Tri-M Systems, Inc.
Unit 100, 1407 Kebet way
Port Coquitlam, BC V3C 6L3
Canada
www.tri-m.com

Phone: 604.945.9565
Fax: 604.945.9566
info@tri-m.com

FV – 25

USER'S GUIDE

This document features the specification of FV-25 and describes the details on using the evaluation kit to evaluate the performance of FV-25 and select the desired functions. It intends to help users to obtain the maximum performance from FV-25 in users' integrating GPS systems.

Version: 1.0
Date: January 2005

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Preface

The objective of The FV-25 User's Guide is to help users to understand the properties of FV-25 thoroughly and, therefore, obtain the maximum performance from the module easily. This document describes and provides the useful information the FV-25 module, which includes the functions of pins on the module, configuration setting, utility, and evaluation kit. It will help users understand the capability of the module and, therefore, successfully integrate the FV-25 into users' GPS systems. Each chapter is one of the pieces for the module and carries its own purpose. The following summary for each chapter and appendix shall help a user to navigate the user's guide as easily and quickly as possible.

Chapter 1 Introduction

This chapter describes the main goal, features, and available supports for the FV-25 module.

Chapter 2 Start

This chapter depicts the definitions of pins on the module and gives an example reference layout of peripheral connections around the module. The utility, "Sanav_Demo.exe", is used to display satellite and receiver information and set configuration for FV-25. All the information about "Sanav_Demo.exe" is introduced step-by-step.

Chapter 3 Alternative Start

This chapter suggests an alternative utility, HyperTerminal, for users to show satellite and receiver information in terms of NMEA sentences. Also, HyperTerminal can be used to save data in the host platform and set configuration to the module. Only the basic operations for desired actions (display, save, and configuration setting) are introduced.

Chapter 4 Navigation

This chapter describes all the information of GPS navigation data available from the module and related issues, such as cold start, warm start, hot start, DGPS, and so on. It also shows corresponding configuration settings for the issues in this chapter.

Chapter 5 Evaluation Kit

This chapter depicts the physical mechanism and functions of evaluation kit for FV-25.

Chapter 6 Antennas

This chapter describes the pro and con for using passive and active antennas with the module.

Chapter 7 Available NMEA and UBX[1] Messages

This chapter lists the available NMEA and u-blox proprietary (UBX) messages for the module.

Chapter 8 Troubleshooting

This chapter provides good helps when the module isn't running properly.

Appendix A Geodetic ID: Coordinate Datum

Appendix B Acronyms

In addition to the above brief description for each chapter, you also can find useful definitions for GPS terminologies in the Appendix B as well as the lists of figures (page ?) and tables (page ?). Please read this user's guide carefully and thoroughly before proceeding the operations of the module. If you experience questions and problems about FV-25 and the evaluation kit, please refer to the Troubleshooting section first. If further helps are needed, please feel free and go to our information service on the homepage, www.sanav.com. We are glad to answer and resolve your questions and problems.

Technical Support

Address:

9F, No. 105, Shi-Cheng Road, Pan-Chiao City,
Taipei Hsien, Taiwan, R.O.C.

Phone:

+886-2-2687-9500

Fax:

+886-2-2687-8893

E-mail Address:

sanav@sanav.com

When you send a request to us, please prepare the following information that may help us to resolve your problem as soon as possible:

1. Serial No. of Product;
2. Type of antenna that is connected to the module;
3. Operating System (OS) of your host PC;
4. Simple description of your integrated system (may also included peripheral connections and devices);
5. Describing the way you operate your system;
6. Description of failure by text, figure, or both;
7. Contact information, such as name, address, phone number, and e-mail address.

[1] UBX: u-blox proprietary protocol.

Chapter 1 Introduction

In this chapter, the main goal of FV-25 will be described and then the features of the FV-25 module will be specified in order that a user can make correct decision about module selection before proceeding further development. Understanding thoroughly the pro and con of FV-25 will clear the compatibility of the module with a user's system. At the same time, let the users make the best performance out the module.

The main goal of FV-25 is to be used as a part of integrated system, which can be a simple PVT (Position-Velocity-Time) system, for instance, G-mouse, or complex wireless systems, such as a system with GSM function, a system with Blue Tooth function, and a system with GPRS function. The module (FV-25) can be the best candidate for users' systems as the users' systems need the careful consideration on the performance, power consumption, and/or size of the module. Table 1.1 summarizes the specification of FV-25. It is noticeable that in addition to excellent start-up times and position accuracy, the updated rate can be up to 4 Hz and the raw measurements, i.e., pseudoranges and carrier phases, can be output in the format of UBX binary message.

FV-25 mainly consists of ATR0600 (RF front-end IC), ATR0610 (LNA IC), and ATR0620 (Baseband IC)[2] as well as 8 Mbit flash memory. Since the low noise amplifier (LNA: ATR0610) is built in the RF section, the passive and active antennas are the available options for the module. The Baseband IC (ATR0620) mainly includes a CPU (ARM7), SRAM, ROM, Battery Backed-up RAM (BBR), and Real-Time Clock (RTC). To keep running of BBR and RTC after power off, a backed-up battery, which has voltage in the range of 1.95 V to 3.6 V, is needed. Since BBR is used to store the updated position, ephemeris, and almanac data, the module can implement all the start-up modes with the back-up battery. Besides the above updated data can be saved to BBR, configuration data, which are available at startup, can be also saved to BBR. In addition, the 8 Mbit flash memory is the other location to save configuration setting permanently without the support of the backed-up battery.

Using high performance of software and firmware from u-blox, the module provides spectacular performance on navigation under static and dynamic conditions in multipath-trended areas, such as urban skyscrapers and canyons, remarkable

[2] ATR 0600, ATR 0610, ATR 0620 are manufactured by Atmel corporation.

sensitivity for weak signals without sacrificing accuracy, AGPS function, DGPS function which is supported by RTCM, WAAS, and EGNOS, and flexibility for system integrations. Because of 8192 frequency search bins at the same time, it accelerates the start-up times of the module.

In addition to the above excellent advantages, FV-25 has the capabilities to perform low power consumption due to the advanced hardware components and implement power saving function owing to versatile firmware. The properties are very suitable for battery-operated products. In addition, our module has the size of only 25.4 mm x 25.4 mm. This feature allows the module more executable and achievable in the system integration, especially for the size-mattered products like handheld devices. Because of using advance technology in package, the module is highly integratable with other components and can be automatically assembled and proceeded in a standard pick-and-place equipment and reflow soldering in high volume. Therefore, the cost of module can be reduced.

1.1 Supports

For FV-25, we will provide a evaluation kit as an optional. The evaluation kit helps the users to perform the estimation of the module, which includes the start-up times, reacquisition time, setting of NMEA sentences, baud rate setting, etc.. All those functions and evaluations are supported by *Sanav_Demo*, which accompanies with the kit and is developed by San Jose Navigation, Inc.. Of course, for the customers without purchasing the kit, a reference layout for peripheral connections and *Sanav_Demo* are available. The details of the reference layout and *Sanav_Demo* will be described in Chapter 2. For the evaluation kit, its introduction is depicted in Chapter 5.

The other available tool for evaluate the module is Window's "HyperTerminal". For utilizing this tool and, at the same time, understanding the capability of the module, the commands and messages for polling data or setting configuration are described in Chapters 4 and 7.

Specification	
Performance Characteristics	
Receiver Type	L1 frequency, C/A code, 16 Channels
Position Accuracy	
w/o aid	3.3 m CEP
DGPS(WAAS, EGNOS,RTCM)	2.6 m
AGPS Support	Yes
Start-up Time	
Hot start	< 3 s
Warm start	35 s
Cold start	41 s
Reacquisition Time	< 1 s
Acceleration	< 4 g
Update Rate	up to 4 Hz
Timing Accuracy	50 ns RMS
Sensitivity	
Acquisition	-140 dBm
Tracking	-149 dBm
Power	
Input Voltage	5.0 ~ 12.0 V DC
Backup Voltage	1.95 ~ 3.3V DC
Power Consumption	
Acquisition	101 mA @ 3 V
Tracking	84 mA @ 3 V
Sleep mode	20 mA @ 3 V
I/O	
Protocols	NMEA, UBX binary, RTCM
Serial Ports	Two RS232s @ 3.3 V
1 PPS	@ 1.8 V
Raw Measurements	Pseudorange and Carrier Phase
Environment	
Operating Temperature	- 40 ^{0}C ~ 85 ^{0}C
Storage Temperature	- 40 ^{0}C ~ 125 ^{0}C
Mechanical Information	

Dimension	37.1mm x 25.6 mm
Thickness	3.9 mm
Weight	9.5 g ***(include an SMA jack and 5 cm RG-316)***
Antenna	
Type	External Active or Passive Antenna
Input Voltage (V_{ANT})	1.8 V ~ 8 V DC
Input Power limit (Active)	< -17 dBm
Gain (Active)	up to 25 dB
Supervision	Build-in short circuit detection, External open circuit detection
Note: For using the passive antenna, Pin VANT has to be connected to GND.	

Table 1.1 Specification of FV-25.

Chapter 2 Start

2.1 Pin Definitions and Reference Layout

Figure 2.1 shows the pin definitions of FV-25. Table 2.1 describes the corresponding definitions for pins. Note that only either use V_{IN-1} (DC 5 ~ 12V) or V_{IN-2} (DC 3.3V) for voltage input. Also, if the Pins 1 ~ 10 are used, please leave Pins a ~ n being opened. There are two comm. ports to input/output the useful information (i.e. receiver's and satellites' data) for the users. The default setting for comm. 1 (either Pins 5 and 10 or Pins l and m) is to input/output the information in the ASCII format, which is NMEA with the default baud rate 4800 bps, and the default setting for comm. 2 (either Pins 4 and 9 or Pins j and k) is to input/output the information in the binary format, which is UBX (proprietary messages) with the default baud rate 4800 bps. The protocols for NMEA and UBX sentences will be introduced in Chapter 7. All the serial ports are operated at the level of 1.8 V.

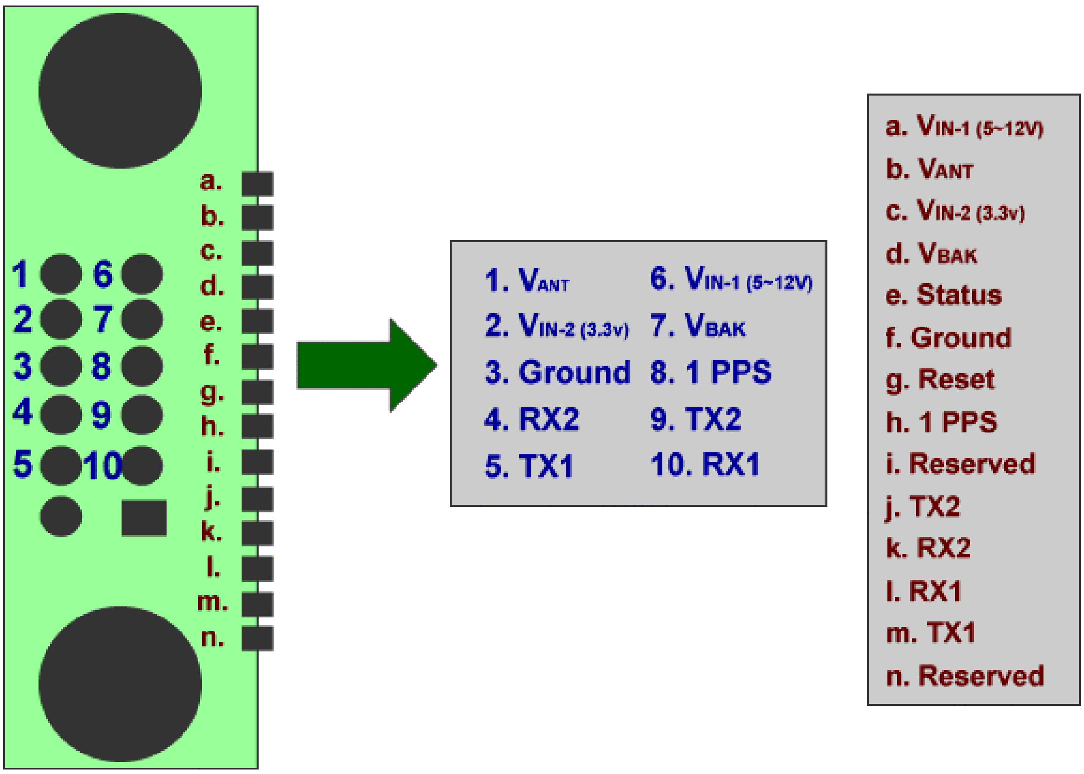


Figure 2.1 FV-25 Pin definitions (Top View)

Pin Definitions

Pin No.	Title	I/O	Note
1	VANT	I	Antenna bias voltage input DC 1.8~ 8.0V (connect to ground if not used)
2	VIN-2	I	Voltage input 3.3V DC (MUST leave open if VIN-1 is used)
3	Ground	I	Ground
4	RX2	I	Serial port 2 (leave open if not used)
5	TX1	O	Serial port 1 (leave open if not used)
6	VIN-1	I	Voltage input 5~12V DC (MUST leave open if VIN-2 is used)
7	VBAK	I	Backup input voltage 1.95 ~ 3.3V DC (connect to ground if not used)
8	1PPS	O	Time pulse (leave open if not used)
9	TX2	O	Serial port 2 (leave open if not used)
10	RX1	I	Serial port 1 (leave open if not used)

Pin No.	Title	I/O	Note
a	VIN-1	I	Voltage input 5~12V DC (MUST leave open if VIN-2 is used)
b	VANT	I	Antenna bias voltage input DC 1.8~ 8.0V (connect to ground if not used)
c	VIN-2	I	Voltage input 3.3V DC (MUST leave open if VIN-1 is used)
d	VBAK	I	Backup voltage input 1.95 ~ 3.3V DC (connect to ground if not used)
e	Status	O	GPS status (leave open if not used)
f	Ground	I	Ground
g	Reset	I/O	Reset (active low, leave open if not used)
h	1 PPS	O	Time pulse (leave open if not used)
i	Reserve	I	External interrupt pin (default: internal pull up, leave open if not used)
j	TX2	O	Serial port 2 (leave open if not used)
k	RX2	I	Serial port 2 (leave open if not used)
l	RX1	I	Serial port 1 (leave open if not used)
m	TX1	O	Serial port 1 (leave open if not used)
n	Reserve	I	Boot mode (in normal operation, leave open if not used)

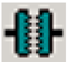
Table 2.1 Description of pin definition for FV-25

Note: Only either VIN-1 or VIN-2 can be used for voltage input, while VIN-2 is the pin for DC 3.3V and VIN-1 is for DC 5~12V.

2.2 Sanav_Demo

Sanav_Demo is required to run on a PC with at least 4 MB RAM and Windows 98 that has at least one available serial comm. port (from 1 to 24).

2.2.1 Port Number & Baud Rate

When users implement *Sanav_Demo*, the first window appeared on the screen is the setting of comm. port number and the corresponding value of baud rate, as shown in Figure 2.3. To open or close the "Setting" window, click the selection "File/Port" or the short cut button .

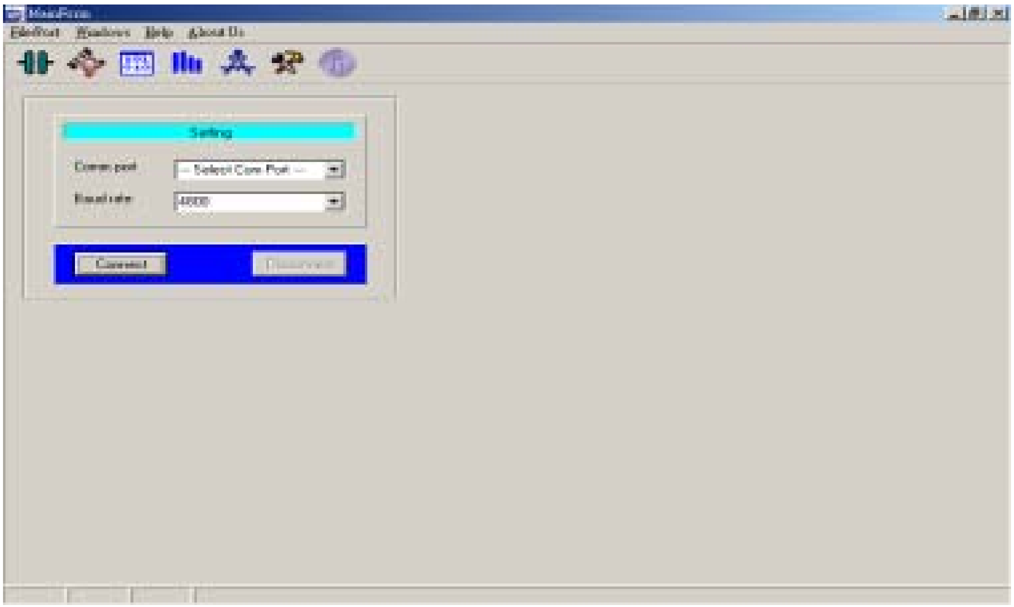


Figure 2.3 Setting of comm. port number and the value of baud rate.

For selecting the comm. port number, pull the scroll-down window for the "Comm port" item and there are twenty-four comm. port number available (i.e. com1 ~ com24), as shown in Figure 2.4. Users can scroll down the desired window to choose the corresponding comm. port number that connects between the module and the host PC.

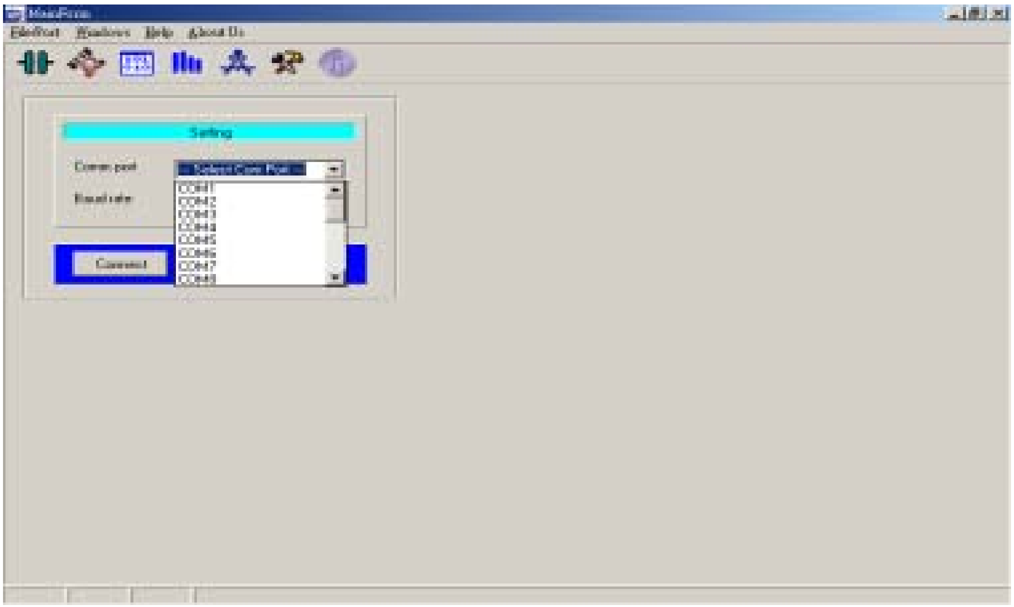


Figure 2.4 Setting of comm. port number.

For setting the value of baud rate, pull the scroll-down window for the “Baud rate” item and the desired window shows that the available range of baud rate is from 2400 bps to 115200 bps, as shown in Figure 2.5. The users select the right one that will communicate the module with the host PC.

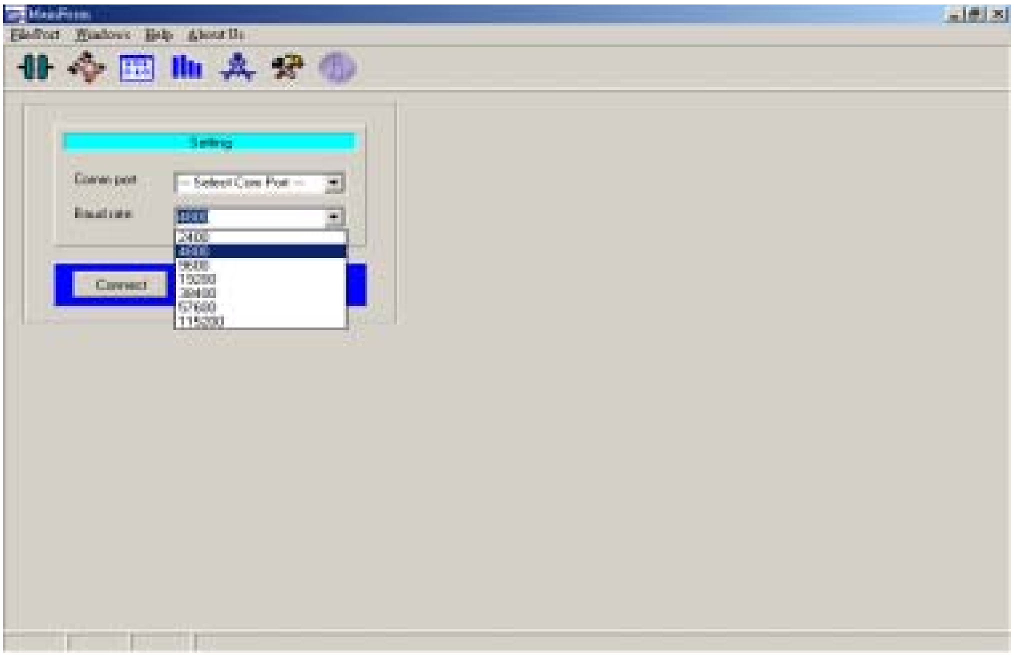


Figure 2.5 Setting of the value of baud rate.

2.2.2 Comm Port Connection and Disconnection

After the setting is completed, click the “Connect” button to make the connection between the GPS receiver (module) and host PC. If the setting is correct, the subsequent window will be the one shown in Figure 2.6, i.e., the navigation data from the module are displayed in the corresponding sub-windows. If the setting values are not correct or the connection hasn't established yet, *Sanav_Demo* will prompt a warning sentence "Comm port couldn't be open, please check the device".

When a new port setting is required, make sure *Sanav_Demo* is disconnected from the module before sending the request, i.e., click the "Disconnect" button in the "Setting" window as *Sanav_Demo* is in the connected mode. Otherwise, if users send a new setting to the module during the connected mode, there will be no response for the request.

