# NR4600-O/G

## PC104 Six Channel GNSS-Locked Reference with Auto-Cal

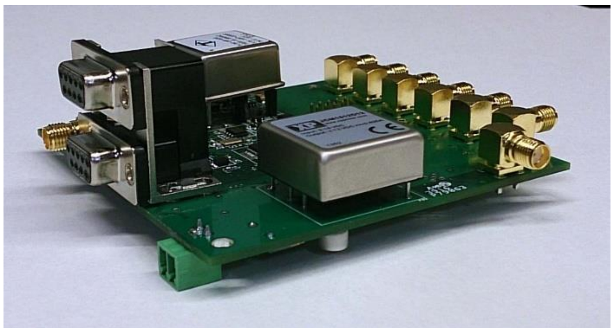
# Contents

## 1.0 Summary

The NR4600-O/G is a GNSS-locked 10 MHz frequency reference with auto-calibration. It features six independent fault and transient protected channels. Each is monitored with an AC to DC converter that can be read over an RS232 port.

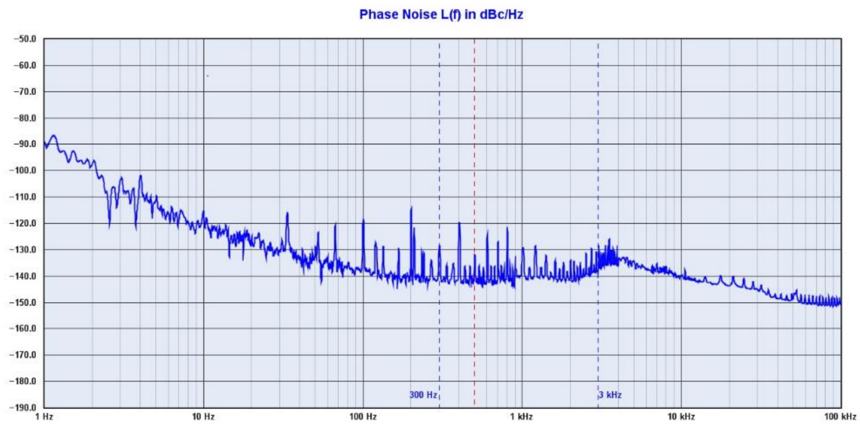
The unit also provides a PPS channel and NMEA 0183 at full RS232 levels. The RS232 ports can also be configured to operate at logic levels.

The overall design form factor is compliant with PC104 standards - simplifying installation.

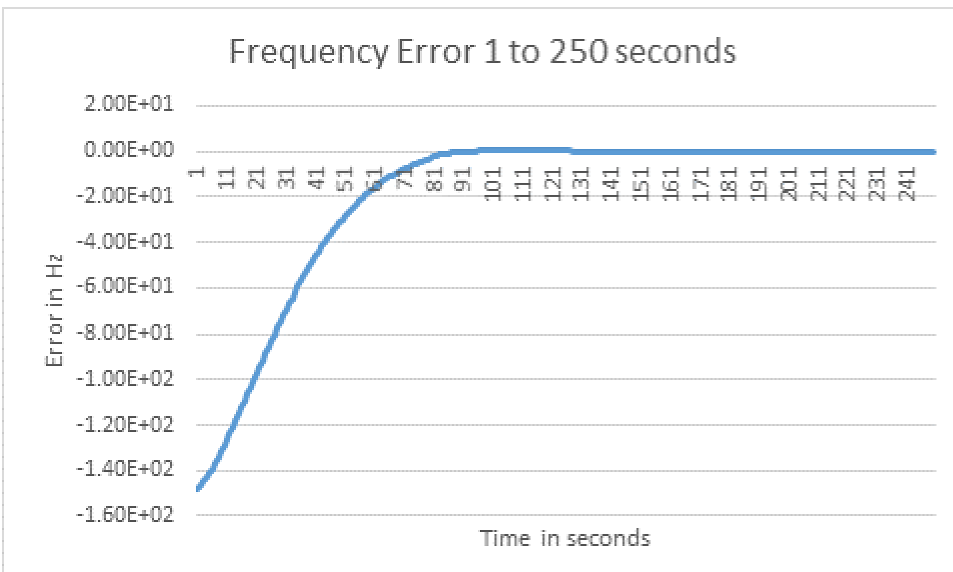


The master timing is from a 26 channel GNSS receiver that supports GPS, GLONASS, SBAS, QZSS. By being able to receive data from multiple satellite constellations, lower TIFF is achieved. With twice the number of satellites in view, as a GPS only configuration, achieving and maintaining lock in poor signal environments is enhanced.

The signal source is a GNSS disciplined low noise OCXO, actively controlled by a mixed-signal phase-lock-loop. Typical phase noise performance follows.




| Trace | Input Freq | Input Amplitude | dBc/Hz at 500 Hz | RMS Jitter | SSB C/N dB | Duration | Acquired | Instrument |
|---|---|---|---|---|---|---|---|---|
| 4600 ypass ant (Unsaved) | 10.000 MHz | 10.3 dBm | −133.6 | 1.8E−13 s | −101.8 | 1m 0s | 600 pts | TimePod 5330A |



Power can range from -60 to +60 VDC in three ranges. The power converter is electrically isolated from signal ground. Unit is transient and reverse polarity protected.

