COMNAV OEM CARD
REFERENCE MANUAL

©2013, ComNav Technology Ltd. All rights reserved. ComNav is the trade mark of ComNav Technology Ltd., registered in People's Republic of China. All other trademarks are the property of their respective owners.

APPROVAL SHEET

SUBSCRIPTION	SIGNATURE	DATE
Prepared By		
Checked By		
Approved By		

DOCUMENT NUMBER	CURRENT REVISION	RELEASE DATE
CNT-OEM-RM001		

REVISION HISTORY

REVISION	MODIFICATION	DATE
1.2K	1) Add velocity type “DOPPLER_VELOCITY” in Table 20. 2) Add description of log message “BD2RAWALM“ in Sec. 5.4.2. 3) Add description of log message “HEADING“ in Sec. 5.4.24. 4) Update the description in Sec. 6.5 to clarify the usage of “INTERFACEMODE”. 5) Fix cross reference errors on Solution Status, Position & Velocity type for BESTPOS, BESTVEL, BESTXYZ, PRSPOS and TRACKSTAT.	2013-07-05
1.2J	1) Correct the description of Field #5 and #6 of the log message GPNTR. 2) Update the Pin information of K502 and K508 OEM board in Table 43 and Table 45 of Appendix A. Physical Information. 3) Rewording the description of the RTCM messages from Sec 5.4.35 ~ Sec 5.4.45 to make them more clearly.	2013-06-21
1.2I	1) Adjust the document format of whole manual 2) Update the contact information of ComNav in Sec. 1.5. 3) Error checking and correcting: a) Words and Phrases b) Cross References to Sections, Tables, or Figures (under way) c) Discrepant Description between Different Sections (under way) 4) Description rewording or polishing of whole manual a) Change document name from “Compass OEM Board Reference Manual” to “***ComNav OEM Board Reference Manual***” 5) Release formal document number as ***CNT-OEM-RM001***, based on ComNav’s document standardization system (Under Construction).	2013-06-05
1.2H	The Latest Card Firmware Version is 1.30D. 1.30D is not released, just in testing.	2013-05-22
1.2G	1) Add message “HEADINGB”, “BESTXYZA”.	2013-05-09

REVISION	MODIFICATION	DATE
1.2E	1) Add message “RANGEB”, “RTCMDATA1B”, “RANGECMPL1B”.	2013-01-25
1.2F	1) Add message “RTCM1002B”, “RTCM1010B”, “RANGEA”, “RANGECMPA”, “BESTVELA”, “BESTVELB”, “IONUTCA”, “IONUTC”, “IONUTCB”.	2013-02-20
1.2D	1) Add K506 pin definition, in section Appendix A.	2013-01-09
1.2B	1) Add a serial log commands to check certain configurations or parameters, in section 5.5.1.	2013-01-04
1.2A	1) Add “BD2 Elevation Mask Angle”, “GLONASS Elevation Mask Angle” and “GALILEO Elevation Mask Angle”, in section 3.1.	2012-10-16
1.2A	1) Add “SET CPUFREQ” command, in section 5.2.21. 2) Add “SET PVTFREQ” command, in section 5.2.21. 3) Add “SET RTKFREQ” command, in section 5.2.21.	2012-09-19
1.2A	1) Add “INTERFACEMODE” status in “SAVECONFIG” command, in section 5.2.13; 2) Add “CLOCKOFFSET” value in “SAVECONFIG” command, in section 5.2.13 3) Add notice of firmware updates, in Appendix C. Firmware Updates; 4) Modify pin definition, in Table 42 5) Add message “GPNTR”, use command “LOG” to set output, in section 5.4.18 6) Configure GNSS cards to work on Common-view time transfer mode is descripted in section 6.5. 7) Add message “GPHPR” in section5.4.23. 8) Add command “RTKREFMODE” in section5.2.28.	2012-08-27
1.2	1) Add command “CLOCKOFFSET delay” 2) Add command “PPSCONTROL switch polarity period width” 3) Add message “GPCDT”, use command “LOG” to set output 4) Add command “RTKSOLUTION mode” 5) Add command “RTKDYNAMICS mode”	2012-07-01

REVISION	MODIFICATION	DATE
	6) Add command “RTKELEVMASK angle” 7) Add command “RTKQUALITYLEVEL mode”	

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1. PREFACE

This preface describes the versions of K-Series OEM board and the main contents of this manual, and lists the conventions and terminology which used.

- About this Manual
- Using this Manual
- Conventions
- Warranty Exclusions and Disclaimer
- Contact Us

1.1 INTRODUCTION

Welcome to ***ComNav OEM Board Reference Manual*** released by Compass Navigation Technology Ltd. The purpose of this manual is to describe the K-Series OEM board and provide guidelines for developers using Compass command set. The precise details of each command, including syntax, reply and any restrictions on its use, are described in this reference manual.

This information is of primary importance for developers to effectively use and write custom interfacing software for specific needs and applications. And it's also useful for the technique supporters and compatible program developers.

In this manual, a considerable amount of generic information is also included about the hardware architecture and Compass software applications, although this usually needs to be supplemented by detailed implementation-specific information from the technical reference manual of the device being used, such as K-*Series board User Guide*.

This manual assumes that you are familiar with the principles of the Global Navigation Satellite System (GNSS), and with the terminology used to discuss it. For example, you should understand some terms, such as elevation mask, single point positioning and Post Processing Kinematic (PPK).

This manual also assumes that you are familiar with Microsoft Windows and know how to use a mouse, select options from menus and dialogs, make selections from lists, and refer to online help.

1.2 USAGE OF THIS MANUAL

The information in this manual is organized into four parts, as listed below.

PART A – INTRODUCTION OF OEM BOARD

In Part A, we introduce the hardware architecture and working model of the COMPASS OEM board. It contains following chapters:

Chapter 2. Overview of OEM Boards

To introduce the hardware architecture of the OEM boards using figures and tables. Also some typical boards are described in this chapter.

Chapter 3. Principle of Work

In chapter 3, the memory map and Board's working model are given in details. After reading this chapter, users can realize how the board works and how the flash memory is distributed.

PART B – COMMAND SET

Part B describes the Command Set of Compass Board, and it consists of Chapter 4 and Chapter 5:

Chapter 4. Binary Commands and Logs

Give the details of commands supported by Compass board, including Compass commands and NovAtel® compatible commands.

Chapter 5. Compatible Commands and Logs

Besides the commands listed in Chapter 4, Compass also defined some commands for special function.

PART C –OPERATION EXAMPLES

Part C provides some examples frequently used such as set-up a base station, log raw data and so on.

Chapter 6. Operations Frequently-Used

In Chapter 6, the operational commands of several frequently-used operations are presented in sequence.

Chapter 7. Application Cases

Three kinds of application cases are described in Chapter 7 to provide users with a wider application perspective.

PART D – OEM BOARD PRODUCT SPECIFICATION

Three appendixes A, B and C of this manual deliver the product specifications of ComNav OEM Board, including Physical Information, Technical Specifications and Firmware Updates, respectively.

1.3 CONVENTIONS

This manual employs typographic and other conventions intended to improve its ease of use.

GENERAL TYPOGRAPHIC CONVENTIONS

typewriter	Is used in the main text, including command descriptions, source code examples, tables and lists, etc.
italic	Highlights important notes, introduces special technical terminology, and denotes the name of device, book, etc.
bold	Is used for emphasis in descriptive lists and elsewhere, where appropriate.
CAPITALS	Are used for a few terms which have specific technical meanings.

OTHER SIMPLE CONVENTIONS

The number following 0x is a hexadecimal number.

Command descriptions use the angle bracket symbols '<>' to represent obligatory parameters.

Command descriptions use the square brackets, [], to represent the optional parameters.

In tables where values are missing they are assumed to be reserved for future use.