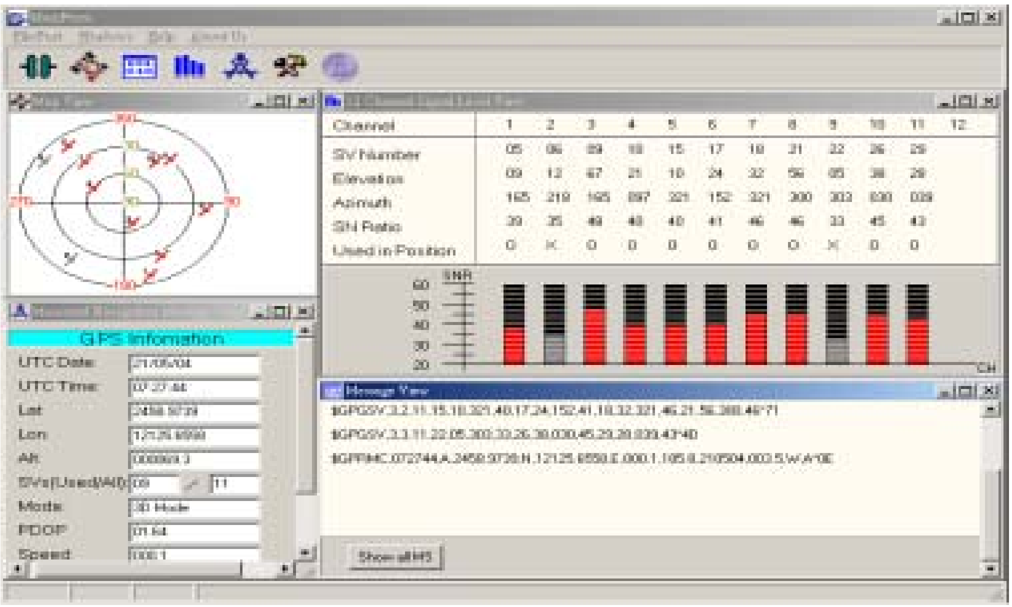


Figure 2.6 Window after correct setting.

2.2.3 Constellation Map

There are two ways to show the constellation of GPS satellites, as shown in Figure 2.7. Click the selection "Windows/Map View" or the short cut button ?. If the module is acquiring a GPS satellite, the corresponding "satellite mark" in the "Map View" is represented by gray color and, on the other hand, if the module is continuously tracking a GPS satellite, the representing color is red, as shown in Figure 2.6.

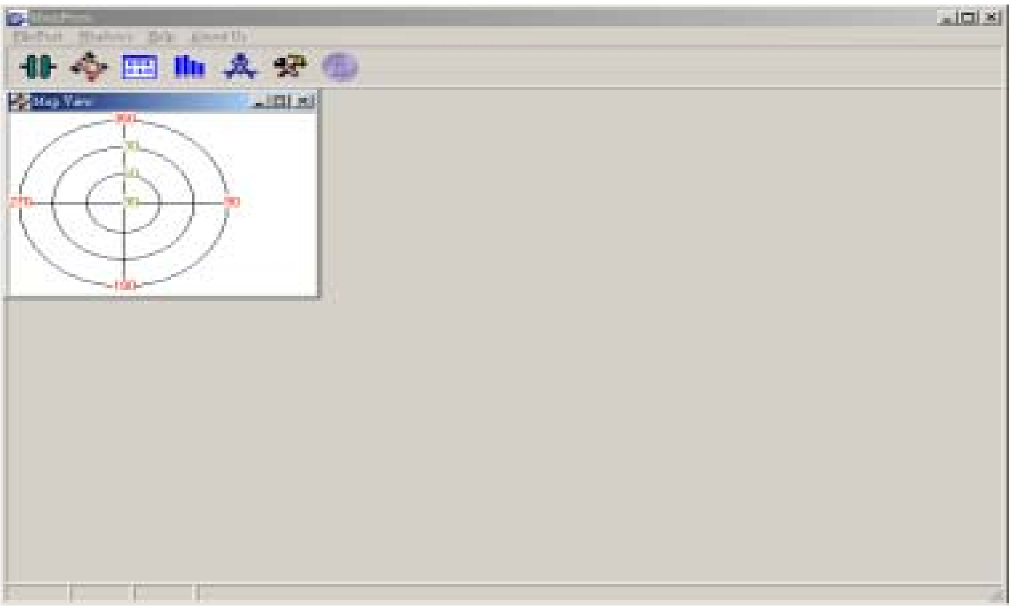


Figure 2.7 Constellation Map of GPS satellites.

2.2.4 Message View for NMEA Messages

Figure 2.8 is the window for showing the desired (user-selected) output NMEA messages. There are two ways to show the "Message View" window. Click the item "Windows/Terminal View" or the shortcut button ?. The default window for "Message View" is only showing the output NMEA messages at current epoch (one epoch), like the one shown in Figure 2.6.

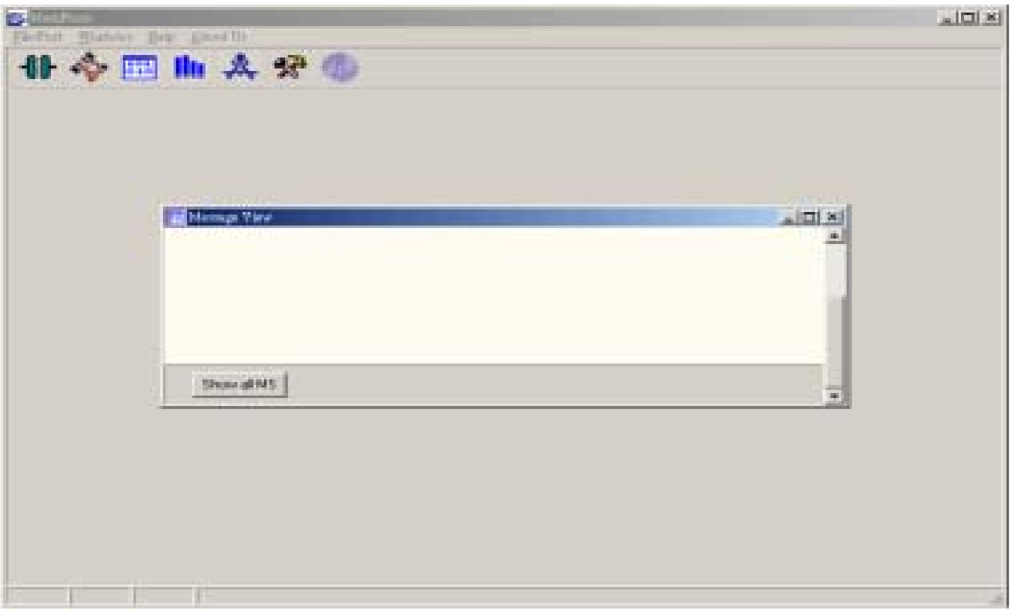


Figure 2.8 Window for showing NMEA messages.

Clicking the "Show all MS" button, the NMEA messages will be displayed accumulatively within the sub-window until the sub-window is filled up, i.e., the “Message View” window contains NMEA messages from several epochs, as shown in Figure 2.9, and the oldest data will be “squeezed” out in the top of the sub-window while the new data will be displayed in the bottom of the sub-window.

After clicking the “Show all MS” button, the “Message View” window shows two available buttons: “Current MS” and “Save”. The “Current MS” button functions as showing the available NMEA messages of the current epoch, i.e., back to the original setting, as shown in Figure 2.6. The “Save” button saves the output NMEA messages in a user-defined file.

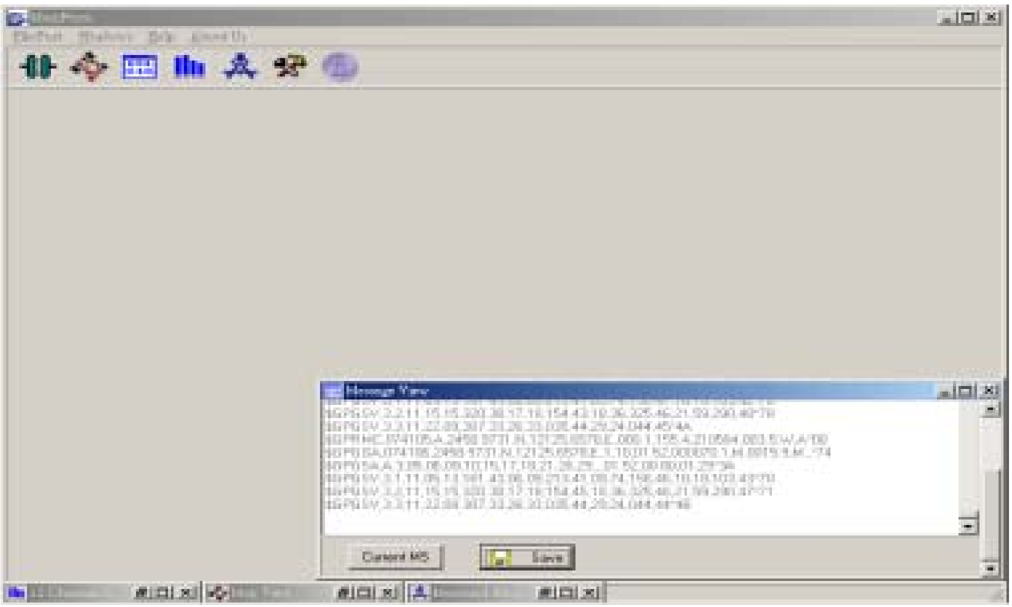


Figure 2.9 “Show all MS” window.

2.2.5 Available NMEA Messages

The output of NMEA messages can be selected through “Interval” under the “User Setting” window, as shown in Figure 2.10. There are two ways to show this sub-window: “Windows/User Setting” or the shortcut button ?.

The available NMEA messages for FV-25 are GGA, GLL, GRS, GSA, GSV, GST, RMC, TXT, VTG, and ZDA. The default output NMEA messages include the above all except TXT message. As shown in Figure 2.10, the number behind each message is the update rate of the sentence. Since the default values of the update rates for all messages are zeros, clicking the “OK” button without changing the default values, the module will stop outputting NMEA messages. If a user wants the module to output, for example, RMC message at the rate of 1 Hz, change the current number to 01 or 1.

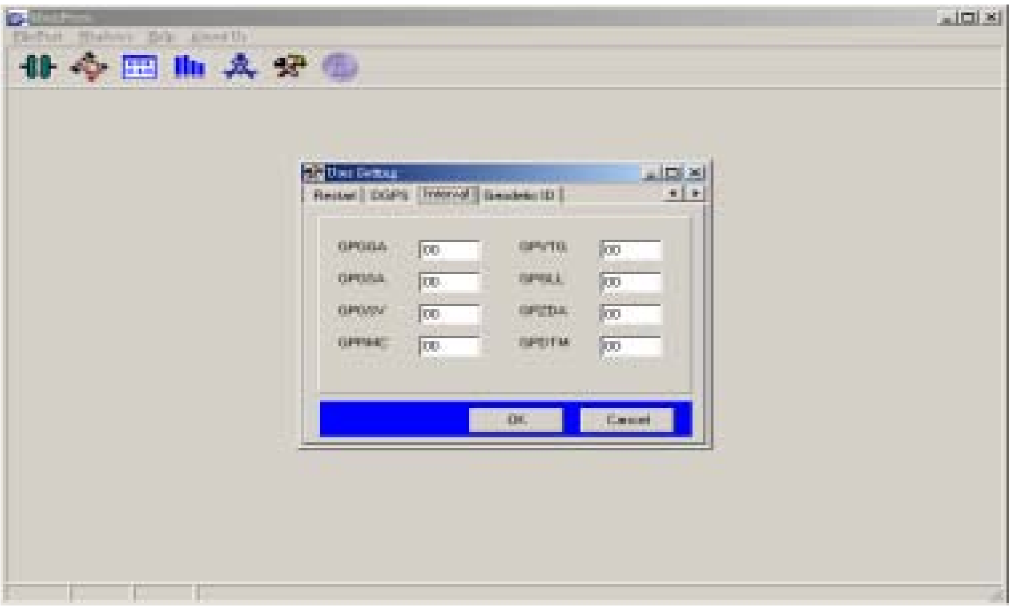


Figure 2.10 Available NMEA messages.

NOTE: *The output NMEA messages will be discarded or not transmitted if the values of the baud rate is not sufficient to transmit the desired messages. Also, the discarded part won't be output in the next epoch.*

NOTE: *The maximum update rate is 4 Hz.*

2.2.6 GPS Satellite Information

Figure 2.11 shows the observable GPS satellite information, which includes SV PRN numbers, the corresponding values for elevation, azimuth, and SNR, and indication for utilization of satellite information in the calculation of the receiver's position. For a satellite not used in the calculation of the receiver's position, the satellite will be marked by "x" in the corresponding row of "Used in Position" and gray color in the SNR diagram. This sub-window can be activated by two ways: "Windows/Channel Signal Level View" or the shortcut button ?.

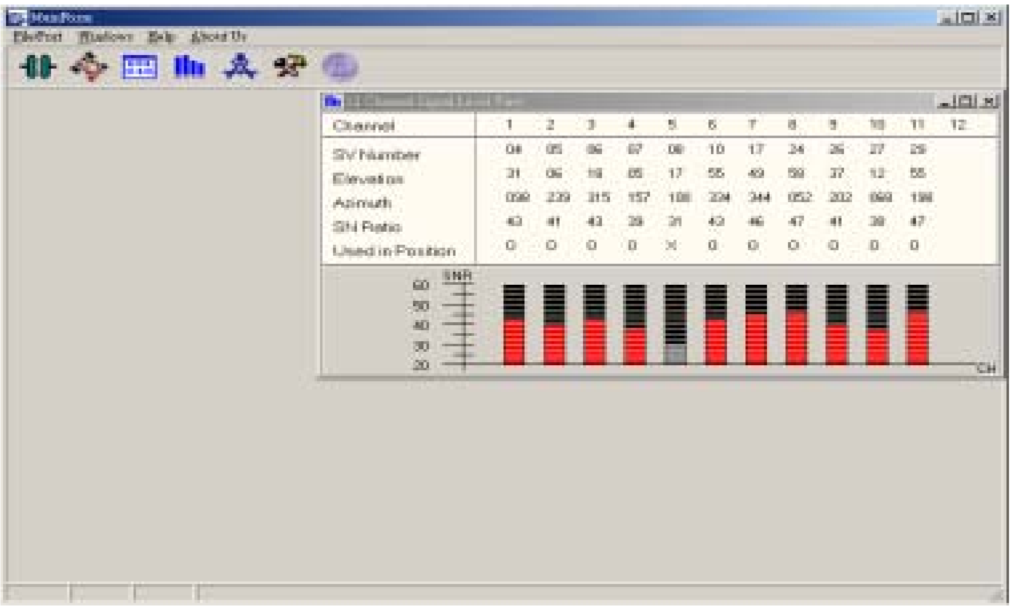


Figure 2.11 GPS satellite information.

2.2.7 Receiver Information

Figure 2.12 describes the receiver information. They are:

UTC Date: day/month/year;

UTC Time: hour:minute:second;

Lat: latitude xxyy.yyyy   xx: degree, yy.yyyy: minute, -: southern hemisphere;

Lon: longitude xxxyy.yyyy   xxx: degree, yy.yyyy: minute, -: western hemisphere;

Alt: altitude (meter);

SVs(Used/All): (number of satellites used for position calculation) / (number of the observable satellites);

Mode: 2D or 3D position;

PDOP: Position Dilution Of Precision: geometry among the receiver and GPS satellites;

Speed: module's speed (knot);

True Course: module's moving direction with respect to North (clockwise, degree);

Datum: type of coordinate frame (default: WGS 84);

GPS Quality: SPS or PPS mode, position fixed or not.

The sub-window is activated by two ways: clicking "Windows/Measured Navigation Message View" or the shortcut button ?.

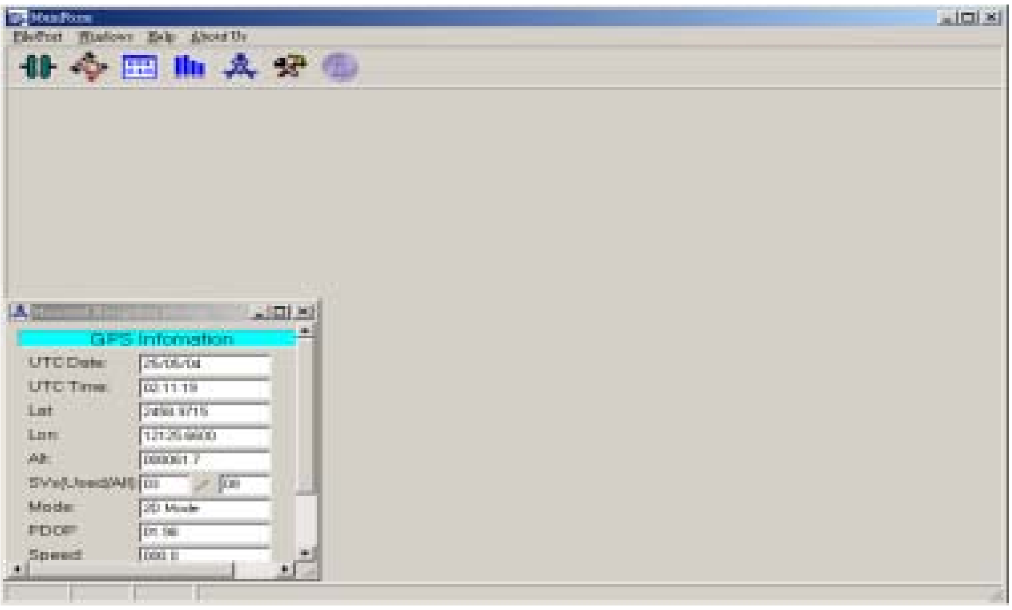


Figure 2.12 Receiver Information.

NOTE: *Data displayed in the sub-windows (Figures 2.7, 2.9, 2.11, and 2.12) depend on the user-selected output NMEA messages, i.e., if, for example, the module doesn't output GSV message, the associated information, such as elevation, azimuth, SNR, etc., will not be displayed in the corresponding sub-windows.*

2.2.8 Tracking View

Clicking "Windows/Tracking View", the global position differences relative to the first position fix will be depicted, as shown in Figure 2.13. The corresponding unit is meter or kilometer, which is indicated in the upper right corner of the sub-window. In Figure 2.13, there are two available functions that change the scale of the concentric circles: "zoom in" and "zoom out". " The scale ranges from 10 m to 500 km.

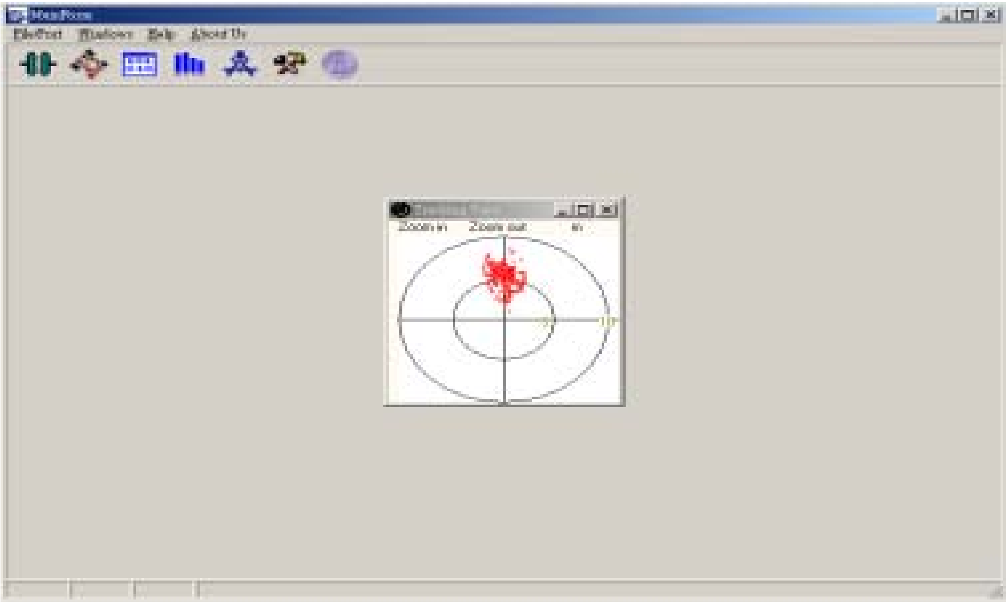


Figure 2.13 Tracking View.

2.2.9 User Setting

Clicking "Windows/User Setting" or the shortcut button ?, the "User Setting" window is activated, as shown in Figure 2.14. Click "←→" to move among the tags.

2.2.9.1 Position

This function sets the initial latitude and longitude, as shown in Figure 2.14. For the initial values of latitude and longitude, users can select the degree (first column from left) and the integral part of minute (second column) from the "scroll-down" windows, and input the fractional part of minute (0 ~ 9999) in the last (third) column.

Figure 2.14 Initial position.

The output position will be updated as the position is fixed.

2.2.9.2 Time and day

This function sets the initial UTC date and time, as shown in Figure 2.15. The format for UTC date is “YYYY (year), MM (month), DD (day)” and the format for UTC time is “hh (hour), mm (minute), ss (second)”. If a setting value is less than 10, the empty part (the left digit) of the setting value is filled by 0, for instance, 01.

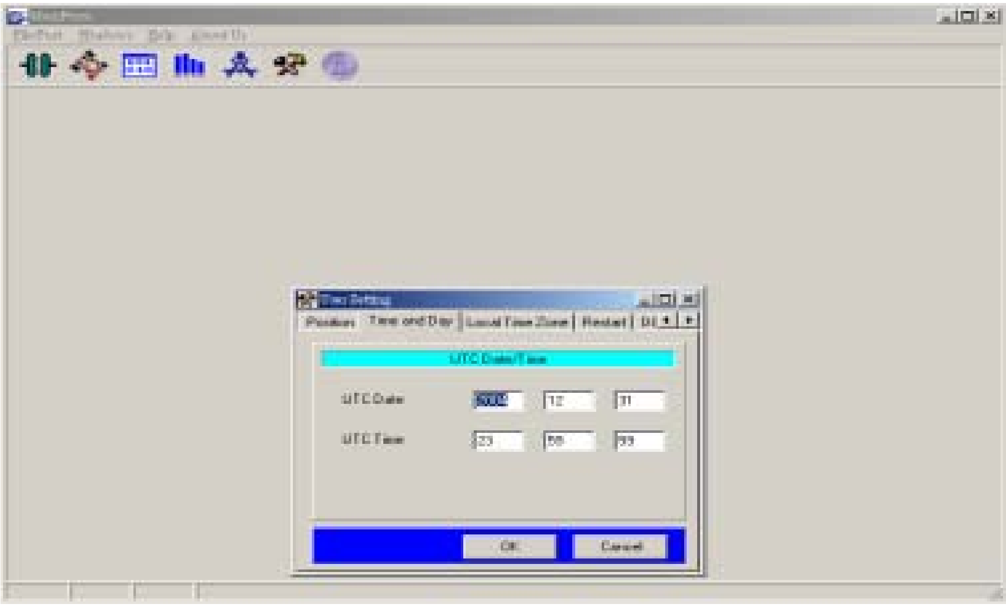


Figure 2.15 Initial UTC time and day.

The initial UTC time and date will be updated as GPS satellites are acquired.

2.2.9.3 Local time zone

This function sets the time difference between the local and Greenwich (UTC reference), as shown in Figure 2.16. The first column (from left) is “local zone hour” ranged from –13 to 13 (i.e. - / +: East / West of Greenwich) and its corresponding format is “hh”, i.e., the left digit might be filled by 0 if the value is less than 10. The second column is “local zone minute” ranged from 00 to 59 and its corresponding format is “mm”, which has the same format as the one for “local zone hour”.