The NR4600-O/G continually monitors temperature and aging so that, when the unit goes into holdover or loses GNSS lock, the output frequency reverts to the last known locked frequency value. The calibration feature continually monitors the correction coefficients developed through GNSS timing information. These are sampled multiple times per day and stored in non-volatile memory and, in the event of a GNSS loss, the saved coefficients are applied to the OCXO. This effectively eliminates long-term crystal drift. Auto-Cal normally keeps the reference ±10 ppb.

There are two RS232 ports - one for NMEA 0183 and the other for unit status reporting. The NMEA port information and baud rate can be selected via commands detailed in the Appendix. The RS232 port provides the status of each channel and self-test results. The RS232 signals are made available through one DB-9 or a stacked DB-9 pair.

All inputs and outputs are electrostatic discharge protected. Any output can be shorted indefinitely with no permanent damage to the unit.

# 2.0 Controls and Indicators

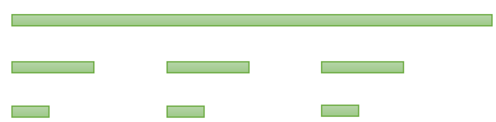
## 2.1 Power LED

The Power LED indicates voltage is applied to the 12V power input connector.

## 2.2 Lock LED

Indicates GPS/GNSS lock has been achieved. This indicator flashes a single short flash to indicate that the receiver is attempting to acquire lock.  When GPS/GNSS lock has been achieved, the indicator may flash a single long flash until the OCXO has reached temperature.  When both lock states are valid, the Lock LED will show a steady illumination.

GPS Locked / OCXO Loop Locked
GPS Locked / OCXO Loop Unlocked
GPS Tracking / Pending Lock



## 2.3 Satellite Number Counter LED

This LED flashes the number of satellites currently in view. If the unit will not lock or takes a long-time to lock - monitoring this LED could help troubleshoot the problem. If only a few satellites can be acquired, the antenna may need to be confirmed to make sure it has a clear view of the sky.

### 2.4 Six Channel LED

Each channel has an AC to DC converter that is monitored. A faulted state will cause the normally constant ON LED to flash green. This will also be reported on the RS232 status bus.

## 3.0 Inputs / Outputs

Each output is fault and electrostatic discharge protected. Each output is independent and any output can be faulted for an indefinite period of time with no permanent damage. Each output is connected to a monitor circuit that detects a local fault on the output. The fault status is indicated for each of the 10 MHz outputs on a LED on the PCB or via the RS232 link.

### 3.1 GNSS Antenna

SMA female antenna connections. Provides internal 3.3VDC power at 45mA 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 Specifications:

| | |
|---|---|
| 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) |

### 3.2 PPS - SMA

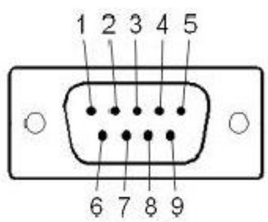
The PPS is a one pulse per second, CMOS, 3.3V signal into 1KOhm. The pulse width is nominally 200 ms but can be programmed at the factory or in the field with the serial port (see Appendix A). The PPS may be advanced/delayed via serial port commands in 1 ns to compensate for antenna cabling delays. The PPS signal is also available optionally on the RS232 NMEA connector pin 1. This is normally not connected but is a factory installed jumper.

### 3.3 10 MHz sine - Six SMA

1 Vrms into 50 Ohms. The unit can be alternately configured to output a square wave.

## 3.4 RS232 - DB9 (Dual)

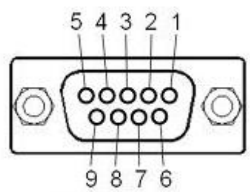
There are two RS232 connectors. The bottom connector (nearest the PCB) is for NMEA data and the top connector is for STATUS. The unit can be configured at the factory to also operate at 3.3 Vdc CMOS instead of the full RS232 levels. Appendix A goes into complete detail as to how to listen to and control the GNSS receiver.




**Male DB-9**

| Pin | Function | I/O |
|---|---|---|
| 1 | NC | |
| 2 | NMEA port RX | I |
| 3 | NMEA Port TX | O |
| 4 | NC | |
| 5 | GND | REF |
| 6 | Status TX | O |
| 7 | Status RX | I |
| 8 | NC | |
| 9 | NC | |

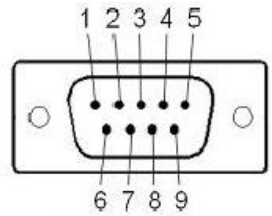
The top DB9 connector communicates with the onboard processor, and operates at RS232 levels. The status indications and alerts can be configured via this port. It is a female DB9 Connector.