ICON DESCRIPTIONS

note box that contains important information you should pay attention to

usage box that contains additional information or examples to help you use your board

1.4 WARRANTY EXCLUSIONS AND DISCLAIMER

These warranties shall be applied only in the event and to the extent that the Products and Software are properly and correctly installed, configured, interfaced, maintained, stored, and operated in accordance with Compass's relevant operator's manual and specifications;

The Products and Software are not modified or misused. The preceding warranties shall not apply to, and Compass shall not be responsible for defects or performance problems resulting from:

The combination or utilization of the Product or Software with hardware or software products, information, data, systems, interfacing or devices not made, supplied or specified by Compass;

The operation of the Product or Software under any specification other than, or in addition to, Compass's standard specifications for its products;

The unauthorized modification or use of the Product or Software;

Damage caused by accident, lightning or other electrical discharge, fresh or salt water immersion or spray;

Normal wear and tear on consumable parts (e.g., batteries);

Compass does not warrant or guarantee the results obtained through the use of the Product.

1.5 CONTACT US

Due to the uncertainty in construction of BD2, some configurations and functions of terminal units should be modified in accordance with the development of BD2, and the reference manual should be updated at the same time, the latest version bulletin should be found in our website. If any issues are encountered, please contact us, and we are very pleased to help you to solve your problems. Because BD2 system is not totally completed yet, so some mistakes are unavoidable in the manual and relevant productions. Notice that, if these mistakes bring you inconvenience and losses, we can't afford the responsibilities.

COMNAV TECHNOLOGY LTD. CHINA HEAD OFFICE		
Address	Building E, No.50 Alley 2080 Lianhua Road Shanghai, China	
Zip Code	201103	
Tel	+86 21 51079100 (China Only)	+86 21 64056796 (International)
Fax	+86 21 54309582	
Email	sales@comnavtech.com	
Website	www.comnav.cn (In Chinese)	www.comnavtech.com (In English)

CHAPTER 2. OVERVIEW OF OEM CARD

This chapter introduces the primary information of OEM cards. It contains:

- Product Summary
- Board Catalog
- Typical Board Introduction

2.1 PRODUCT SUMMARY

2.1.1 The introduction to OEM board

OEM Board is the core product of COMPASS. We offer a wide variety of boards for numerous precision farming applications. Our proprietary positioning technology provides users with high accuracy and a flexible solution for the most challenging applications and environments. Furthermore, OEM Boards are continually being updated with advancements in GPS correction sources and GNSS technology.

If you want to learn more about COMPASS products, please visit our website: www.comnav.cn.

2.1.2 Compass GNSS Board

The Compass GNSS board is used for a wide range of precise positioning and navigation applications. It offers centimeter-level accuracy based on RTK/OTF (Real-Time Kinematic/On-the-Fly) solutions and decimeter accuracy based on L1 C/A (Coarse/Acquisition) code phase solutions. Automatic initialization and switching between positioning modes allow for the best position solutions possible. Low latency and high update rates give the response time and accuracy required for precise dynamic applications.

Designed for reliable operation in all environments, the Compass board provides a positioning interface to a PC, external processing device, or control system. The board can be controlled through a serial port or SPI or IIC or USB or CAN bus using a user interface. User interface lets you script the Compass board operation with a single command. Alternatively, you can use Compass Utilities, such as Compass Solution, to handle board configuration and controlling.

You can configure the Compass board as an autonomous base station or as a rover board. Streamed outputs from the board provide detailed information, including the time, position, quality assurance (figure of merit) numbers, and the number of tracked satellites.

With the improvement of navigation technology, we keep modifying the architecture of Compass board to meet latest industrial standards. In this section, hardware architectures will be described.

2.1.3 Preparing for the future

Some new Global Navigation Satellite Systems (GNSS) are under construction, such as Galileo system proposed by the European Union and the Beidou-2 System devised by China. Compass fully supports this advancement in the GNSS market. We'll be sure to have Galileo and Beidou-2 compatible products available for our customers in the near future.

It is our goal to offer the most productive and competitive equipment that meet our customers' needs both now and in the future.

2.2 TYPICAL BOARDS

This section gives information of COMPASS typical boards, provides description of their features and technical specifications.

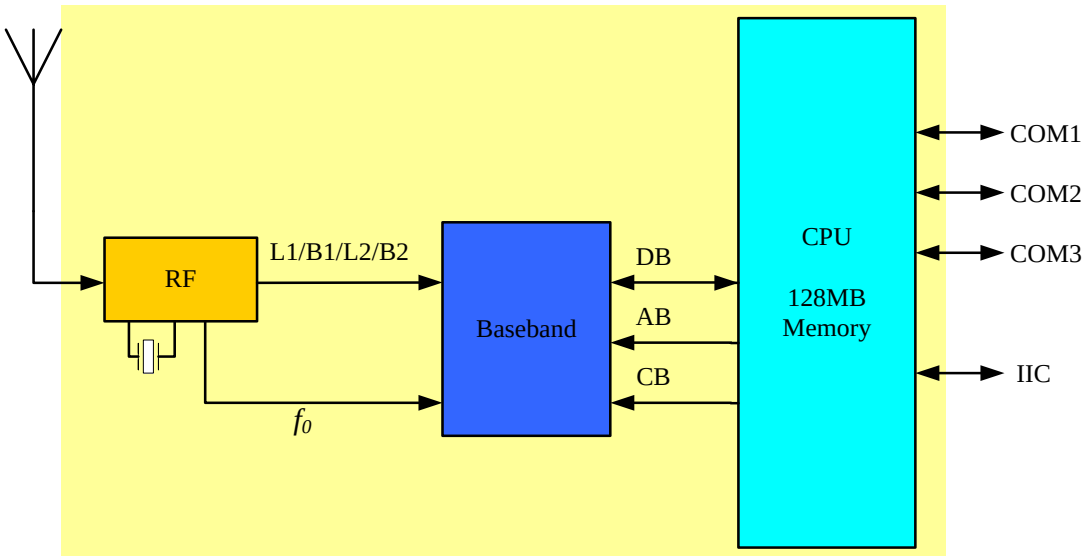


Figure 1. OEM Circuit Diagram

Board dimensions and pin definitions are in Appendix.

CHAPTER 3. PRINCIPLE OF WORK

This chapter introduces the primary information of COMPASS (China Compass) Boards. It contains:

- Memory allocation map
- The working mode of board

3.1 MEMORY ALLOCATION MAP

In this section, it's introduced that how board's memory is distributed.

3.1.1 Board's system information

The first 128 bytes are used to restore the board's information, including revision information, register code and operating settings, etc.

Table 1. System Information Section

BYTE	DESCRIPTION	NOTE
0-31	Protocol Class, Board S/N, Date of production, Hardware Revision by a blank space.	For example: 1907 123456 2012-01-01 201
32-39	Registration Code, 8 bytes	
44	Additional symbol of Device type	
45	Internal Oscillator	
48	Static/Dynamic Flag (0: static, 1: dynamic)	

BYTE	DESCRIPTION	NOTE
50	GPS Elevation Mask Angle	
51	Memory Size (16–8M bytes; 32–16M bytes)	
52 - 55	Firmware Revision, 4 bytes.	
56	BD2 Elevation Mask Angle	
57	GLONASS Elevation Mask Angle	
58	GALIEEO Elevation Mask Angle	
59 - 62	Reserved	
63	Differential Data Format (CMR/CMR+/RTCM2/RTCM3/RTCA)	
64 - 89	P/N Number, 16 bytes	
90-95	Reserved	
96	Coordinate settings of Base Station	
97 - 127	Reserved	

NOTE: Users can get S/N, P/N number and size information from the label on shell of board, as shown in Figure 2.1.

CHAPTER 4. BINARY COMMANDS AND LOGS

This chapter describes the syntax and usage of board commands defined by COMPASS.

4.1 COMMAND FORMATS

4.1.1 COMPASS Command Formats

$	$	Cmd	Direct	Len	Data	Cksum	\r	\n

Table 2. Description of Parameters

ITEM	LENGTH	DESCRIPTION
$$	2 bytes	Prompt
Cmd	2 bytes	Command Code
Direct*	1 byte	ID of Source device and Target device
Len*	1 bytes (2 bytes before Ver5.0)	Length of Data
Data	N bytes	Data
Cksum*	1 byte	Checksum
\r\n	2 bytes	Carriage return and line feed. Tail of Command

NOTE:

*** Direct**

The high 4 bits is id of source device, and the low 4 bits is id of target device. All IDs are listed in Table 4. For example:

```
@=0x18
```

Where source device id =0001 (PC/PDA COM Port), destination device id=1000 (Data controller).