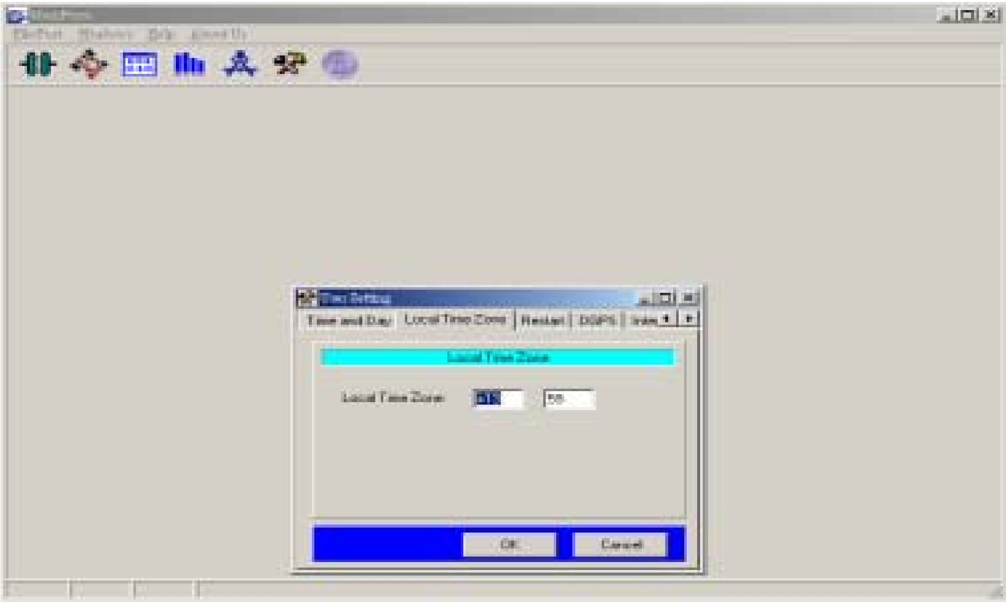


Figure 2.16 Local time zone.

2.2.9.4 Restart

This function sets the initial start-up mode, such as cold-start, warm-start, and hot-start, for the module, as shown in Figure 2.17.

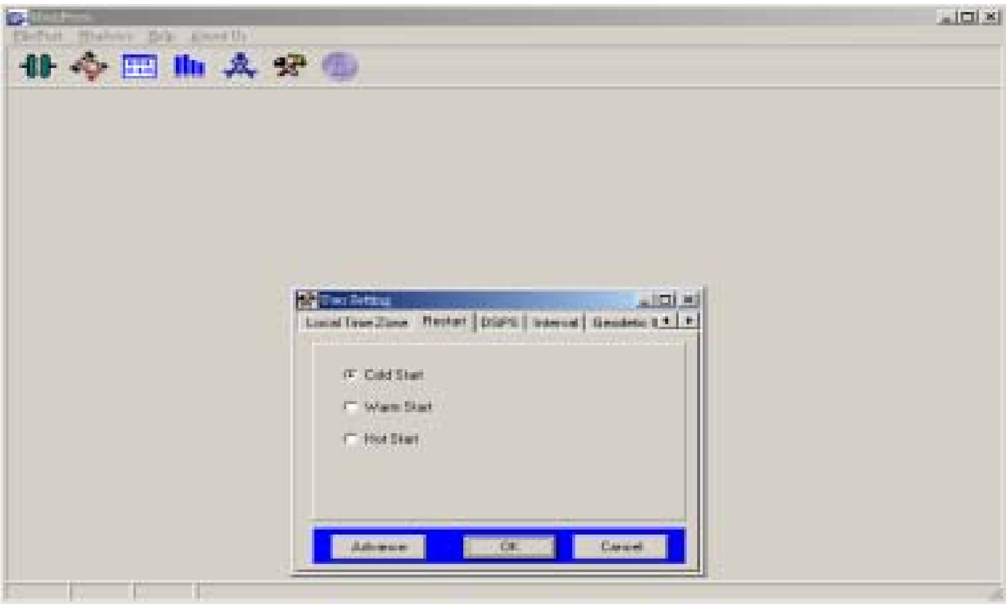


Figure 2.17 Restart.

NOTE: *For implementing the hot and warm starts, the module need a backed-up battery to run RTC and support BBR, which is used to save updated position, ephemeris, and almanac data.*

2.2.9.5 DGPS

This function activates the differential GPS functions of the module, such as RTCM and WAAS/EGNOS, or only GPS function without aids, as shown in Figure 2.18.

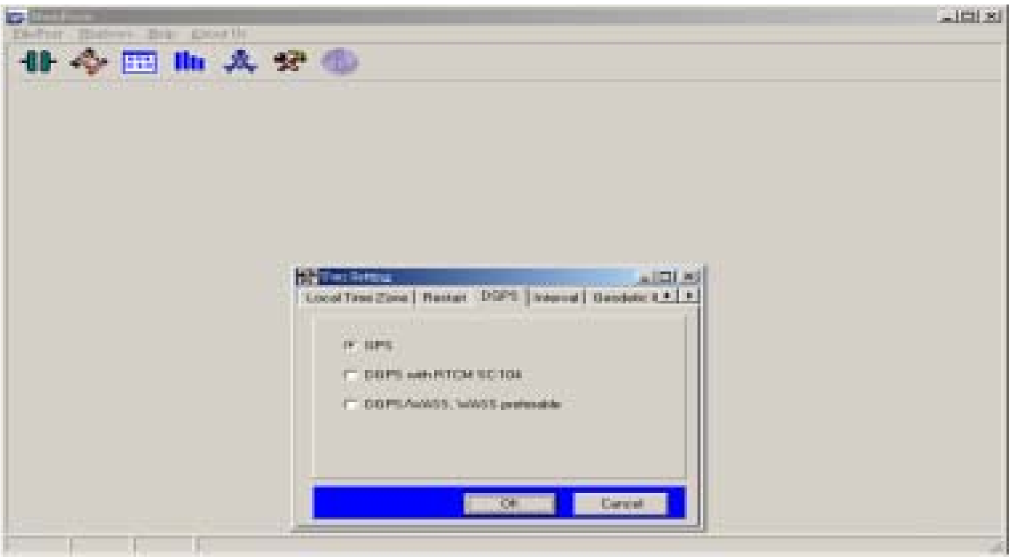


Figure 2.18 DGPS.

2.2.9.6 Interval

Referred to Section 2.2.5.

2.2.9.7 Geodetic ID

This function sets coordinate datum that users prefer, as shown in Figure 2.19. A list of datum ID is summarized in the Appendix A.

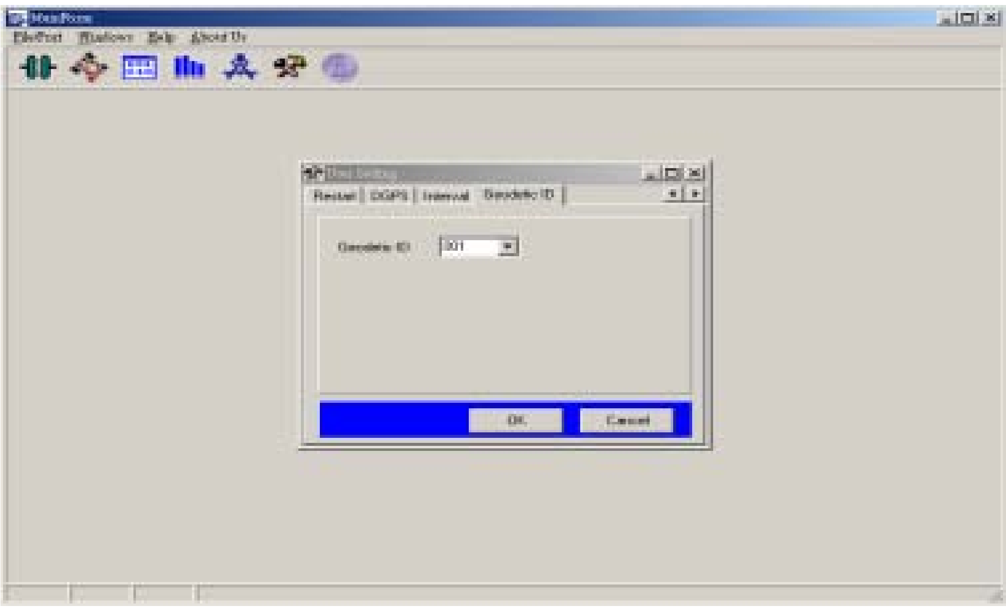


Figure 2.19 Setting of coordinate datum.

Chapter 3 Alternative Start

This chapter introduces an alternative utility, HyperTerminal (from Windows), to display the NMEA information. And, Using the utility, users can send a request to poll the desired NMEA information or implement other configurations from the module without the aid of *Sanav_Demo*. The following information only describes the needed operations for our purposes.

3.1 Connection Settings

To activate the application, HyperTerminal, click "Start/Programs/Accessories/Communications/HyperTerminal" under Windows. Figure 3.1 depicts the default window of HyperTerminal. As usual, before implementing the communication, users have to set the comm. port number, port setting (i.e. baud rate, data bits, parity, stop bits, and flow control), and so on. The connection/communication setting can be done by clicking **"File/Properties"** or **the first shortcut button from right**. The resulting window is shown in Figure 3.2. But, before a user sets any connection settings, HyperTerminal has to be in the mode of disconnection, which can be activated by clicking **the fourth shortcut button from right**. The status (connected/disconnected) can be seen at the lower right corner of the window. The "Configure…" button in Figure 3.2 functions as port settings, such as baud rate, data bits, parity, stop bits, and flow control.

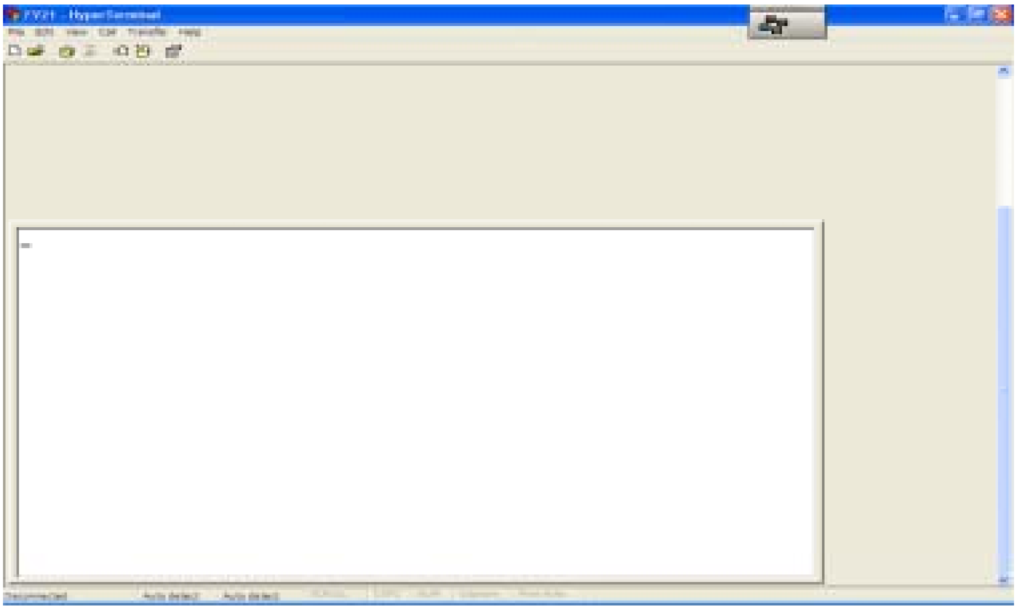


Figure 3.1 HyperTerminal application.

NOTE: *The connection settings can not be implemented while HyperTerminal is in* *the mode of connection.*

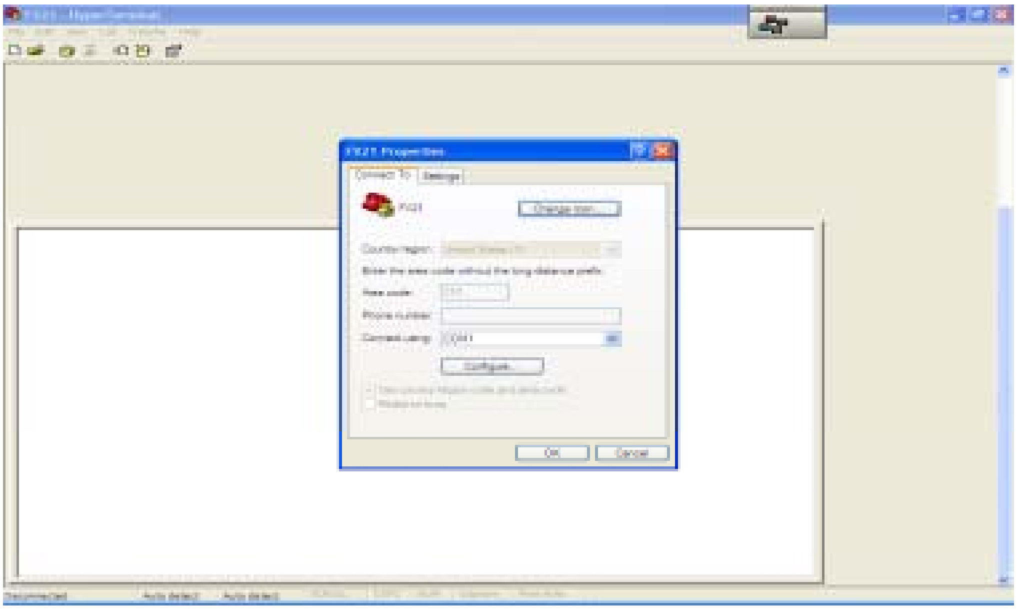


Figure 3.2 Connection settings.

After setting all the necessary data, click the connection button, which is **the fifth shortcut button from right**. If the setting is correct, the HyperTerminal window will show desired output (NMEA messages), as shown in Figure 3.3, and if not, the window will show random characters or nothing at all.

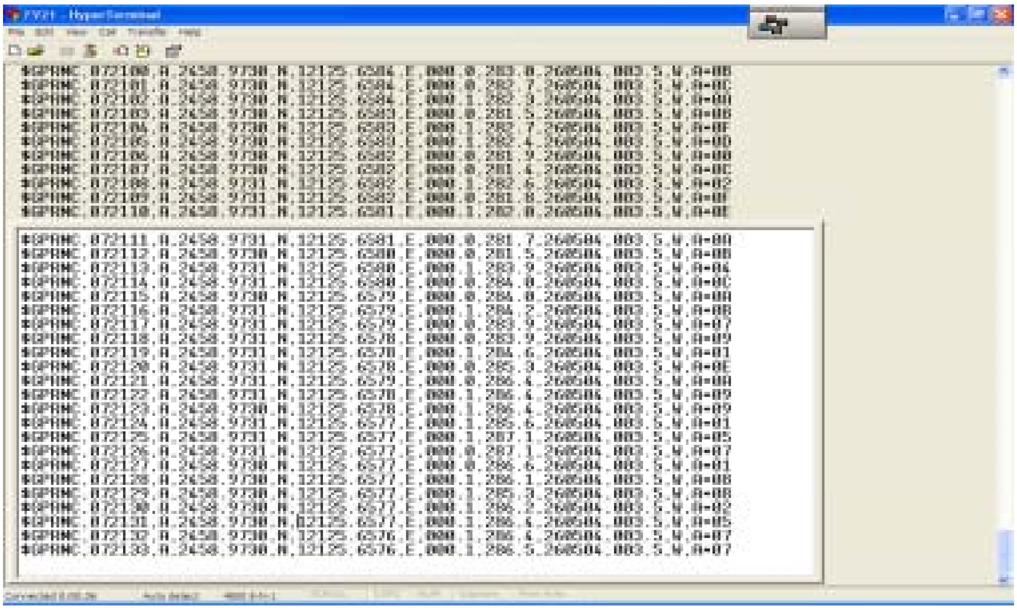


Figure 3.3. Correct connection settings.

3.2 Saving the Data

For saving the output data, click "Transfer/Capture Text…". The subsequent window will ask users to input the file name and folder.

3.3 Setting Configuration or Polling Information from Module

For setting or polling the desired information, click “Transfer/Send Text File…” button to send a “.txt” file, which contains command sentences, to activate the module. The file is created by users before click the button, and the formats for the command sentences are referred to Chapter 7.

Chapter 4 Navigation

4.1 Operating Modes

4.1.1 Continuous Tracking Mode (CTM)

CTM is the default setting of the module. While the CTM is on, the module tracks GPS signals and estimates position continuously, i.e., satellite acquisition, reacquisition, and tracking are the states in the CTM. This is the standard operating mode for the general GPS receivers. Therefore, this mode is not designed for saving power but for obtaining maximum accuracy in position. In other words, the module with the CTM on usually operates in the Full Power State and the corresponding operating current, which depends on the activities of CPU load, I/Os, and peripheral hardware, may fluctuate significantly.

4.1.2 FixNOW Mode (FXN)

This is a power saving mode, which will shut down the module automatically if no GPS signals are detectable. For further saving power consumption, the FXN allows users to set the module into Sleep State. This mode is especially important for power-concerned products, such as handheld devices.

During this mode, the navigation data is computed as required or at the predefined intervals. This (navigation data) can be done by using the UBX-RXM-POSREQ or Pin 6 “Extint 0” to wake up the module and then calculate a Position-Velocity-Time (PVT) solution during the off-time of FixNOW Mode. The other way to wake up the module without using serial port communication or external interrupt is to utilize the internal RTC, which is used for a timeout setting. For enabling or disabling the FXN, send the request by using the UBX-CFG-RXM message. For the detail configuration of this mode, refer to the UBX-CFG-FXN message.

NOTE: *The descriptions of the UBX proprietary messages are referred to Chapter 7.*

NOTE: *To implement the current configuration in the next time, the current one has be saved in the Battery Backed RAM (BBR), which is powered by a backed-up battery (1.95V ~ 3.6V), or the Flash memory.*

4.2 Start-Up Modes

Table 4.1 shows the differences among cold-start, warm-start, and hot-start modes.

Conditions / Modes	Time	Position	Almanac	Ephemeris
Cold Start	None	None	None	None
Warm Start	Yes	Yes	Yes	None
Hot Start	Yes	Yes	Yes	Yes

Table 4.1 Conditions for Start-Up modes.

For the cold-start mode, the module assigns all the available SVs to 16 channels in a defaulted order. As a satellite is acquired, GPS time, associated ephemeris and almanac data, which will take 12.5 minutes to download the data for all the available satellites, are being downloaded and decoded, and the module's status is then transferred to tracking start. Once number of tracking satellites with valid ephemeredes are greater than and equal to 3, the module's position is calculated and output, i.e., the module starts to navigate.

For the warm-start mode, based on the available time (from RTC), position, and almanac data, the channels (up to 12) are assigned with observable satellites and the rest of them are assigned to unobservable satellites. As the observable satellites are acquired, time and almanac data are updated (if needed) and the corresponding ephemeredes are downloaded and decoded. As soon as the module are tracking at least three GPS satellites, the position is calculated and updated, and the module is in the navigation mode.

For the hot-start mode, based on the available time, position, almanac, and ephemeris data, the channels (up to 12) are assigned with observable satellites and the rest of them are assigned to unobservable satellites. The module enters the navigation mode almost instantly after power on. The time and position will be updated if needed as the satellites are acquired. But the almanac and ephemeris data will not be updated since they are already the "newest" information.

NOTE: *To implement the warm and hot starts, a backed-up battery is needed to run the RTC. The updated position, ephemeris, and almanac can be retrieved from BBR or Flash memory.*

4.3 Aiding - AGPS

The module can implement Assisted GPS (AGPS) function, which will accept external input information, such as time, position, almanac, and ephemeris. This will improve the performance of the module on Time To First Fix (TTFF). How much this will improve on TTFF depends on the accuracy of position and time from a near base station (service center) as well as hardware synchronization.

The AGPS function of the module is activated by sending u-blox binary protocol UBX-AID-REQ. If there is no data available from a near base station, the module is back to its normal start-up modes.

4.4 Sensitivity

There are three modes available for the module, which are “Normal”, “Fast Acquisition” and “High Sensitivity”. Table 4.2 lists their associated definitions.

Sensitivity Modes	Properties	Notes
Normal	Default setting	
Fast Acquisition	“Normal” sensitivity – 3 dB	When the C/N_0 ratio of the strongest GPS signal is greater than 48 dB, this mode can be used.
High Sensitivity	“Normal” sensitivity + 3 dB	When the C/N_0 ratio of the strongest GPS signal is less than 45 dB, this mode can be used.

Table 4.2 Available sensitivity modes.

When the module tracks the weak GPS signals, the “High Sensitivity” mode is preferable as compared with the case for tracking strong GPS signals in which the “Fast Acquisition” is preferable. Different modes correspond to different TTFF times under different start-up modes, i.e., it’s a trade-off between sensitivity and TTFF time. Usually, the TTFF relationships among three modes are

$TTFF_{fast} < TTFF_{normal} < TTFF_{high}$

where

$TTFF_{(\cdot)}$: TTFF for “Fast Acquisition”, “Normal”, or “High Sensitivity” mode.

Users are recommended to use the default setting, “Normal” mode, due to the unknown and variable operating condition that the module is surrounded. The sensitivity setting is activated by sending the request the UBX-CFG-RXM message.

NOTE: *This module has a built-in LNA. If an active antenna with gain exceeded 25* *dB is used, the "High Sensitivity" mode is not recommended.*

4.5 Navigation Data

4.5.1 Position Format

The navigation data can be output in the format of local geodetic frame (latitude, longitude, and altitude), ECEF (Earth-Centered Earth-Fixed) frame, or Universal Transverse Mercator (UTM) frame. To poll the navigation information from the module, send the request UBX-CFG-NAV. For FV-25, the default position settings are expressed in the format of local geodetic frame, which can be retrieved from message UBX-NAV-POSLLH, and ECEF frame, which can be retrieved from message UBX-NAV-POSECEF. The position expressed in UTM frame can be obtained from "$PUBX,01,…" under proprietary NMEA protocol. The "$PUBX,01,…" is not a standard output for FV-25 and can be polled by sending "$PUBX,sid*cs<CR><LF>".

NOTE: *The descriptions of the standard and proprietary NMEA messages are described in Chapter 7.*

4.5.2 Datums

The position expressed in WGS 84 format (default) can be transferred to the user's preferable format based on more than 200 standard datums (referred to Appendix A), or a user-defined datum, which is activated by sending the UBX-CFG-DAT message.

4.5.3 Update Rate

The module supports the update rates up to 4 Hz. This function is activated by sending the UBX-CFG-RATE message. The default update rate is 1 Hz.

NOTE: *The update rate has effects on power consumption and position accuracy.*

4.5.4 Kinematic Mode

The module enables users to select the corresponding kinematic mode, such as static case and different dynamic scenarios, for a vehicular carrier. This function is implemented by sending the UBX-CFG-NAV message.

4.6 Navigation for Less Than 4 Observable Satellites

4.6.1 2D Navigation

When number of observable satellites is 3, the navigation algorithm of the module allows position estimate but with the assumption of constant altitude, i.e., the module enters 2D navigation. If the 2D position fix is the first position fix since power on, the initial/assumed value of the altitude is 500 m. If the 2D position fix occurs after the 3D position fix (number of observable satellites drops from at least 4 to 3), the value of the altitude will keep the last known value of the altitude from the previous 3D position fix.

4.6.2 Dead Reckoning

As the module loses the tracks for all observable GPS signals because of, for example, an external blockage, the navigation algorithm implements the Dead Reckoning strategy. The strategy assumes the same velocity and direction as the last known values of velocity and direction, i.e., the constant velocity and direction, during the event. Under the assumption, the positions are predicted (extrapolated) but with indication "NoFix" until the Dead Reckoning timeout is reached. The value of the timeout is set by the UBX-CFG-NAV message.

4.7 Almanac Navigation

With Almanac Navigation enabled, based on valid almanac, the position can be estimated without valid ephemeris data. This is a possible scenario that the position is fixed while ephemeris data have not been downloaded completely. Therefore, the TTFF times are much faster for Almanac Navigation than "normal navigation" (using ephemeredes to estimate position). However, the deviation of position can be up to a few kilometers. However, this event might be particularly useful when users or carriers need position desperately, such as emergency and security systems, but "ephemeris" position is not available.

