START

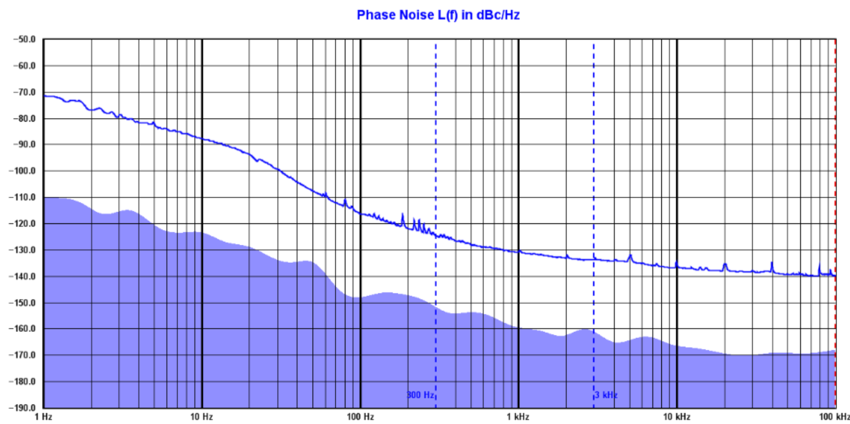


TYPICAL OCXO

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

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

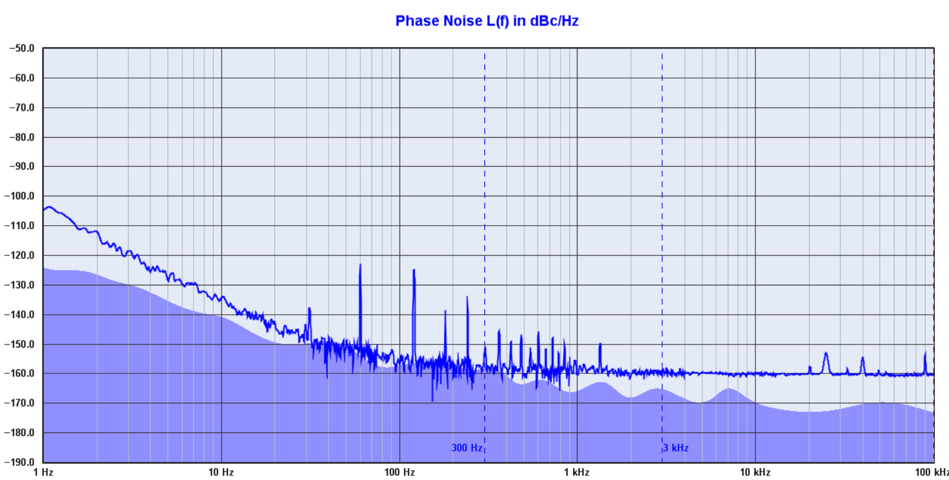
TYPICAL PHASE NOISE PERFORMANCE FOR A RUBIDIUM SOURCE



Trace	Notes	Input Freq	Sample Interval	dBc/Hz at 100 kHz	RMS Noise (degs)
rub		10.000 MHz	0.010 s	−139.7	1.18E−3

For applications requiring the stability of an atomic source but also requiring low phase noise, a low phase noise OCXO is disciplined to an atomic source. The phase noise for the NR2310-RO has phase noise improved by well over 20 dB by this technique.

TYPICAL PHASE NOISE PERFORMANCE – RUBIDIUM WITH OCXO



Trace	Input Amplitude	Sample Interval	dBc/Hz at 100 kHz	RMS Noise (degs)	RMS Jitter	SSB C/N dB	Duration	Options
NR2110-R-O-G (Unsaved)	6.4 dBm	0.010 s	−160.3	5.38E−5	1.5E−14 s	−123.5	10m 0s	

When the stability of an atomic or crystal source is not sufficient, a GNSS disciplined source is an option. A GNSS receiver is installed and timing information from the GNSS is used to discipline the timing device. Timing accuracy to a few ppb is readily achievable.

The GNSS is used to provide timing for a DDS (direct digital waveform synthesizer). While the DDS has outstanding long-term accuracy, the short-term stability very poor due to the nature of the timing source. A GNSS timing source has considerable short-term instability due to the numerous radio effects-multi-path, signal weakness etc. In order to develop a stable reference, the GNSS timing waveform is used to discipline a low noise source with a Kalman filter. A good example of the improved jitter performance of a Kalman filter is shown below:

KALMAN FILTER PERFORMANCE

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TYPICAL ACCEPTANCE TESTING DATA FOR THE NR3620-CAL GNSS LOCKED REFERENCE

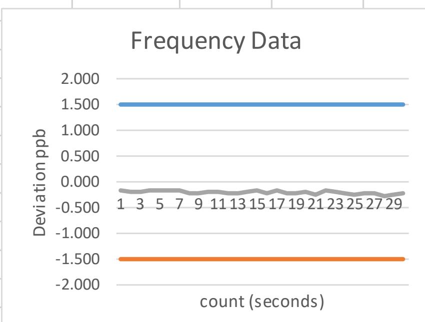
Novus- Reference Group
201 N Forest Ave Suite 225
Independence, MO 64050
866 984 6887

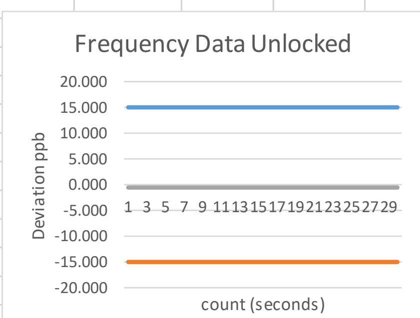
Date	1/12/2015	Model	NR3620-CAL
Tech	DS	Serial	03150565

Output amplitude	
Hi Limit	1.25
Measurement Hi	1.00
Measurement Low	0.99
Low limit	0.8

Frequency Specification	Limit ±15ppb

Equipment	Model	Cal Exp Date
Frequency Counter	Agilent 53230a	9/8/2015





Actual				
Frequency Locked			Frequency Unlocked	
Count (second)	Frequency	Actual - Deviation (ppb)	Frequency Unlocked	Actual - Deviation (ppb) Unlocked
1	9999999.998	-0.174	9999999.995	-0.545
2	9999999.998	-0.198	9999999.994	-0.563
3	9999999.998	-0.198	9999999.995	-0.543
4	9999999.998	-0.176	9999999.995	-0.538
5	9999999.998	-0.163	9999999.994	-0.554
6	9999999.998	-0.173	9999999.995	-0.546
7	9999999.998	-0.176	9999999.994	-0.564
8	9999999.998	-0.223	9999999.995	-0.521
9	9999999.998	-0.230	9999999.994	-0.552
10	9999999.998	-0.193	9999999.994	-0.556
11	9999999.998	-0.212	9999999.995	-0.530
12	9999999.998	-0.217	9999999.995	-0.529
13	9999999.998	-0.220	9999999.995	-0.507
14	9999999.998	-0.200	9999999.995	-0.526
15	9999999.998	-0.177	9999999.994	-0.553
16	9999999.998	-0.226	9999999.994	-0.563
17	9999999.998	-0.178	9999999.995	-0.527
18	9999999.998	-0.223	9999999.994	-0.565
19	9999999.998	-0.225	9999999.995	-0.537
20	9999999.998	-0.206	9999999.994	-0.568
21	9999999.998	-0.245	9999999.995	-0.524
22	9999999.998	-0.184	9999999.995	-0.526
23	9999999.998	-0.213	9999999.995	-0.546
24	9999999.998	-0.223	9999999.994	-0.551
25	9999999.997	-0.255	9999999.995	-0.502
26	9999999.998	-0.232	9999999.995	-0.549
27	9999999.998	-0.238	9999999.994	-0.587
28	9999999.997	-0.277	9999999.994	-0.568
29	9999999.997	-0.254	9999999.995	-0.516
30	9999999.998	-0.219	9999999.994	-0.561

3.0 GPS Receiver

The receiver and companion elements generate the GNSS sine wave, 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)

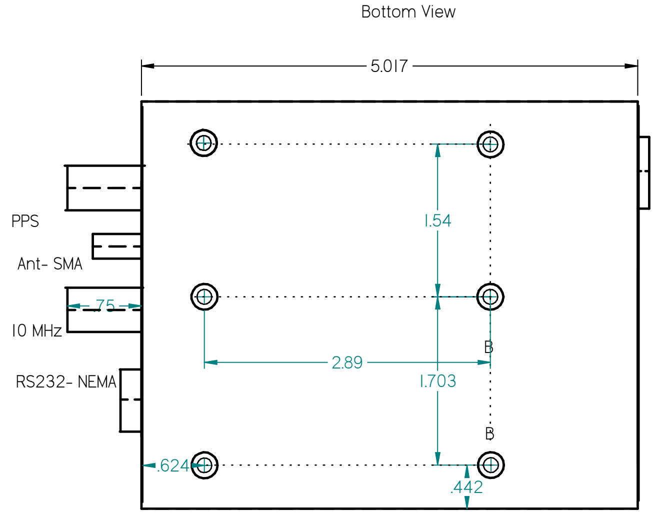
4.0 Input/Output Connectors/Mechanical

All versions of the NR3620 are available in either the flanged chassis (Type II) or with pressed inserts located on the bottom of the unit (Type I), The inserts are #6-32.