*** Len**

Only the low 6 bits are used to store the length of data package (exclude prompt '$$' and tail '\r\n').

*** Cksum**

From the first byte of *Cmd* block to the last byte of *Data* block, perform XOR operation one byte by one byte. And the result is checksum.

C++ example:

```
BYTE strStream[MAX_SUM];
BYTE bSum=0;
For(int i=2; i<num; i++)    bSum ^= strStream[i];
```

4.1.2 Error Message List

The board is capable of outputting several responses for various conditions. Most of these responses are error messages to indicate where something is incorrect.

The output format of the messages is dependent on the format of the input command. The responses are always packaged in **ST** message.

Table 3. Response Messages

MESSAGES	DESCRIPTION
Checksum Error	The checksum byte you send is wrong.
No Field	The command you send doesn't exist!
Command Invalid!	The command you call is not available at current condition

4.1.3 Examples of Error Messages

Checksum Error

Description

If you sent a command string with a wrong checksum byte, the response would hint you, Checksum Error.

Send (Hex):

```
24 24 53 49 18 00 03 0d 0a
```

The checksum byte (0x03) is wrong. It should be 0x02.

Reply (Hex):

```
24 24 53 54 81 13 5b 43 68 65 63 6b 20 53 75 6d
20 45 72 72 6f 72 5d 0d 0a 40 0d 0a
```

Checksum Error

No Field

Description

If you sent a command that doesn't exist, the board would reply with a message "No Field".

Send (Hex):

```
24 24 53 53 18 00 18 0d 0a
```

Send "SS" (this command doesn't exist).

Reply (Hex):

```
24 24 53 54 81 0a 4e 6f 20 46 69 65 6c 64 0d 0a
c8 0d 0a
```

ST "No Field"

Command Invalid

Description

If you sent a command that is invalid in current condition, the board would reply with a message "Command Invalid".

Send (Hex):

```
24 24 52 52 18 0018 0d 0a
```

Send “RR” command which is only valid in B20 board.

Reply (Hex):

```
24 24 53 54 81 12 43 4f 4d 4d 41 4e 44 20 49 4e
56 41 4c 49 44 21 0d 0a 84 0d 0a
```

Command Invalid!

4.1.4 Device ID List

Compass defined a set of id codes for specifying device. These id codes are mainly used in command sentences as a parameter. All of them are listed in Table 4.

Table 4. Device ID

CODE (BINARY)	DESCRIPTION

4.2 BINARY COMMON COMMANDS

COMPASS common commands, defined by COMPASS itself, are sent from remote device to the board to execute operations or to request data reports from boards. All kinds of boards produced by COMPASS acknowledge these commands. It does this by sending a corresponding report packet.

This section provides details for each command including their syntax and function, which enables user calling them correctly.

NOTE:

Please pay attention to the **case sensitivity** of command name. For example, the **WC** command is a totally different command from **Wc**. So are the FS & Fs, SD & Sd.

Some abbreviated terms:

- dir: Direct byte includes the source device id and the target device id
- cksum: Checksum
- Send len : The length of data in send messages
- Reply len: The length of data in reply messages.

3. The reply messages are returned if the command is called correctly. As for the returned error messages, see 3.1.2.

COMPASS COMMAND LIST

Table 5. Command List

COMMAND	DESCRIPTION
System Command	
SD	Detect the power supply
SG	Shut down board
SI	Request System Information
SJ	Write system information

COMMAND	DESCRIPTION
SR	Request board's working status
SZ	Perform a flash self-examination
File Operation Command	
FC	Erase files
FM	Request the file catalog
FS	Delete a file
FT	Cancel reading file
FW	Read a file
FX	Write point name and antenna height
Memory Operation Command	
MK	Clear one or N memory blocks
Other Operation	
RB	Insert info into data file.
RY	Set differential data format

*** Reserved command** -- these commands are reserved for future. The board could recognize these requests, but would reply without any data.

4.2.1 SG Shut down board

The ***SG*** command is used to shut down the board.

Format

Send

$$	SG	dir	0x01	flag	cksum	\r\n

Reply

$$	ST	dir	0x15	hint	cksum	\r\n

Parameter

Send len = 0x01; reply len = 0x15 (21 bytes)

<*flag*> 1 byte

0	Request to shut down
1	Reply to shut down
2	turn off radio
3	turn on radio
4	Restore the main power

NOTE: 2,3 AND 4 WERE ADDED IN VER5.3.

<*hint*> string

Once closing board successfully, PC/PDA would receive a response “Close the board!”.

The process of shut down is:

Command Style

1. PC/PDA send command SG with parameter 0 to board’s master CPU.
2. Master CPU transmits the command to slave CPU.
3. Slave CPU reply SG command with parameter 1, then shut down the device.

Button Style

1. Master/Slave CPU find the power button is pressed. Then it will inform another CPU by sending command SG with parameter 0.
2. Slave CPU shut down the device.

Example

Send (Hex):

```
24 24 53 47 18 01 000d0d 0a
```

Reply (Hex):

```
24 24 53 54 81 15 43 6c 6f 73 65 20 74 68 65 20
72 65 63 65 69 76 65 72 21 0d 0a 83 0d 0a

Close the board!\r\n
```

4.2.2 SI Request System Information

The ***SI*** command request board to output all of its system information. You could find the details of system information in *3.1.1Board's system information on page 9.*

Format

$$	SI	dir	0x00	cksum	\r\n

Reply

Package 1

$$	SI	dir	0x37	Info1	cksum	\r\n

Package 2

$$	SI	dir	0x37	Info2	cksum	\r\n

Package 3

$$	SI	dir	0x12	Info3	cksum	\r\n

Parameter

Send len = 0x00; Reply len = 0x37+0x37+0x12 = 0x80 (128 bytes)

<*info*> 128 bytes the system information, see Table 2.1.

Example

Request system information. See *4.2.2 SI Request System Information*.

Send (Hex):

```
24 24 53 49 18 00 02 0d 0a
```

Reply (Hex)

Package 1:

```
24 24 53 49 81 37 31 39 30 38 20 30 35 32 30 35
33 20 32 30 30 39 2d 31 31 2d 31 32
ffffffffffffffffffff 00 00 38 7b 39 aa 81 7f 00
ff 00 00 00 ffffffff 05 0d 21 37 2e 31 75 0d 0a
```

Package 2:

```
24 24 53 49 81 37 41 ff ff ff 01 00 01 03 00 30
37 30 39 30 32 32 36
ffffffffffffffffffffffffffffffffffff 01 01
ffffffff 00 ffffffffffffffffffffffff e6 0d 0a
```

Package 3:

```
24 24 53 49 81 12 ffff 31 31 39 30 38 33 33 34
35 31 ffffffffffff 88 0d 0a
```

4.2.3 SJ Write system information

The ***SJ*** command writes system information to board's memory. Please be cautious to calling this command. The board could not work correctly if you wrote improper data in the improper address. You could find the details of system information in *2.1.1 Board's system information.*

NOTE: THE FIRST 32 BYTES COULD NOT BE MODIFIED.

Send

$$	SJ	dir	N+1	begin	data	cksum	\r\n

Reply

$$	SJ	dir	0x00	cksum	\r\n

Parameter

Send len = N+2; Reply len = 0x00

<*begin*> 1 byte the first address, value>31.

<*data*> N bytes data you write

Example

Send (Hex):

```
24 24 53 4a 18 02 32 0a 3b 0d 0a
```

Change the value of Elevation Mask Angle (byte #50) to 0x0a.

Reply (Hex)

```
24 24 53 4a 81 00 98 0d 0a
```

4.2.4 SR Request board's status

The ***SR*** command requests two types of status.

Type1 Get Working status

Send

$$	SR	dir	0x00	cksum	\r\n

Reply

Package 1

$$	ST	dir	0x22	status	cksum	\r\n

Package 2

$$	SR	dir	0x00	cksum	\r\n

Parameter

Send len = 0x00; Reply len = 0x22 (34 bytes)

<*status*>string The string describes the working status.