The activation of Almanac Navigation is implemented by the UBX-CFG-NAV message. By controlling the position accuracy, use parameters in the UBX-CFG-NAV message, such as "PDOP Mask" and "Position Accuracy Mask", to filter out the "outsiders".

4.8 DGPS – WAAS, EGNOS, & RTCM

The module utilizes the correction data from WAAS, EGNOS, or RTCM to obtain better position accuracy. Use the UBX-CFG-SBAS message, the functions for enabling WAAS or EGNOS tracking can be activated. For activation of RTCM, the users need an extra antenna-micro controller set, which has ability to receive and retrieve correction data from the signal transmitted from the near service station, connected to one of the comm. ports of the module. The corresponding comm. port needs correct setting, which is set by the "$PUBX,41,…" message. The module supports RTCM Correction Type Messages 1, 2, 3, and 9. For more information about

RTCM protocol, please refer to the web site http://www.rtcm.org/.

The DGPS parameters can be changed in the UBX-CFG-NAV message, like DGPS Timetag Rounding. Do not change them under no specific reasons because the default values are based on real tests with DGPS function.

NOTE: *The correction data from the RTCM messages can be monitored by the UBX-NAV-DGPS message, which doesn't provide the supervision on WAAS and EGNOS.*

4.9 Receiver Autonomous Integrity Monitoring (RAIM)

The purpose of RAIM is to monitor the received GPS signals and ensure the message data from satellites which are valid for estimating navigation solution. With five observable GPS satellites, a bad satellite could be detected if existed. For the case with at least six observable satellites, an existed bad satellite could be detected and neglected in the estimation of navigation solution. The default setting for RAIM is on and can be controlled by three parameters- Range Check, Doppler Check, and Delta Check (all enabled)- in the UBX-CFG-NAV message. It is recommended that RAIM function is always on.

4.10 Time Pulse (1 PPS)

Pin 14 "Time Pulse" will output the default setting 1 PPS if it is connected. For the Time Pulse settings and information, refer to the UBX-CFG-TP and UBX-TIM-TP messages.

Chapter 5 Evaluation Kit

The evaluation kit is an optional accessory while purchasing the module. It will provide an easy way to estimate the performance of our module. The users can also follow the reference circuit design in Chapter 2 to test the performance of the module.

In this chapter, all the information about the evaluation kit, which includes the output ports, buttons, and LED lights, is described. As long as the procedure is correct and complete, the module will output the desired messages at the desired port and activate the desired functions through the desired port. All of those functions can be achieved by using software commands. The settings and commands are described in Chapters 2 and 7.

As shown in Figure 5.1, the appearance of the evaluation kit is depicted. The whole kit should include, in addition to the main box itself,

- a 12 V adapter;
- an active antenna with SMA (male) connector;
- two RS232 cables;

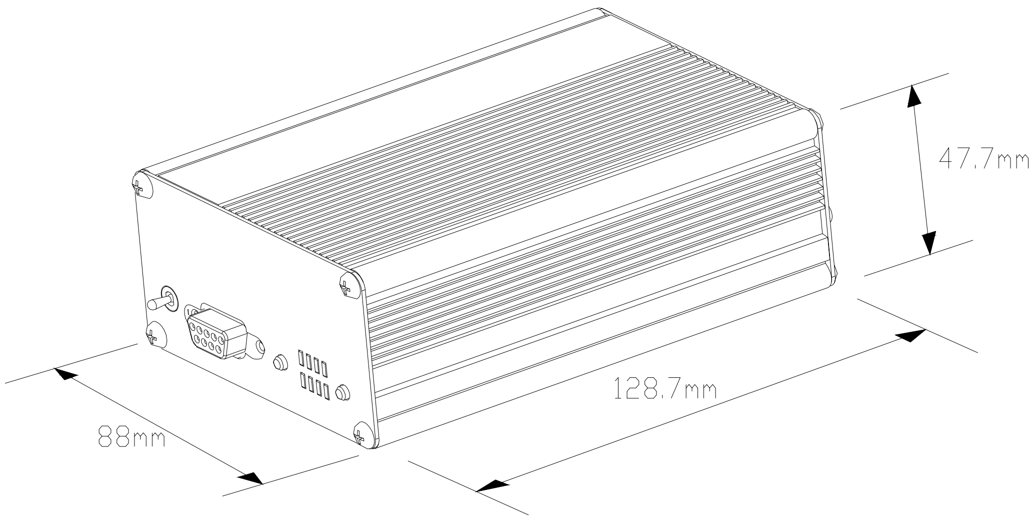


Figure 5.1 Main box of the evaluation kit.

Figure 5.2 shows the front panel of the evaluation kit. It includes (from left to right) Power Switch, Comm. Port 2, Boot button, LED function lights, and Reset button. The default output protocol for Comm. Port 2 is UBX binary messages with baud rate 57600 bps. The Boot button is for read/write purpose to the flash memory. The definitions for LED lights are indicated in the figure. The Reset button can be used to re-start up the GPS module in the either Continuous Tracking Mode or FixNow mode.

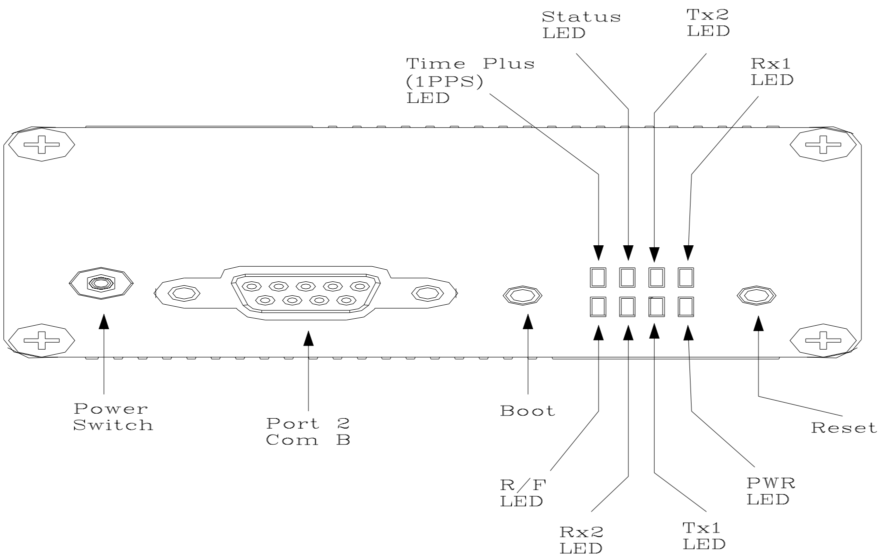


Figure 5.2 Front panel of the evaluation kit.

Figure 5.3 shows the back panel of the evaluation kit. It includes (from left to right) the Antenna Input, Comm. Port 1, 1PPS Output, and Power Input. The Antenna Input is a SMA female connecter which is for 3.0 V or 5.0 V active antenna depending on the jump position (J16). The Comm. Port 1 outputs NMEA messages at the baud rate of 19200 bps as the default setting. The 1PPS Output, which is a BNC (female) output port, is used to output a time pulse per second. For the Power Input of the kit, it accepts the input voltage in the range of 8 ~ 40 V.

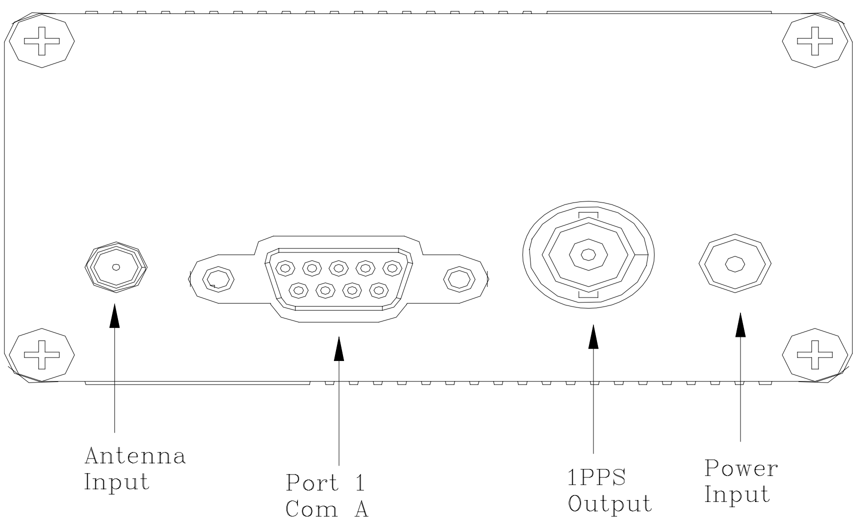


Figure 5.3 Back panel of the evaluation kit.

Both Comm. ports are the bi-directional ports, i.e., the ports also accepts user software commands. For receiving RTCM message, either port can be used to accept the data through software command.

Chapter 6 Antennas

To get the maximum performance from the module, in addition to the own properties of the module, one of the important factors is how to select fitted antennas for the module because the quality of the received signals is determined as soon as the signals enter the RF section and can not be improved much by the subsequent filters and amplifiers.

The character of the GPS signal is right hand circular polarized (RHCP). So, for obtaining good GPS signals without losing too much, it’s better to use the RHCP antennas. Otherwise, for example, using a simple linear polarized antenna to receive GPS signals, the received GPS signals will lose at least 3 dB in SNR. In addition, the size of an antenna also affects the received signal energy or SNR. Usually, the smaller the size of the antenna, the lower overall gain pattern of the antenna. In other words, the smaller size of the antenna will result in the lower SNR of the received GPS signals. As more and more new antenna products emphasize on the size issue because of more and more GPS related portable devices appeared, there is no way to avoid this problem (low SNR), even with the aid of an amplifier after the antenna.

Therefore, for retrieving the most information, a large size antennas are preferable, and even for special applications (e.g. surveying), a special mechanism structure design is desirable, such as choke ring antenna which is used for mitigating multipath effect. As a result, an antenna with large size, high power consumption, and high cost is produced for high precision applications. Furthermore, for high precision applications with millimeter accuracy in position, it is important to have stable phase centers (L1/L2) that are exactly known.

6.1 Passive Antennas

Utilizing passive antennas in users’ applications, more attention is needed in the layout of the RF section. Usually, the passive antenna is placed next to a module as close as possible because of dB loss and no power amplification. However, the proximity of antenna to electronic parts will induce the interference on the incoming GPS signals from the module and the peripheral electronic circuits, even worse the interference will cause signal jamming. Therefore, more careful considerations on the layout of RF section should be taken. This selection is only suitable for those who are familiar with the RF design.

For using passive antennas, the pin VANT (DC bias voltage) on the module is connected to ground, and the antenna is directly connected to the GPS signal input pin ANT. Sometimes, a passive matching connection is required to match the electrical circuit to 50 Ohms impedance.

6.2 Active Antennas

For FV-25, the active antenna is integrated with a Low Noise Amplifier (LNA), which is a built-in component part, in the RF section. Through pin ANT, the module obtains the incoming signal from the antenna. The power supply for the active antenna is from pin VANT and, in general, the supply voltage is transmitted by the coaxial RF cable. The supply voltage in pin VANT is supported by either source. One is from the external power supply and the other is from the output pin V_{RF} (connected with VANT), which is the power supply from the module for RF section. The voltage requirements for the antenna and the pins on the module have to be specified.

The use of the active antennas will decrease the "bad" effects, which result from the cable loss and hardware noises, on the received GPS signals. Therefore, the placement of the active antenna can be away from the possible noise sources, for example, the module and peripheral circuits, and the active antenna will have good performance if it is located far from the noise sources. This will ease the circuit design, and the received signals is less sensitive to jamming. But the active antenna will increase the power consumption of the whole system, typically in the range of 5 mA to 20 mA.

It is recommended to use an active antenna if the cable length between module and antenna exceeds 10 cm. The same advice also goes for users without much experience on the RF design. For FV-25, the active antenna gain should not exceeds 25 dB because an saturation (overload) condition might occur for high gain (> 25 dB) cases.

NOTE: *It's better not to disconnect antenna during the operation of the module. The calculation of the reference floor noise is based on the actual condition after the power is turned on. Hence, the reacquisition time may be prolonged after re-connecting the antenna to the module.*

NOTE: *To verify the reacquisition time, users can use a physical object to block the antenna from receiving the signal until the module loses the lock of the satellites and then take the object away from the antenna.*

6.3 Active Antenna Supervisor - Short Circuit Protection

This is a built-in function that is monitored by the BaseBand processor. If an abnormal current occurs and is detected, the voltage supply at pin VANT (from the external or internal power supply) will be turned off by the BaseBand processor. The way to reset the operation of the module is to have a hardware reset of the module, such as turning off and then on the module or pressing the reset button.

NOTE: *Without the short circuit protection, the large current will cause the damage on the module permanently.*

Chapter 7 Available NMEA and UBX Messages

7.1 NMEA Protocol

The NMEA protocol expresses the data in the format of ASCII. This is a standard format for GPS applications. The module (FV-25) outputs two types of NMEA messages. One is the standard NMEA messages, that are widely accepted by plotters and GPS related devices, and the other is u-blox proprietary NMEA messages.

7.1.1 Standard NMEA Messages

The module can output 10 standard NMEA messages, which are

GGA – Global Positioning System Fix Data;
GLL – Geographic Position – Latitude/Longitude;
GRS – GNSS Range Residuals;
GSA – GNSS DOP and Active Satellites;
GST – GNSS Pseudorange Error Statistics;
GSV – GNSS Satellites in View;
RMC – Recommended Minimum Specific GNSS Data;
TXT – Test Transmission;
VTG – Course Over Ground and Ground Speed;
ZDA – Time & Date.

The default output messages include all messages except the TXT message. Those messages are output at comm. port 1 at the rate of 19200 bps (default setting). The request for outputting user-selected standard NMEA messages is the "$xxGPQ,.." message (referred to the following interpretation for GPQ). The port settings can be performed by sending the "$PUBX,41,.." message (ASCII format) or UBX-CFG-PRT message (Binary format).

The following will summarize the available NMEA messages. More information about the NMEA messages refers to "NMEA 0183, Standard For Interfacing Marine Electronic Devices, Version 2.30, March 1, 1998".

NOTE: *In the NMEA messages, the position fix is valid only if the following conditions are satisfied: 1) at least three satellites observable (i.e. 2D or 3D); 2) for the 3D case, the position accuracy should be less than the setting value of the "Position Accuracy Mask"; 3) The PDOP value is constrained by the setting value of* *the “PDOP Accuracy Mask”.*

GGA – GPS Fix Data

Position fix related data, such as position, time, number of satellites in use, etc..

$GPGGA,gga1,gga2,gga3,gga4,gga5,gga6,gga7,gga8,gga9,gga10,gga11,gga12,gga13,gga14*hh<CR><LF>

Parameters	Descriptions	Notes
gga1	UTC time as position is fixed	hhmmss.ss: hh – hour; mm – minute; ss.ss – second
gga2	Latitude	ddmm.mmmmm: dd – degree; mm.mmmmm – minute (0^o ~ 90^o)
gga3	Latitude sector	N – North; S - South
gga4	Longitude	dddmm.mmmmm: dd – degree; mm.mmmmm – minute (0^o ~ 180^o)
gga5	Longitude sector	E – East; W - West
gga6	GPS quality indicator	0 – No fixed or invalid position 1 – SPS Position available 2 – Differential GPS (SPS) 6 – Estimated position (DR)
gga7	Number of SVs used in position estimation	xx: 00 ~ 12
gga8	HDOP	xx.x: 00.0 ~ 99.9
gga9	Altitude above mean sea level (geoid)	
gga10	Unit for Altitude	M: meter
gga11	Geoidal separation	
gga12	Unit for geoidal separation	M: meter
gga13	Age of differential corrections	unit : second; null when DGPS is not used
gga14	Reference station ID (DGPS)	xxxx: 0000 ~ 1023
hh	Checksum	hex number (2 – character)
<CR><LF>	End of message	

GLL – Geographic Position – Latitude/Longitude

Navigation data and status.

$GPGLL,gll1,gll2,gll3,gll4,gll5,gll6,gll7*hh<CR><LF>

Parameters	Descriptions	Notes
gll1	Latitude	ddmm.mmmmm: dd – degree; mm.mmmmm – minute (0^o ~ 90^o)
gll2	Latitude sector	N – North; S – South
gll3	Longitude	dddmm.mmmmm: ddd – degree; mm.mmmmm – minute (0^o ~ 180^o)
gll4	Longitude sector	E – East; W – West
gll5	UTC time as position is fixed	hhmmss.ss: hh – hour; mm – minute; ss.ss – second
gll6	Status for position fix	A – Valid; V – Invalid
gll7	Navigation mode indicator	A – Autonomous mode (fix); D – Differential mode (fix); E – DR (fix); N – not valid
hh	Checksum	hex number (2 – character)
<CR><LF>	End of message	

GRS – GNSS Range Residual

This message is used to monitor and support RAIM.

$GPGRS,grs1,grs2,(grs3*12)*hh<CR><LF>

Parameters	Descriptions	Notes
grs1	UTC time from the GGA	hhmmss.ss: hh – hour; mm – minute; ss.ss – second
grs2	Mode to indicate the way to calculate the range residuals. 0 – calculate the range residuals while the GGA position is estimated; 1 – recalculate the range residuals after the GGA position is estimated.	Always in Mode 1
grs3*12	Range residuals for satellites used in position calculation. There will be 12 available fields for residuals. If number of satellites is less than 12, the remaining fields will be left as empty fields. If number of satellites is greater than 12, only the values of the first 12 satellites will be output.	-999.9 ~ 999.9
hh	Checksum	hex number (2 – character)
<CR><LF>	End of message	

GSA – GNSS DOP and Active Satellites

Receiver operating mode, the values of DOPs, and PRN numbers for satellites used in the GGA position solution.

$GPGSA,gsa1,gsa2,(gsa3*12),gsa4,gsa5,gsa6*hh<CR><LF>

Parameters	Descriptions	Notes
gsa1		
gsa2	Mode for position fix	1 – fix not available; 2 – 2D; 3 – 3D;
gsa3*12	PRN numbers for satellites used in the position solution. There will be 12 available fields for PRN numbers. If number of satellites is less than 12, the remaining fields will be left as empty fields. If number of satellites is greater than 12, only the values of the first 12 satellites will be output.	xx
gsa4	PDOP	0 ~ 99.9
gsa5	HDOP	0 ~ 99.9
gsa6	VDOP	0 ~ 99.9
hh	Checksum	hex number (2 – character)
<CR><LF>	End of message	

GST – GNSS Pseudorange Error Statistics

This message is used to monitor and support RAIM.

$GPGST,gst1,gst2,gst3,gst4,gst5,gst6,gst7,gst8*hh<CR><LF>

Parameters	Descriptions	Notes
gst1	UTC time from the GGA	hhmmss.ss: hh – hour; mm – minute; ss.ss – second
gst2	RMS value of the standard deviation of the range	
gst3	Standard deviation of semi-major axis of error ellipse (meters)	Not supported (empty field)
gst4	Standard deviation of semi-minor axis of error ellipse (meters)	Not supported (empty field)
gst5	Orientation of semi-major axis of error ellipse	Not supported (empty field)
gst6	Standard deviation of latitude error (meters)	
gst7	Standard deviation of longitude error (meters)	
gst8	Standard deviation of altitude error (meters)	
hh	Checksum	hex number (2 – character)
<CR><LF>	End of message	

GSV – GNSS Satellites in View

This message indicates the observable satellites' information, such as PRN numbers, elevation, azimuth, SNR, and number of satellites in view.

$GPGSV,gsv1,gsv2,gsv3,((gsv4,gsv5,gsv6,gsv7)*n)*hh<CR><LF>

Parameters	Descriptions	Notes
gsv1	Total number of messages	1 ~ 9
gsv2	Message number	1 ~ 9
gsv3	Total number of satellites in view	
gsv4	PRN number	
gsv5	Elevation (degrees)	90^o maximum
gsv6	Azimuth (degrees)	0^o ~ 360^o
gsv7	SNR (C/N_0)	0 ~ 99 dB-Hz, null when not tracking
hh	Checksum	hex number (2 – character)
<CR><LF>	End of message	

The message can carry at most four (gsv4,gsv5,gsv6,gsv7) sets of observable satellites. For a less than four-set case, the message only transmits available sets and the rest of them will not be output, i.e., the message doesn't transmit empty fields.

RMC – Recommended Minimum Specific GNSS Data

This message transmits the necessary navigation data, such as time, position, speed, course, and so on.

$GPRMC,rmc1,rmc2,rmc3,rmc4,rmc5,rmc6,rmc7,rmc8,rmc9,rmc10,rmc11,rmc12*hh<CR><LF>

Parameters	Descriptions	Notes
rmc1	UTC time as position is fixed	hhmmss.ss: hh – hour; mm – minute; ss.ss – second
rmc2	Status of position fix	A – data valid, which includes the scenarios of 2D, 3D, and DR. V – navigation receiver warning
rmc3	Latitude	ddmm.mmmmm: dd – degree; mm.mmmmm – minute (0^o ~ 90^o)
rmc4	Latitude sector	N – North; S – South
rmc5	Longitude	dddmm.mmmmm: ddd – degree; mm.mmmmm – minute (0^o ~ 180^o)
rmc6	Longitude sector	dddmm.mmmmm: ddd – degree; mm.mmmmm – minute (0^o ~ 180^o)
rmc7	Speed over ground (SOG) (knots)	
rmc8	Course over ground (COG) (degrees)	Referenced to true north
rmc9	UTC Date	ddmmyy: dd – day; mm – month; yy – year
rmc10	Magnetic variation (degrees)	Not supported
rmc11	Direction of magnetic variation	Not supported
rmc12	Navigation mode indicator	A – Autonomous mode (fix); D – Differential mode (fix); E – DR (fix); N – not valid
hh	Checksum	hex number (2 – character)
<CR><LF>	End of message	

TXT – Text Transmission

The message is used to transmit short text messages. Transmitting a longer message needs multi-TXT messages.

$GPTXT,txt1,txt2,txt3,txt4*hh<CR><LF>

Parameters	Descriptions	Notes
txt1	Total number of messages	01 ~ 99
txt2	Message number	01 ~ 99
txt3	Text identifier	00 – error 01 – warning 02 – notice 07 – user
txt4	Text	ASCII format
hh	Checksum	hex number (2 – character)
<CR><LF>	End of message	

VTG – Course Over Ground and Ground Speed

This message transmits the speed and course relative to ground.

$GPVTG,vtg1,vtg2,vtg3,vtg4,vtg5,vtg6,vtg7,vtg8,vtg9*hh<CR><LF>

Parameters	Descriptions	Notes
vtg1	Course over ground (degrees)	Referenced to true north (000.00^{o} ~ 359.99^{o})
vtg2	Indicator of course reference	T – true north
vtg3	Course over ground (degrees)	Referenced to magnetic north (000.00^{o} ~ 359.99^{o})
vtg4	Indicator of course reference	M – magnetic north
vtg5	Speed over ground (knots)	
vtg6	Unit of speed	N – nautical miles per hour
vtg7	Speed over ground (km/hr)	
vtg8	Unit of speed	K – kilometers per hour
vtg9	Navigation mode indicator	A – Autonomous mode (fix); D – Differential mode (fix); E – DR (fix); N – not valid
hh	Checksum	hex number (2 – character)
<CR><LF>	End of message	

ZDA – Time & Date

This message transmits UTC time and date, and local time zone.