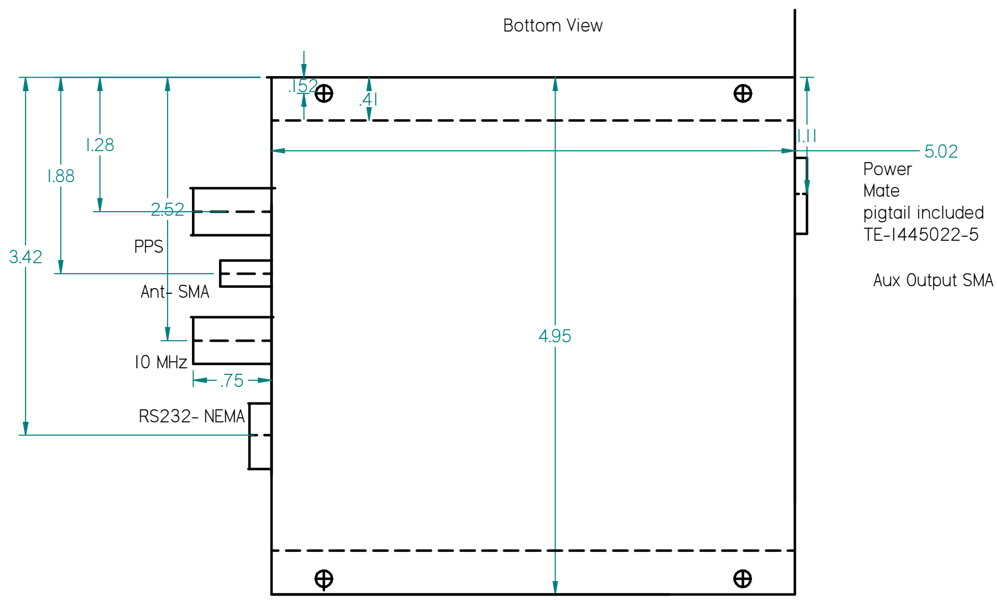
When using the bottom inserts for the Type I chassis, the screw must not enter the chassis by no more than 0.15 inches. A longer screw will damage the unit and void the warranty!!!

The Type II chassis is a mechanical package that has two 0.5 inch flanges that extend beyond the main chassis. Each flange has 2 holes that can be used to attach the unit to a flat surface.

Type I Chassis



Type II Chassis



GPS Ant - SMA connects to the GPS ant - provides 3.3 VDC 25mA max.

PPS - BNC - one pulse per second

10MHz sine - sine or CMOS output

RS232 - standard NMEA output NMEA-0183

REV A and REV B Products:
Power - TE Connectivity part #2-1445055-5

1. Ground
2. Power – Nominal +12 VDC (8 to 16 VDC)
3. No connection
4. No connection
5. No connection

Note - Unit ships with a power pigtail

REV C Products January 2014:
The power connector was changed to a 4 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 screw driver.

Pin assignments

1. power ground
2. power positive
3 no connect
4. no connect

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.
REV C Products January 2014:

After June 1 2016 the pin out on the power connector is:

1. power ground
2. power positive
3 status relay
4. status relay

The DB9 now contains the NMEA serial lines, GPS lock (set of relay contacts) and System Alert (set of relay contacts). The pin-out on the REV.C product has changed:

Pin	OLD CONFIGURATION	Pin	NEW CONFIGURATION
1	GPS relay #1	1	Optional PPS signal
2	NMEA - Tx	2	NMEA - Tx
3	NMEA - Rx	3	NMEA - Rx
4	no connection	4	no connection
5	GND	5	GND
6	N/C	6	GPS lock contact #1
7	GPS relay contact #2	7	GPS lock relay contact #2
8	Alert relay contact #1	8	Alert relay contact #1
9	Alert relay contact #2	9	Alert relay contact # 2

Products produced after June 1, 2016:

Pin	NEW CONFIGURATION
1	Optional PPS signal
2	NMEA - Tx
3	NMEA - Rx
4	no connection
5	GND
6,7,8,9	N/C

Contact closure occurs in the normal operating state for Alert and the GPS lock relay closes when lock is achieved. The optional PPS signal has to be specifically requested at the time the product is purchased.   Routing the PPS through the DB9 is offered as an option that might ease system integration.

5.0 Typical Phase Noise

10MHz Sine- Primary Output

Offset Frequency (Hz)	Typical (dBc / Hz)
10	-125
100	-140
1K	-145
10K	-150

Trace	DUT Freq	Input Freq	Input Amplitude	dBc/Hz at 200 Hz	RMS Noise (degs)	RMS Jitter	Duration	Acquired
NR3620-CAL 20201456	10.000 MHz	10.000 MHz	12.9 dBm	−152.5	7.16E−5	2.0E−14 s	5m 0s	300 pts

6.0   Alerts - Function Relay

There numerous critical circuits in the unit. These are monitored and a failure of any of these will initiate an ALERT condition. The ALERT LED green to red and the ALERT relay will open. The normal operating state is the relay contacts will be closed. During cold start, the oven can behave in such a manner as to give an Oven alert. This is normal and will only occur from a cold start. This condition should only exist for approximately five minutes.

Units manufactured after June 1, 2016 move combines the GNSS lock and alert relay to a single series connection that is routed to the rear connector. When the unit passes self-test and achieves GNSS lock, the relay closes. The relays can be separated and routed to the DB-9 with a special request.

7.0 GPS/GNSS Function

The receiver needs to be able to see at least four satellite vehicles (SVs) 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). Inside a building or beneath a bridge, it may not be possible to update a position fix. 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.

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.

The GPS Lock LED illuminates green when the unit is locked to the GPS system. If the LED is red, the unit is operating on the OCXO.
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The GPS lock status is on the RS232 connector. After June 1, 2016 the GNSS lock and status relay is combined and available on the rear panel connector pins 3,4.

If the GPS indicator remains 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.

8.0 Technical Specification

10MHz Sine	1.0 ±0.1 Vrms,50 Ohm - BNC
Harmonics	Less than -30 dBc
Locked Stability	<~E-11 after 100 seconds
RS232	NMEA 0183 at full RS232 levels default is 38.4K Baud
First Year Frequency Stability	±50 ppb (long-term unlocked)
Temp Stability	±10 ppb
Yearly Aging	±50ppb
PPS	30ns @ 1σ RMS accuracy, 3.3 volt logic, output impedance CMOS (±20mA)
PPS	
Amplitude for 1PPS	3.3 Vdc CMOS (5 Vdc option)
Pulse width for 1PPS	Programmable 1 to 500ms in 1 ms steps
Rise time for 1PPS	<5 ns (faster edge available)
Connector	BNC
Load Impedance	50 Ohm (after March 2020)
Location	rear
Remote interface & control	
Protocol	RS232
Connector	DB-9
Location	Rear panel
Protocol	Bit plus stop
Standard Baud Rates	Selectable 4800, 9600, 19200, 38400, 57600 or 115200 bps
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 -1 10 MHz output	
	BNC -2 PPS 3.3 Vdc CMOS	
	5-pin power connector - power in, status relay contacts, GPS lock signal TE Connectivity part #2-1445055-5- for non-Type II REV A, REV B models. REV C model uses 4 pin terminal block Phoenix Contact #1844236 and mates with Phoenix Contact #1840382 connector which is included with unit.	

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.	

9.0 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..
Your dated sales or delivery receipt is your proof of the purchase date. You may be required to provide proof of purchase as a condition of receiving warranty service. You are entitled to hardware warranty service according to the terms and conditions of this document if a repair to your NOVUS product is required during the limited warranty period. Our obligation at NOVUS is limited to repair or replace products which prove to be defective.

Should Novus be unable to repair or replace the product within a reasonable amount of time, the customer's alternate remedy shall be a refund of the purchase price upon return of the product to Novus. The liability of NOVUS under this warranty is limited to replacing, repairing or issuing a credit, at its option, for any such item returned by Buyer under the terms of this warranty.

EXCLUSIONS: The above warranty shall not apply to defects resulting from improper or inadequate maintenance by the customer, customer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product or improper site preparation and maintenance (if applicable). For probes, cables, antennas and accessories, the warranty period is 90 (ninety) days.

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10.0 Appendix A – NMEA, Radio Control and Status

Users Manual **Appendix A**

Appendix A

GPS/GNSS Receiver Communications Specification NMEA-0183

Table of Contents:

1 Communication Specification

Signal Lines used:	TXD, RXD
Flow Control:	None
System:	Full Duplex Asynchronous
Speed:	Configurable, Default 38400 bps (*1)
Start Bit:	1 bit
Data Length:	8 bits
Stop Bit:	1 bit
Parity Bit:	None
Data Output Interval:	1 second

Character Codes used: NMEA-0183 Ver.4.10 data based

ASCII code (*2) Protocol: Input data
NMEA Standard
sentence NMEA
Proprietary
sentence
Output data
NMEA Standard
sentence NMEA
Proprietary
sentence

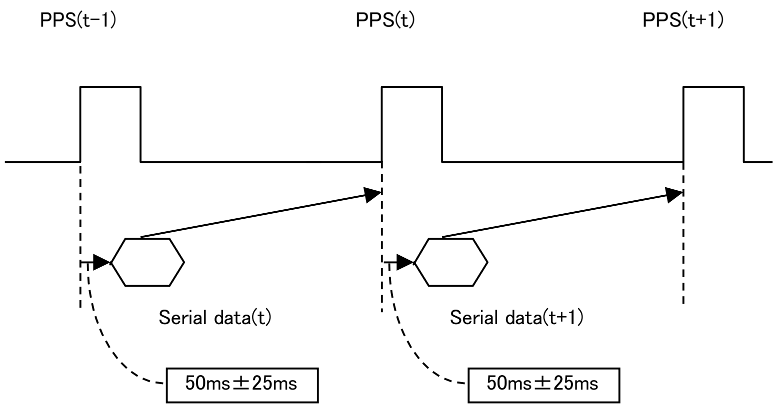
Note 1: Communication speed can be changed into 4800, 9600, 19200, 38400, 57600 or 115200 bps.
Please refer to section "UART1 – Serial Communication Port" for how to configure the communication speed. In case of using low baud rate, please adjust size of output sentence by NMEAOUT command and CROUT command to output all sentence within one second.