**Female DB-9**

| Pin | Function | I/O |
|---|---|---|
| 1 | NC | |
| 2 | STATUS port / Command Port TX | O |
| 3 | STATUS Port / Command Port RX | I |
| 4 | NC | |
| 5 | GND | |
| 6 | NC | |
| 7 | NC | |
| 8 | NC | |
| 9 | NC | |

### 3.5 RS232 – DB9 (Single)




**Male DB-9**

As an alternative to the stacked DB-9 connectors – the product is also configurable as a single MALE DB-9 as follows:

| Pin | Function | I/O |
|---|---|---|
| 1 | NC | |
| 2 | NMEA Port TX | O |
| 3 | NMEA Port RX | I |
| 4 | NC | |
| 5 | GND | |
| 6 | Status TX | O |
| 7 | Status RX | I |
| 8 | BIT | O |
| 9 | NC | |

The BIT (Built in Test) indicator is a composite AND of the following statuses, also available from the serial Status TX stream:

- GPS Locked
- No channel Faults
- No Power Supply Faults

If all the above conditions are met, the BIT status is HIGH (3V3), else, the BIT status is LOW (0V).

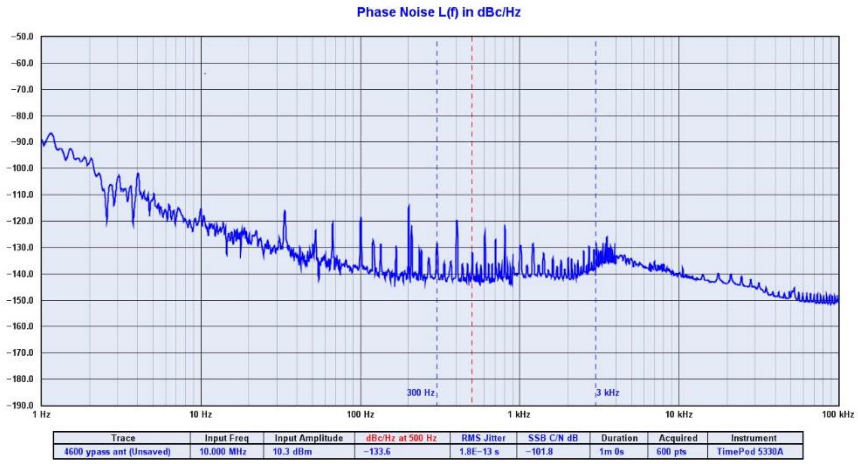
### 3.6 Power Connector

Mating connector:
OnShore Technology Inc.
Part# OSTTJ0211530

Pin 1: + (closest to the edge of the pcb) +VDC
Pin 2: - -VDC

The unit draws < 6 Watts at turn-on and drops to < 3 W after the OCXO warms. During conditions at 25°C, the crystal will warm in less than three minutes.

## 4.0 Typical Phase Noise




**10MHz Sine- Primary Output**

| Offset Frequency (Hz) | Typical (dBc / Hz) |
|---|---|
| 10 | -102 |
| 100 | -110 |
| 1K | -140 |
| 10K | -145 |

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

## 5.0 Built-in Test

There are a number of power supplies in the design to meet special needs and noise reduction. Each supply is monitored and a power failure will be reported through the $GPSNV status strings.

Channel faults are also monitored and reported via RS232.

The lock status is a combination of GNSS receiver lock and the Kalman filter locking. A failure of the Kalman filter to lock is considered a failure mode.

The BIT (Built in Test) indicator is a composite AND of the following statuses, also available from the serial Status TX stream:

- GPS Locked
- No channel Faults
- No Power Supply Faults

If all the above conditions are met, the BIT status is HIGH (3V3), else, the BIT status is LOW (0V).

## 6.0 Power

The platform is designed to operate from -60 to +60 VDC. This is done in three ranges.

±12 V (10-18 VDC)
±24 V (19-36 VDC)
±48 V (37-60 VDC)

The unit incorporates reverse polarity protection by having a diode bridge on the input power.

The unit is also fused with a 5 Amp slow blow.

Power < 6 watts. Power is highest at turn on as the OCXO is warmed rapidly. Crystal power will start over 3 Watts and drop to approximately 1.5 Watts after three minutes at 25°C.

The nominal power is 12 VDC. Other than 12 VDC operation must be requested at the time of ordering.

## 7.0 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 3-D 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 GNSS 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.

This LED illuminates green when the unit is locked to the GNSS system. If the LED is flashing green, the unit is operating on the OCXO and is attempting to gain GNSS Lock.

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The GNSS lock status is also on the RS232 connector.

If the GNSS indicator remains flashing green 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 at 866-313-9401.

There is free software that can be downloaded from www.synreference.com that will allow baud rate changes, cable compensation and other features (see screen shots).

## 8.0 Programming Guide (STATUS Port)

The NR4600-OG can accept user commands which will provide particular fault detection performance which may be customized by the user, and saved in non-volatile flash memory.

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

Table 1 shows a complete list of input commands and descriptions. As a general rule, a command can be input without "=" or additional value, and the unit will respond with the current setting's value. If the input is not understood, the microcontroller will return the value "$?<CR><LF>"
**NOTE: All commands should be followed by <cr><lf>.**

A checksum can be added to all input commands, and the requirement for a checksum can be turned on. The checksum method is the two-hexadecimal character representation of an XOR of all characters in the sentence between, but not including, the $ and the * character.