Example

Send (Hex):

```
24 24 53 52 18 00 19 0d 0a
```

Reply (Hex):

Package 1:

```
24 24 53 54 81 22 57 6f 72 6b 4d 6f 64 65 20 3d
20 31 2c 20 45 6d 70 74 79 20 42 6c 6f 63 6b 20
3d 20 46 46 30 3b 0d 0a ab 0d 0a
```

The status string is “WorkMode 1, empty block = FF0;”.

Package 2

```
24 24 53 52 81 00 80 0d 0a
```

Type2 Get Expire status

Send

$$	SR	dir	0x01	flag	cksum	\r\n

Reply

$$	SR	dir	0x22	status	cksum	\r\n

Parameter

Send len = 0x01; Reply len = 0x18 (24 bytes)

<*flag*> byte0—to judge if it has expired; 1—to get the expire date

<*status*> string If you send with flag=0, the response is expired status (0—not expire, 1--expired).Else if you send with flag=1, the response is the expired date.

Example 1

Send (Hex):

```
24 24 53 52 18 01 00 18 0d 0a
```

To judge if it’s out of date

Reply (Hex):

```
24 24 53 52 81 11 45 78 70 69 72 65 64 20 73 74
61 74 75 73 3a 20 30 d8 0d 0a
```

Expired status: 0

Example 2

Send (Hex):

```
24 24 53 52 18 01 01 19 0d 0a   //Get expire date
```

Reply (Hex):

```
24 24 53 52 81 18 45 78 70 69 72 65 64 20 64 61
74 65 3a 20 32 30 31 33 2d 30 37 2d 32 33 e7 0d
0a
```

Expired date: 2013-07-23

4.2.5 FC Erase a file

The ***FC*** command is used to erase a file. The file erased can't be restored.

Format

$$	FC	dir	0x04	fileid	cksum	\r\n

Reply

$$	FC	dir	0x00	cksum	\r\n

Parameter

<*fileid*>DWORD, 4 bytes. Id of the file to be erased

Example

Send (Hex):

```
24 24 46 43 18 04 00 02 14 55 5a 0d 0a
```

Reply (Hex):

```
24 24 46 43 81 00 84 0d 0a
```

4.2.6 FM Request the File Catalog

The ***FM*** command requests board to send the file catalog.

Send

$$	FM	dir	0x00	cksum	\r\n

Reply

Package 1

$$	FM	dir	0x37	catalog	cksum	\r\n

Package 2 …… Package N

Parameter

Send len = 0x00; Reply len = N

<catalog> BYTE The file catalog. The length of each file is 16 bytes, and the first four bytes is file id.

Example

Send (Hex):

```
24 24 46 4d 18 00 13 0d 0a
```

Reply(Hex):

Package 1

```
24 24 46 4d 81 37 2a 39 e1 8d 40 ff 0b 00 ae 18
00 00 ffffffff 3c 39 e1 8d 40 35 33 36 32 4a 00
00 39 00 00 00 2a 39 e1 8d 7a ff 1f 00 b2 18 00
00 ffffffff 3c 39 e1 8d 7a 35 33 c2 0d 0a
```

Package2…..Package N

Analyze

```
File 1: 2a 39 e1 8d 40 ff 0b 00 ae 18 00 00
ffffffff

File 2: 3c 39 e1 8d 40 35 33 36 32 4a 00 00 39
00 00 00

File 3: 2a 39 e1 8d 7a ff 1f 00 b2 18 00 00
ffffffff
```

……

4.2.7 FS Delete a file

The ***FS*** command is used to delete a file. FS command is different from FC that it only set the deleted flag of a file instead of erasing the file from memory. Not available in board of R series.

Send

$$	FS	dir	0x04	fileid	cksum	\r\n

Reply

$$	FS	dir	N	data	cksum	\r\n

Parameter

<*fileid*> DWORD file id

Example

Send (Hex):

```
24 24 46 53 18 04 2a 39 e1 8d76 0d 0a
```

Reply (Hex)

```
24 24 46 53 81 00 94 0d 0a
```

4.2.8 FT Exit file-read mode

The ***FT*** command is used to exit the file-read mode.

Send

$$	FT	dir	0x00	cksum	\r\n

Reply

$$	FS	dir	0x00	cksum	\r\n

Example

Send (Hex):

```
24 24 46 54 18 00 0a 0d 0a
```

Reply (Hex)

```
24 24 46 54 81 00 93 0d 0a
```

4.2.9 FW Read a file

The ***FW*** command is used to enter file-read mode. And there is no response for this command.

Send

$$	FW	dir	0x04	fileid	cksum	\r\n

Reply

$$	FW	dir	0x00	cksum	\r\n

Parameter

<*FileId*> DWORD

It's the id of file to be read. Please note that this id must can be found in the file catalog, or this command would fail. See command ***FM*** about outputting file catalog.

Example

Send (Hex):

```
24 24 46 57 18 04 2a 39 e1 8d 72 0d 0a
```

Reply (Hex)

```
No response!
```

4.2.10 FX Write point name and antenna height

The ***FX*** command is used to write the point name and antenna height.

Send

$$	FX	dir	0x07	ant	ptname	cksum	\r\n

Reply

$$	FX	dir	0x00	cksum	\r\n

Parameter

<*ptname*> string, 5 bytes survey point's name. It's a part of file name.

<*ant*> short Antenna height.

Example

Send (Hex):

```
24 24 46 58 18 0701 01 31 32 33 34 35 3c 0d 0a
```

Reply (Hex)

```
24 24 46 58 81 00 93 0d 0a
```

4.2.11 MK Clear one or N memory blocks

The ***MK*** command is used to clear several flash blocks. If succeed, board would reply with the cleared block's id. Not available in board of R series.

Send

$$	MK	dir	0x03	blockid	blocknum	cksum	\r\n

Reply

$$	MK	dir	0x02	lastblock	cksum	\r\n

Parameter

Send len = 0x03; Reply len = 0x02

<*Blockid*>2 bytesthe first block's id. (0-1023)

<*blocknum*>1 byte The number of blocks you will clear

<lastblock> 1 byte id of the last block you clear.

Example

Clear block 1.

Send (Hex):

```
24 24 4d 4b 18 03 00 01 01 1d 0d 0a
```

Reply (Hex):

```
24 24 4d 4b 81 02 00 01 84 0d 0a
```

4.2.12 RB Insert info into data file

Users could insert some test info into the data file by sending ***RB*** command. Not available in board of R series.

Send

$$	RB	dir	N	Data	cksum	\r\n

Reply

$$	RB	dir	0x00	cksum	\r\n

Parameter

<*data*> string The data you write to board.

Example

Send (Hex):

```
24 24 52 42 18 0d 74 65 73 74 64 61 74 61 31 32
33 34 35 32 0d 0a
```

```
Write "testdata12345"
```

Reply (Hex):

```
24 24 52 42 81 00 91 0d 0a
```

4.2.13 RY Set differential data format

The ***RY*** command is used to set the format of differential data and the output port.

Send

$$	RY	dir	0x02	interface	format	cksum	\r\n

Reply

$$	RY	dir	0x00	cksum	\r\n

Parameter

<interface> 1 byte the output port of differential data

0	Board's COM1
1	Board's COM2
2	

<format> 1 byte the format of differential data

0	CMR
1	CMR+
2	RTCM2.0
3	RTCM3.0

Example

Send CMR data to board's COM1.

Send (Hex):

```
24 24 52 59 18 02 00 00 11 0d 0a
```

Reply(Hex):

```
24 24 52 59 81 00 8a 0d 0a
```

CHAPTER 5. COMPATIBLE COMMANDS AND LOGS

Except for those commands handled by CPU, COMPASS board also support GPS board commands. This chapter introduces GPS board commands, including: COMPASS Board Commands and NovAtel® Commands.

Along with the release of GPS board developed by COMPASS itself, the board command packets are issued.

The syntax of COMPASS board command is similar to that of NovAtel® OEM board. But there also exist a little difference. Here, we introduce COMPASS board command packets, and NovAtel® OEM Board Commands will be summarized in next section.