Note 2: "NMEA 0183 STANDARD FOR INTERFACING MARINE ELECTRONIC DEVICES Version 4.10" (NATIONAL MARINE ELECTRONICS ASSOCIATION, June, 2012)

2 Serial data output timing △4

The output timing of serial data is synchronous with PPS output timing. Serial data is begun to output in the 25ms to 75ms range after PPS is output.

The time of serial data indicates next PPS output timing.



3 NMEA Sentence Format

13.1 Standard Sentence

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

4 Proprietary Sentence Format:

$	P	<maker ID>	<sentence type>	,	<data field>	...	*<checksum field>	<CR>	<LF>
		3 bytes	3 bytes						

Field	Description
$	Start-of-Sentence marker
P	Proprietary sentence identifier
<maker ID>	3-byte fixed length. GT-87's maker ID is "ERD" meaning eRide.
<sentence type>	Indicates the type of sentence.
<data field>	Variable or fixed-length fields preceded by delimiter ","(comma). (Layout is maker-definable.)
<checksum field>	8 bits data between "$" and "*"(excluding "$" and "*") are XORed, and the resultant value is converted to 2 bytes 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

5 Standard NMEA Output Sentences

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 use differing transmission rates.

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

e*Ride* does populate all the fields described in the NMEA specification. Uncalculated fields are indicated as “Not Supported”.

GGA – Global Positioning System Fix Data Format:

$XXGGA	,	hhmmss.sss	,	ddmm.mmmm	,	a	,	dddmm.mmmm	,	a	,	x	,	xx	,
		1		2		3		4		5		6		7	

x.x	,	x.x	,	M	,	x.x	,	M	,	xxx	,	xxx	*hh	<CR>	<LF>
8		9		10		11		12		13		14			

#.	**Description**	**Range**
1.	UTC	
	"hh": hour	00 - 23
	"mm": minute	00 - 59
	"ss.sss": second	00.000 - 59.999
2-3.	Latitude	
	"dd": degree	00 - 90
	"mm.mmmm": minute	00.0000 - 59.9999
	"a": North/South	N or S
4-5.	Longitude	
	"ddd": degree	000 - 180
	"mm.mmmm": minute	00.0000 - 59.9999
	"a": East/West	E or W
6.	GPS Quality Indication	0 - 2 "0": Fix not available or invalid "1": Valid fix "2": DGPS positioning
7.	Number of satellites used for positioning	00 – 12 [*1]
8.	Horizontal dilution of precision (HDOP)	0.0-50.0
	Note: A null field is output while positioning is interrupted.	
9.	Altitude above/below mean sea-level (geoid)	
10.	Unit of Altitude, meter	M
11.	Geoidal height	
12.	Unit of Geoidal height	M
13.	Age of differential GPS data	n/a
14.	Differential reference station ID	n/a

Example:

$GPGGA,025411.516,3442.8146,N,13520.1090,E,1,11,0.8,24.0,M,36.7,M,,*66
UTC: 02:54:11.516 34 deg 42.8146 min N 135 deg 20.1090 min E
Status: Valid fix Number of satellites: 11 satellites HDOP: 0.8
Altitude: 24.0 meters high Geoidal height: 36.7 meters high

[*1] GPS, SBAS, QZSS only. Galileo and GLONASS are not counted. Upper limit is 12.

GLL – Geographic Position - Latitude/Longitude ▵6

Format:

$XXGLL	,	ddmm.mmmm	,	a	,	dddmm.mmmm	,	a	,	hhmmss.sss	,	a	,	a	*hh	<CR>	<LF>
		1		2		3		4		5		6		7			

#	Description	Range
1-2.	Latitude	
	"dd": degree	00 - 90
	"mm.mmmm": minute	00.0000 - 59.9999
	"a": North/South	N or S
3-4.	Longitude	
	"ddd": degree	000 - 180
	"mm.mmmm": minute	00.0000 - 59.9999
	"a": East/West	E or W
5.	UTC	
	"hh": hour	00 - 23
	"mm": minute	00 - 59
	"ss.sss": second	00.000 - 59.999
6.	Status ▵6	A or V "A": Data Valid "V": Data Invalid
7.	Position System Mode Indication	A, D or N "A": Autonomous "D": Differential "N": Data Invalid

Example:

$GPGLL,3442.8146,N,13520.1090,E,025411.516,A,A*5F
34 deg 42.8146 min N 135 deg 20.1090 min E
UTC: 02:54:11.516 Mode: Data Valid

GNS – GNSS Fix Data Format:

$XXGNS	,	hhmmss.sss	,	ddmm.mmmm	,	a	,	dddmm.mmmm	,	a	,	c--c	,	xx	,
		1		2		3		4		5		6		7	

x.x	,	x.x	,	x.x	,	x	,	x	,	x	*hh	<CR>	<LF>
8		9		10		11		12		13			

#.	**Description**	**Range**
1.	UTC	
	"hh": hour	00 - 23
	"mm": minute	00 - 59
	"ss.sss": second	00.000 - 59.999
2-3.	Latitude	
	"dd": degree	00 - 90
	"mm.mmmm": minute	00.0000 - 59.9999
	"a": North/South	N or S
4-5.	Longitude	
	"ddd": degree	000 - 180
	"mm.mmmm": minute	00.0000 - 59.9999
	"a": East/West	E or W
6.	Mode Indicator for each satellite system (GPS, GLONASS, Galileo)	
		"A": Autonomous
		"D": Differential
		"N": Data Invalid
7.	Number of satellites used for positioning	00 - 32
8.	Horizontal dilution of precision (HDOP)	0.0 - 50.0
	Note: A null field is output while positioning is interrupted.	
9.	Altitude above/below mean sea-level (geoid)	
10.	Geoidal height	
11.	Age of differential GPS data	n/a
12.	Differential reference station ID	n/a
13.	Navigation Status Indicator	S, C, U or V
		"S": Safe
		"C": Caution
		"U": Unsafe
		"V": Not Valid

Example:

$GNGNS,004457.000,3442.8266,N,13520.1235,E,DDN,22,0.5,40.6,36.7,,,V*60
UTC: 00:44:57.000 34 deg 42.8266 min N 135 deg 20.1235 min E
Status: Data Valid (GPS: differential, GLONASS: differential, Galileo: Invalid)
Number of satellites: 22 satellites HDOP: 0.5
Altitude: 40.6 meters high Geoidal height: 36.7 meters high
Navigation Status Indicator: Not Valid

GSA – GNSS DOP and Active Satellites △4

Format:

$XXGSA	,	a	,	a	,	xx	,	xx	,	xx	,	…	,	xx	,	x.x	,	x.x	,	x.x	,	h	*hh	<CR>	<LF>
		1		2		3		4		5		6-13		14		15		16		17		18			

#	Description	Range
1.	Operational mode	M or A "M": 2D/3D fixed mode "A": 2D/3D Auto-switching mode
2.	Mode	1 - 3 "1": No fix "2": 2D fix "3": 3D fix
3-14.	Satellite Numbers used for positioning Note: A null field is output unless a satellite is available.	01 - 99
15.	PDOP Note: A null field is output unless 3D-positioning is performed.	0.0 - 50.0
16.	HDOP Note: A null field is output while positioning is interrupted.	0.0 - 50.0
17.	VDOP Note: A null field is output unless 3D-positioning is performed.	0.0 - 50.0
18.	GNSS System ID	n/a

Example:

$GNGSA,A,3,09,15,26,05,24,21,08,02,29,28,18,10,0.8,0.5,0.5,1*33
$GNGSA,A,3,79,69,68,84,85,80,70,83,,,,,0.8,0.5,0.5,2*30

2D/3D Auto-switching mode, 3D fix
Satellite used: 09, 15, 26, 05, 24, 21, 08, 02, 29, 28, 10, 79, 69, 68, 84, 85, 80, 70, 83
PDOP: 0.8 HDOP: 0.5 VDOP: 1.5

Notes: △4

- To adds extra fields to the GPGSA NMEA string to show more than 12 satellites used in the fix, please input "$PERDAPI,EXTENDGSA,num*hh<CR><LF>". num is Number of fields for satellites used in the fix. Acceptable values are: 12-16. Default num is 12. By creating more fields for satellites used in the fix, the PDOP/HDOP/VDOP values shift by num12 fields.
- Satellite number means the follow.

Satellite number from 01 to 32 indicates GPS (01 to 32)
Satellite number from 33 to 51 indicates SBAS (120 to 138)
Satellite number from 65 to 92 indicates GLONASS (slot 01 to slot 28)
Satellite number from 93 to 99 indicates QZSS (193 to 199)

GSV – GNSS Satellites in View △4

Format:

$XXGSV	,	x	,	x	,	x	,	xx	,	xx	,	xxx	,	xx	,	xx	,	xx	,	xxx	,	xx	,
		1		2		3		4		5		6		7		8		9		10		11	

xx	,	xx	,	xxx	,	xx	,	xx	,	xx	,	xxx	,	xx		h	*hh	<CR>	<LF>
12		13		14		15		16		17		18		19		20			

#	Description	Range
1.	Total number of messages	1 - 4
2.	Number of messages	1 - 4
3.	Number of satellites in line-of-sight	00 - 14
4.	1st Sat. ID number	01 - 99
5.	1st Sat. elevation angle (degree)	00 - 90
6.	1st Sat. azimuth angle (degree)	000 - 359
7.	1st Sat. SNR (Signal/Noise Ratio) (dB)	00 - 99
8-11.	2nd Sat. Details	
12-15.	3rd Sat. Details	
16-19.	4th Sat. Details	
20.	Signal ID	

Example:

$GPGSV,4,1,14,15,67,319,52,09,63,068,53,26,45,039,50,05,44,104,49,1*6E
$GPGSV,4,2,14,24,42,196,47,21,34,302,46,18,12,305,43,28,11,067,41,1*68
$GPGSV,4,3,14,08,07,035,38,29,04,237,39,02,02,161,40,50,47,163,44,1*67
$GPGSV,4,4,14,42,48,171,44,93,65,191,48,,,,,,,,,1*60
$GLGSV,3,1,09,79,66,099,50,69,55,019,53,80,33,176,46,68,28,088,45,1*76
$GLGSV,3,2,09,70,25,315,46,78,24,031,42,85,18,293,44,84,16,246,41,1*7A
$GLGSV,3,3,09,86,02,338,,,,,,,,,,,,1*45

→ Not fixed
→ Message number
→ Total number of message

<checksum><CR><LF> is output right after the last satellite data output.