Example: $BAUDNV=38400*08

## 8.1 Status Commands

| Setting | Command | Response | Description |
|---|---|---|---|
| STATUS PORT BAUD RATE | $BAUDNV | $BAUDNV=<current Baud Rate> | Query Baud Rate on Status Port RS232.PORT (Default = 38400) |
| | $BAUDNV=38400 | | Assign Baud rate to Status Port RS232 Input. (4800, 9600, 19200, 38400, 57600, or 115200) |
| POWER SUPPLY FAULT THRESHOLD FACTOR | $PTSF | $PTSF=<current Power Supply Fault threshold factor (from 0.01 to 0.99)> | Query or set the ratio at which the power supply monitor reports a fault. For example, if the PTSF is set to "0.15", the power supply Fault Byte will report an error if the measured value exceeds ±15% of its target value. |
| | $PTSF=0.15 | | |
| CHANNEL FAULT LOW THRESHOLD VALUE (V) | $THR | $THR=<current Channel Fault Threshold (from 0.02V to 3V)> | Query or set the absolute voltage at which the Channel monitor reports a fault. For example, if the THR is set to "0.4", the Channel Fault Byte will report an error if the measured Vrms is lower than 0.4V. |
| | $THR=0.4 | | |
| NVS1 OUTPUT | $NVS1 | $NVS1=<current RMC output frequency> | Query NVS1 String output Frequency. (Default = 1) |
| | $NVS1=1 | | Change NVS1 String output Frequency in seconds. (0-60) |
| NVS2 OUTPUT | $NVS2 | $NVS2=<current RMC output frequency> | Query NVS2 String output Frequency. (Default = 1) |
| | $NVS2=1 | | Change NVS2 String output Frequency in seconds. (0-60) |
| NVS3 OUTPUT | $NVS3 | $NVS3=<current RMC output frequency> | Query NVS3 String output Frequency. (Default = 1) |
| | $NVS3=1 | | Change NVS3 String output Frequency in seconds. (0-60) |
| REQUIRE CHECKSUM | $CSUM | $CSUM=<current CSUM> | Query or set mandatory checksum on all incoming STATUS port communication. 1 = Enabled, 0 = Disabled. Default = 0. |
| | $CSUM=1 | | |
| ALL STRINGS OUTPUT | $ALL=1 | $ALL=1 | Change ALL String output Frequencies in seconds. (0-60). Note this is a convenient way to set all string frequencies at once, usually back to 1Hz. Setting ALL=0 will shut off all STATUS string output. Any other ALL setting will also affect all STATUS strings at once. |

| Setting | Command | Response | Description |
|---|---|---|---|
| STATUS OUTPUT | $STAT<n> | <$GPNVS,1....> | Query NVS<n> String. Useful for status output on demand when user does not require regular string output. |
| | $STAT1 | | Outputs current $GPNVS,1 string on demand. |
| | $STAT2 | <$GPNVS,2....> | Outputs current $GPNVS,2 string on demand. |
| | $STAT3 | <$GPNVS,3....> | Outputs current $GPNVS,3 string on demand. |
| SAVE ALL VALUES TO FLASH MEMORY | $SAVEFLASH | $SAVED.<br>$FLASH SAVE FAILED. | This command will translate all current variables to flash string and write. Data is then read back for verification, and result reported. |
| RESET ALL TO DEFAULT | $RESETALL | $RESET FLASH VARIABLES. | Resets all user settings to default values and overwrites flash memory with defaults. |
| INVALID INPUT | | $? | Command not recognized. |
| ID | $IDN? | NOVUS,PCB<nnn><a>,<n.n> | PCB Revision Number, Software Revision Number |

Table 1 Status Commands

## 8.2 Status String ($GPNVS,1) Fault Bytes

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

| # | Description | Range |
|---|---|---|
| 1. | Identifier | $GPNVS |
| 2. | String ID | 1 |
| 3. | Time (UTC) | hhmmss |
| 4. | Date | mmddyy |
| 5. | GPS Lock (Valid) | "A" = Valid, "V" = Not Valid |
| 6. | # of Sats in View | Greater of GPS or GNSS count |
| 7. | Channel Fault Byte | 0x00 to 0x3F (Hex OR'd value) |
| 8. | Power Supply Fault Byte | 0x00 to 0x1F (Hex OR'd value) |
| 9. | Error Message Byte | 0x00 to 0x0F (Hex OR'd value) |
| 10. | NMEA Checksum | *XX (xor'd value of bytes between $ and *) |

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

### 8.3 Status String ($GPNVS,2) Channel Values

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

| # | Description | Range |
|---|---|---|
| 1. | Identifier | $GPNVS |
| 2. | String ID | 2 |
| 3. | Time (UTC) | hhmmss |
| 4. | Date | mmddyy |
| 5. | Channel 1 Vrms | 0.00 to 6.60 [V] |
| 6. | Channel 2 Vrms | 0.00 to 6.60 [V] |
| 7. | Channel 3 Vrms | 0.00 to 6.60 [V] |
| 8. | Channel 4 Vrms | 0.00 to 6.60 [V] |
| 9. | Channel 5 Vrms | 0.00 to 6.60 [V] |
| 10. | Channel 6 Vrms | 0.00 to 6.60 [V] |
| 11. | NMEA Checksum | *XX (xor'd value of bytes between $ and *) |