5.1 COMMAND FORMATS

In the OEM card, we adopt GNSS card produced by other company, like NovAtel®. So the board not only supports COMPASS commands, but the board commands as well.

5.1.1 Format

The OEM card handles incoming and outgoing data in three different message formats: Abbreviated ASCII, ASCII, and Binary. This allows for a great deal of versatility in the way the OEMV family boards can be used. All NovAtel® commands and logs can be entered, transmitted, output or received in any of the three formats. The board also supports RTCA, RTCMV3, RTCM, CMR, and NMEA format message.

ASCII

ASCII messages are readable by both the user and a computer. The structures of all ASCII messages follow the general conventions as noted here:

1) The lead code identifier for each record is '#'.

2) Each log or command is of variable length depending on amount of data and formats.

3) All data fields are delimited by a comma with two exceptions. **First exception** is the last header field which is followed by a ';' to denote the start of the data message. **Another one** is the last data field, which is followed by a * to indicate end of message data.

4) Each log ends with a hexadecimal number preceded by an asterisk and followed by a line termination using the carriage return and line feed characters, for example, *1234ABCD[CR][LF]. This value is a 32-bit CRC of all bytes in the log, excluding the'#' identifier and the asterisk preceding the four checksum digits.

Example

```
com com1,57600,n,8,1,n,off,on
```

Abbreviated ASCII

This message format is designed to make the entering and viewing of commands and logs by the user as simple as possible. The data is represented as simple ASCII characters separated by spaces or commas and arranged in an easy to understand fashion. There is also no 32-bit CRC for error detection because it is meant for viewing by the user.

Example Command:

```
log version
```

Resultant Log:

```
<VERSION COM1 0 60.0 UNKNOWN    0      0.000
00000000 0000 1114

<     1

<         GPSCARD "S2002" "00902165         "
"CARD-501AA-22" "1.10A-1.10A" "1.000" "2012/May/
5" "18:18:52"
```

As you can see the array of 4 logs are offset from the left hand side and start with '<'.

Binary

The binary format is similar to that of COMPASS format. See *Section 4.1 COMPASS Board Commands*.

Send Message

Format

Cmd param1 …paramN\r\n

The sending message is a simple ASCII string in which characters are separated by **spaces** and arranged in an easy to understand fashion. The first character is command name. And don't miss the tail, "\r\n".

Reply Message

Except LOG command, other command's response is:

If succeed, "OK! \r\n Command Accepted!"

If failed, "Error! \r\n Unidentifiable Command!"

5.1.2 Command List

Table 6. Command List

ID	COMMANDS	DESCRIPTIONS	REFER
1	ASSIGN	Assign individual satellite channel to a PRN	5.2.1
2	BD2ECUTOFF	Set BD2 satellite elevation cut-off	5.2.29
3	COM	COM port configuration control	5.2.2
4	DGPSTXID	DGPS transmit ID	5.2.9
5	DYNAMICS	Tune receiver parameters	5.2.3
6	ECUTOFF	Set satellite elevation cutoff	5.2.4
7	ERASE	Erase all data restored in flash	5.2.19
8	FIX	Constrain fix height or position	5.2.5
9	FRESET	Reset and set configuration to factory setting	5.2.6
10	INTERFACEMODE	Set receive or transmit modes for ports	5.2.22
11	LOCKOUT	Prevent the receiver from using a satellite by specifying its PRN	5.2.7
12	LOCKOUTSYSTEM	Prevent the receiver to using a system	5.2.30
13	LOG	Request a log	5.2.8
14	MAGVAR	Set magnetic variation correction	5.2.18
15	PPMADJUST	Adjust clock-error	5.2.10
16	READ	Read restored data in flash	5.2.20

ID	COMMANDS	DESCRIPTIONS	REFER
17	REFAUTOSETUP	Ref-station auto setup	5.2.11
18	RESET	Perform a hardware reset	5.2.12
19	RTKCOMMAND	Reset or set the RTK filter to its defaults	5.2.24
20	RTKTIMEOUT	Set maximum age of RTK data	5.2.23
21	SAVECONFIG	Save current configuration in memory	5.2.13
22	SET	Configure according settings	5.2.21
23	UNLOCKOUT	Reinstate a satellite in the solution computation	5.2.14
24	UNLOCKOUTALL	Reinstate all previous locked out satellites	5.2.17
25	UNLOCKOUTSYSTEM	Reinstate previously locked out system	5.2.31
26	UNLOG	Remove log from logging control	5.2.15
27	UNLOGALL	Remove all logs from logging control	5.2.16

5.2 COMMAND REFERENCE

5.2.1 ASSIGN Assign a Channel to a PRN

Format:

ASSIGN <*channel*> <*prn*>

Description:

This command may be used to aid in the initial acquisition of a satellite by allowing you to override the automatic satellite/channel assignment and reacquisition processes with manual instructions. The command specifies that the indicated tracking channel search for a specified satellite.

Parameters:

channel Channel number (0~11)

prn Satellite number (1~32)

Example:

```
ASSIGN 2 19
```

The above example shows that channel 2 is acquiring satellite PRN 19.

5.2.2 COM Set baud rate

Format:

COM <*port*> <*baudrate*>

Description:

This command permits you to set the baud rate of COM port.

Parameters:

port refer to Table 7

baudrate valid value refer to Table 8

Example:

```
COM COM1 9600
```

Table 7. Port ID

PORT ID
COM1
COM2
COM3
BLUETOOTH

Table 8. Baud Rate

BAUDRATE
4800
9600

19200
38400
57600
115200

5.2.3 DYNAMICS Tune board parameters

Format

DYNAMICS <*status*>

Description:

This command adjusts the board dynamics to that of your environment. It is used to optimally tune board parameters.

The DYNAMICS command should only be used by advanced users. The default of AIR should **not** be changed except under very specific conditions.

Parameters:

<status>

AIR	Board is in an aircraft or a land vehicle, for example a high speed train, with velocity greater than 110 km/h. This is also the most suitable dynamic for a jittery vehicle at any speed.
LAND	Board is in a stable land vehicle with velocity less than 110 km/h
FOOT	Board is being carried by a person with velocity less than 11 km/h

Example:

```
DYNAMICS FOOT
```

5.2.4 ECUTOFF Set satellite elevation cut-off angle

Format:

ECUTOFF <cutoff-angle>

Description:

This command sets the elevation cut-off angle for tracked satellites. The board does not start automatically searching for a satellite until it rises above the cut-off angle. Tracked satellites that fall below the cut-off angle are no longer tracked unless they were manually assigned (see 3.1.2 ASSIGN command).

Parameters:

cutoff-angle the value of cut-off angle (0 ~ 90 degrees).

Example:

```
ECUTOFF 10.0
```

This command permits a negative cut-off angle; it could be used in these situation:

1. The antenna is at a high altitude, and thus can look below the local horizon.
2. Satellites are visible below the horizon due to atmospheric refraction.

5.2.5 FIX Constrain to fixed height and position

Format:

FIX POSITION <*lat*> <*lon*> <*hgt*>

Description:

This command fixes three parameters of the board: latitude, longitude, height. For various applications, fixing these values can assist in improving acquisition times and accuracy of position or corrections.

Parameters:

lat latitude (-90 to 90 degrees).

lon longitude in degrees. (-180 to 180 degrees)

hgt mean sea level (MSL) height (-1,000 to 20,000,000 m).

Example:

```
FIX POSITION 30.0 150.0 50
```

5.2.6 FRESET Reset to the factory default

Format:

FRESET

Description:

This command clears data which is stored in non-volatile memory, and set the baud rate to 38400. No data log is outputted.

Example:

```
FRESET
```

5.2.7 LOCKOUT Prevent the board from using a satellite

Format

LOCKOUT <*prn*>

Description:

This command prevents the board from using a satellite by de-weighting its range in the solution computations. Note that the LOCKOUT command does not prevent the board from tracking an undesirable satellite. This command must be repeated for each satellite to be locked out.

See also the UNLOCKOUT.