Notes: △4

- In this sentence, a maximum of four satellite details is indicated per each output. Five or more satellite details are output in the 2nd or 3rd messages. When there is an item which is not fixed in the satellite details, a null field is output. When there are only one to four satellite details, <checksum><CR><LF> is issued immediately after Sat. SV#, Sat. elevation angle, Sat. azimuth angle and SNR.
- Satellite number means the follow.

Satellite number from 01 to 32 indicates GPS (01 to 32)
Satellite number from 33 to 51 indicates SBAS (120 to 138)
Satellite number from 65 to 92 indicates GLONASS (slot 01 to slot 28)

Satellite number from 93 to 99 indicates QZSS (193 to 199)

RMC – Recommended Minimum Navigation Information △6

Format:

$XXRMC	,	hhmmss.sss	,	a	,	ddmm.mmmm	,	a	,	dddmm.mmmm	,	a	,	x.x	,
		1		2		3		4		5		6		7	

x.x	,	ddmmyy	,	x.x	,	a	,	a	,	a	*hh	<CR>	<LF>
8		9		10		11		12		13			

#	Description	Range
1.	UTC	
	"hh": hour	00 - 23
	"mm": minute	00 - 59
	"ss.sss": second	00.000 - 59.999
2.	Status △6	A or V "A": Data valid "V": Data not valid
3-4.	Latitude	
	"dd": degree	00 - 90
	"mm.mmmm": minute	00.0000 - 59.9999
	"a": North/South	N or S
5-6.	Longitude	
	"ddd": degree	000 - 180
	"mm.mmmm": minute	00.0000 - 59.9999
	"a": East/West	E or W
7.	Speed (kts)	
8.	True Course (degree)	
9.	Date "dd": date "mm": month "yy": last two digits of the year	
10.	Magnetic declination Note: A null field is output unless magnetic declination information is available.	
11.	Correction direction of magnetic declination Note: A null field is output unless magnetic declination information is available.	
12.	Positioning System Mode Indication	A, D or N "A": Autonomous "D": Differential "N": Data Invalid
13.	Navigation Status Indicator	S, C, U or V "S": Safe "C": Caution "U": Unsafe "V": Not Valid

Example:

$GNRMC,012344.000,A,3442.8266,N,13520.1233,E,0.00,0.00,191132,,,D,V*0B
UTC: 01:23:44.000 Differential 34 deg 42.8266 min N 135 deg 20.1233 min E
Speed: 0.0 kts True Course: 0.0 degrees UTC Date: Nov 19, 2032

VTG – Course Over Ground and Ground Speed Format:

$XXVTG	,	x.x	,	T	,	x.x	,	M	,	x.x	,	N	,	x.x	,	K	,	a	*hh	<CR>	<LF>
		1		2		3		4		5		6		7		8		9			

#	Description	Range
1-2.	True Course (degree)	
	"T" (meaning TRUE)	T
3-4.	Magnetic Direction	
	"M" (meaning Magnetic Direction)	M
	Note: A null field is output unless magnetic direction information is available.	
5-6.	Speed (kts)	
	"N" (meaning knot)	N
7-8.	Speed (km/h)	
	"K" (meaning km/h)	K
9.	Positioning System Mode Indication	A, D or N "A": Autonomous "D": Differential "N": Data Invalid

Example:

$GNVTG,0.00,T,,M,0.00,N,0.00,K,D*26

True Course: 0.00 degrees Speed: 0.00 kts, 0.00 km/h Mode: Differential

ZDA – Time & Date Format:

$XXZDA	,	hhmmss.sss	,	xx	,	xx	,	xxxx	,	xxx	,	xx	*hh	<CR>	<LF>
		1		2		3		4		5		6			

#	Description	
1.	UTC: Time	
	"hh": hour	00 - 23
	"mm": minute	00 - 59
	"ss.sss": second	00.000 - 59.999
2.	UTC: Day of Month	01 - 31
3.	UTC: Month	01 - 12
4.	UTC: Year	1999 - 2099 △3
5.	Local Zone Hours	(+/-) 00 - 23
6.	Local Zone Minutes	00 - 59

Example:

$GPZDA,014811.000,13,09,2013,+00,00*7B

UTC: 01:48:11.000 13th September, 2013

6 Proprietary NMEA Input Sentences

These sentences are input commands for the protocol of this receiver.

GNSS – Satellite System Configuration △4 △8

Format:

$PERDAPI	,	GNSS	,	talkerID	,	gps	,	glonass	,	galileo	,	qzss	,	sbas	*hh	<CR>	<LF>
		1		2		3		4		5		6		7			

Num	Contents	Range	Default	Remark
1	GNSS	-	-	Command Name
2	talkerID	AUTO, LEGACYGP or GN △8	AUTO	AUTO: GLGSV is omitted in case of no glonass. GPGSV is omitted in case of no GPS, SBAS and QZSS. LEGACYGP: GL and GN sentence is omitted. GN: GLGSV is output even if no glonass. GPGSV is output even if no GPS, SBAS and QZSS.
3	gps	0 or 2	2	GPS mode △3
4	glonass	0 or 2	2	Glonass mode △3
5	galileo	0	0	Galileo mode (unimplemented)
6	qzss	0 or 2	2	Qzss mode △3
7	sbas	0, 1 or 2	1	Sbas mode △2

Example:

$PERDAPI,GNSS,AUTO,2,2,0,2,2*41
Use: GPS, GLONASS, QZSS, SBAS
Mask: Galileo

Notes: △4

- This command controls which Global Navigation Satellite Systems are used by the receiver. The mode can be set to 0 or 2 for each satellite system. User can also set SBAS mode to 1. Mode 0 means to disable the system.

Mode 1 means to enable tracking only (do not use in position fix etc).

Mode 2 means to enable tracking and use the in position fix calculation.

- In GT-87, default setting of SBAS mode is 1, because to use calculation data of SBAS tends to reduce the accuracy of 1PPS. Therefore although GT-87 becomes to differential fix, SBAS is not appeared in GSA sentence in default setting.
- The response which is inserted current value to each field is obtained by receiving an effective command for setting or inputting a command which is omitted the fields after Command Name, that is, $PERDAPI,GNSS,QUERY*18.
- "Sbas only configuration" and "No tracking configuration" are not accepted.

$PERDAPI,GNSS,AUTO,0,0,0,0,2*43

$PERDAPI,GNSS,AUTO,0,0,0,0,1*40

$PERDAPI,GNSS,AUTO,0,0,0,0,0*41

- Cold restart (time also be cleared) is run when satellite system configuration is changed from/to glonass only fix configuration. In the others configuration, hot restart is run.

FIXMASK – Setting of Positioning and Satellite Mask △4

Format:

$PERDAPI	,	FIXMASK	,	mode	,	elevmask	,	Reserve1	,	snrmask	,	Reserve2	[,
		1		2		3		4		5		6	

Prohibit SVs (GPS)	,	Prohibit SVs (GLONASS)	,	Prohibit SVs (Galileo)	,	Prohibit SVs (QZSS)	,	Prohibit SVs (SBAS)]	*hh	<CR>	<LF>
7		8		9		10		11			

Num	Contents	Range	Default	Remark
1	FIXMASK	-	-	Command Name
2	mode	USER	-	Fixed Value
3	elevmask	0 to 90	0	Elevation mask (in degree) Only SVs whose age is within this threshold are used in the position fix calculation.
4	Reserve1	0	0	Reserve field
5	snrmask	0 to 99	0	Signal level mask (in dB-Hz) Only SVs above this mask are fixed.
6	Reserve2	0	0	Reserve field
7	Prohibit SVs (GPS)	32BIT (HEX)	0	GPS Satellite number mask Each bit represents one SVID. The GPS satellites indicated by this field are not used in the position fix calculation. Lowest order bit means SV=01. Highest order bit means SV=32. △4
8	Prohibit SVs (GLONASS)	28BIT (HEX)	0	GLONASS Satellite number mask Each bit represents one SVID. The GLONASS satellites indicated by this field are not used in the position fix calculation. Lowest order bit means SV=65. Highest order bit means SV=92. △4
9	Prohibit SVs (Galileo)	20BIT (HEX)	0	Galileo Satellite number mask Each bit represents one SVID. This field is unimplemented. △4
10	Prohibit SVs (QZSS)	7BIT (HEX)	0	QZSS Satellite number mask Each bit represents one SVID. The QZSS satellites indicated by this field are not used in the position fix calculation. Lowest order bit means SV=93. Highest order bit means SV=99. △4
11	Prohibit SVs (SBAS)	19BIT (HEX)	0	SBAS Satellite number mask Each bit represents one SVID. The SBAS satellites indicated by this field are not used in fix. Lowest order bit means SV=33. Highest order bit means SV=51. △4

Example:

$PERDAPI,FIXMASK,USER,10,0,37,0,0x92,0x01,0x00,0x00,0x20000*50

Elevation mask: 10 degrees
Signal level mask: 37 dBHz
GPS mask: GPS (BIT2 = SVID 2), GPS (BIT5 = SVID 5) and GPS (BIT9 = SVID 9)
GLONASS mask: GLONASS (BIT1 = SVID 65)
SBAS mask: SBAS (BIT18 = SVID 50)

Notes:

- It is applied not only to First Fix or the time of a positioning return but to all the positioning.
- It is omissible after the 7th field.
- The response which is inserted current value to each field is obtained by receiving an effective command for setting or inputting a command which is omitted the fields after Command Name, that is, $PERDAPI,MASK,QUERY*50.