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

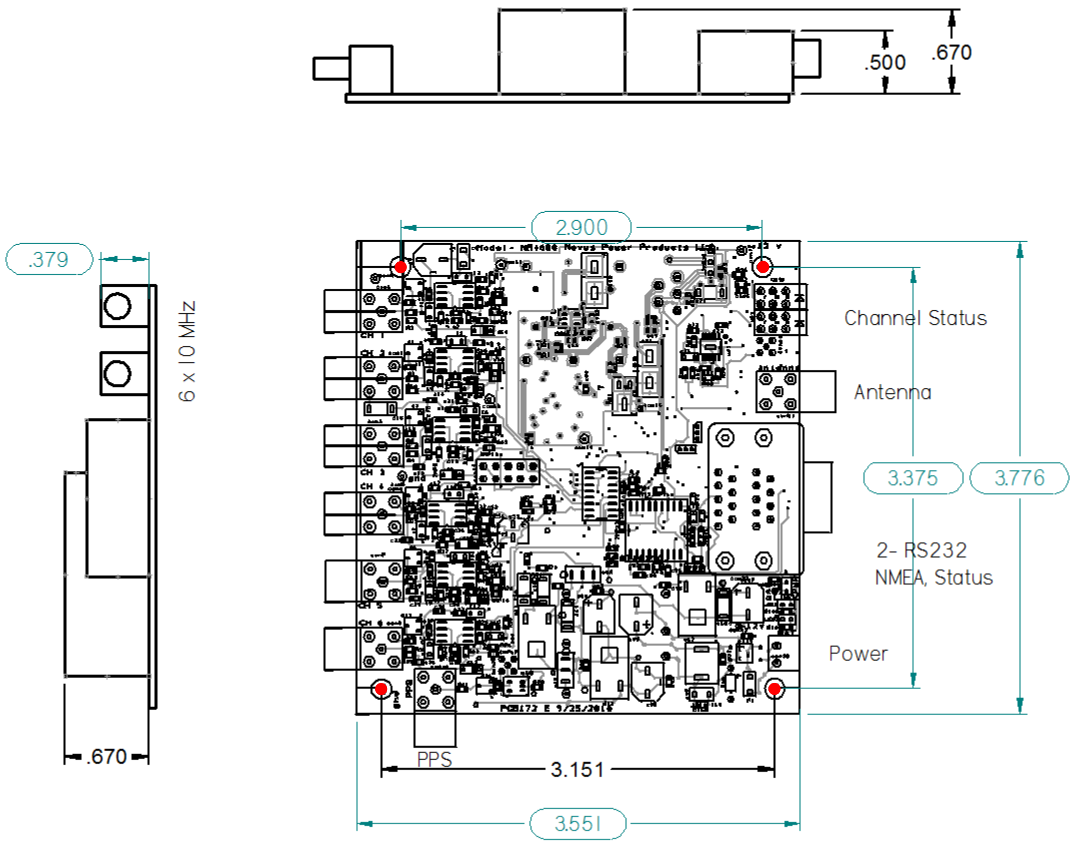
## 8.4 Status String ($GPNVS,3) Power Supply Values

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

| # | Description | Range |
|---|---|---|
| 1. | Identifier | $GPNVS |
| 2. | String ID | 2 |
| 3. | Time (UTC) | hhmmss |
| 4. | Date | mmddyy |
| 5. | -5Vdc Power Supply | -30.0 to 30.0 [V] |
| 6. | +5Vdc Power Supply | -30.0 to 30.0 [V] |
| 7. | 10kΩ Thermistor | 0.00 to 3.30 [V] |
| 8. | +5Vdc Power Supply(opt) | -30.0 to 30.0 [V] |
| 9. | OCXO Control Voltage | 0.00 to 3.30 [V] |
| 10. | NMEA Checksum | *XX (xor'd value of bytes between $ and *) |

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

## 9.0 Mechanical




There are four 0.156” pads on the board intended for mechanical mounting. They are shown in red above.

# 10.0 Performance

## 10.1 Technical Specifications

| | |
|---|---|
| 10MHz Sine | 1 ±0.1 Vrms, 50 Ohms. |
| Harmonics | Less than -30dBc |
| First Year Frequency Stability | ± 50 ppb unlocked |
| Temp Stability | ±10 ppb unlocked |
| Daily Aging OCXO | ±5 ppb/day unlocked |
| Yearly Aging | ±50 ppb (without GNSS lock) |
| Accuracy Auto-Cal (24 hrs.) | 10 MHz<5ppb (does not include crystal drift if not GNSS locked) |
| Receiver Sensitivity | -155dBm |
| **Remote interface & control** | |
| Protocol | RS232 NMEA-0183 |
| Connector | DB-9 |
| Location | Rear panel |
| Protocol | Bit plus stop |
| Standard Baud Rates | Selectable 4800, 9600, 19200, 38400, 57600 or 115200 bps |
| | |
| **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 | |
| PPS | 20ns RMS accuracy, 3.3 volt logic | |
| GPS Lock | LED on board and status via serial port | |
| Alert | LED on board and status via serial port | |
| Power Requirements | Nominal 12 VDC (10-18) options cover -60 to +60 VDC | |
| Connectors | 6-SMA 10 MHz output, sine wave | |
| | SMA PPS CMOS | |
| | SMA Antenna connector (3.5 VDC < 20 ma) | |
| Locked Accuracy | < 3E-11 @ 200 sec | |
| Options: | | |