Parameters:

prn pr number of satellite (refer to Table 9)

Example:

```
LOCKOUT 10
```

Table 9. GNSS Name and Corresponding PRN

GNSS	PRN
GPS	1~32
BD2	141~177

5.2.8 LOG Request logs from board

Format:

LOG <*message-type*> <*type-trigger*> <*interval*>

Description:

The board is capable of generating many different logs.

Parameters:

message-type Choose the data types you want to generate, refer to Table 10

type-trigger Choose log type triggers, refer to Table 17.

Interval The data for synchronous logs is generated on a regular schedule. *Interval* specify the time interval.

Table 10.Logs in Alphabetical Order

NO	MESSAGE TYPE	DESCRIPTION	BINARY
1	BD2EPHEM	BD2 decoded ephemeris information	Y
2	BD2RAWEPHEMB	BD2 Raw ephemeris	Y
3	BESTPOSB	Best position Data	Y
4	BESTVEL		
5	BESTXYZ		
6	CMROBSB	Base station Satellite Observation Information	Y
7	CMRREFB	Base station Position Information	Y

NO	MESSAGE TYPE	DESCRIPTION	BINARY
8	COMCONFIGA	COM configuration Information in ASCII Format	N
9	COMCONFIGB	COM configuration Information in binary Format	Y
10	GPCDT	Differential timing result	N
11	GPGGA	GPS Fix Data and Undulation	N
12	GPGGARTK	GPS Fix Data and Undulation	N
13	GPGLL	Latitude and Longitude of Present Vessel Position	N
14	GPGSA	GPS DOP and Active Satellites	N
15	GPGST	Only DOP Values are Valid Currently	N
16	GPGSV	GPS Satellites in View	N
17	GPHDT	Actual Vessel Heading in Degrees True	N
18	GPHRR (5.4.22)		
19	GPNTR	Distance between rover-station and reference-station	???
20	GPRMC	GPS Specific Information	N
21	GPSEPHEM	GPS decoded ephemeris information	Y
22	GPVTG	The Track Made Good and Speed Relative to the Ground	N
23	GPZDA	UTC Time and Date	N
24	IONUTC		
25	PJKPARA	PJK Parameters Used in PTNLPJK Message	N
26	PSRDOPB	DOP of SVs Currently Tracking	Y
27	PSRPOSB	Pseudorange Position	Y
28	PTNLPJK	PJK Position	N
29	RANGE		
30	RANGECMPB	Compressed Version of the RANGE log	Y
31	RAWALMB	Raw Almanac	Y
32	RAWEPHEMB	Raw Ephemeris	Y
33	REFSTATIONB	Base station Position	Y
34	RTCM1002B		

NO	MESSAGE TYPE	DESCRIPTION	BINARY
35	RTCM1004B	Extended L1/L2 GPS RTK Observables	Y
36	RTCM1005B	RTK Base Station ARP	Y
37	RTCM1006B	Base Station ARP with Height	Y
38	RTCM1007B	Extended Antenna Descriptor and Setup Information	Y
39	RTCM1008B	Extended Antenna Descriptor and Setup Information	Y
40	RTCM1010B		
41	RTCM1033B	Receiver and Antenna Descriptors	Y
42	RTCM1104B	Extended B1, B2 or B3 BD2 RTK Observables	Y
43	RTCM1819B	Type 18 and 19 Raw Measurement	Y
44	RTCM3B	Type 3 Base Station Parameters	Y
45	RTCMDATA1		
46	SATMSGB	Satellite Status (defined by COMPASS)	Y
47	SATVISB	Satellite Visibility	Y
48	TIMEB	Board time Information	Y
49	TRACKSTATB	Satellite Tracking Status	Y
50	VERSION	Board Hardware and Software Version Numbers in Abbreviated ASCII Format;	N
51	VERSIONA	Board Hardware and Software Version Numbers in ASCII Format;	N
52	VERSIONB	Board Hardware and Software Version Numbers	Y

Example:

```
LOG VERSIONA
```

The above example shows the ASCII data of board version is logging to the appointed COM port.

5.2.9 DGPSTXID DGPS transmit ID

Format:

DGPSTXID <*type*> <*ID*>

Description:

This command sets the station ID value for the receiver when it is transmitting corrections. This allows for the easy identification of which base station was the source of the data.

For example, if you want to compare RTCM and RTCMV3 corrections, you would be easily able to identify their base stations by first setting their respective DGPSTXID values.

Parameter:

type differential data format such as RTCMV3

ID reference station ID

Example:

```
DGPSTXID RTCMV3 10
```

This command set reference station ID as 10 in RTCMV3 format.

5.2.10 PPMADJUST Adjust PPM or not

Format:

PPMADJUST <*status*>

Description:

This command is used to decide whether adjust the PPM or not.

Parameters:

status ON (adjust) / OFF (don't adjust)

Example:

```
PPMADJUST ON          //Adjust PPM.
PPMADJUST OFF         //Not adjust PPM.
```

5.2.11 REFAUTOSETUP Set base station self-starting

Format:

REFAUTOSETUP <*status*>

Description:

This command is used to decide whether the base station self-starts or not. This command is defined by COMPASS.

Parameters:

status	ON (self-start) / OFF (don't self-start)

Example:

```
REFAUTOSETUP ON          //Self-start
REFAUTOSETUP OFF         //Don't self-start
```

5.2.12 RESET Perform a hardware reset

Format:

RESET

Description:

This command performs a hardware reset. Following a RESET command, the board initiates a cold-start boot up.

Example:

```
RESET
```

5.2.13 SAVECONFIG Save current configuration

Format:

SAVECONFIG

Description:

This command saves the user's present configuration, including the current log settings (type, whether output testing data, etc.), FIX settings, baud rate, and so on, refer to Table 11.

Example:

```
SAVECONFIG
```

Table 11.Saved Configuration

CONFIGURATION	DESCRIPTION
LOG	All logs in all ports are saved
FIX	Just fix position is saved
COM	baud rates of all ports are saved
ECUTOFF	Cutoff-angles include BD2 are saved
PJKPARA	Six parameters of PJK are saved
PPSOFFSET	Configured offset is saved
INTERFACEMODE	Ports mode status of COM1, COM2 and COM3

5.2.14 UNLOCKOUT Reinstate a satellite in the solution

Format:

UNLOCKOUT <*prn*>

Description:

This command allows a satellite which has been previously locked out (LOCKOUT command) to be reinstated in the solution computation. If more than one satellite is to be reinstated, this command must be reissued for each satellite reinstatement.

Parameters:

prn pr number of satellite, refer to Table 9.

Example:

```
UNLOCKOUT 10
```

5.2.15 UNLOG Remove a log from logging control

Format:

UNLOG <message-type>

Description:

This command permits you to remove a specific log request from the system.

Parameters

message-type refer to Table 18.

Example:

```
UNLOG VERSIONB
```

5.2.16 UNLOGALL Remove all logs from logging control

Format:

UNLOGALL <*port*>

Description:

This command disables all logs on the port if port is specified, if no port is specified, all logs of all ports would be disabled.

Parameters

port refer to Table 7.

Example:

```
UNLOGALL COM1

UNLOGALL
```

5.2.17 UNLOCKOUTALL Reinstate a satellite in the solution

Format:

UNLOCKOUTALL

Description:

This command allows all satellites which have been previously locked out (LOCKOUT command) to be reinstated in the solution computation.

Example:

```
UNLOCKOUTALL
```

5.2.18 MAGVAR Set a magnetic variation correction

Format:

MAGVAR <type> <correction>

Description:

The receiver computes directions referenced to True North. Use this command (magnetic variation correction) if you intend to navigate in agreement with magnetic compass bearings. The receiver uses the magnetic variation correction 0 degree if you don't set any magnetic correction.

Parameters

type refer to Table 12.

correction magnitude of correction (±180 degrees)

Example:

```
MAGVAR CORRECTION 10
```

Table 12.MAGVAR Type

TYPE	DESCRIPTION
CORRECTION	Use the value inputted

5.2.19 ERASEFLASH Erase files restored in flash

Format

ERASEFLASH

Description:

The receiver erase all files which include GNSS observation and ephemeris restored in flash. If no corresponding software in your computer to erase these files, this command would be a good choice.