$GPZDA,zda1,zda2,zda3,zda4,zda5,zda6*hh<CR><LF>

Parameters	Descriptions	Notes
zda1	UTC time	hhmmss.ss: hh – hour; mm – minute; ss.ss – second
zda2	UTC day	01 ~ 31
zda3	UTC month	01 ~ 12
zda4	UTC year	xxxx (4 digits)
zda5	Local zone hours	Not supported (default: 00)
zda6	Local zone minutes	Not supported (default: 00)
hh	Checksum	hex number (2 – character)
<CR><LF>	End of message	

7.1.2 Proprietary NMEA Messages

The non-standard NMEA messages is proposed by u-blox. The proprietary (non-standard) NMEA messages are grouped into two categories:

Proprietary NMEA (PUBX)

- PUBX,00 – Latitude/Longitude Position Data
- PUBX,01 – UTM Position Data
- PUBX,03 – Satellite Status
- PUBX,04 – Time of Day and Clock Information
- PUBX,40 – Set NMEA Message Update Rate
- PUBX,41 – Set Protocols and Baudrate

Queries

- GPQ – Polls a Standard NMEA Message
- PUBX – Polls a PUBX Message.

PUBX, 00 – Latitude/Longitude Position Data

Output message. This message transmits navigation data defined in the local geodetic frame.

$PUBX,00,p00x1,p00x2,p00x3,p00x4,p00x5,p00x6,p00x7,p00x8,p00x9,p00x10,p00x11,p00x12,p00x13,p00x14,p00x15,p00x16,p00x17,p00x18,p00x19*hh<CR><LF>

Parameters	Descriptions	Notes
p00x1	UTC time	hhmmss.ss: hh – hour; mm – minute; ss.ss – second
p00x2	Latitude	ddmm.mmmmm: dd – degree; mm.mmmmm – minute (0^o ~ 90^o)
p00x3	Latitude sector	N – North; S – South
p00x4	Longitude	dddmm.mmmmm: ddd – degree; mm.mmmmm – minute (0^o ~ 180^o)
p00x5	Longitude sector	E – East; W – West
p00x6	Altitude above ellipsoid (meters)	
p00x7	Navigation mode	NF – not fix DR – dead reckoning solution G2 – 2D G3 – 3D D2 – differential 2D D3 – differential 3D
p00x8	Position accuracy in the horizontal direction (meters)	0 ~ 9999
p00x9	Position accuracy in the vertical direction (meters)	0 ~ 9999
p00x10	Speed over ground (km/hr)	-999.99 ~ 999.99
p00x11	Course over ground (degrees)	000.00 ~ 359.99
p00x12	Velocity in the vertical direction (m/s)	-999.99 ~ 999.99 (positive: up)
p00x13	Age of DGPS corrections (seconds)	000.00 ~ 999.99 (empty field for not available)
p00x14	HDOP	00.0 ~ 99.9
p00x15	VDOP	00.0 ~ 99.9
p00x16	GDOP	00.0 ~ 99.9
p00x17	Number of GPS satellites used in	

	the position calculation	
p00x18	Number of GLONASS satellites used in the position calculation	Always 0
p00x19	Dead reckoning used	0 – No; 1 – Yes
hh	Checksum	hex number (2 – character)
<CR><LF>	End of message	

PUBX, 01 – UTM Position Data

Output message. This message transmits navigation data defined in the Universal Transverse Mercator (UTM) frame.

$PUBX,01,p01x1,p01x2,p01x3,p01x4,p01x5,p01x6,p01x7,p01x8,p01x9,p01x10,p01x11,p01x12,p01x13,p01x14,p01x15,p01x16,p01x17,p01x18,p01x19*hh<CR><LF>

Parameters	Descriptions	Notes
p01x1	UTC time	hhmmss.ss: hh – hour; mm – minute; ss.ss – second
p01x2	UTM Easting (meters)	
p01x3	Longitude sector	E – East; W – West
p01x4	UTM Northing (meters)	
p01x5	Hemisphere	N – North; S – South
p01x6	Altitude above ellipsoid (meters)	
p01x7	Navigation mode	NF – not fix DR – dead reckoning solution G2 – 2D G3 – 3D D2 – differential 2D D3 – differential 3D
p01x8	Position accuracy in the horizontal direction (meters)	0 ~ 9999
p01x9	Position accuracy in the vertical direction (meters)	0 ~ 9999
p01x10	Speed over ground (km/hr)	-999.99 ~ 999.99
p01x11	Course over ground (degrees)	000.00 ~ 359.99
p01x12	Velocity in the vertical direction (m/s)	-999.99 ~ 999.99 (positive: up)
p01x13	Age of DGPS corrections (seconds)	000.00 ~ 999.99 (empty field for not available)
p01x14	HDOP	00.0 ~ 99.9
p01x15	VDOP	00.0 ~ 99.9
p01x16	GDOP	00.0 ~ 99.9
p01x17	Number of GPS satellites used in the position calculation	
p01x18	Number of GLONASS satellites	Always 0

	used in the position calculation	
p01x19	Dead reckoning used	0 – No; 1 – Yes
hh	Checksum	hex number (2 – character)
<CR><LF>	End of message	

PUBX,03 – Satellite Status

Output message.

$PUBX,03,p03x1,((p03x2,p03x3,p03x4,p03x5,p03x6,p03x7)*n)*hh<CR><LF>

Parameters	Descriptions	Notes
p03x1	Number of GPS satellites tracked	
p03x2	PRN number	01 ~ 32
p03x3	Satellite status	- – not used U – used e – available for navigation, but no ephemeris
p03x4	Azimuth (degrees)	000 ~ 359
p03x5	Elevation (degrees)	00 ~ 90
p03x6	SNR (dB-Hz)	00 ~ 55
p03x7	Carrier lock time (seconds)	0 ~ 255 0: code lock only; 255: lock time at least 255 seconds.
hh	Checksum	hex number (2 – character)
<CR><LF>	End of message	

The message will repeatedly output the format-(p03x2,p03x3,p03x4,p03x5,p03x6,p03x7)- n times, which is equal to the value in p03x1 field.

PUBX,04 – Time of Day and Clock Information

Output message. This message transmits UTC time, week number, and clock offset.

$PUBX,04,p04x1,p04x2,p04x3,p04x4,p04x5,p04x6,p04x7,p04x8*hh<CR><LF>

Parameters	Descriptions	Notes
p04x1	UTC time	hhmmss.ss: hh – hour; mm – minute; ss.ss – second
p04x2	UTC date	ddmmyy: dd – day; mm – month; yy – year
p04x3	UTC – time of week (seconds)	
p04x4	GPS week number	
p04x5	Reserved	
p04x6	Receiver clock bias (nanoseconds)	
p04x7	Receiver clock drift (nanoseconds/second)	
p04x8	Time pulse granularity (nanoseconds)	
hh	Checksum	hex number (2 – character)
<CR><LF>	End of message	

GPQ – Poll Message

Input message. Poll a standard NMEA message.

$xxGPQ,gpq1*hh<CR><LF>

Parameters	Descriptions	Notes
$xxGPQ	NMEA message header	xx: talker device identifier
gpq1	NMEA message ids	String format: GGA, GLL, GRS, GSA, GST, GSV, RMC, TXT, VTG, and ZDA
hh	Checksum	hex number (2 – character)
<CR><LF>	End of message	

PUBX – Poll a PUBX Message

Input message. Poll the proprietary PUBX messages.

$PUBX,p1*hh<CR><LF>

Parameters	Descriptions	Notes
p1	Proprietary message ids	xx: 00, 01, 03, and 04
hh	Checksum	hex number (2 – character)
<CR><LF>	End of message	

PUBX,40 – Set NMEA Message Output Rate

Input message.

$PUBX,40,p40x1,p40x2,p40x3,p40x4,p40x5*hh<CR><LF>

Parameters	Descriptions	Notes
p40x1	NMEA message ids	String format: GGA, GLL, GRS, GSA, GST, GSV, RMC, TXT, VTG, and ZDA
p40x2	Number of cycles	USART 0 output rate 0 – disabled 1 - enabled
p40x3	Number of cycles	USART 1 output rate
p40x4	Number of cycles	USART 2 output rate
p40x5	Reserved	Always 0
hh	Checksum	hex number (2 – character)
<CR><LF>	End of message	

PUBX,41 – Set Protocols and Baudrate

Input message.

$PUBX,41,p41x1,p41x2,p41x3,p41x4,p41x5*hh<CR><LF>

Parameters	Descriptions	Notes
p41x1	USART id	0, 1, 0r 2
p41x1	Input protocol mask	0 – UBX 1 – NMEA 2 – RTCM 12 – 15: USER0 ~ USER3
p41x1	Output protocol mask	0 – UBX 1 – NMEA 2 – RAW 12 – 15: USER0 ~ USER3
p41x1	Baudrate (bps)	
p41x1	Autobauding*	0 – disabled 1 - enabled
hh	Checksum	hex number (2 – character)
<CR><LF>	End of message	

*: The Autobauding function will adjust the baud rate of the serial port automatically based on the detected conditions, such as multiple break and framing-error conditions.

NOTE: *If the comm. port of your host PC experiences errors frequently, please disable the Autobauding function.*

7.2 UBX Binary Protocol

To obtain the maximum performance from GPS chips, which mainly consists of FV-25, u-blox proposed a proprietary binary protocol. The binary protocol can set and poll all the available actions and messages from the module. Using asynchronous RS232 ports, the module communicates with a host platform in terms of the alternative, UBX protocol, to carry GPS data. The noticeable features for the UBX protocol are

1. 8 bits binary data;
2. low-overhead checksum algorithm;
3. 2-stage message identifier, i.e., Class ID + Message ID.

Figure 7.1 depicts the sentence structure for the UBX protocol. The UBX messages always begin with “0xB5 0x62” (hex number). The selection of a CLASS ID and MESSAGE ID, which are described in the end of this section, depends on the user’s need, and it will also define the content of DATA and its corresponding length (i.e. the value of DATA LENGTH). **For those multi-byte values, the rule of little Endian is adopted for transmitting the values.** It is noticeable that the DATA LENGTH is the value to indicate the length that only contains the subsequent input/output DATA and doesn’t include the checksum bytes.

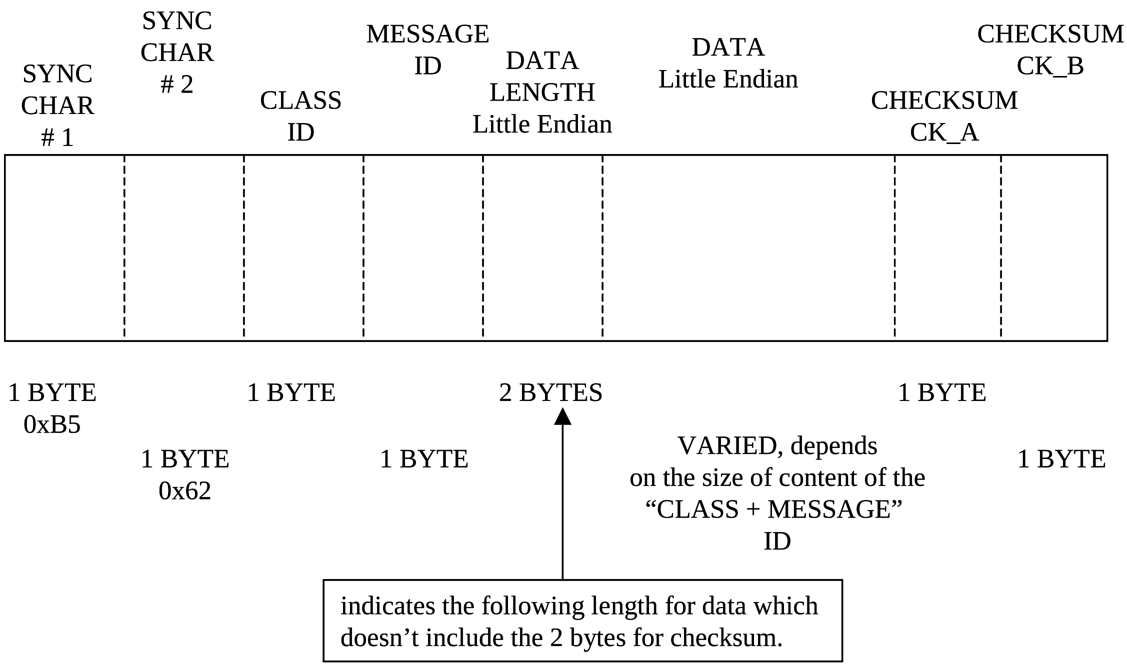


Figure 7.1 UBX protocol structure.

For the calculation of the checksum, u-blox utilizes the low-overhead checksum algorithm, which is the TCP standard (RFC 1145). The calculation of the checksum covers the range from the CLASS ID byte (included) to DATA bytes (included). It can be described as

```
CK_A=0;
CK_B=0;
for(i = 0;i < N;i ++)
{
    CK_A += buffer[i];
    CK_B += CK_A;
}
```

where

CK_A and CK_B: 8-bit unsigned integers;

buffer[·]: vector that contains the data in the calculating range (i.e. from CLASS ID to DATA);

N: number of bytes that contains the desired data.

The two checksums have to be masked with 0xFF after the operations in the loop, if large-sized integer values are executed.

7.2.1 Data Format

Table 7.1 describes the types of data that are used in the module. On the basis of IEEE754 single/double precision, the floating-point values are defined.

Acronym	Date Type	Size (bytes)	Range	Resolution	Note
U1	Unsigned Char	1	0 ~ 255	1	
I1	Signed Char	1	-128 ~ 127	1	2’s complement
U2	Unsigned Short	2	0 ~ 65535	1	
I2	Signed Short	2	-32768 ~ 32767	1	2’s complement
U4	Unsigned Long	4	0 ~ 4294967295	1	
I4	Signed Long	4	-2147483648 ~ 2147483647	1	2’s complement
R4	IEEE754 Single Precision	4	$-1*2^{127} \sim 2^{127}$	$\sim$Value$*2^{-24}$	

R8	IEEE754 Double Precision	8	$-1*2^{1023} \sim 2^{1023}$	$\sim$Value$*2^{-53}$	
CH	ASCII / ISO 8859.1 Encoding	1			

Table 7.1 The types of data.

7.2.2 Classification of UBX Messages

The u-blox proprietary messages are classified into 9 groups. Based on a specific topic, each group contains the associated information. They are summarized in Table 7.2.

Class ID	Class Name	Class No (Hex)	Comment
ACK	Acknowledgement	0x05	Respond to the input request: Ack/Nack
AID	Aiding	0x0B	AGPS or other similar functions
CFG	Configuration	0x06	Configuration input: port setting, DOP mask, etc.
INF	Informative	0x04	Printf-Style messages: Error, Warning , Notice
MON	Monitor	0x0A	Monitor the stack usage, CPU load, task status, etc.
NAV	Navigation	0x01	Navigation information: PVT, DOP, Course
RXM	Receiver Manager	0x02	Receiver manager messages: Pseudorange, Channel status
TIM	Timing	0x0D	Time pulse data: 1 PPS
UPD	Update	0x09	Firmware update messages

Table 7.2 UBX message classes.

7.2.3 Responses to the Users' Inputs

Basically, there are two kinds of module's responses for the users' requests: *Acknowledgement* and *Polling Mechanism*. When users send the Class CFG messages to the module, the module will reply the Acknowledgement or Not Acknowledgement message based on whether the desired message is implemented correctly or not. For the Polling Mechanism, the messages that can be output also can be polled. In this particular protocol, the output and polling requests use the same message. The difference between both is that, for the polling purpose, the message doesn't contain the DATA, i.e., the value of the DATA LENGTH is 0.

NOTE: *The default settings for output the binary messages from the module are on the comm. port 2 with the baud rate 57600 bps.*

7.2.4 UBX Messages

UBX Class ACK

This class is used for responding a CFG message.

ACK – ACK (0x05 0x01)

Message acknowledged.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x05 0x01	2	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U1	Class ID for the desired acknowledged message	
1	U1	Message ID for the desired acknowledged message	

ACK – NAK (0x05 0x00)

Message not-acknowledged.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x05 0x00	2	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U1	Class ID for the desired not-acknowledged message	
1	U1	Message ID for the desired not-acknowledged message	

UBX Class AID

This class is used to support AGPS function or send aiding data, such as time, position, almanac, and ephemeris, to the GPS receiver.

AID – REQ (0x0B 0x00)

It's a virtual request to poll all GPS aiding data (AID-DATA). The character of AID-REQ is determined by CFG-MSG. If AID-REQ is set as the output message and the internal stored data (i.e. time, position, almanac, and ephemeris) don't allow the receiver to execute a hot start, the receiver will request to poll all the aiding data after startup.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0B 0x00	0	None	CK_A CK_B

AID – DATA (0x0B 0x10)

It's a request to poll all the GPS initial aiding data. This message will activate the sending of AID-INI, AID-HUI, AID-EPH, and AID-ALM as it is received by the module.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0B 0x10	0	None	CK_A CK_B

AID – INI (0x0B 0x01)

It's a poll request when "data length" is equal to 0. Poll GPS initial aiding data.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0B 0x01	0	None	CK_A CK_B

AID – INI (0x0B 0x01)

This is an I/O message. It contains the information of position and time. As an output message, the value of the clock drift is always 0 and assigned invalid.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0B 0x01	48	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	I4	X coordinate in the ECEF frame (cm)	
4	I4	Y coordinate in the ECEF frame (cm)	
8	I4	Z coordinate in the ECEF frame (cm)	
12	U4	Position accuracy (cm)	Standard deviation
16	U2	Time mark configuration	0x01 – enable time mark 0x02 – falling edge Pin used for time mark: 0x00 – Extint 0 0x10 – Extint 1 0x20 – Extint 2
18	U2	GPS week number	
20	U4	GPS time of week (ms)	
24	I4	Subms part of GPS time (ns)	
28	U4	Millisecond part of time accuracy (ms)	
32	U4	Nanosecond part of time accuracy (ns)	
36	I4	Clock drift (ns/s)	
40	U4	Clock drift accuracy (ns/s)	
44	U4	Flags	0x1 – valid position fields 0x2 – valid time fields 0x4 – valid clock drift fields 0x8 – accurate time is input by with time pulse

AID – HUI (0x0B 0x02)

It's a poll request when "data length" is equal to 0. Poll GPS health, UTC, and Ionosphere data.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0B 0x02	0	None	CK_A CK_B

AID – HUI (0x0B 0x02)

It's an I/O message. It transmits GPS health, UTC, and Ionosphere (Klobuchar parameters) data.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0B 0x02	72	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	Health bit mask	Every bit represents the health of a GPS satellite (1 ~ 32). 1 – health; 0 – not health
4	R8	UTC – parameter A1	
12	R8	UTC – parameter A0	
20	I4	UTC – reference time of week	
24	I2	UTC – reference week number	
26	I2	UTC – time difference because of leap seconds before event occurs	
28	I2	UTC – week number when the next leap-second event occurs	
30	I2	UTC – day of week when the next leap-second event occurs	
32	I2	UTC – time difference because of leap seconds after event occurs	
34	I2	UTC – spare to ensure the sentence structure is a multiply of 4 bytes	
36	R4	Alpha0	Klobuchar parameters
40	R4	Alpha1	Klobuchar parameters
44	R4	Alpha2	Klobuchar parameters

48	R4	Alpha3	Klobuchar parameters
52	R4	Beta0	Klobuchar parameters
56	R4	Beta1	Klobuchar parameters
60	R4	Beta2	Klobuchar parameters
64	R4	Beta3	Klobuchar parameters
68	U4	Flag3	0x1 – valid health bit mask fields 0x2 – valid UCT parameter fields 0x4 – valid Klobuchar parameter fields

AID – ALM (0x0B 0x30)

It's a poll request when "data length" is equal to 0. Poll all available aiding almanac data.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0B 0x30	0	None	CK_A CK_B

AID – ALM (0x0B 0x30)

It's also a poll request. Poll a specific aiding almanac data.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0B 0x30	1	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U1	PRN number	This will request the desired almanac data for the specific GPS satellite

AID – ALM (0x0B 0x30)

It's an I/O message. Poll aiding almanac data.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0B 0x30	40	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	PRN number	The following data are for this specific satellite
4	U4	Issue date of Almanac	GPS week number. If this value is equal to 0, the following Words (0 ~ 7) don't contain the valid data.
8	U4	Almanac – WORD0	
12	U4	Almanac – WORD1	
16	U4	Almanac – WORD2	
20	U4	Almanac – WORD3	
24	U4	Almanac – WORD4	

28	U4	Almanac – WORD5	
32	U4	Almanac – WORD6	
36	U4	Almanac – WORD7	

NOTE: *1. WORD0 ~ WORD7 contain the data following the Hand-Over Word (HOW) in the navigation message. The data are from the sub-frame 4 of Pages 1 ~ 24 and the sub-frame 5 of Pages 2 ~ 10. More information about almanac data structure is referred to ICD-GPS-200.*

2. WORD0 ~ WORD7 don't include the data of the parity bits. Hence, Bits 0 ~ 23 is used to locate the 24 bits of the data and Bits 24 ~ 31 are the sign-extension of the data.

AID – EPH (0x0B 0x31)

It's a poll request when "data length" is equal to 0. Poll all available aiding ephemeris data.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0B 0x31	0	None	CK_A CK_B

AID – EPH (0x0B 0x31)

It's also a poll request. Poll a specific aiding ephemeris data.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0B 0x31	1	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U1	PRN number	This will request the desired almanac data for the specific GPS satellite

AID – EPH (0x0B 0x31)

It's an I/O message. Poll aiding almanac data.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0B 0x31	8+n*96	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	PRN number	The following data are for this specific satellite
4	U4	Hand-Over Word (HOW) of the first sub-frame	0 – invalid ephemeris data
The following data will be repeated n times (n: number of valid ephemerides).			
8+n*96	U4	Sub-frame 1 – WORD0	
12+n*96	U4	Sub-frame 1 – WORD1	
16+n*96	U4	Sub-frame 1 – WROD2	
20+n*96	U4	Sub-frame 1 – WORD3	
24+n*96	U4	Sub-frame 1 – WORD4	
28+n*96	U4	Sub-frame 1 – WORD5	

32+n*96	U4	Sub-frame 1 – WORD6	
36+n*96	U4	Sub-frame 1 – WORD7	
40+n*96	U4	Sub-frame 2 – WORD0	
44+n*96	U4	Sub-frame 2 – WORD1	
48+n*96	U4	Sub-frame 2 – WORD2	
52+n*96	U4	Sub-frame 2 – WORD3	
56+n*96	U4	Sub-frame 2 – WORD4	
60+n*96	U4	Sub-frame 2 – WORD5	
64+n*96	U4	Sub-frame 2 – WORD6	
68+n*96	U4	Sub-frame 2 – WORD7	
72+n*96	U4	Sub-frame 3 – WORD0	
76+n*96	U4	Sub-frame 3 – WORD1	
80+n*96	U4	Sub-frame 3 – WORD2	
84+n*96	U4	Sub-frame 3 – WORD3	
88+n*96	U4	Sub-frame 3 – WORD4	
92+n*96	U4	Sub-frame 3 – WORD5	
96+n*96	U4	Sub-frame 3 – WORD6	
100+n*96	U4	Sub-frame 3 – WORD7	

NOTE: *1. Sub-frame 1 – WORD0 ~ Sub-frame 3 – WORD7 contain the data following the Hand-Over Word (HOW) in the navigation message. The data are from the sub-frame 1 to sub-frame 3. More information about ephemeris data structure is referred to ICD-GPS-200.*

2. Sub-frame 1 – WORD0 ~ sub-frame 3 – WORD7 don't include the data of the parity bits. Hence, Bits 0 ~ 23 is used to locate the 24 bits of the data and Bits 24 ~ 31 are the sign-extension of the data.