### 10.2 Environmental and Mechanical

| | | |
|---|---|---|
| Operating Temperature | 0 to 50ºC non-condensing (extended temperature range available) | |
| Storage Temperature | -40 to 85ºC | |
| Width | 3.7” | |
| Depth | 3.5” | |
| Height | ~1.5” | |
| Weight | ~5 oz. | |



## 11.0 LIMITED HARDWARE WARRANTY

**Novus Power Products** (hereinafter Novus) warrants its products to the original end user (“original purchaser”) and warranty is not transferable. Novus guarantees that the NOVUS hardware products that you have purchased from NOVUS are free from defects in materials or workmanship under normal use during the LIMITED WARRANTY PERIOD. The LIMITED WARRANTY PERIOD starts on the date of shipment and for the period of 1 (one) year to be free from defects caused by faulty materials or poor workmanship, provided:

(a) NOVUS is notified in writing by Buyer of such defect prior to the expiration of the warranty period, and

(b) after receiving return authorization –RMA- from NOVUS, the defective item is returned with transportation prepaid to NOVUS, Independence, Missouri, with transportation charges prepaid by Buyer …see RMA policy in Terms and conditions, and

(c) NOVUSs' examination of such unit shall disclose to its satisfaction that such defect(s) exist and have not been caused by misuse, neglect, improper installation, improper storage, unauthorized modifications, inadequate maintenance, operation outside the environmental specifications for the product, repair alteration, or accident. NOVUS assumes no risk or liability for results of the use of products purchased from it, including but without limiting the generality of the foregoing: (1) the use in combination with any electrical or electronic components, circuits, systems, assemblies or any other materials or substances; (2) unsuitability of any product for use in any circuit or assembly. Removal or tampering with tamper-proof label on merchandise will void warranty coverage unless with the written authorization from NOVUS

(d) an evaluation fee will be charged to Buyer to cover inspection and testing costs for any item returned by Buyer under this paragraph which is found to be within specifications and/or otherwise not the responsibility of NOVUS under the terms and conditions of this paragraph or any other part of this Agreement..

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## 12.0 Appendix: GPS/GNSS Command Reference

See Attached.

**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

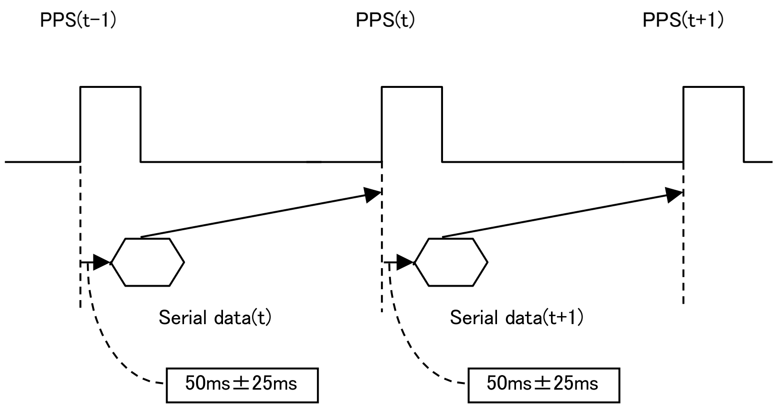
Note 1: Communication speed can be changed into 4800, 9600, 19200, 38400, 57600 or 115200 bps.