Example:

```
ERASEFLASH
```

5.2.20 READFLASH Read files from flash

Format:

READFLASH

Description:

The receiver reads all files which include GNSS observation and ephemeris restored in flash and output to current port. This command only be used in situation that you couldn't download the files using corresponding software.

Example:

```
READFLASH
```

5.2.21 SET Configure settings

Format

SET <*type*> <*para1*> <*para2*>…

Description:

This command should be used to configure some special settings such as PJK parameters, debug information output, and so on.

Parameters

type refer to Table 13.

para refer to Table 13.

Example:

```
SET DIFFMATCHMODE synch

SET STATIC on

SET PJKPARA 6378137.0 298.257223563 0 120 0
500000

SET WORKMODE timing
```

```
SET TIMINGREFXYZ -2844870.0 4662776.0 3282481.0

SET BD2PVTOBS B2I

SET CPUFREQ 624

SET PVTFREQ 5

SET RTKFREQ 5
```

Table 13.SET Type and Parameter

TYPE	DESCRIPTION	PARAMETER
DIFFMATCHMODE	Set RTK in synchronous mode or asynchronous mode	One parameter, could be: SYNCH or ASYNCH
STATIC	Start or end static data collection	One parameter, could be: ON(start a static file collection) or OFF(end a static file collection)
PJKPARA	Set PJK parameters in coordinate conversion. The default settings are: A: 6378137.0; F: 1.0 / 298.257223563; B0: 0; L0: 120 / 180 * PI N0: 0 E0: 500000	Six parameters: A: the long axle of the earth 1/F: F is the Earth flat rate B0: reference latitude(in degree) L0: reference longitude(in degree) N0: reference north coordinate E0: reference east coordinate
WORKMODE	Set receiver work-mode: PVT mode or Timing Mode. Following a command set work-mode to timing mode, reference station coordinates should be set using command below. If switching work-mode from PVT to TIMING, two commands: SET WORKMODE TIMING SET TIMINGREFXYZ X Y Z	One parameter, could be: PVT or TIMING

TYPE	DESCRIPTION	PARAMETER
	should be needed. If switching work-mode from TIMING to PVT, only one command: SET WORKMODE PVT is needed.	
TIMINGREFXYZ	In timing mode, this command is used to set reference station coordinates as x, y and z (WGS84).	Three parameters: X (WGS84) Y (WGS84) Z (WGS84)
BD2PVTOBS	This command could be used to choose signal of BD2 in PVT computation. Command: SET BD2PVTOBS B2I means that, in PVT computation, observations, ephemeris and almanac are subtract in B2I.	One parameter, could be: B1I, B2I or B3I
CPUFREQ	This command could be used to set frequency of CPU core. In some cases high update rate observation, PVT or RTK is needed, the default CPU core frequency couldn't bear so huge calculation load, so a higher frequency is necessary, at the same time, it means more power cost.	Valid CPU frequency: 208, 416, 624, 806. Default value is 416.
PVTFREQ	Compass board work in 5hz pvt in default setting, if a higher or lower pvt update frequency is needed, this command could configure the PVT update rate at most 20hz. But the calculation ability of CPU is not unlimited, in 5hz PVT, RTK could work on 5hz; if a 10hz PVT and 10hz RTK are needed at the same time, a higher CUP frequency at least 624mHZ is necessary.	Valid PVT frequency: 1, 2, 5, 10, 20. Default setting: 5hz.
RTKFREQ	Notice: please keep RTK frequency is not higher than	Valid RTK frequency:

TYPE	DESCRIPTION	PARAMETER
	PVT frequency.	1, 2, 5, 10. Default setting: 5hz.

5.2.22 INTERFACEMODE Set receive or transmit modes for ports

Format

INTERFACEMODE <*port*> <*input-mode*> <*output-mode*>

Description

This command configures a port to detect data or output data in specified mode. **Currently output-mode is not affected by command and always in generic mode**.

Parameters

port refer to Table 7

input-mode refer to Table 14

output-mode always be GENERIC mode, refer to Table 14.

Example:

```
INTERFACEMODE COM1 RTCMV3 RTCMV3
```

Table 14.INTERFACEMODE

MODE NAME	DESCRIPTION	SUPPORT
NONE	The port is disabled.	Y
NOVATEL	NovAtel® commands and logs	Y
RTCM	RTCM corrections	Y
RTCA	RTCA corrections	N

MODE NAME	DESCRIPTION	SUPPORT
CMR	CMR corrections	Y
OMNISTAR	OMNISTAR corrections	N
IMU	IMU information	N
RTCMNOCR	RTCM with no CR/LF	N
CDGPS	GPS *C code	N
TCOM1	Tune mode	N
TCOM2		
TCOM3		
TAUX		
RTCMV3	RTCMV3 corrections	Y
NOVATELBINARY	NovAtel® binary messages	Y
GENERIC	No limit	Y
AUTO	RTCM, RTCMV3 and CMR are auto switched.	Y
COMPASS	Compass commands and logs	Y

5.2.23 RTKTIMEOUT Set maximum age of RTK data

Format

RTKTIMEOUT <*time-delay*>

Description

This command is used to set the maximum age of RTK data to use when operating as a rover station. RTK data received that is older than the specified time is ignored.

Parameters

time-delay less than 200s, default 60s

Example:

```
RTKTIMEOUT 30
```

5.2.24 RTKCOMMAND Reset or set the RTK filter to its defaults

Format

RTKCOMMAND *<action>*

Description

This command provides the ability to reset the RTK filter and clear any set RTK parameters. The RESET parameter causes the advance RTK algorithm to undergo a complete reset, forcing the system to restart the ambiguity resolution calculations.

Parameters

action RESET

Example:

```
RTKCOMMAND RESET
```

5.2.25 RTKSOLUTION Set RTK solution mode

Format

RTKSOLUTION <*mode*>

Description

This command provides a method to configure RTK resolution engine. In some situations, only RTD is needed to get a quicker initiation process and a not so accurate result, this command can be used to configure RTK engine to RTD mode.

Parameters

mode integer number,

0: dual-frequency RTK;

1: single-frequency RTD;

2: dual-frequency RTD;

3: triplex-frequency RTK;

4: triplex-frequency RTD;

5: L1/L2/B1/B3 RTK;

Example:

```
RTKSOLUTION 1
```

5.2.26 RTKDYNAMICS Set RTK dynamic mode

Format

RTKDYNAMICS <*mode*>

Description

This command can be used to set dynamic mode. In different mode, RTK engine should treat the observation data in different style to promote the performance of RTK engine.

Parameters

mode 'dynamic', 'static' or 'auto'.

Example:

```
RTKDYNAMICS DYNAMIC
```

5.2.27 RTKELEVMASK Set the RTK elevation mask angle

Format

RTKELEVMASK <*type*> <*angle*>

Description

This command is used to set elevation mask angle of RTK engine. In some situations, observations of low-elevation satellites may influence the resolution process and result of RTK, so a higher mask angle should be a good choice to ensure a better performance of RTK engine.

Parameters

type 'auto' or 'user'. If 'auto' mode is set, RTK engine should set elevation mask automatically, in 'user' mode, RTK engine should set elevation mask as user identified.

angle integer number. Angle should be more than 0 degree and less than 90 degree.

Example:

```
RTKELEVMASK user 10
```

5.2.28 RTKREFMODE Set the RTK ref-station position mode

Format

RTKREFMODE <*mode*>

Description

This command is used to configure rover station to process position of reference station as moving base station RTK mode or fixed base station RTK.

Parameters

mode 0: fixed base station RTK; 1: moving base station RTK;

Example:

```
RTKREFMODE 1
```

5.2.29 BD2ECUTOFF Set BD2 satellite elevation cut-off

Format

BD2ECUTOFF <cutoff-angle>

Description

This command sets the elevation cut-off angle for tracked BD2 satellites.

Parameters

cutoff-angle the value of bd2 cutoff-angle(0~90 degrees)

Example:

```
BD2ECUTOFF 10
```

5.2.30 LOCKOUTSYSTEM Prevent the receiver from using a system

Format

LOCKOUTSYSTEM <*system*>

Description

This command prevents the receiver from using satellites in the specified system in the solution computation.