PPS – Setting of PPS (Pulse per second) △4 Format:

$PERDAPI	,	PPS	,	type	,	mode	,	period	,	pulse width	,	cable delay	,
		1		2		3		4		5		6	

polarity	[,	PPS accuracy threshold]	*hh	<CR>	<LF>
7		8			

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

Example:

$PERDAPI,PPS,LEGACY,1,0,200,0,0,25*29
Type: LEGACY PPS Mode: Always output
1PPS Pulse width: 200 ms cable delay: 0 ns
Polarity: rising edge of PPS is synchronous with UTC time.
PPS estimated accuracy threshold is 25nsec.

Notes: △4

- LEGACY PPS setting is output legacy PPS which is not synchronized with frequency which is output from GCLK pin, but which is output immediately after first fix in case of cold start.
- GCLK PPS setting is output GCLK PPS which synchronized with frequency which is output from GCLK pin, but it takes some to become GCLK PPS steady after first fix (typically, 1~2 minutes after fist fix). User can confirmed whether GCLK PPS is steady by GCLK accurate field of TPS4 sentence.
- User can choose GPS, UTC (USNO) and UTC (SU) as alignment of PPS by TIMEALIGN command. The default is UTC (USNO). As for details, please refer to the page of TIMEALIGN command.
- The condition of PPS synchronization is the follow.

[1] GPS alignment

PPS mode	Before first fix	After first fix
0	OFF	OFF
1	Sync with RTC	Sync with GPS
2~4	OFF	Sync with GPS

[2] UTC (USNO) alignment (default)

PPS mode	Before first fix	After first fix	After taking UTC (USNO) parameter from GPS
0	OFF	OFF	OFF
1	Sync with RTC	Sync with GPS	Sync with UTC (USNO)
2~4	OFF	Sync with GPS	Sync with UTC (USNO)

[3] UTC (SU) alignment

PPS mode	Before first fix	After first fix	After taking UTC (SU) parameter from GLONASS
0	OFF	OFF	OFF
1	Sync with RTC	Sync with GPS	Sync with UTC (SU)
2~4	OFF	Sync with GPS	Sync with UTC (SU)

- About PPS estimated accuracy, please refer to the page of CRX (TPS2) sentence.

RESTART - Restart command △4 Format:

$PERDAPI	,	RESTART	,	restart mode	*hh	<CR>	<LF>
		1		2			

Num	Contents	Range	Default	Remark
1	RESTART	-	-	Command Name
2	restart mode	HOT WARM COLD FACTORY	-	Restart mode

Example:

$PERDAPI,RESTART,COLD*08
Mode: cold restart

Notes: △4

- As for the differences depending on the restart mode, please refer to the page of "Backup of the Receiver Parameters (for BBRAM)".
- The data which is stored by FLASHBACKUP command in Flash is not cleared even if FACTORY restart is occurred.
- Power off/on of GT-87 corresponds to hot restart when it is within 4 hours after last fix.
- Power off/on of GT-87 corresponds to warm restart when it is over 4 hours after last fix.

TIME – Setting of time information △4

Initial time is configured. The setting of time is effective only within the case that time is not decided by other factors. A setting of a millennium which is the times of GPS week rollover is received also after time decision.

Format:

$PERDAPI	,	TIME	,	time of date	,	day	,	month	,	year	*hh	<CR>	<LF>
		1		2		3		4		5			

Num	Contents	Range	Default	Remark
1	TIME	-	-	Command Name
2	Time of date	00 to 23 00 to 59 00 to 59	0	UTC (Hour) UTC(Minute) UTC(Second)
3	day	1 to 31	22	UTC (Date)
4	month	1 to 12	8	UTC (Month)
5	year	2013 to 2099	1999	UTC (Year) △3

Example:

$PERDAPI,TIME,021322,24,11,2020*64
Time: 02:13:22 on 24th November, 2020

Notes: △4
- This command is needed to input correct date within +/- 1 year.
- Under normal conditions, User needs not to set initial time because time is decided by satellite navigation data.
- As for GPS week rollover timing and GT-87 week rollover timing, please refer to the follow.

event	date	GPS week
GPS week rollover timing (1st) **default time of date of GT-87**	**1999/08/22**	**1024**
GPS week rollover timing (2nd)	2019/04/07	2048
rollover timing of GT-87	**2032/08/15**	**2745**
GPS week rollover timing (3rd)	2038/11/21	3072
…		
operable time limit of GT-87	**2099/12/31**	**6260**

[In case that GT-87 does not have glonass]

GT-87 can keep outputting correct date after 2032/08/15 during power distribution.
GT-87 will output 2012/12/30 after 2032/08/15 unless user sets correct date by TIME command after user turns off GT-87 and also turns off backup current for BBRAM.

[In case that GT-87 has glonass]

GT-87 can adjust millennium automatically in the timing of first fix of glonass and outputs correct date until 2099/12/31 without user setting even if user turns off GT-87 and backup current.

TIMEZONE – Local Zone Time △4

This sentence is reflected to ZDA sentence (not only local zone field but also UTC time field).

Format:

$PERDAPI	,	TIMEZONE	,	sign	,	hour	,	minute	*hh	<CR>	<LF>
		1		2		3		4			

Num	Contents	Range	Default	Remark
1	TIMEZONE	-	-	Command Name
2	sign	0 to 1	0	GMT sign "0" shows positive, "1" shows negative.
3	hour	0 to 23	0	GMT (Hour)
4	minute	0 to 59	0	GMT (Minute)

Example:

$PERDAPI,TIMEZONE,0,9,0*69
As GMT offset, display time is carried out +9:00.

Notes: △4
- In UTC (SU) alignment, GMT offset is changed to +3:00 automatically.

SURVEY –Position Mode △1 Format:

$PERDAPI	,	SURVEY	,	position mode	[,	sigma threshold	,	time threshold]
		1		2		3		4

[,	latitude	,	longitude	,	altitude]]	*hh	<CR>	<LF>
	5		6		7			

Num	Contents	Range	Default	Remark
1	SURVEY	-	-	Command Name
2	position mode	0 to 3	2	0: Normal NAV (navigation) mode 1: Position Survey SS (self survey) mode 2: Position Survey CSS (continual self survey) mode 3: Position-hold TO (time only) mode
3	sigma threshold	0 to 255	0 △3	Sigma threshold (m) which changes automatically to position-fixed. (When the threshold value is 0, it is not used.)
4	time threshold	0 to 10080	480 (8hours) △3	Time threshold (minute) which changes automatically to position-fixed. (When the threshold value is 0, it is not used.)
5	latitude △1	-90 to 90	0	Latitude for hold position in TO mode. (degree) A positive number means the north latitude and a negative number means the south latitude. This field can be set only when position mode is 3.
6	longitude △1	-180 to 180	0	Longitude for hold position in TO mode. (degree) A positive number means the east longitude and a negative number means the west longitude. This field can be set only when position mode is 3.
7	altitude △1	-1000 to 18000	0	Altitude for hold position in TO mode. (m) This field can be set only when position mode is 3.

Example:

$PERDAPI,SURVEY,1,10,1440*74

Mode: SS mode   Sigma Threshold: 10   Time Threshold: 1440

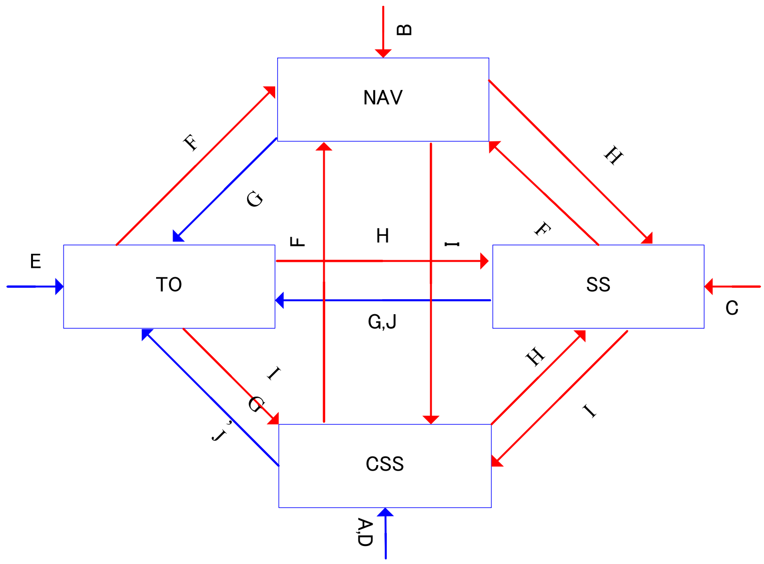
$PERDAPI,SURVEY,3,0,0,37.78700,-122.45100,31.5*53

Mode: TO mode   Sigma Threshold: 0   Time Threshold: 0

Fixed position: 37.78700 degrees north 122.45100 degrees west Altitude: 31.5 m

Notes:

- It is omissible after the 3rd field.
- When the position mode is "1", a position is re-calculated after power supply OFF/ON. Please use it, when the antenna position may change before power supply OFF.
- When the position mode is "2", after power supply OFF/ON, the estimated position that calculated before power supply OFF is kept, and the position is updated. By using it when the antenna position does not change after the power supply OFF, the time for changing to Position-hold mode can be shortened.
- In order to change automatically to Position-hold mode, it is necessary to set to Survey mode.
- If both sigma threshold and time threshold are configured, the position mode changes to Position-hold mode when either is fulfilled. When the threshold value is 0, it is not used.
- The displayed position may differ a little from the configured position due to conversion error.
- Hot start is occurred when survey mode is shift to NAV mode. △1



Flow chart about position mode

	Transition condition	Whether keep or not survey position and number of times of survey process
A	After first power on, or after factory restart (default)	Discard
B	After power on in case that last mode is "SURVEY,0".	Discard
C	After power on in case that last mode is "SURVEY,1".	Discard
D	After power on in case that last mode is "SURVEY,2".	Keep
E	After power on in case that last mode is "SURVEY,3".	Keep
F	"SURVEY,0" command	Discard
G	"SURVEY,3" after self survey position is fixed. "SURVEY,3" with user's hold position.	Keep
H	"SURVEY,1" command	Discard
I	"SURVEY,2" command	Discard

J	The condition of survey is satisfied. [*] Position mode is always started by time only mode if TO mode by this condition and power off.	Keep

FREQ – Setting of GCLK FREQUENCY △2△7 Format:

$PERDAPI	,	FR	,	mode	,	freq	[,	duty	,	offset]	*hh	<CR>	<LF>
		1		2		3		4		5			

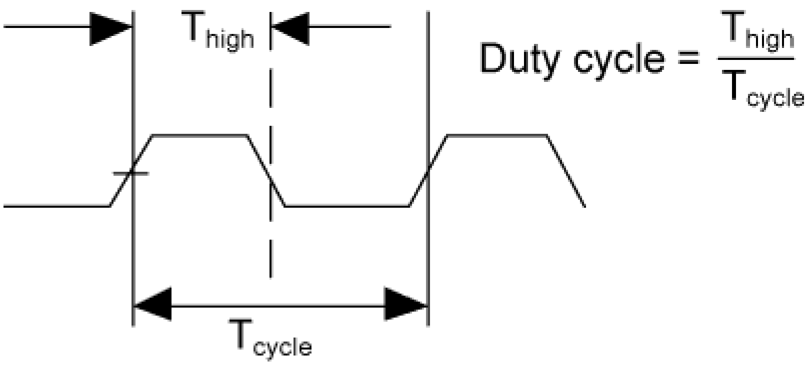
Num	Contents	Range	Default	Remark
1	FREQ	-	-	Command Name
2	mode	0 to 1	0	0 : stop 1 : output
3	freq	4000 to 40000000	10000000 (10MHz)	frequency[Hz]
4	duty △2	10 to 90 △7	50	duty cycle [%]
5	offset △2	0 to 99	0	phase delay in cycle [%] from GCLK-PPS edge

Example:

$PERDAPI,FREQ,1,10000000*47
Mode: output
Frequency: 10MHz

Notes:

- It is omissible after the 4th field.
- The response which is inserted current value to each field is obtained by receiving an effective command for setting or inputting a command which is omitted the fields after Command Name, that is, $PERDAPI,FREQ,QUERY*11.
- Duty cycle is derived from Thigh / Tcycle in the follow figure. △2
- User can stock current FREQ command setting on Flash by FLASHBACKUP command.



DEFLS – Setting of default leap second △4 △6 Format:

$PERDAPI	,	DEFLS	,	sec	[,	mode]	*hh	<CR>	<LF>
		1		2		3			

Num	Contents	Range	Default	Remark
1	DEFLS	-	-	Command Name
2	sec	0 to 32	16	Default leap second
3	mode	AUTO or FIXED	AUTO	AUTO: default leap second is updated automatically after taking leap second from satellites. FIXED: default leap second is kept as user setting.

Example:

$PERDAPI,DEFLS,16,AUTO*27
Default leap second: 16 second (this value is updated automatically).

Notes:

- It is omissible after the 3rd field.
- This value is used before leap second is confirmed by other factors which are to take UTC (USNO) parameter which is broadcasted from GPS or to take time difference between GPS and GLONASS.
- GT-87 can store current DEFLS command setting in Flash by FLASHBACKUP command.
- Cold restart (time also be cleared) is run when this command is run. △6

TIMEALIGN – setting of time alignment ⊿4 Format:

		1		2			
$PERDAPI	,	TIMEALIGN	,	mode	*hh	<CR>	<LF>

Num	Contents	Range	Default	Remark
1	TIMEALIGN	-	-	Command Name
2	mode	1 to 3	2	1 : GPS alignment 2 : UTC(USNO) alignment 3 : UTC(SU) alignment

Example:

$PERDAPI,TIMEALIGN,2*31
UTC (USNO) alignment

Notes:

- Please note that mode 0 is invalid value.
- User can store current TIMEALIGN command setting on Flash by FLASHBACKUP command.
- This command is used to set output time alignment and 1PPS alignment.

[1: GPS alignment]

・Leap second is not applied to output time even if GT-87 already has leap second.
・PPS is output in synchronization with GPS even if GT-87 already has UTC parameter.
・In Glonass only mode, correct default leap second is needed to output correct time.

[2: UTC (USNO) alignment]

・Leap second is applied to output time.
・PPS is output in synchronization with GPS before taking UTC (USNO) parameter from GPS.
・PPS is output in synchronization with UTC(USNO) after taking UTC (USNO) parameter from GPS.
・In Glonass only fix, because GT-87 can't take UTC (USNO) parameter from GLONASS, PPS is kept to output in synchronization with GPS.

[3: UTC (SU) alignment]

・Leap second is applied to output time. And, GMT offset is set as +3:00.
・PPS is output in synchronization with GPS before taking UTC (SU) parameter from GLONASS.
・PPS is output in synchronization with UTC(SU) after taking UTC (SU) parameter from GLONASS.
・In GPS only fix, because GT-87 can't take UTC (SU) parameter from GPS, PPS is kept to output in synchronization with GPS.

Restriction:

Output time

	GPS only fix setting	GLONASS only fix setting	GPS + GLONASS setting
GPS alignment	OK	**accurate default leap second is required [*1]**	OK
UTC(USNO) alignment	OK	OK	OK
UTC(SU) alignment	OK	OK	OK

PPS

	GPS only fix setting	GLONASS only fix setting	GPS + GLONASS setting
GPS alignment	OK	OK	OK
UTC(USNO) alignment	OK	**NG**	OK
UTC(SU) alignment	**NG**	OK	OK

[*1] In GPS alignment and GLONASS only fix setting, to output correct output time, user needs to set accurate default leap second by DEFLS command.

- In this graph, QZSS is treated as GPS.

FLASHBACKUP – Setting of backup in Flash ⊿4 Format:

$PERDAPI	,	FLASHBACKUP	,	type	*hh	<CR>	<LF>
		1		2			

Num	Contents	Range	Default	Remark
1	FLASHBACKUP	-	-	Command Name
2	type	0x00 to 0x07 (HEX)	0x00	Target of backup Each bit represents one command setting 0x01 : FREQ command setting 0x02 : DEFLS command setting 0x04 : TIMEALIGN command setting 0x00 means that flash backup is initialised.

Example:

$PERDAPI,FLASHBACKUP,0x03*4E
Current setting of FREQ and DEFLS command is stored in flash.

Notes:

- This data stored in Flash is erased when software update.
- This data stored in Flash is not erased by factory cold restart.
- Hot start is occurred when this command is input.
- Please don't turn off GT-87 during this command is sent.

Restriction:

GT-87 has two ways to backup data.

[1] BBRAM

BBRAM is RAM which is available to store data as long as backup current is impressed. GT-87 can store ephemeris data, almanac data and configuration which user sets by commands etc in BBRAM, and the data is not erased even if GT-87 is turned off.

The backup timing of BBRAM is every second. The data is cleared when user inputs RESTART command and/or user turns off backup current.

[2] FLASH

GT-87 can store FREQ command setting, DEFLS command setting and/or TIMEALIGN command setting in flash when user inputs FLASHBACKUP command. The data is not erased even if GT-87 is turned off or RESTART command. The data is cleared when user inputs FLASHBACKUP command or software update.

If GT-87 has different backup data between BBRAM and Flash, BBRAM data have a priority over flash. In this case, when the data of BBRAM is invalid because that backup current is turned off, Flash data is applied.

CROUT – Setting of CR Output Format:

$PERDAPI	,	CROUT	,	type	,	rate	*hh	<CR>	<LF>
		1		2		3			

Num	Contents	Range	Default	Remark
1	CROUT	-	-	Command Name
2	type	N,M,W,X,Y,Z	W,X,Y,Z	Output CR sentence [*] Alphabets of outside range are reserved.
3	rate	W,X,Y,Z : 0 to 255 N,M : 0 to 1	1	W,X,Y,Z : 1-255:Update interval of the sentence (sec) 0: The sentence(s) is/are stopped. N,M : 1: Sentence(s) is/are output every event occurred. 0: The sentence(s) is/are stopped.

Example:

$PERDAPI,CROUT,W,1*4E
CRW (TPS1) sentence is output every second.

$PERDAPI,CROUT,XZ,3*19
CRX (TPS2) sentence and CRZ(TPS4) sentenced are output every 3 seconds.

$PERDAPI,CROUT,W,0*4F
CRW (TPS1) sentence is stopped.

$PERDAPI,CROUT,N,1*57
CRN sentence is output every event occurred.