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.<br><br>All output sentences must begin with a "$" followed by a TalkerID. The relevant Talker IDs are GP for GPS, GN for GNSS, GL for GLONASS and GA for Galileo.<br><br>For the sentences received from external equipment, the GT-87 accepts any talker ID. Talker ID "XX" found on the succeeding pages is a wildcard meaning "any valid talker ID". |
| <data field> | Variable or fixed-length fields preceded by delimiter ","(comma).<br><br>Comma(s) are required even when valid field data are not available i.e. null fields. Ex. ",,,,,"<br><br>In a numeric field with fixed field length, fill unused leading digits with zeroes. |
| *<checksum field> | 8 bits data between "$" 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>.<br><br>All output sentences have checksum.<br><br>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.<br>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).<br>(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>.<br><br>All output sentences have checksum.<br><br>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<br>"0": Fix not available or invalid<br>"1": Valid fix<br>"2": DGPS positioning |
| 7. | Number of satellites used for positioning | 00 – 12 [*1] |
| 8. | Horizontal dilution of precision (HDOP)<br>Note: A null field is output while positioning is interrupted. | 0.0-50.0 |
| 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<br>"A": Data Valid<br>"V": Data Invalid |
| 7. | Position System Mode Indication | A, D or N<br>"A": Autonomous<br>"D": Differential<br>"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<br>"M": 2D/3D fixed mode<br>"A": 2D/3D Auto-switching mode |
| 2. | Mode | 1 - 3<br>"1": No fix<br>"2": 2D fix<br>"3": 3D fix |
| 3-14. | Satellite Numbers used for positioning<br>Note: A null field is output unless a satellite is available. | 01 - 99 |
| 15. | PDOP<br>Note: A null field is output unless 3D-positioning is performed. | 0.0 - 50.0 |
| 16. | HDOP<br>Note: A null field is output while positioning is interrupted. | 0.0 - 50.0 |
| 17. | VDOP<br>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<br>"A": Data valid<br>"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<br>"dd": date<br>"mm": month<br>"yy": last two digits of the year | |
| 10. | Magnetic declination<br>Note: A null field is output unless magnetic declination information is available. | |
| 11. | Correction direction of magnetic declination<br>Note: A null field is output unless magnetic declination information is available. | |
| 12. | Positioning System Mode Indication | A, D or N<br>"A": Autonomous<br>"D": Differential<br>"N": Data Invalid |
| 13. | Navigation Status Indicator | S, C, U or V<br>"S": Safe<br>"C": Caution<br>"U": Unsafe<br>"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<br>"A": Autonomous<br>"D": Differential<br>"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.<br>LEGACYGP: GL and GN sentence is omitted.<br>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)<br>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)<br>Only SVs above this mask are fixed. |
| 6 | Reserve2 | 0 | 0 | Reserve field |
| 7 | Prohibit SVs (GPS) | 32BIT (HEX) | 0 | GPS Satellite number mask<br>Each bit represents one SVID.<br>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<br>Each bit represents one SVID.<br>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<br>Each bit represents one SVID.<br>This field is unimplemented. △4 |
| 10 | Prohibit SVs (QZSS) | 7BIT (HEX) | 0 | QZSS Satellite number mask<br>Each bit represents one SVID.<br>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<br>Each bit represents one SVID.<br>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<br>GCLK | LEGACY | PPS type |
| 3 | mode | 0 to 4 | 4 | PPS mode<br>0: Always stop<br>1: Always output<br>2: Output only during positioning more than one satellite<br>3: Output only when TRAIM is OK<br>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<br>0: 1PPS (A pulse is output per second)<br>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)<br>Plus brings delay PPS.<br>Minus brings forward PPS. |
| 7 | polarity | 0 to 1 | 0 | PPS polarity (LEGACY PPS is rising edge only)<br>0 : rising edge<br>1 : falling edge |
| 8 | PPS accuracy threshold | 5 to 9999 | 1000 | PPS estimated accuracy threshold<br>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<br>WARM<br>COLD<br>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<br>00 to 59<br>00 to 59 | 0 | UTC (Hour)<br>UTC(Minute)<br>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)<br>**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<br>"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<br>NAV (navigation) mode<br>1: Position Survey<br>SS (self survey) mode<br>2: Position Survey<br>CSS (continual self survey) mode<br>3: Position-hold<br>TO (time only) mode |
| 3 | sigma threshold | 0 to 255 | 0 △3 | Sigma threshold (m) which changes automatically to position-fixed.<br>(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.<br>(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)<br>A positive number means the north latitude and a negative number means the south latitude.<br>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)<br>A positive number means the east longitude and a negative number means the west longitude.<br>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)<br>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

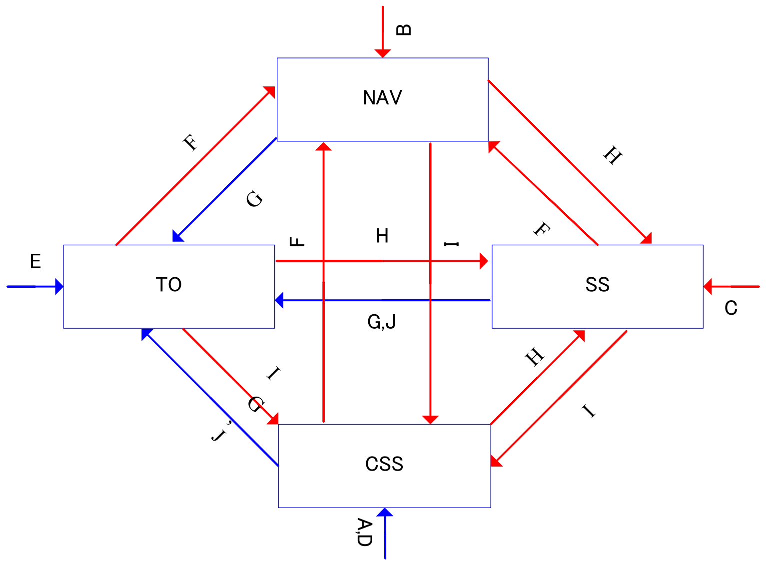
$PERDAPI,SURVEY,3,0,0,37.78700,-122.45100,31.5*53