UBX Class CFG

This class is used to configure the GPS module and output the current configuration of the GPS module. The module will respond the ACK-ACK message if the request is proceeded correctly and ACK-NAK message if the request is failed.

CFG – PRT (0x06 0x00)

It's a poll request. Poll the current configuration for a specific comm. port.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x00	1	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U1	Port number	

CFG – PRT (0x06 0x00)

It's an I/O message. As an input message, the port configurations for several ports can be put together into one input sentence. As an output message, the message only transmits the configuration from one specific comm. port.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x00	N*20	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
The following data will be repeated N times (number of comm. ports).			
0+N*20	U1	Port number	
1+N*20	U1	Reserved	
2+N*20	U2	Reserved	
4+N*20	U4	USART mode	Bit mask Bit[7:6]: character length 00 – 5 bits ; 01 – 6 bits 10 – 7 bits ; 11 – 8 bits Bit[11:9]: parity 000 – even ; 001 – odd 10X – no ; X1X – reserved Bit[13:12] 00 – 1 stop bit ; 01 – 1.5 stop bit

			10 – 2 stop bit ; 11 – reserved Bit[16] 0 – LSB first bit order 1 – MSB first bit order Bit[19] 0 – 16x oversampling 1 – 8x oversampling
8+N*20	U4	Baud rate (bps)	
12+N*20	U2	Input protocol for a single port. Multi-protocols can be selected for a single port.	Bit mask 0x0001 – UBX protocol 0x0002 – NMEA protocol 0x0004 – RTCM protocol 0x1000 – User0-defined protocol 0x2000 – User1-defined protocol 0x4000 – User2-defined protocol 0x8000 – User3-defined protocol The rest of bits are reserved.
14+N*20	U2	Output protocol for a single port. Multi-protocols can be selected for a single port.	Bit mask. 0x0001 – UBX protocol 0x0002 – NMEA protocol 0x0008 – RAW protocol 0x1000 – User0-defined protocol 0x2000 – User1-defined protocol 0x4000 – User2-defined protocol 0x8000 – User3-defined protocol The rest of bits are reserved.
16+N*20	U2	Flags	Bit mask. Bit 0 – if set, the Autobauding is enabled; Bits 1 ~ 15 are reserved.
18+N*20	U2	Reserved	

CFG – MSG (0x06 0x01)

It's a poll request. Poll a message configuration.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x01	2	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U1	Class ID	
1	U1	Message ID	

CFG – MSG (0x06 0x01)

It's an I/O message. As an input message, the message rate configurations for several targets can be put together into one input sentence. As an output message, the message only transmits one message rate configuration from one target.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x01	N*6	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
The following data will be repeated N times (number of targets) if needed.			
0+N*6	U1	Class ID	
1+N*6	U1	Message ID	
2+N*6	U1	Message rate on I/O Target 0	
3+N*6	U1	Message rate on I/O Target 1	
4+N*6	U1	Message rate on I/O Target 2	
5+N*6	U1	Message rate on I/O Target 3	

CFG – MSG (0x06 0x01)

It's an input message. Set message rate configuration for the current target.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x01	3	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U1	Class ID	
1	U1	Message ID	
2	U1	Message rate on the current target	

CFG – NMEA (0x06 0x17)

It's a poll request. Poll the NMEA protocol configuration.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x17	0	None	CK_A CK_B

CFG – NMEA (0x06 0x17)

It's an input message. Set the desired NMEA protocol.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x17	4	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U1	Filtering. Disable or not.	Bit 0 – position filtering Bit 1 – masked position filtering Bit 2 – time filtering Bit 3 – date filtering
1	U1	NMEA version	0x23 – version 2.3 Only version 2.3 is supported.
2	U1(2)	Reserved	

CFG – RATE (0x06 0x08)

It’s a poll request. Poll the current navigation/measurement rate setting. The module will respond the same message defined below (I/O message).

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x08	0	None	CK_A CK_B

CFG – RATE (0x06 0x08)

It’s an I/O message. It polls or sets the navigation/measurement rate.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x08	6	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U2	Measurement rate (ms).	
2	U2	Navigation rate (cycles)	Number of measurement cycles
4	U2	Alignment to reference time	0 – UTC time !0 – GPS time

NOTE:

*Navigation Update Rate (1/s) = 1000 / (NavigationRate * MeausrementRate(ms)).*

CFG – CFG (0x06 0x09)

It's a command message. The message will clear, save, and load configurations. The command consists of the three masks (clear, save, and load) in each individual bit.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x09	12	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	Clear configurations	Load factory defaults to active settings. See below for bit definitions.
4	U4	Save configurations	Save the active settings to non-volatile memory. See below for bit definitions.
8	U4	Load configurations	Load configurations from non-volatile memory to active settings. See below for bit definitions.

Bit Definitions	
Bits	**Descriptions**
0	I/O port assignments, protocols, and baud rates (referred to UBX-CFG-PRT).
1	Message configuration (referred to UBX-CFG-MSG and UBX-CFG-NMEA).
2	INF message configuration (referred to UBX-CFG-INF).
3	Navigation configuration (referred to UBX-CFG-DAT, UBX-CFG-NAV, UBX-CFG-RATE, UBX-CFG-TM, and UBX-CFG-TP).
4	Receiver manager (RXM) configuration (referred to UBX-CFG-RXM and UBX-CFG-SBAS).
5	Power saving mode configuration (referred to UBX-CFG-FXN).
6 ~ 9	EKF receiver (dead reckoning).
10	Model-specific settings for receiver (e.g.

	UBX-CFG-ANT)
11	Reserved
12 ~ 15	Reserved for user applications
16 ~ 31	Reserved

CFG – TP (0x06 0x07)

It's a poll request. Poll time pulse information. The module will respond the same message defined below (I/O message).

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x07	0	None	CK_A CK_B

CFG – TP (0x06 0x07)

It's an I/O message. Poll and set time pulse information.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x07	20	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	Time interval for time pulse (us).	
4	U4	Length of time pulse (us).	
8	I1	Status of time pulse	> 0 - positive 0 – off < 0 – negative
9	U1	Reference time	0 – UTC time !0 – GPS time
10	U2	Reserved	
12	I2	Delay due to antenna cable (ns)	
14	I2	RF group delay (ns)	
16	I4	User time function delay (ns)	

CFG – NAV (0x06 0x03)

It’s a poll request. Poll engine settings for navigation. The module will respond the same message defined below (I/O message).

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x03	0	None	CK_A CK_B

CFG – NAV (0x06 0x03)

It’s an I/O message. Poll and set engine settings for navigation.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x03	28	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U1	Kinematic model	1 – stationary 2 – pedestrian 3 – automotive 4 – sea 5 – airborne with acceleration < 1g 6 – airborne with acceleration < 2g 7 – airborne with acceleration < 4g 8 ~ 255 – reserved
1	U1	Minimum number of SVs for navigation	1 ~ 16
2	U1	Maximum number of SVs for navigation	1 ~ 16
3	U1	C/N0: conditional lower limit	This condition will be applied if and only if enough satellites (say 5) are being tracked and above this limit.
4	U1	C/N0: absolute lower limit	A satellite with C/N0 below this limit is not used in the navigation solution.
5	U1	Minimum elevation for SVs	

		used in the navigation solution	
6	U1	DGPS timetag rounding	1 – enable 0 – disable
7	U1	Timeout for differential correction data (s)	
8	U1	Timeout for pseudorange correction data (s)	
9	U1	Timeout for carrier phase correction data (s)	
10	U2	Carrier Lock Time (CLT): conditional lower limit (ms)	
12	U2	CLT: absolute lower limit (ms)	
14	U1	Epochs for DR	
15	U1	Navigation options	Bit mask 0x01 – enable pseudorange check 0x02 – enable Doppler check 0x04 – enable Delta range check 0x08 – enable ALM-EPH consistency check 0x10 – enable almanac navigation 0x20 – reserved 0x40 – reserved 0x80 – reserved
16	U2	PDOP mask	Scaling : 0.1
18	U2	TDOP mask	Scaling : 0.1
20	U2	Position accuracy mask (m)	
22	U2	Time accuracy mask (m)	
24	U2	Frequency accuracy mask (m/s)	Scaling : 0.1
26	U1	Static threshold (cm/s)	0 – disable
27	U1	Reserved	

CFG – DAT (0x06 0x06)

It's a poll request. Poll datum setting. The module will respond the same message defined below (I/O message).

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x06	0	None	CK_A CK_B

CFG – DAT (0x06 0x06)

It's an input message. Set the standard datum.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x06	2	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U2	Datum number	Referred to Appendix A

CFG – DAT (0x06 0x06)

It's an input message. Set user-defined datum.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x06	44	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	R8	Semi-major axis (m)	6,300,000.0 ~ 6,500,000.0
8	R8	1.0/flattening	0.0 ~ 500.0
16	R4	Offset from the origin – X axis (m)	-5000.0 ~ 5000.0
20	R4	Offset from the origin – Y axis (m)	-5000.0 ~ 5000.0
24	R4	Offset from the origin – Z axis (m)	-5000.0 ~ 5000.0
28	R4	Rotation about X axis (milli-arc seconds)	-20.0 ~ 20.0
32	R4	Rotation about Y axis (milli-arc seconds)	-20.0 ~ 20.0
36	R4	Rotation about Z axis(milli-arc	-20.0 ~ 20.0

		seconds)	
40	R4	Scale change (ppm)	0.0 ~ 50.0

CFG – DAT (0x06 0x06)

It's an output message. Poll the current datum. If the datum number is –1, the module is using the user-defined datum and only the value for semi-major axis is valid and the rest of them are not valid.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x06	52	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U2	Datum number	
2	CH[6]	Datum name	ASCII format
8	R8	Semi-major axis (m)	6,300,000.0 ~ 6,500,000.0
16	R8	1.0/flattening	0.0 ~ 500.0
24	R4	Offset from the origin – X axis (m)	-5000.0 ~ 5000.0
28	R4	Offset from the origin – Y axis (m)	-5000.0 ~ 5000.0
32	R4	Offset from the origin – Z axis (m)	-5000.0 ~ 5000.0
36	R4	Rotation about X axis (milli-arc seconds)	-20.0 ~ 20.0
40	R4	Rotation about Y axis (milli-arc seconds)	-20.0 ~ 20.0
44	R4	Rotation about Z axis(milli-arc seconds)	-20.0 ~ 20.0
48	R4	Scale change (ppm)	0.0 ~ 50.0

CFG – INF (0x06 0x02)

It's a poll request. It's used to identify the output protocol.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x02	1	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U1	Protocol ID	0 – UBX protocol 1 – NMEA protocol 2 – RTCM protocol (used for input only) 3 – RAW protocol 4 ~ 11 – reserved 12 – User0-defined protocol 13 – User1-defined protocol 14 – User2-defined protocol 15 – User3-defined protocol 16 ~ 255 – reserved

CFG – INF (0x06 0x02)

It's an I/O message. It's used to set/get message configuration. As an input message, several message configurations can be put into as one input sentence. But as an output message, the sentence only transmits one message configuration.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x02	N*8	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
The following data will be repeated N times (number of comm. ports).			
0+N*8	U1	Protocol ID	0 – UBX protocol 1 – NMEA protocol 2 – RTCM protocol (used for input only) 3 – RAW protocol 4 ~ 11 – reserved 12 – User0-defined protocol

			13 – User1-defined protocol 14 – User2-defined protocol 15 – User3-defined protocol 16 ~ 255 – reserved
1+N*8	U1	Reserved	
2+N*8	U2	Reserved	
4+N*8	U1	Information message enabled (INF class) at I/O target 0 (USART 0)	Bit mask. Referred to INF class, such as INF-ERROR and INF-WARNING
5+N*8	U1	Information message enabled (INF class) at I/O target 1 (USART 1)	Same as above
6+N*8	U1	Information message enabled (INF class) at I/O target 2 (USART 2)	Same as above
7+N*8	U1	Information message enabled (INF class) at I/O target 3 (reserved)	Same as above

CFG – RST (0x06 0x04)

It's an input message. It's used to reset receiver or clear backup data structure.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x04	4	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U2	Clear backup data in BBR	0x0001 – ephemeris 0x0002 – almanac 0x0004 – health 0x0008 – Klobuchar 0x0010 – position 0x0020 – clock drift 0x0040 – oscillation parameter 0x0080 – UTC correction parameters 0x0100 – RTC 0x0000 – hot-start 0x0001 – warm-start 0xFFFF – cold-start
2	U1	Reset	0x00 – hardware reset (watchdog) 0x01 – controlled software reset 0x02 – controlled software reset (GPS only) 0x08 – controlled GPS stop 0x09 – controlled GPS start
3	U1	Reserved	

CFG – RXM (0x06 0x11)

It’s a poll request. It’s used to poll RXM configuration. The module responds the same message defined below.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x11	0	None	CK_A CK_B

CFG – RXM (0x06 0x11)

It’s an I/O message. It’s used to set/get RXM configuration.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x11	2	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U1	GPS sensitivity mode	0 – Normal 1 – Fast acquisition 2 – High sensitivity > 2 – Reserved
1	U1	Power mode	0 – Continuous tracking mode 1 – FixNow mode (power saving mode) > 1 – Reserved

CFG – ANT (0x06 0x13)

It's a poll request. It's used to poll antenna control settings. The module responds the same message defined below.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x13	0	None	CK_A CK_B

CFG – ANT (0x06 0x13)

It's an I/O message. It's used to set/get antenna control settings.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x13	4	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U2	Antenna flag mask	Bit 0 – enable
2	U2	Antenna pin configuration	0 – Continuous tracking mode 1 – FixNow mode (power saving mode) > 1 – Reserved

CFG – FXN (0x06 0x0E)

It's a poll request. It's used to poll power saving (FixNow) mode configuration. The module responds the same message defined below.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x0E	0	None	CK_A CK_B

CFG – FXN (0x06 0x0E)

It's a command message. It's used to configure the FixNow mode. It is enabled by the CFG-RXM message.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x0E	36	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	FixNow mode configuration	Bit mask 0x02 – set: Sleep state 0x04 – reserved (never set this bit) 0x08 – absolute alignment (on/off time) 0x10 – use on/off time the rest of bits – not set
4	U4	Last fix timeout (ms)	
8	U4	Sleep time (ms)	After a last fix timeout
12	U4	Last reset timeout (ms)	
16	U4	Sleep time (ms)	After a last reset timeout
20	U4	On time (ms)	Start with first fix
24	U4	Sleep time (ms)	After a normal on time (may vary because of data download)
28	U4	Reserved	
32	U4	Base TOW (ms)	TO which "On time" and corresponding "Sleep time" are aligned if ABSOLUTE_ALIGN is set.

CFG – SBAS (0x06 0x16)

It's a command message. It's used to configure SBAS systems, such as WAAS, EGNOS, and MSAS. More information about SBAS services is referred to document RTCA/DO-229C (www.rtca.org).

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x16	8	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U1	SBAS mode.	Bit mask Bit 0 – 1: SBAS enabled; 0: SBAS disabled Bit 1 – SBAS testbed; 1: use data anyhow; 0: ignore data when in test mode (SBAS Msg 0) Bits 2-7 – reserved
1	U1	SBAS usage	Bit mask Bit 0 – use ranges for navigation solution Bit 1 – use differential correction Bit 2 – use integrity information
2	U1	Maximum number of channels for searching SBAS satellites	0 ~ 3
3	U1	Reserved	
4	U4	SBAS PRN numbers in searching channels	All bits are set to 0 – auto-scan (searching all available PRNs) Bit 0 – PRN 120 Bit 1 – PRN 121 …. Bit 18 – PRN 138 Bits 19-31 – reserved (set to 0)

CFG – TM (0x06 0x10)

It’s a poll request. It’s used to poll time mark configuration.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x10	0	None	CK_A CK_B

CFG – TM (0x06 0x10)

It’s an I/O message. It’s used to set/get time mark configuration.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x10	12	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	Time mark input source	EXTINT 0 (31) EXTINT 1 (30) EXTINT 2 (29)
4	U4	Rate of time mark task (ms)	
8	U4	Flags for time mark task	Bit mask Bit 0 – 0: time mark disabled; 1: time mark enabled Bit 1 – 0: time mark on rising edge; 1: time mark on falling edge Bit 2 – 0: based on GPS time; 1: based on UTC time

CFG – EKF (0x06 0x12)

It's a poll request. It's used to poll EKF configuration. The module responds the same message defined below.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x12	0	None	CK_A CK_B

CFG – EKF (0x06 0x12)

It's an I/O message. It's used to set/get EKF configuration.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x06 0x12	16	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U1	EKF status	1 – disabled 0 – enabled
1	U1	Flags	Bit 0 – reserved (always 0) Bit 1 – clear temperature compensation table Bit 2 – clear stored calibration Bit 3 – reserved (always 0) Bit 4 – set nominal tacho pulses as defined in Field "Nominal pulses per kilometer" Bit 5 – set nominal gyro values as defined in Fields "Nominal gyro zero point output" and "Nominal gyro sensitivity" Bit 6 – set temperature table configuration as defined in Fields "Maximum allowable RMS threshold" and " The time interval for saving temperature table to flash" Bit 7 – set direction pin and gyro sense meaning as defined in Field "Inverse_flags"

2	U1	Reserved	
3	U1	Inverse_flags	Bit 0 – invert meaning of direction pin; 0: High=Forwards; 1: High=Backwards Bit 1 – invert meaning of gyro rotation sense; 0: clockwise positive; 1: counterclockwise positive
4	U4	Reserved	Always 0
8	U2	Nominal pulses per kilometer	1100 ~ 45000
10	U2	Nominal gyro zero point output (mV)	2000 ~ 3000
12	U1	Nominal gyro sensitivity (mV/(deg/s))	20 ~ 40
13	U1	Maximum allowable RMS threshold (mV)	For zero velocity temperature compensation: 1 ~ 10 Scaling: 0.1
14	U2	The time interval for saving temperature table to flash (s)	Minimum: 9

UBX Class INF

Basically, the INF class is an output class. It outputs strings with a printf-style call.

INF – ERROR (0x04 0x00)

It outputs an ASCII string to indicate error message.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x04 0x00	N*1	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
The following data will be repeated N times (variable length).			
0+N*1	U1	ASCII character	

INF – WARNING (0x04 0x01)

It outputs an ASCII string to indicate warning message.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x04 0x01	N*1	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
The following data will be repeated N times (variable length).			
0+N*1	U1	ASCII character	

INF – NOTICE (0x04 0x02)

It outputs an ASCII string to transmit informational contents.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x04 0x02	N*1	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
The following data will be repeated N times (variable length).			
0+N*1	U1	ASCII character	

INF – TEST (0x04 0x03)

It outputs an ASCII string to indicate test message.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x04 0x03	N*1	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
The following data will be repeated N times (variable length).			
0+N*1	U1	ASCII character	

INF – DEBUG (0x04 0x04)

It outputs an ASCII string to indicate debug message.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x04 0x04	N*1	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
The following data will be repeated N times (variable length).			
0+N*1	U1	ASCII character	

INF – USER (0x04 0x07)

It outputs an ASCII string to indicate user output message.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x04 0x07	N*1	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
The following data will be repeated N times (variable length).			
0+N*1	U1	ASCII character	

UBX Class MON

This message is used to transmit GPS receiver status, such as CPU status, I/O status, etc..

MON – SCHD (0x0A 0x01)

It periodically polls the status of system scheduler.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0A 0x01	24	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	Status: indicating which tasks have run	Bit mask
4	U4	Status: indicating which tasks are scheduled to run	Bit mask
8	U4	Status: indicating which tasks are overrun	Bit mask
12	U4	Status: indicating which task IDs have a registered task function	Bit mask
16	U2	Number of bytes used for system stack (bytes)	
18	U2	Stack size in bytes	
20	U2	CPU idle time in the scale of 1/1000	
22	U1	Number of fully used slots in the last 100	
23	U1	Number of partly used slots in the last 100	

MON – IO (0x0A 0x02)

It periodically polls the I/O status.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0A 0x02	80	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
The following data will be repeated four times (N = 4).			
0+N*20	U4	Number of bytes which are received (bytes)	
4+N*20	U4	Number of bytes which are sent (bytes)	
8+N*20	U2	Number of 100 ms slots which have overrun errors	
10+N*20	U2	Number of 100 ms slots which have framing errors	
12+N*20	U2	Number of 100 ms slots which have overrun errors	
14+N*20	U2	Number of 100 ms slots which have break conditions	
16+N*20	U1	Flag	Indicating that receiver is busy
17+N*20	U1	Flag	Indicating that transmitter is busy
18+N*20	U2	Reserved	

MON – MAGPP (0x0A 0x06)

It periodically polls message parse and process status.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0A 0x06	144	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U2[16]	Number of successful parsed message for each protocol on Target 0	
32	U2[16]	Number of successful parsed message for each protocol on Target 1	
64	U2[16]	Number of successful parsed message for each protocol on Target 2	
96	U2[16]	Number of successful parsed message for each protocol on Target 3	
128	U4[4]	Number of skipped bytes for each target	

MON – RXBUF (0x0A 0x07)

It periodically polls the status of receiver buffer.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0A 0x07	16	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U2[4]	Number of pending bytes in receiver buffer on each target (bytes)	
8	U1[4]	Maximum usage receiver buffer for the last system-monitoring period of each target	
12	U1[4]	Maximum current usage receiver buffer for each target	

MON – TXBUF (0x0A 0x08)

It periodically polls the status of transmitter buffer.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0A 0x08	20	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U2[4]	Number of pending bytes in receiver buffer on each target (bytes)	
8	U1[4]	Maximum usage receiver buffer for the last system-monitoring period of each target	
12	U1[4]	Maximum current usage receiver buffer for each target	
16	U1	Maximum usage receiver buffer for the last system-monitoring period of all targets	
17	U1	Maximum current usage receiver buffer for all targets	
18	U1	Error flags	Bit mask Bits 0 ~ 3 – buffer limit of corresponding target Bits 4 ~ 6 – reserved Bit 7 – allocation error (Tx buffer full)
19	U1	Reserved	

MON – VER (0x0A 0x04)

It is used to poll the hardware/software version.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0A 0x04	40+N*30	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	CH[30]	Software version	
30	CH[10]	Hardware version	
The following data will be repeated N times.			
40+N*30	CH[30]	Extension package version	

UBX Class NAV

The messages in this class transmit navigation data, status flags, and accuracy information.