Notes:

- “M” or/and “N” can be output only in case that baud rate is 115200bps. △1

7 CFG – Setting of Application Software

NMEAOUT – Standard NMEA Output △9

Format:

$PERDCFG	,	NMEAOUT	,	type	,	interval	*hh	<CR>	<LF>
		1		2		3			

Num	Contents	Range	Default	Remark
1	NMEAOUT	-	-	Command Name
2	type	[*1]	-	Standard NMEA sentence [*1] GGA, GLL, GNS, GSA, GSV, RMC, VTG, ZDA, ALL△9. (ALL means all sentences from GGA to ZDA.)
3	Interval	0 to 255	-	Update interval of the sentence (sec) When the value is "0", the sentence is output only once. After that, the sentence is stopped.

Example:

$PERDCFG,NMEAOUT,GGA,2*57
Interval: 2 seconds

$PERDCFG,NMEAOUT,GSV,0*56
GSV sentence is output only once. After that, GSV sentence is stopped.

UART1 – Serial Communication Port 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

Notes:

- When the setting of the serial communication port is changed by this command, ACK sentence is output by the baud rate which was being used.

- 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.

SYS – PVT System

1.2 VERSION – Software Version

Format:

$PERDSYS	,	VERSION	*hh	<CR>	<LF>
		1			

Num	Contents	Range	Default	Remark
1	VERSION	-	-	Command Name

Example:

$PERDSYS,VERSION*2C

GPIO – General Purpose Input/output Format:

$PERDSYS	,	GPIO	*hh	<CR>	<LF>
		1			

Num	Contents	Range	Default	Remark
1	GPIO	-	-	Command Name

Example:

$PERDSYS,GPIO*67

8 Proprietary NMEA Output Sentences

This sentence is a protocol only for our company. It starts from "$PERD" which shows that it is an original sentence.

ACK – Output the Command Reception Check Format:

$PERDACK	,	command	,	sequence	,	subcommand	*hh	<CR>	<LF>
		1		2					

Num	Contents	Range	Default	Remark
1	command	-	-	First field of received command
2	sequence	-1 to 255	0	The number of times successful for the reception. It is added 1 whenever it succeeds in command reception, and 0 to 255 is repeated. When command reception is failed, -1 is returned.
3	subcommand	-	-	Second token of input command

Example:

$PERDACK,PERDAPI,-1,PPS*72
PERDAPI,PPS command input is failed.

Notes:

- As for the command, check sum must be effective before ACK is sent.

9 CR – eRide GNSS Core Library Interface

CRW(TPS1) – Output Time Transfer Info per Second (Date and leap second) △4 △5 Format:

$PERDCRW	,	TPS1	,	Date & Time	,	time status	,	update date	,	present LS	,
		1		2		3		4		5	

future LS	,	pps status	*hh	<CR	<LF>
6		7			

Num	Contents	Range	Default	Remark
1	TPS1	-	-	Command Name
2	Date & Time	14-byte fixed length	19990822000000	Present date and time year, month, day, hour, minute, second
3	time status	0 to 2 (1byte)	0	Present time status of output sentence 0: RTC 1: GPS (GT-87 doesn't apply leap second or has only default leap second) 2: UTC (GT-87 has confirmed leap second and applies it.)
4	update date	14-byte fixed length	00000000000000	Leap second update schedule year, month, day, hour, minute, second This date indicates zero when no leap second update schedule.
5	present LS	-31 to +32 (3byte)	+16 △5	Present leap second received from satellites
6	future LS	-31 to +32 (3byte)	+00	Future leap second received from satellites
7	pps status △4	0 to 3 (1byte)	0	Present pps is synced with the follow. 0:RTC 1:GPS 2:UTC(USNO) 3:UTC(SU)

Example:

$PERDCRW,TPS1,20120303062722,2,20120701000000,+15,+16,2*09

Present date: 2012/03/03 06:27:22
Time status: present time of output sentence is sync with UTC.
Leap second update schedule: 2012/7/1 00:00:00
Current leap second: +15
Future leap second: +16

Pps status: present pps is sync with UTC (USNO)

Notes:

- This command is output every second.
- Present LS is current leap second. This is updated in the timing of leap second update schedule.
- $PERDAPI,CROUT,W,0*4F stops outputting this command.
- Update data indicate zero when no update schedule.

Restriction:

About time status

alignment	Before first fix	After first fix	After taking confirmed leap second
GPS	RTC	GPS	GPS
UTC(USNO)	RTC	GPS	UTC
UTC(SU)	RTC	GPS	UTC

About leap second which is used to adjust output time

alignment	Before first fix	After first fix	After taking confirmed leap second
GPS	0	0	0
UTC(USNO)	Default leap second	Default leap second	confirmed leap second
UTC(SU)	Default leap second	Default leap second	confirmed leap second

GT-87 takes confirmed leap second when GT-87 takes UTC (USNO) parameter which is broadcasted from GPS or takes time both GPS and GLONASS.

CRX(TPS2) – Output Time Transfer Info per Second (PPS) △4 Format:

$PERDCRX	,	TPS2	,	pps status	,	pps mode	,	pps period	,	pulse width	,	cable delay
		1		2		3		4		5		6

,	polarity	,	pps type	,	estimated accuracy	,	Sawtooth	,	pps acc threshold	*hh	<CR>	<LF>
	7		8		9		10		11			

Num	Contents	Range	Default	Remark
1	TPS2	-	-	Command Name
2	pps status	0 to 1 (1byte)	0	Output status of 1PPS 0: 1PPS OFF 1: 1PPS ON
3	pps mode	0 to 4 (1byte)	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
4	period	0 to 1 (1byte)	0	1PPS output interval 0: 1PPS (A pulse is output per second) 1: PP2S (A pulse is output per two seconds)
5	pulse width	001 to 500 (3byte)	200	1PPS pulse width (ms)
6	cable delay	-100000 to +100000 (7byte)	+000000	1PPS cable delay (ns)
7	polarity	0 to 1 (1byte)	0	0 : rising edge 1 : falling edge
8	pps type	0 to 1 (1byte)	0	0 : LEGACY PPS 1 : GCLK PPS
9	estimated accuracy	0000 to 9999 (4byte)	0	1PPS estimated accuracy. (ns)
10	Sawtooth	-1.760 to +1.760 (6byte)	+0.000	Sawtooth correction (ns)
11	pps acc threshold	0000 0005 to 9999 (4byte)	1000	PPS estimated accuracy threshold (ns) This threshold is used for pps mode 4. 0 means that this threshold is not used.

$PERDCRX,TPS2,1,2,0,200,+001000,0,0,0005,+0.000,1000*29

PPS status: PPS ON (1)
PPS mode: during on fix (2)
PPS period: 1PPS (0)
PPS pulse width: 200ms
PPS cable delay: +1000ns
Polarity: rising edge
Type: LEGACY PPS
Estimated accuracy: 5ns
Sawtooth: +0.000ns
PPS estimated accuracy threshold: 1us

Notes:

- This command is output every second.
- $PERDAPI,CROUT,X,0*40 stops outputting this command.
- Output Values of period, pulse width, polarity are switched by pps type (LEGACY or GCLK).
- PPS estimated accuracy means estimated difference between PPS of GT-87 and GPS, UTC (USNO) or UTC (SU) timing which user sets by TIMEALIGN command. This is not guarantee value, but user can use this value to get a rough idea.
- Sawtooth means correction value under the resolution of GT-87, that is, about 3.5 ns.
- Sawtooth value is applied to prior to the one second PPS.

Corrected PPS [t-1] = output PPS [t-1] + Sawtooth value [t]

CRY(TPS3) – Output Time Transfer Info per Second (Survey & TRAIM) Format:

$PERDCRY	,	TPS3	,	pos mode	,	sigma	,	sigma threshold	,	time	,	time threshold	,
		1		2		3		4		5		6	

TRAIM solution	,	TRAIM status	,	Removed SVs	,	Receiver status	*hh	<CR>	<LF>
7		8		9		10			

Num	Contents	Range	Default	Remark
1	TPS3	-	-	Command Name
2	pos mode	0 to 3 (1byte)	2	Positioning mode 0: Normal 1: Survey mode (re-calculation for every power supply OFF/ON) 2: Survey mode(calculation continuously before and after power supply OFF/ON) 3: Position-hold mode
3	sigma	0000 to 1000 (4byte)	1000	Current variance value of survey position (m)
4	sigma threshold	000 to 255 (3byte)	000 △3	Sigma threshold (m) which changes automatically to position-fixed.
5	time	0 to 999999 (6byte)	000000	Current update times of survey position (sec). It is not updated at the time of positioning interruption.
6	time threshold	0 to 604800 (6byte)	028800 △3	Time threshold (sec) which changes automatically to position-fixed.
7	TRAIM solution	0 to 2 (1byte)	2	TRAIM solution 0: OK 1: ALARM 2: UNKNOWN, due to a. alarm threshold set too low b. insufficient satellites being tracked
8	TRAIM status	0 to 2 (1byte)	2	TRAIM status 0: detection and isolation possible 1: detection only possible 2: neither possible
9	removed SV	0 to 3 (2byte)	00	number of the removed satellite by TRAIM
10	Receiver status △3	10byte	0x00000000	Reserve field

$PERDCRY,TPS3,2,0003,001,002205,086400,0,0,00,0x00000000*68

Positioning mode: Survey mode (calculation continuously) (2)
Survey sigma: 3 [m]
Survey sigma threshold: 1 [m]
Survey time: 2205 [seconds]
Survey time threshold: 86400 [seconds]
TRAIM solution: OK (0)
TRAIM status: OK (0)
Removed SVs: 0
Receiver status: 0x00000000

Notes:

- This command is output every second.
- $PERDAPI,CROUT,Y,0*41 stops outputting this command.