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.<br>"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.<br>[*] 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 | | | |

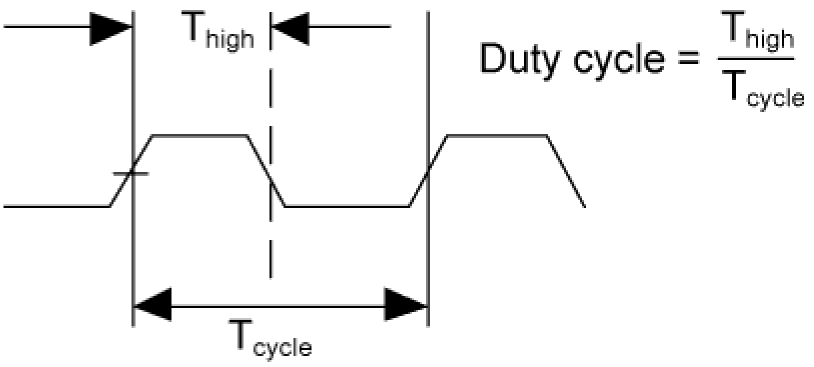
| Num | Contents | Range | Default | Remark |
|---|---|---|---|---|
| 1 | FREQ | - | - | Command Name |
| 2 | mode | 0 to 1 | 0 | 0 : stop<br>1 : output |
| 3 | freq | 4000 to 40000000 | 10000000 (10MHz) | frequency[Hz] |
| 4 | duty △2 | 10 to 90 △7 | 50 | duty cycle [%] |
| 5 | offset △2 | 0 to 99 | 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.<br>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<br>2 : UTC(USNO) alignment<br>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<br>Each bit represents one command setting<br>0x01 : FREQ command setting<br>0x02 : DEFLS command setting<br>0x04 : TIMEALIGN command setting<br><br>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<br><br>[*] Alphabets of outside range are reserved. |
| 3 | rate | W,X,Y,Z : 0 to 255<br>N,M : 0 to 1 | 1 | W,X,Y,Z :<br>1-255:Update interval of the sentence (sec)<br>0: The sentence(s) is/are stopped.<br><br>N,M :<br>1: Sentence(s) is/are output every event occurred.<br>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<br><br>[*1]<br>GGA, GLL, GNS, GSA, GSV, RMC, VTG, ZDA, ALL△9.<br>(ALL means all sentences from GGA to ZDA.) |
| 3 | Interval | 0 to 255 | - | Update interval of the sentence (sec)<br>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<br>year, month, day, hour, minute, second |
| 3 | time status | 0 to 2 (1byte) | 0 | Present time status of output sentence<br>0: RTC<br>1: GPS (GT-87 doesn't apply leap second or has only default leap second)<br>2: UTC (GT-87 has confirmed leap second and applies it.) |
| 4 | update date | 14-byte fixed length | 00000000000000 | Leap second update schedule<br>year, month, day, hour, minute, second<br>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.<br>0:RTC<br>1:GPS<br>2:UTC(USNO)<br>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<br>0: 1PPS OFF<br>1: 1PPS ON |
| 3 | pps mode | 0 to 4 (1byte) | 4 | PPS mode<br>0: Always stop<br>1: Always output<br>2: Output only during positioning more than one satellite<br>3: Output only when TRAIM is OK<br>4: Output only when estimated accuracy is less than estimated accuracy threshold |
| 4 | period | 0 to 1 (1byte) | 0 | 1PPS output interval<br>0: 1PPS (A pulse is output per second)<br>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<br>1 : falling edge |
| 8 | pps type | 0 to 1 (1byte) | 0 | 0 : LEGACY PPS<br>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<br>0005 to 9999 (4byte) | 1000 | PPS estimated accuracy threshold (ns)<br>This threshold is used for pps mode 4.<br>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<br>0: Normal<br>1: Survey mode (re-calculation for every power supply OFF/ON)<br>2: Survey mode(calculation continuously before and after power supply OFF/ON)<br>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<br>△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<br>△3 | Time threshold (sec) which changes automatically to position-fixed. |
| 7 | TRAIM solution | 0 to 2 (1byte) | 2 | TRAIM solution<br>0: OK<br>1: ALARM<br>2: UNKNOWN, due to<br>a. alarm threshold set too low<br>b. insufficient satellites being tracked |
| 8 | TRAIM status | 0 to 2 (1byte) | 2 | TRAIM status<br>0: detection and isolation possible<br>1: detection only possible<br>2: neither possible |
| 9 | removed SV | 0 to 3 (2byte) | 00 | number of the removed satellite by TRAIM |
| 10 | Receiver status<br>△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<br>2: lock<br>3: hold over<br>4: free run<br>5: coarse mode<br>6: fine mode |
| 3 | Freq status | 0 or 1 (1byte) | 0 | 0: Not output<br>1: Output |
| 4 | GCLK accuracy | 0 or 1 (1byte) | 0 | 0: Not accurate<br>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<br>In case of GT-8777 of "4850466003"<br>➔ 8777 + 03 = 877703<br>In case of GT-87 of "4850466005"<br>➔ 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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