NAV – POSECEF (0x01 0x01)

It periodically polls the receiver's position in the ECEF frame.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x01 0x01	20	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	GPS time of week (ms)	
4	I4	X coordinate (cm)	In the ECEF frame
8	I4	Y coordinate (cm)	In the ECEF frame
12	I4	Z coordinate (cm)	In the ECEF frame
16	U4	Position accuracy (cm)	

NAV – POSLLH (0x01 0x02)

It periodically polls the receiver's position in the local geodetic frame.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x01 0x02	28	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	GPS time of week (ms)	
4	I4	Longitude (degrees)	In the local geodetic frame Scaling: 1E-07
8	I4	Latitude (degrees)	In the local geodetic frame Scaling: 1E-07
12	I4	Height above ellipsoid (mm)	In the local geodetic frame
16	I4	Height above mean see level (mm)	
20	U4	Horizontal accuracy (mm)	
24	U4	Vertical accuracy (mm)	

NAV – POSUTM (0x01 0x08)

It periodically polls the receiver's position in the UTM frame.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x01 0x08	18	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	GPS time of week (ms)	
4	I4	Easting component (cm)	In the UTM frame
8	I4	Northing component (cm)	In the UTM frame
12	I4	Altitude (cm)	In the UTM frame
16	I1	UTM zone number	
17	I1	Hemisphere sector	0 – north 1 – south

NOTE: *1. Doesn't output zone characters (i.e. northing element of a zone description).*

2. Doesn't support the irregularities of UTM grids in the areas of North Pole and Scandinavian.

NAV – DOP (0x01 0x04)

It periodically polls the values of DOPs.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x01 0x04	18	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	GPS time of week (ms)	
4	U2	GDOP	Geometric DOP
6	U2	PDOP	Positional DOP
8	U2	TDOP	Time DOP
10	U2	VDOP	Vertical DOP
12	U2	HDOP	Horizontal DOP
14	U2	NDOP	Northing DOP
16	U2	EDOP	Easting DOP

NOTE: *All have Scaling 0.01.*

NAV – STATUS (0x01 0x03)

It periodically polls navigation status.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x01 0x03	16	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	GPS time of week (ms)	
4	U1	Navigation modes	0x00 – no fix 0x01 – dead reckoning 0x02 – 2D fix 0x03 – 3D fix 0x04 – GPS + dead reckoning 0x05 ~ 0xFF – reserved
5	U1	Flags	0x01 – GPS fix ok (under DOP and accuracy masks) 0x02 – DGPS used 0x04 – week number valid 0x08 – time of week valid the rest of them – reserved
6	U1	Differential status	Bits[1:0] – DGPS input status 00 – none 01 – PR+PRR correction 10 – PR+PRR+CP correction 11 – high accuracy PR+PRR+CP correction the rest of bits – reserved
7	U1	Reserved	
8	U4	Time to first fix (TTFF)	Millisecond time tag
12	U4	Millisecond since startup/reset	

NAV – SOL (0x01 0x06)

It periodically polls the information about navigation solution.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x01 0x06	52	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	GPS time of week (ms)	
4	I4	Remainder of rounded GPS time of week relative to GPS millisecond time of week (ns)	-500000 ~ 500000
8	I2	GPS week	
10	U1	Navigation mode	0x00 – no fix 0x01 – dead reckoning 0x02 – 2D fix 0x03 – 3D fix 0x04 – GPS + dead reckoning 0x05 ~ 0xFF – reserved
11	U1	Flags	0x01 – GPS fix ok (under DOP and accuracy masks) 0x02 – DGPS used 0x04 – week number valid 0x08 – time of week valid the rest of them – reserved
12	I4	X coordinate (cm)	In the ECEF frame
16	I4	Y coordinate (cm)	In the ECEF frame
20	I4	Z coordinate (cm)	In the ECEF frame
24	U4	3D position accuracy (cm)	
28	I4	X velocity (cm/s)	In the ECEF frame
32	I4	Y velocity (cm/s)	In the ECEF frame
36	I4	Z velocity (cm/s)	In the ECEF frame
40	U4	Speed accuracy (cm/s)	
44	U2	PDOP	Scaling: 0.01
46	U1	Reserved	
47	U1	Number of SVs used in the navigation solution	
48	U4	Reserved	

NAV – VELECEF (0x01 0x11)

It periodically polls velocity solution in the ECEF frame.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x01 0x11	20	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	GPS time of week (ms)	
4	I4	X velocity (cm/s)	In the ECEF frame
8	I4	Y velocity (cm/s)	In the ECEF frame
12	I4	Z velocity (cm/s)	In the ECEF frame
16	U4	Speed accuracy (cm/s)	

NAV – VELNED (0x01 0x12)

It periodically polls velocity solution in the NED frame.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x01 0x12	36	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	GPS time of week (ms)	
4	I4	North velocity (cm/s)	In the NED frame
8	I4	East velocity (cm/s)	In the NED frame
12	I4	Down velocity (cm/s)	In the NED frame
16	U4	Speed (cm/s)	3D
20	U4	Ground speed (cm/s)	2D
24	I4	Heading (degrees)	2D Scaling: 1E-05
28	U4	Speed accuracy (cm/s)	
32	U4	Course/Heading accuracy (degrees(	Scaling: 1E-05

NAV – TIMEGPS (0x01 0x20)

It periodically polls the information about GPS time.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x01 0x20	16	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	GPS time of week (ms)	
4	I4	Remainder of rounded GPS time of week relative to GPS millisecond time of week (ns)	-500000 ~ 500000
8	I2	GPS week	
10	I1	Leap seconds (s)	GPS – UTC
11	U1	Flags	0x01 – valid time of week 0x02 – valid week number 0x04 – valid UTC
12	U4	Time accuracy (ns)	

NAV – TIMEUTC (0x01 0x21)

It periodically polls the information about UTC time.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x01 0x21	20	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	GPS time of week (ms)	
4	U4	Time accuracy (ns)	
8	I4	Nanoseconds of second (UTC)	-500000000 ~ 500000000
12	U2	Year (UTC)	1999 ~ 2099
14	U1	Month (UTC)	
15	U1	Day (UTC)	
16	U1	Hour (UTC)	0 ~ 23
17	U1	Minute (UTC)	0 ~ 59
18	U1	Second (UTC)	0 ~ 59
19	U1	Flags	0x01 – valid time of week 0x02 – valid week number 0x04 – valid UTC

NAV – CLOCK (0x01 0x22)

It periodically polls receiver clock information.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x01 0x22	20	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	GPS time of week (ms)	
4	I4	Clock bias (ns)	
8	I4	Clock drift (ns/s)	
12	U4	Time accuracy (ns)	
16	U4	Frequency accuracy (ps/s)	

NAV – SVINFO (0x01 0x30)

It periodically polls the information about UTC time.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x01 0x30	8+N*12	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	GPS time of week (ms)	
4	U1	Number of channels	1 ~ 16
5	U1	Reserved	
6	U2	Reserved	
The following data will be repeated N times (number of channels).			
8+N*12	U1	Channel number	0 ~ 15
9+N*12	U1	PRN number (SV ID)	
10+N*12	U1	Flags for the above specified SV	Bit mask 0x01 – used for navigation 0x02 – differential correction data available 0x04 – ephemeris or almanac available 0x08 – ephemeris available 0x10 – unhealth status (shall not be used) 0x20,0x40,0x80 – reserved
11+N*12	I1	Signal quality indicator for the above specified SV	0 – idle 1,2 – searching 3 – signal detected but unused 4 – code lock 5,6 – code and carrier locks 7 – code and carrier locks, receiving navigation message data (50 bps)
12+N*12	U1	CN0 (dBHz)	Carrier to noise ratio
13+N*12	I1	Elevation (degrees)	Integer value
14+N*12	I2	Azimuth (degrees)	Integer value
16+N*12	I4	Pseudo range residual (cm)	

NAV – DGPS (0x01 0x31)

It periodically polls DGPS correction data that are used in the navigation solution.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x01 0x31	16+N*12	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	GPS time of week (ms)	
4	I4	Age of newest correction data (ms)	
8	I2	DGPS reference station ID	
10	I2	Health status for DGPS station	
12	U1	Number of channels (correction data is following)	
13	U1	DGPS data type	00 – none 01 – PR+PRR correction 10 – PR+PRR+CP correction 11 – high accuracy PR+PRR+CP correction
14	U2	Reserved	
The following data will be repeated N times (number of channels).			
16+N*12	U1	PRN number (SV ID)	
17+N*12	U1	Flags	Bit mask 0x01 ~ 0x08 – channel number 0x10 – DGPS used 0x20 ~ 0x80 – reserved
18+N*12	U2	Age of the latest correction data (ms)	
20+N*12	R4	Pseudo range correction (m)	
24+N*12	R4	Pseudo range rate correction (m/s)	

NAV – SBAS (0x01 0x32)

It periodically polls the status of SBAS.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x01 0x32	12+N*12	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	GPS time of week (ms)	
4	U1	PRN number for SBAS, e.g. WAAS, EGNOS.	
5	U1	SBAS mode	0 – disabled 1 – enabled integrity 2 – enabled test mode
6	I1	SBAS type	-1 – unknown 0 – WAAS 1 – EGNOS 2 – MSAS 16 – GPS
7	U1	SBAS services	Bit 0 – ranging Bit 1 – corrections Bit 2 – integrity Bit 3 – test mode
8	U1	Number of SV data following	
9	U1[3]	Reserved	
The following data will be repeated N times (number of SVs).			
12+N*12	U1	PRN number (SV ID)	
13+N*12	U1	Flags	
14+N*12	U1	Monitoring status	
15+N*12	U1	SBAS type	-1 – unknown 0 – WAAS 1 – EGNOS 2 – MSAS 16 – GPS
16+N*12	U1	SBAS services	Bit 0 – ranging Bit 1 – corrections Bit 2 – integrity Bit 3 – test mode

17+N*12	U1	Reserved	
18+N*12	I2	Pseudo range correction (cm)	
20+N*12	I2	Reserved	
22+N*12	I2	Ionosphere correction (cm)	

UBX Class RXM

This class transmits the status of receiver manager and received raw data, e.g. pseudorange and carrier phase measurements, ephemeris, and almanac data.

RXM – RAW (0x02 0x10)

It periodically outputs raw measurement data. It defines all the necessary data for a RINEX file.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x02 0x10	8+N*24	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	I4	GPS time of week (ms)	Receiver time
4	I2	GPS week number	Receiver time
6	U1	Number of satellites following	
7	U1	Reserved	
The following data will be repeated N times (number of satellites).			
8+N*24	R8	Carrier phase measurement (cycles)	L1 frequency CP
16+N*24	R8	Pseudorange measurement (m)	PR
24+N*24	R4	Doppler measurement (Hz)	DO
28+N*24	U1	PRN number	
29+N*24	I1	Measurement quality indicator	>= 4 – PR+DO >=5 – PR+DO+CP <6 – likely loss of carrier lock in the previous interval
30+N*24	I1	CN0 (dBHz)	Carrier to noise ratio
31+N*24	U1	Indicator for loss of lock	RINEX definition

RXM – SFRB (0x02 0x11)

It periodically outputs the data in the subframe of navigation message.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x02 0x11	42	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U1	Channel number	
1	U1	PRN number	
2	I4	WORD0	
6	I4	WORD1	
10	I4	WORD2	
14	I4	WORD3	
18	I4	WORD4	
22	I4	WORD5	
26	I4	WORD6	
30	I4	WORD7	
34	I4	WORD8	
38	I4	WORD9	

NOTE: *For GPS satellites, each word contains the parity checked subframe data in 24 bits (Bits 23 ~ 0) and the rest of 8 bits in each word are undefined. The higher order bits receive data first. For more information about GPS navigation message, please refer to the documentation ICD-GPS-200.*

For SBAS satellites, the first 7 words (WORD0 ~ WORD6) contain 224 bits of data for the 250 bit message block. The rest of 26-bit data are contained in Bits 25 ~ 0 of WORD7, where Bit 25 is last bit of the data. For more information about SBAS, please refer to RTCA/DO-229C (MOPS).

RXM – SVSI (0x02 0x20)

It periodically polls the information of SV status.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x02 0x20	8+N*6	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	I4	GPS time of week (ms)	
4	I2	GPS week number	
6	U1	Number of observable satellites	
7	U1	Number of satellite data following	
The following data will be repeated N times (number of satellites).			
8+N*6	U1	PRN number	
9+N*6	U1	Flags	0x01 – health SV 0x02 – ephemeris valid 0x04 – almanac valid
10+N*6	I2	Azimuth (degrees)	
12+N*6	I1	Elevation (degrees)	
13+N*6	U1	Age of almanac (ALM) and ephemeris (EPH)	Bits 0 ~ 3 – age of ALM in days offset by 4, Bits 4 ~ 7 – age of EPH in hours offset by 4. i.e. the reference time may be in the future: age_of_alm = (Age & 0x0f) – 4 age_of_eph = ((Age & 0xf0) >> 4) - 4

RXM – ALM (0x02 0x30)

It's an input request for polling almanac data. The receiver responds with all available (32) RXM-ALM messages defined below.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x02 0x30	0	None	CK_A CK_B

RXM – ALM (0x02 0x30)

It's an input request for polling almanac data of one specific SV. The receiver responds with a RXM-ALM message defined below.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x02 0x30	1	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U1	PRN number	1 ~ 32

RXM – ALM (0x02 0x30)

It's an output message that carries almanac data of one specific SV.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x02 0x30	40	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	PRN number	1 ~ 32
1	U4	GPS week number	
2	U4	WORD0	
6	U4	WORD1	
10	U4	WORD2	
14	U4	WORD3	
18	U4	WORD4	
22	U4	WORD5	
26	U4	WORD6	
30	U4	WORD7	

NOTE: *1. If the value of week number is 0, the almanac data in WORDs (0 ~ 7) are* *not valid.*

2. WORD0 ~ WORD7 contain the data following the Hand-Over Word (HOW) in the navigation message. The data are from the sub-frame 4 of Pages 1 ~ 24 and the sub-frame 5 of Pages 2 ~ 10. More information about almanac data structure is referred to ICD-GPS-200.

3. WORD0 ~ WORD7 don't include the data of the parity bits. Hence, Bits 0 ~ 23 is used to locate the 24 bits of the data and Bits 24 ~ 31 are the sign-extension of the data.

RXM – EPH (0x02 0x31)

It's an input request for polling ephemeris data. The receiver responds with all available RXM-EPH messages defined below.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x02 0x31	0	None	CK_A CK_B

RXM – EPH (0x02 0x31)

It's an input request for polling ephemeris data of one specific SV. The receiver responds with a RXM-EPH message defined below.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x02 0x31	1	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U1	PRN number	1 ~ 32

RXM – EPH (0x02 0x31)

It's an output message that carries almanac data of one specific SV.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x02 0x31	8+n*96	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	PRN number	The following data are for this specific satellite
4	U4	Hand-Over Word (HOW) of the first sub-frame	0 – invalid ephemeris data
The following data will be repeated n times (n: number of valid ephemerides).			
8+n*96	U4	Sub-frame 1 – WORD0	
12+n*96	U4	Sub-frame 1 – WORD1	
16+n*96	U4	Sub-frame 1 – WROD2	
20+n*96	U4	Sub-frame 1 – WORD3	
24+n*96	U4	Sub-frame 1 – WORD4	
28+n*96	U4	Sub-frame 1 – WORD5	
32+n*96	U4	Sub-frame 1 – WORD6	

36+n*96	U4	Sub-frame 1 – WORD7	
40+n*96	U4	Sub-frame 2 – WORD0	
44+n*96	U4	Sub-frame 2 – WORD1	
48+n*96	U4	Sub-frame 2 – WORD2	
52+n*96	U4	Sub-frame 2 – WORD3	
56+n*96	U4	Sub-frame 2 – WORD4	
60+n*96	U4	Sub-frame 2 – WORD5	
64+n*96	U4	Sub-frame 2 – WORD6	
68+n*96	U4	Sub-frame 2 – WORD7	
72+n*96	U4	Sub-frame 3 – WORD0	
76+n*96	U4	Sub-frame 3 – WORD1	
80+n*96	U4	Sub-frame 3 – WORD2	
84+n*96	U4	Sub-frame 3 – WORD3	
88+n*96	U4	Sub-frame 3 – WORD4	
92+n*96	U4	Sub-frame 3 – WORD5	
96+n*96	U4	Sub-frame 3 – WORD6	
100+n*96	U4	Sub-frame 3 – WORD7	

NOTE: *1. Sub-frame 1 – WORD0 ~ Sub-frame 3 – WORD7 contain the data following the Hand-Over Word (HOW) in the navigation message. The data are from the sub-frame 1 to sub-frame 3. More information about ephemeris data structure is referred to ICD-GPS-200.*

2. Sub-frame 1 – WORD0 ~ sub-frame 3 – WORD7 don't include the data of the parity bits. Hence, Bits 0 ~ 23 is used to locate the 24 bits of the data and Bits 24 ~ 31 are the sign-extension of the data.

RXM – POSREQ (0x02 0x40)

It's an input message for requesting a position fix in the FixNow mode (power saving mode).

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x02 0x40	0	None	CK_A CK_B

UBX Class TIM

This class transmits the information of time pulse and time mark.

TIM – TM (0x0D 0x02)

It periodically polls the time mark data.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0D 0x02	28	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	Counter difference since last polled time	
4	U4	Time difference since last polled time (ms)	
8	U4	Sub-millisecond part of "time difference" (ms/2^32)	
12	U4	Quantization (ms/2^32)	
16	U4	GPS time of week (ms)	Time pulse
20	U4	Sub-millisecond part of "GPS time of week" (ms/2^32)	
24	U2	GPS week number	Time pulse
26	U1	Flags	Bit 0 – 0: GPS time base; 1: UTC time base Bit 1 – 0: UTC not available; 1: UTC available Bit 2 – 0: time not available; 1: time available
27	U1	Reserved	

TIM – TP (0x0D 0x01)

It periodically polls the time pulse data.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x0D 0x01	16	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	GPS time of week: time pulse (ms)	
4	U4	Sub-millisecond part of “GPS time of week” (ms/2^32)	
8	I4	Quantization error of time pulse (ps)	
12	U2	GPS week number	Time pulse
14	U1	Flags	Bit 0 – 0: GPS time base; 1: UTC time base Bit 1 – 0: UTC not available; 1: UTC available
15	U1	Reserved	

UBX Class UPD

This class is used to update the firmware.

UPD – DOWNL (0x09 0x01)

It is an I/O message. It is used to download data to memory.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x09 0x01	8+N*1	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	Download starting address	
4	U4	Flags	0 – download 1 – download ACK 2 – download NACK
The following data will be repeated N times (depending on the length of data).			
8+N*1	U1	Data	

NOTE: *A block of data may be downloaded to memory by implementing several UPD-DOWNL messages. The starting addresses are increased for the following UPD-DOWNL messages based on the already transmitted bytes.*

UPD – UPLOAD (0x09 0x02)

It is an I/O message. It is used to upload data from memory.

Header	ID	Data Length	Data	Checksum
0xB5 0x62	0x09 0x02	12+N*1	See below	CK_A CK_B

Data			
Offset bytes	**Format**	**Descriptions**	**Notes**
0	U4	Upload starting address	
4	U4	Data size	
8	U4	Flags	0 – upload 1 – upload ACK 2 – upload NACK
The following data will be repeated N times (depending on the length of data).			
12+N*1	U1	Data	

NOTE: *A block of data may be uploaded from memory by implementing several UPD-UPLOAD messages. The starting addresses are increased for the following UPD-UPLOAD messages based on the already received bytes.*

Chapter 8 Troubleshooting

The following table lists questions/problems that you might encounter for operating the module and possible suggested resolutions for the questions/problems. If you have further questions/problems that cannot be resolved in this table, please feel free to contact us.

Questions/Problems	Suggestions
1. Nothing is output from the module after power on.	1. Check the port settings, such as baud rate, comm. port number, etc. ; 2. Check the cable connection between the module and running host platform (whether the cable is firmly connected or not).
2. The performance of the module is not as good as one expects.	1. The observability of the antenna is not good. Move the antenna to open space or remove the blockages. 2. Check the antenna matching problem. For the active antennas, the antenna gain cannot exceed 25 dB.
3. The module doesn't output the desired messages.	1. Check the module whether the desired messages are activated or not. 2. Check the port setting whether the baud rate is sufficient or not.
4. Comm. port numbers are not shown in the list.	All the available comm. ports for a computer are listed in the table. If you can not select the desired one, make sure the comm. port is not used by other application.
5. The variation of position is significant.	1. Check the observability of the antenna. Make sure the antenna has an open space view. 2. Check the constellation of the observable GPS satellites (i.e. the values of DOPs). Usually, the higher the values of DOPs, the worse the position accuracy.

6. The estimated positions have steadily expressed about a few meters or up to a few hundred meters off the reference position.	Make sure the estimated position and reference position are expressed in the same coordinate frame. The default datum of the module is WGS 84.
7. The estimated position has a few kilometer away from the reference position.	The module may execute almanac navigation.
8. The module doesn't perform well in TTFFs of warm-start and hot-start.	A back-up battery is needed to support the running of RTC and Battery backed-up RAM (BBR). The update position, ephemeris, and almanac can be retrieved from BBR or flash memory.
9. The module doesn't perform the last configuration settings.	Save the configuration settings to BBR, which needs a backed-up battery supported, or flash memory.

Table 8.1 Troubleshooting.