CRZ (TPS4) – Output Time Transfer Info per Second (FREQUENCY) ⊿3 Format:

$PERDCRZ	,	TPS4	,	freq mode	,	Freq status	,	GCLK accuracy	,	e	,	de	,
		1		2		3		4		5		6	

lock cnt	,	lockoff cnt	,	reserve	,	IDtag	,	GCLK setting 1	,	GCLK setting 2	*hh	<CR>	<LF>
7		8		9		10		11		12			

Num	Contents	Range	Default	Remark
1	TPS4	-	-	Command Name
2	freq mode	1 to 6 (1byte)	1	1: warm up 2: lock 3: hold over 4: free run 5: coarse mode 6: fine mode
3	Freq status	0 or 1 (1byte)	0	0: Not output 1: Output
4	GCLK accuracy	0 or 1 (1byte)	0	0: Not accurate 1: GCLK PPS and GCLK frequency are accurate
5	e	-999999 to +999999 (7byte)	-	Phase delay between LEGACY and GCLK PPS (no dimensional)
6	de	-999999 to +999999 (7byte)	-	Amount of change of phase delay (no dimensional)
7	lock cnt	0 to 999999 (7byte)	-	Duration time of Lock (sec)
8	lockoff cnt	0 to 999999 (7byte)	-	Duration time of holdover/free run (sec)
9	reserve	0x00 to 0xFF (6byte)	-	Reserve field
10	IDtag	(6byte)	-	Product name and last two digits of product version In case of GT-8777 of "4850466003" ➔ 8777 + 03 = 877703 In case of GT-87 of "4850466005" ➔ 8700 + 05 = 870005
11	GCLK setting 1	(4byte)	-	Reserve field
12	GCLK setting 2	(4byte)	-	Reserve field

$PERDCRZ,TPS4,1,1,0,+000000,+000000,+000000,+000000,000000,000000,0x15,0000*57
Freq mode: warm up
Freq status: output
GCLK accuracy: accurate

Notes:

- This command is output every second.
- $PERDAPI,CROUT,Z,0*42 stops outputting this command.

CRM – Measurement Data of GPS

Format:

$PERDCRM	,	time	,	sennum	,	maxsen	,	system	,	svid	,	reserve
		1		2		3		4		5		6

snr	,	adr	,	doppfreq	,	pseudorange	*hh	<CR>	<LF>
7		8		9		10			

Num	Contents	Range	Default	Remark
1	time	0 to 604799	-	GPS time of week
2	sennum	1 to 32	-	Sentence number
3	maxsen	1 to 32	-	Maximum number of sentences
4	system	1	-	GNSS system ID (1=GPS)
5	svid	1 to 99	-	Satellite number
6	reserve	1 to 3	-	Reserve field
7	snr	0 to 55	-	Signal to Noise Ration [dB-Hz]
8	adr	32bit	-	Accumulated Doppler Range [Cycles, LSB=-6]
9	doppfreq	32bit	-	Doppler Frequency [meters/sec, LSB=-12]
10	pseudorange	32bit	-	Pseudrange [meters, LSB=-6]

Example:

$PERDCRM,467055,9,10,1,18,2,40,251470,-225117,1630912949*4C

Notes:

- This sentence will be output as a set once per second and will contain measurements for all GPS systems.
- To output this sentence, please input "$PERDAPI,CROUT,M,1*54" when baud rate is 115200bps.

CRN – Navigation Data

Format:

$PERDCRN	,	system	,	svid	,	subframe data	*hh	<CR>	<LF>
		1		2		3			

Num	Contents	Range	Default	Remark
1	system	1	-	GNSS system ID (1=GPS)
2	svid	1 to 99	-	Satellite number
3	subframe data	10 words (60 strings)	-	Subframe data no parirt included

Example:

$PERDCRN,1,7,8B0B349809AC00424A2471C5FF9F27BB10C82EB5884CC987FFA50C0BF2A8*0C

Notes:

- For each GPS satellite decoding data, this string is output once every 6 seconds.
- For GPS, the subframe field is a hexadecimal representation of all 10 words of a subframe.
- If a word was not decoded or contained a parity error, the six characters associated with that word will be reported as "------".
- To output this sentence, please input "$PERDAPI,CROUT,N,1*57" when baud rate is 115200bps.

SYS – Answer of PVT System

7.3.1 ERSION- Software Version

Format:

$PERDSYS	,	VERSION	,	device	,	version	,	reserve1	,	reserve2	*hh	<CR>	<LF>
		1		2		3		4		5			

Num	Contents	Range	Default	Remark
1	VERSION	-	-	Command Name
2	device	-	-	Device Name
3	version	-	-	Version number
4	reserve1	-	-	Reserve field
5	reserve2	-	-	Reserve field

Example:

$PERDSYS,VERSION,OPUS7_SFLASH_ES2_64P,ENP622A1226410F,QUERY,N/A*1A

Notes:

- Character string of the device and version is free format.

GPIO- General Purpose Input/output Format:

$PERDSYS	,	GPIO	,	state	*hh	<CR>	<LF>
		1		2			

Num	Contents	Range	Default	Remark
1	GPIO	-	-	Command Name
2	state	H or L	-	GPIO state (H:High , L:Low)

Example:

$PERDSYS,GPIO,HHHHLLLL*4B

Notes:

- This first character represents GPIO 0 and the last character represents GPIO 8.

FIXSESSION- Fix Session △1 Format:

$PERDSYS	,	FIXSESSION	,	reserve1	[,	reserve2	,	reserve3]	*hh	<CR>	<LF>
		1		2		3		4			

Num	Contents	Range	Default	Remark
1	FIXSESSION	-	-	Command Name
2	reserve1	-	-	reserve field
3	reserve2	-	-	reserve field
4	reserve3	-	-	reserve field

Example:

$PERDSYS,FIXSESSION,ON,19015,19.015*7C

Notes:

- This string is sent when certain events occur. This is for *eRide* use only.

ANTSEL- Antenna selecting △1 Format:

$PERDSYS	,	ANTSEL	,	reserve1	,	reserve2	*hh	<CR>	<LF>
		1		2		3			

Num	Contents	Range	Default	Remark
1	ANTSEL	-	-	Command Name
2	reserve1	-	-	reserve field
3	reserve2	-	-	reserve field

Example:

$PERDSYS,ANTSEL,FORCE1L,1LOW*32

Notes:

- This string is sent when certain events occur. This is for *eRide* use only.

BBRAM - Battery Backup Random Access Memory △1 Format:

$PERDSYS	,	BBRAM	,	reserve1	[,	reserve2]	*hh	<CR>	<LF>
		1		2		3			

Num	Contents	Range	Default	Remark
1	BBRAM	-	-	Command Name
2	reserve1	-	-	reserve field
3	reserve2	-	-	reserve field

Example:

$PERDSYS,BBRAM,PASS*15

Notes:

- This string is sent when certain events occur. This is for *eRide* use only.

MSG – Event Driven Message △1 Format:

$PERDMSG	,	key	[,	string]	*hh	<CR>	<LF>
		1		2			

Num	Contents	Range	Default	Remark
1	key	-	-	Alphanumeric event indicator
2	string	-	-	Description of event

Example:

$PERDMSG,1A*06

Notes:

- This string is sent when certain events occur. Some strings are for *eRide* use only and contain only an alphanumeric key. Others provide user feedback and contain description of the event.

10 Backup of the Receiver Parameters (for BBRAM) △4

The parameters which this receiver has backed up are shown below.

Chart. Backup of the receiver parameter

CONTENTS	PARAMETER	HOT	WARM	COLD	FACTORY	POWER OFF/ON
Present time	Date & Time	YES	YES	YES	NO	YES
	Millennium	YES	YES	YES	NO	YES
Receiver's present position	Latitude	YES	YES	YES	NO	YES
	Longitude	YES	YES	YES	NO	YES
	Altitude	YES	YES	YES	NO	YES
Receiver's hold position[*1]	Latitude	YES	YES	YES	NO	YES[*3]
	Longitude	YES	YES	YES	NO	YES[*3]
	Altitude	YES	YES	YES	NO	YES[*3]
Ephemeris	Ephemeris data	YES	NO	NO	NO	YES[*2]
Almanac	Almanac data	YES	YES	NO	NO	YES

Chart. Backup of the receiver parameter of command

COMMAND NAME	PARAMETER	HOT	WARM	COLD	FACTORY	POWER OFF/ON
GNSS	GNSS setting	YES	YES	YES	NO	YES
FIXMASK	FIXMASK setting	YES	YES	YES	NO	YES
PPS	PPS setting	YES	YES	YES	NO	YES
TIMEZONE	GMT setting	YES	YES	YES	NO	YES
SURVEY	position mode	YES	YES	YES	NO	YES
	Sigma threshold for survey	YES	YES	YES	NO	YES
	Time threshold for survey	YES	YES	YES	NO	YES
	Current sigma for survey	YES[*3]	YES[*3]	YES[*3]	NO	YES[*3]
	Current time for survey	YES[*3]	YES[*3]	YES[*3]	NO	YES[*3]
FREQ	FREQ setting	YES	YES	YES	NO	YES
CROUT	CROUT setting	YES	YES	YES	NO	YES
DEFLS	Default leap sec	YES	YES	YES	NO	YES

TIMEALIGN	Time alignment	YES	YES	YES	NO	YES
FLASHBACKUP	Backup in flash	YES	YES	YES	YES	YES

Chart. Backup of the configure parameter of command

COMMAND NAME	PARAMETER	HOT	WARM	COLD	FACTORY	POWER OFF/ON
UART1	Baud rate of UART1	YES	YES	YES	YES	NO
NMEAOUT	NMEA output interval	YES	YES	YES	YES	NO

[*1] The position calculated by position survey mode or input by $PERDAPI,SURVEY,3. [*2] There is a time limitation (4 hours).
[*3] CSS (continues survey) mode or TO (time only) mode only

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