Appendix A Geodetic ID: Coordinate Datum

Index	Name	Acronym	DX (m)	DY(m)	DZ (m)	Ellipsoid Index (See below)	Rotation and Scale (See below)
0	World Geodetic System - 84	WGS 84	0.0	0.0	0.0	0	0
1	World Geodetic System - 72	WGS 72	0.0	0.0	4.5	23	1
2	Earth-90 - GLONASS Coordinate system	ETH 90	0.0	0.0	4.0	8	0
3	Adindan - Mean Solution (Ethiopia & Sudan)	ADI-M	-166.0	-15.0	204.0	7	0
4	Adindan - Burkina Faso	ADI-E	-118.0	-14.0	218.0	7	0
5	Adindan - Cameroon	ADI-F	-134.0	-2.0	210.0	7	0
6	Adindan - Ethiopia	ADI-A	-165.0	-11.0	206.0	7	0
7	Adindan - Mali	ADI-C	-123.0	-20.0	220.0	7	0
8	Adindan - Senegal	ADI-D	-128.0	-18.0	224.0	7	0
9	Adindan - Sudan	ADI-B	-161.0	-14.0	205.0	7	0
10	Afgooye - Somalia	AFG	-43.0	-163.0	45.0	21	0
11	ARC 1950 - Mean (Botswana, Lesotho, Malawi, Swaziland, Zaire, Zambia, Zimbabwe)	ARF-M	-143.0	-90.0	-294.0	7	0
12	ARC 1950 - Botswana	ARF-A	-138.0	-105.0	-289.0	7	0
13	ARC 1950 - Burundi	ARF-H	-153.0	-5.0	-292.0	7	0
14	ARC 1950 - Lesotho	ARF-B	-125.0	-108.0	-295.0	7	0
15	ARC 1950 - Malawi	ARF-C	-161.0	-73.0	-317.0	7	0
16	ARC 1950 - Swaziland	ARF-D	-134.0	-105.0	-295.0	7	0
17	ARC 1950 - Zaire	ARF-E	-169.0	-19.0	-278.0	7	0

18	ARC 1950 - Zambia	ARF-F	-147.0	-74.0	-283.0	7	0
19	ARC 1950 - Zimbabwe	ARF-G	-142.0	-96.0	-293.0	7	0
20	ARC 1960 - Mean (Kenya, Tanzania)	ARS	-160.0	-6.0	-302.0	7	0
21	Ayabelle Lighthouse - Djibouti	PHA	-79.0	-129.0	145.0	7	0
22	Bissau - Guinea-Bissau	BID	-173.0	253.0	27.0	20	0
23	Cape - South Africa	CAP	-136.0	-108.0	-292.0	7	0
24	Carthage - Tunisia	CGE	-263.0	6.0	431.0	7	0
25	Dabola - Guinea	DAL	-83.0	37.0	124.0	7	0
26	Leigon - Ghana	LEH	-130.0	29.0	364.0	7	0
27	Liberia 1964	LIB	-90.0	40.0	88.0	7	0
28	Massawa - Eritrea (Ethiopia)	MAS	639.0	405.0	60.0	5	0
29	Merchich - Morocco	MER	31.0	146.0	47.0	7	0
30	Minna - Cameroon	MIN-A	-81.0	-84.0	115.0	7	0
31	Minna - Nigeria	MIN-B	-92.0	-93.0	122.0	7	0
32	M'Poraloko - Gabon	MPO	-74.0	-130.0	42.0	7	0
33	North Sahara 1959 - Algeria	NSD	-186.0	-93.0	310.0	7	0
34	Old Egyptian 1907 - Egypt	OEG	-130.0	110.0	-13.0	17	0
35	Point 58 - Mean Solution (Burkina Faso & Niger)	PTB	-106.0	-129.0	165.0	7	0
36	Pointe Noire 1948 - Congo	PTN	-148.0	51.0	-291.0	7	0
37	Schwarzeck - Namibia	SCK	616.0	97.0	-251.0	5	0
38	Voirol 1960 - Algeria	VOR	-123.0	-206.0	219.0	7	0
39	Ain El Abd 1970 - Bahrain Island	AIN-A	-150.0	-250.0	-1.0	20	0
40	Ain El Abd 1970 - Saudi Arabia	AIN-B	-143.0	-236.0	7.0	20	0

41	Djakarta (Batavia)-Sumatra (Indonesia)	BAT	-377.0	681.0	-50.0	5	0
42	Hong Kong 1963 - Hong Kong	HKD	-156.0	-271.0	-189.0	20	0
43	Hu-Tzu-Shan - Taiwan	HTN	-637.0	-549.0	-203.0	20	0
44	Indian - Bangladesh	IND-B	282.0	726.0	254.0	9	0
45	Indian - India & Nepal	IND-I	295.0	736.0	257.0	11	0
46	Indian 1954 - Thailand	INF-A	217.0	823.0	299.0	9	0
47	Indian 1960 - Vietnam (near 16N)	ING-A	198.0	881.0	317.0	9	0
48	Indian 1960 - Con Son Island (Vietnam)	ING-B	182.0	915.0	344.0	9	0
49	Indian 1975 - Thailand	INH-A	209.0	818.0	290.0	9	0
50	Indonesian 1974	IDN	-24.0	-15.0	5.0	19	0
51	Kandawala - Sri Lanka	KAN	-97.0	787.0	86.0	9	0
52	Kertau 1948 - West Malaysia & Singapore	KEA	-11.0	851.0	5.0	13	0
53	Nahrwan - Masirah Island (Oman)	NAH-A	-247.0	-148.0	369.0	7	0
54	Nahrwan - United Arab Emirates	NAH-B	-249.0	-156.0	381.0	7	0
55	Nahrwan - Saudi Arabia	NAH-C	-243.0	-192.0	477.0	7	0
56	Oman	FAH	-346.0	-1.0	224.0	7	0
57	Qatar National - Qatar	QAT	-128.0	-283.0	22.0	20	0
58	South Asia - Singapore	SOA	7.0	-10.0	-26.0	15	0
59	Timbalai 1948 - Brunei & East Malaysia (Sarawak & Sabah)	TIL	-679.0	669.0	-48.0	10	0
60	Tokyo - Mean Solution (Japan,Okinawa & South Korea)	TOY-M	-148.0	507.0	685.0	5	0
61	Tokyo - Japan	TOY-A	-148.0	507.0	685.0	5	0

62	Tokyo - Okinawa	TOY-C	-158.0	507.0	676.0	5	0
63	Tokyo - South Korea	TOY-B	-146.0	507.0	687.0	5	0
64	Australian Geodetic 1966 - Australia & Tasmania	AUA	-133.0	-48.0	148.0	3	0
65	Australian Geodetic 1984 - Australia & Tasmania	AUG	-134.0	-48.0	149.0	3	0
66	European 1950 - Mean (AU, B, DK, FN, F, G, GR, I, LUX, NL, N, P, E, S, CH)	EUR-M	-87.0	-98.0	-121.0	20	0
67	European 1950 - Western Europe (AU, DK, FR, G, NL, CH)	EUR-A	-87.0	-96.0	-120.0	20	0
68	European 1950 - Cyprus	EUR-E	-104.0	-101.0	-140.0	20	0
69	European 1950 - Egypt	EUR-F	-130.0	-117.0	-151.0	20	0
70	European 1950 - England, Wales, Scotland & Channel Islands	EUR-G	-86.0	- 96.0	-120.0	20	0
71	European 1950 - England, Wales, Scotland & Ireland	EUR-K	-86.0	- 96.0	-120.0	20	0
72	European 1950 - Greece	EUR-B	-84.0	-95.0	-130.0	20	0
73	European 1950 - Iran	EUR-H	-117.0	-132.0	-164.0	20	0
74	European 1950 - Italy - Sardinia	EUR-I	-97.0	-103.0	-120.0	20	0
75	European 1950 - Italy - Sicily	EUR-J	-97.0	-88.0	-135.0	20	0
76	European 1950 - Malta	EUR-L	-107.0	-88.0	-149.0	20	0
77	European 1950 - Norway & Finland	EUR-C	-87.0	-95.0	-120.0	20	0
78	European 1950 - Portugal & Spain	EUR-D	-84.0	-107.0	-120.0	20	0
79	European 1950 - Tunisia	EUR-T	-112.0	-77.0	-145.0	20	0

80	European 1979 - Mean Solution (AU, FN, NL, N, E, S, CH)	EUS	-86.0	-98.0	-119.0	20	0
81	Hjorsey 1955 - Iceland	HJO	-73.0	46.0	-86.0	20	0
82	Ireland 1965	IRL	506.0	-122.0	611.0	2	0
83	Ordnance Survey of GB 1936 - Mean (E, IoM, S, ShI, W)	OGB-M	375.0	-111.0	431.0	1	0
84	Ordnance Survey of GB 1936 - England	OGB-A	371.0	-112.0	434.0	1	0
85	Ordnance Survey of GB 1936 - England, Isle of Man & Wales	OGB-B	371.0	-111.0	434.0	1	0
86	Ordnance Survey of GB 1936 - Scotland & Shetland Isles	OGB-C	384.0	-111.0	425.0	1	0
87	Ordnance Survey of GB 1936 - Wales	OGB-D	370.0	-108.0	434.0	1	0
88	Rome 1940 - Sardinia Island	MOD	-225.0	-65.0	9.0	20	0
89	S-42 (Pulkovo 1942) - Hungary	SPK	28.0	-121.0	-77.0	21	0
90	S-JTSK Czechoslavakia (prior to 1 Jan 1993)	CCD	589.0	76.0	480.0	5	0
91	Cape Canaveral - Mean Solution (Florida & Bahamas)	CAC	-2.0	151.0	181.0	6	0
92	N. American 1927 - Mean Solution (CONUS)	NAS-C	-8.0	160.0	176.0	6	0
93	N. American 1927 - Western US	NAS-B	-8.0	159.0	175.0	6	0
94	N. American 1927 - Eastern US	NAS-A	-9.0	161.0	179.0	6	0
95	N. American 1927 -	NAS-D	-5.0	135.0	172.0	6	0

	Alaska (excluding Aleutian Islands)						
96	N. American 1927 - Aleutian Islands, East of 180W	NAS-V	-2.0	152.0	149.0	6	0
97	N. American 1927 - Aleutian Islands, West of 180W	NAS-W	2.0	204.0	105.0	6	0
98	N. American 1927 - Bahamas (excluding San Salvador Island)	NAS-Q	-4.0	154.0	178.0	6	0
99	N. American 1927 - San Salvador Island	NAS-R	1.0	140.0	165.0	6	0
100	N. American 1927 - Canada Mean Solution (including Newfoundland)	NAS-E	-10.0	158.0	187.0	6	0
101	N. American 1927 - Alberta & British Columbia	NAS-F	-7.0	162.0	188.0	6	0
102	N. American 1927 - Eastern Canada (Newfoundland, New Brunswick, Nova Scotia & Quebec)	NAS-G	-22.0	160.0	190.0	6	0
103	N. American 1927 - Manitoba & Ontario	NAS-H	-9.0	157.0	184.0	6	0
104	N. American 1927 - Northwest Territories & Saskatchewan	NAS-I	4.0	159.0	188.0	6	0
105	N. American 1927 - Yukon	NAS-J	-7.0	139.0	181.0	6	0
106	N. American 1927 - Canal Zone	NAS-O	0.0	125.0	201.0	6	0
107	N. American 1927 -	NAS-P	-3.0	142.0	183.0	6	0

	Caribbean						
108	N. American 1927 - Central America	NAS-N	0.0	125.0	194.0	6	0
109	N. American 1927 - Cuba	NAS-T	-9.0	152.0	178.0	6	0
110	N. American 1927 - Greenland (Hayes Peninsula)	NAS-U	11.0	114.0	195.0	6	0
111	N. American 1927 - Mexico	NAS-L	-12.0	130.0	190.0	6	0
112	N. American 1983 - Alaska (excluding Aleutian Islands)	NAR-A	0.0	0.0	0.0	16	0
113	N. American 1983 - Aleutian Islands	NAR-E	-2.0	0.0	4.0	16	0
114	N. American 1983 - Canada	NAR-B	0.0	0.0	0.0	16	0
115	N. American 1983 - Mean Solution (CONUS)	NAR-C	0.0	0.0	0.0	16	0
116	N. American 1983 - Hawaii	NAR-H	1.0	1.0	-1.0	16	0
117	N. American 1983 - Mexico & Central America	NAR-D	0.0	0.0	0.0	16	0
118	Bogota Observatory - Colombia	BOO	307.0	304.0	-318.0	20	0
119	Campo Inchauspe 1969 - Argentina	CAI	-148.0	136.0	90.0	20	0
120	Chua Astro - Paraguay	CHU	-134.0	229.0	-29.0	20	0
121	Corrego Alegre - Brazil	COA	-206.0	172.0	-6.0	20	0
122	Prov S. American 1956 - Mean Solution (Bol, Col, Ecu, Guy, Per & Ven)	PRP-M	-288.0	175.0	-376.0	20	0
123	Prov S. American 1956 -	PRP-A	-270.0	188.0	-388.0	20	0

	Bolivia						
124	Prov S. American 1956 - Northern Chile (near 19S)	PRP-B	-270.0	183.0	-390.0	20	0
125	Prov S. American 1956 - Southern Chile (near 43S)	PRP-C	-305.0	243.0	-442.0	20	0
126	Prov S. American 1956 - Colombia	PRP-D	-282.0	169.0	-371.0	20	0
127	Prov S. American 1956 - Ecuador	PRP-E	-278.0	171.0	-367.0	20	0
128	Prov S. American 1956 - Guyana	PRP-F	-298.0	159.0	-369.0	20	0
129	Prov S. American 1956 - Peru	PRP-G	-279.0	175.0	-379.0	20	0
130	Prov S. American 1956 - Venezuela	PRP-H	-295.0	173.0	-371.0	20	0
131	Prov South Chilean 1963	HIT	16.0	196.0	93.0	20	0
132	South American 1969 - Mean Solution (Arg, Bol, Bra, Chi, Col, Ecu, Guy, Par, Per, Tri & Tob, Ven)	SAN-M	-57.0	1.0	-41.0	22	0
133	South American 1969 - Argentina	SAN-A	-62.0	-1.0	-37.0	22	0
134	South American 1969 - Bolivia	SAN-B	-61.0	2.0	-48.0	22	0
135	South American 1969 - Brazil	SAN-C	-60.0	-2.0	-41.0	22	0
136	South American 1969 - Chile	SAN-D	-75.0	-1.0	-44.0	22	0
137	South American 1969 - Colombia	SAN-E	-44.0	6.0	-36.0	22	0
138	South American 1969 - Ecuador (excluding	SAN-F	-48.0	3.0	-44.0	22	0

	Galapagos Islands)						
139	South American 1969 - Baltra, Galapagos Islands	SAN-J	-47.0	26.0	-42.0	22	0
140	South American 1969 - Guyana	SAN-G	-53.0	3.0	-47.0	22	0
141	South American 1969 - Paraguay	SAN-H	-61.0	2.0	-33.0	22	0
142	South American 1969 - Peru	SAN-I	-58.0	0.0	-44.0	22	0
143	South American 1969 - Trinidad & Tobago	SAN-K	-45.0	12.0	-33.0	22	0
144	South American 1969 - Venezuela	SAN-L	-45.0	8.0	-33.0	22	0
145	Zanderij - Suriname	ZAN	-265.0	120.0	-358.0	20	0
146	Antigua Island Astro 1943 - Antigua, Leeward Islands	AIA	-270.0	13.0	62.0	7	0
147	Ascension Island 1958	ASC	-205.0	107.0	53.0	20	0
148	Astro Dos 71/4 - St Helena Island	SHB	-320.0	550.0	-494.0	20	0
149	Bermuda 1957 - Bermuda Islands	BER	-73.0	213.0	296.0	6	0
150	Deception Island, Antarctica	DID	260.0	12.0	-147.0	7	0
151	Fort Thomas 1955 - Nevis, St Kitts, Leeward Islands	FOT	-7.0	215.0	225.0	7	0
152	Graciosa Base SW 1948 - Faial, Graciosa, Pico, Sao Jorge, Terceira Islands (Azores)	GRA	-104.0	167.0	-38.0	20	0
153	ISTS 061 Astro 1968 - South Georgia Islands	ISG	-794.0	119.0	-298.0	20	0

154	L.C. 5 Astro 1961 - Cayman Brac Island	LCF	42.0	124.0	147.0	6	0
155	Montserrat Island Astro 1958 - Montserrat Leeward Islands	ASM	174.0	359.0	365.0	7	0
156	Naparima, BWI - Trinidad & Tobago	NAP	-10.0	375.0	165.0	20	0
157	Observatorio Meteorologico 1939 - Corvo and Flores Islands (Azores)	FLO	-425.0	-169.0	81.0	20	0
158	Pico De Las Nieves - Canary Islands	PLN	-307.0	-92.0	127.0	20	0
159	Porto Santo 1936 - Porto Santo and Madeira Islands	POS	-499.0	-249.0	314.0	20	0
160	Puerto Rico - Puerto Rico & Virgin Islands	PUR	11.0	72.0	-101.0	6	0
161	Qornoq - South Greenland	QUO	164.0	138.0	-189.0	20	0
162	Sao Braz - Soa Miguel, Santa Maria Islands (Azores)	SAO	-203.0	141.0	53.0	20	0
163	Sapper Hill 1943 - East Falkland Island	SAP	-355.0	21.0	72.0	20	0
164	Selvagem Grande 1938 - Salvage Islands	SGM	-289.0	-124.0	60.0	20	0
165	Tristan Astro 1968 - Tristan du Cunha	TDC	-632.0	438.0	-609.0	20	0
166	Anna 1 Astro 1965 - Cocos Islands	ANO	-491.0	-22.0	435.0	3	0
167	Gandajika Base 1970 - Republic of Maldives	GAA	-133.0	-321.0	50.0	20	0
168	ISTS 073 Astro 1969 -	IST	208.0	-435.0	-229.0	20	0

	Diego Garcia						
169	Kerguelen Island 1949 - Kerguelen Island	KEG	145.0	-187.0	103.0	20	0
170	Mahe 1971 - Mahe Island	MIK	41.0	-220.0	-134.0	7	0
171	Reunion - Mascarene Islands	RUE	94.0	-948.0	-1262.0	20	0
172	American Samoa 1962 - American Samoa Islands	AMA	-115.0	118.0	426.0	6	0
173	Astro Beacon "E" 1945 - Iwo Jima	ATF	145.0	75.0	-272.0	20	0
174	Astro Tern Island (Frig) 1961 - Tern Island	TRN	114.0	-116.0	-333.0	20	0
175	Astronomical Station 1952 - Marcus Island	ASQ	124.0	-234.0	-25.0	20	0
176	Bellevue (IGN) - Efate and Erromango Islands	IBE	-127.0	-769.0	472.0	20	0
177	Canton Astro 1966 - Phoenix Islands	CAO	298.0	-304.0	-375.0	20	0
178	Chatham Island Astro 1971 - Chatham Island (New Zeland)	CHI	175.0	-38.0	113.0	20	0
179	DOS 1968 - Gizo Island (New Georgia Islands)	GIZ	230.0	-199.0	-752.0	20	0
180	Easter Island 1967 - Easter Island	EAS	211.0	147.0	111.0	20	0
181	Geodetic Datum 1949 - New Zealand	GEO	84.0	-22.0	209.0	20	0
182	Guam 1963 - Guam Island	GUA	-100.0	-248.0	259.0	6	0
183	GUX 1 Astro - Guadalcanal Island	DOB	252.0	-209.0	-751.0	20	0
184	Indonesian 1974 - Indonesia	IDN	-24.0	-15.0	5.0	19	0

185	Johnston Island 1961 - Johnston Island	JOH	189.0	-79.0	-202.0	20	0
186	Kusaie Astro 1951 - Caroline Islands, Fed. States of Micronesia	KUS	647.0	1777.0	-1124.0	20	0
187	Luzon - Philippines (excluding Mindanao Island)	LUZ-A	-133.0	-77.0	-51.0	6	0
188	Luzon - Mindanao Island (Philippines)	LUZ-B	-133.0	-79.0	-72.0	6	0
189	Midway Astro 1961 - Midway Islands	MID	912.0	-58.0	1227.0	20	0
190	Old Hawaiian - Mean Solution	OHA-M	61.0	-285.0	-181.0	6	0
191	Old Hawaiian - Hawaii	OHA-A	89.0	-279.0	-183.0	6	0
192	Old Hawaiian - Kauai	OHA-B	45.0	-290.0	-172.0	6	0
193	Old Hawaiian - Maui	OHA-C	65.0	-290.0	-190.0	6	0
194	Old Hawaiian - Oahu	OHA-D	58.0	-283.0	-182.0	6	0
195	Pitcairn Astro 1967 - Pitcairn Island	PIT	185.0	165.0	42.0	20	0
196	Santo (Dos) 1965 - Espirito Santo Island	SAE	170.0	42.0	84.0	20	0
197	Viti Levu 1916 - Viti Levu Island (Fiji Islands)	MVS	51.0	391.0	-36.0	7	0
198	Wake-Eniwetok 1960 - Marshall Islands	ENW	102.0	52.0	-38.0	18	0
199	Wake Island Astro 1952 - Wake Atoll	WAK	276.0	-57.0	149.0	20	0
200	Bukit Rimpah - Bangka and Belitung Islands (Indonesia)	BUR	-384.0	664.0	-48.0	5	0
201	Camp Area Astro - Camp McMurdo Area,	CAZ	-104.0	-129.0	239.0	20	0

	Antarctica						
202	European 1950 - Iraq, Israel, Jordan, Kuwait, Lebanon, Saudi Arabia & Syria	EUR-S	-103.0	-106.0	-141.0	20	0
203	Gunung Segara - Kalimantan (Indonesia)	GSE"	-403.0	684.0	41.0	5	0
204	Herat North - Afghanistan	HEN	-333.0	-222.0	114.0	20	0
205	Indian - Pakistan	IND-P	283.0	682.0	231.0	9	0
206	Pulkovo 1942 - Russia	PUK	28.0	-130.0	-95.0	21	0
207	Tananarive Observatory 1925 - Madagascar	TAN	-189.0	-242.0	-91.0	20	0
208	Yacare - Uruguay	YAC	-155.0	171.0	37.0	20	0
209	Krassovsky 1942 - Russia	KRA42	26.0	-139.0	-80.0	21	0
210	Lommel Datum 1950 - Belgium & Luxembourg	BLG50	-55.0	49.0	-158.0	20	0
211	Reseau National Belge 1972 - Belgium	RNB72	-104.0	80.0	-75.0	20	0
212	NTF - Nouvelle Triangulation de la France	NTF	-168.0	-60.0	320.0	7	0
213	Netherlands 1921 - Netherlands	NL21	719.0	47.0	640.0	5	0
214	European Datum 1987, IAG RETrig Subcommision.	ED87	-82.5	-91.7	-117.7	20	2
215	Swiss Datum 1903+ (LV95)	CH95	674.374	15.056	405.346	5	0

Ellipsoids

Index	Name	Semi Major Axis (m)	1/Flattening
0	WGS 84	6378137.000	298.257223563
1	Airy 1830	6377563.396	299.3249646
2	Modified Airy	6377340.189	299.3249646
3	Australian National	6378160.000	298.25
4	Bessel 1841 (Namibia)	6377483.865	299.1528128
5	Bessel 1841	6377397.155	299.1528128
6	Clarke 1866	6378206.400	294.9786982
7	Clarke 1880	6378249.145	293.465
8	Earth 90	6378136.000	298.257839303
9	Everest (India 1830)	6377276.345	300.8017
10	Everest (Sabah Sarawak)	6377298.556	300.8017
11	Everest (India 1956)	6377301.243	300.8017
12	Everest (Malaysia 1969)	6377295.664	300.8017
13	Everest (Malay. & Singapore 1948)	6377304.063	300.8017
14	Everest (Pakistan)	6377309.613	300.8017
15	Modified Fischer 1960	6378155.000	298.3
16	GRS 80	6378137.000	298.257222101
17	Helmert 1906	6378200.000	298.3
18	Hough 1960	6378270.000	297.0
19	Indonesian 1974	6378160.000	298.247
20	International 1924	6378388.000	297.0
21	Krassovsky 1940	6378245.000	298.3
22	South American 1969	6378160.000	298.25
23	WGS 72	6378135.000	298.26

Rotation and Scale Table

Index	Name	Rot. X (seconds)	Rot. Y (seconds)	Rot. Z (seconds)	Scale (-)
0		+0.0000	+0.0000	+0.0000	0.000
1		0.0000	0.0000	-0.5540	0.220
2	European Datum 1987 IAG RETrig Subcommision.	0.1338	-0.0625	-0.0470	0.045

Appendix B Acronyms

BBR	Battery Backed-up RAM
CLT	Carrier Lock Time
CN0	Carrier to Noise Ratio
COG	Course Over Ground
CTM	Continuous Tracking Mode
DGPS	Differential GPS
DOP	Dilution of Precision
DR	Dead Reckoning
ECEF	Earth-Centered Earth-Fixed
EDOP	Easting Dilution of Precision
EGNOS	the European Geostationary Navigation Overlay Service
EKF	Extended Kalman filter
GDOP	Geometric Dilution of Precision
GNSS	Global Navigation Satellite System
HDOP	Horizontal Dilution of Precision
HOW	Hand-Over Word
LNA	Low Noise Amplifier
MSAS	MTSAT-Based Augmentation System
NDOP	Northing Dilution of Precision
NMEA	the National Marine Electronics Association
PDOP	Positional Dilution of Precision
PRN	Pseudorandom Noise
PVT	Position Velocity Time
RINEX	Receiver Independent Exchange Format
RTC	Real Time Clock
RTCM	the Radio Technical Commission for Maritime Services
SBAS	Satellite Based Augmentation Systems
SNR	Signal-to-Noise Ratio
SOG	Speed Over Ground
SPS	Standard Positioning Service
TDOP	Time Dilution of Precision
TOW	Time of Week
TTFF	Time To First Fix
VDOP	Vertical Dilution of Precision
UTM	Universal Transverse Mercator
WAAS	Wide Area Augmentation System

References

1. ANTARIS[R] Chipset – System Integration- Manual for San Jose Navigation, Doc. No. GPS.G3-DK-03014.
2. ANTARIS[R] Protocol Specifications, Doc. No. GPS.G3-X-03002.
3. NMEA 0183, Standard For Interfacing Marine Electronic Devices, Version 2.30, March 1, 1998.