Parameters

System the name of a specified GNSS system, refer to Table 15

Example:

```
LOCKOUTSYSTEM BD2
```

Table 15.GNSS System

GNSS SYSTEM
GPS
BD2
GLONASS
GALILEO

5.2.31 UNLOCKOUTSYSTEM Reinstate previously locked out system

Format

UNLOCKOUTSYSTEM <*system*>

Description

This command allows a system which previously locked out to be reinstated in the solution computation.

Parameters

system the name of a specified GNSS system, refer to Table 15

Example:

```
UNLOCKOUTSYSTEM BD2
```

5.2.32 CLOCKOFFSET Adjust for delay in 1 PPS output

Format

CLOCKOFFSET <*delay*>

Description

This command can be used to adjust PPS output delay in nanoseconds. In timing situations, the time delay is not a fix value attribute to two factors:

1. Signal path from the antenna to the RF, for example, using a cable with 10ns delay should import a 10ns extra delay in PPS output

2. A signal process path delay from the RF to the digital sections, in types of different circuit boards and signal processing method, a little different delay exists;

Major common delay has been compensated by default setting, but a residual delay should be adjusted by user according to different antenna and cables.

Parameters

delay a positive value indicates a delay output relative to current PPS, a negative value indicates a forward output.

Example:

```
CLOCKOFFSET -200
```

The above command set a forward 200 nanoseconds PPS output relative to current output.

5.2.33 PPSCONTROL Control the PPS output style

Format

PPSCONTROL <*switch*><*polarity*><*period*><*pulse-width*>

Description

This command can be used to set the polarity, period and pulse-width of PPS output. The PPS can't be disabled and the period is fixed to 1 second.

Parameters

switch 'enable' or 'disable', the switch should be set to 'enable', and 'disable' is not allowed.

polarity 'positive' and 'negative', if 'positive', it should be a high level pulse, a low level pulse correspond to a 'negative' mode.

period in seconds, 'period' can't be configured, it is constantly 1 second temporary.

pulse-width in microseconds, pulse-width should be less than half of period.

Example:

```
PPSCONTROL ENABLE POSITIVE 1 1000
```

5.3 DATA LOGS

5.3.1 Logs Introduction

Format

Many different types of data can be logged using LOG command. See *5.2.8 LOG*. This section covered all types of data logs supported by COMPASS board.

Send

LOG <*message-type*> <*type-trigger*> <*interval*> See *5.2.8 LOG*

Reply

The format of reply message is Binary, which is quite different from sending message. The board also supports NMEA string.

Binary Message Layout

Header	Data	CRC

Header 3 Sync bytes plus 25 bytes of header information. The header length is variable as fields may be appended in the future. Always check the header length.

Data variable

CRC 32-bit CRC performed on all data including the header.

HEADER

FIELD #	FIELD NAME	FIELD TYPE	DESCRIPTION	BINARY BYTES	BINARY OFFSET
1	Sync	Char	Hexadecimal 0xAA.	1	0
2	Sync	Char	Hexadecimal 0x44.	1	1
3	Sync	Char	Hexadecimal 0x12.	1	2
4	Header Lgth	Uchar	Length of the header.	1	3
5	Message ID	Ushort	Message ID	2	4
6	Reserved			1	6
7	Reserved			1	7
8	Message Length	Ushort	The length in bytes of the body of the message. This does not include the header nor the CRC.	2	8
9	Reserved			2	10
10	Reserved			1	12
11	Reserved			1	13
12	Week	Ushort	GPS week number.	2	14
13	ms	GPS time	Milliseconds from the beginning of the GPS week.	4	16
14	Reserved			4	20
15	Reserved	Ushort	Reserved for internal use.	2	24
16	Receiver S/W Version	Ushort	This is a value (0 - 65535) that represents the receiver software build number.	2	26

NOTE:

In current version, the length of header is always 28 bytes.

The length of data block is variable.

Log Message ID List

Currently supported Message ids listed below.

Table 16.Current Supported Log Message ID

NO	ID	LOG TYPE	DESCRIPTION
1	**71**	**BD2EPHEM (B)**	BD2 decoded ephemeris information
2	**412**	**BD2RAWEPHEM (B)**	BD2 Raw ephemeris
3	**741**	**BD2RAWALM (B)**	BD2 raw almanac
4	**210**	**BDGGA**	BD2 PVT information
5	**42**	**BESTPOS (A and B)**	Best position data
6	**241**	**BESTXYZ (A and B)**	Position information in xyz.
7	**99**	**BESTVEL (A, B and Abb)**	Best velocity data
8	**390**	**CMROBS (B)**	Base station satellite observation information
9	**391**	**CMRREF (B)**	Base station position information
10	**717**	**CMRPLUS (B)**	CMR+ message
11	**317**	**COMCONFIG (A and B)**	COM configuration Information in ASCII Format
12	**792**	**GLORAWEPHEM (B)**	GLONASS raw ephemeris message.
13	**211**	**GPCDT**	Differential timing result
14	**218**	**GPGGA**	GPS Fix Data and Undulation
15	**259**	**GPGGARTK**	GPS Fix Data and Undulation
16	**219**	**GPGLL**	Latitude and Longitude of Present Vessel Position
17	**221**	**GPGSA**	GPS DOP and Active Satellites
18	**222**	**GPGST**	Only Dop Values are Valid Currently
19	**223**	**GPGSV**	GPS Satellites in View

NO	ID	LOG TYPE	DESCRIPTION
20	**228**	**GPHDT**	Actual Vessel Heading in Degrees True
21	**209**	**GPNTR**	Information about navigating to reference station.
22	**225**	**GPRMC**	GPS Specific Information
23	**712**	**GPSEPHEM (B)**	GPS decoded ephemeris information
24	**226**	**GPVTG**	The Track Made Good and Speed Relative to the Ground
25	**227**	**GPZDA**	UTC Time and Date
26	**971**	**HEADING (A and B)**	Heading angle message
27	**8**	**IONUTC (A, B and Abb)**	Ionosphere and UTC parameters
28	**5**	**LOGLIST (A)**	Log settings in each port.
29	**2013**	**PJKPARA**	PJK Parameters Used in PTNLPJK Message
30	**174**	**PSRDOP (B)**	DOP of SVs currently tracking
31	**47**	**PSRPOS (A, B and Abb)**	Pseudorange Position
32	**229**	**PTNLPJK**	PJK Position
33	**140**	**RANGECMP (A, B and Abb)**	Compressed version of the RANGE log
34	**136**	**RANGECMPL1 (B)**	L1 and B1 information
35	**43**	**RANGE (A, B and Abb)**	Detailed range information
36	**74**	**RAWALM (B)**	Raw almanac
37	**41**	**RAWEPHEM (B)**	Raw ephemeris
38	**175**	**REFSTATION (B)**	Base station Position
39	**107**	**RTCM1 (B)**	Pseudorange correction message in RTCM2.3
40	**785**	**RTCM1002 (B)**	Extended L1-Only GPS RTK Observables
41	**787**	**RTCM1004 (B)**	Extended L1/L2 GPS RTK Observables
42	**788**	**RTCM1005 (B)**	RTK Base Station ARP
43	**789**	**RTCM1006 (B)**	Base Station ARP with Height
44	**856**	**RTCM1007 (B)**	Extended Antenna Descriptor and Setup Information
45	**857**	**RTCM1008 (B)**	Extended Antenna Descriptor and Setup Information
46	**898**	**RTCM1010 (B)**	Extended L1-OnlyGLONASS RTK Observables

NO	ID	LOG TYPE	DESCRIPTION
47	**999**	**RTCM1033 (B)**	Receiver and Antenna Descriptors
48	**781**	**RTCM1104 (B)**	Extended B1, B2 or B3 BD2 RTK Observables
49	**399**	**RTCM1819 (B)**	Type18 and Type 19 Raw Measurements
50	**402**	**RTCM3 (B)**	Type 3 Base Station Parameters
51	**396**	**RTCMDATA1 (B)**	Pseudorange correction message
52	**911**	**SATMSG (B)**	Satellite status (defined by COMPASS)
53	**48**	**SATVIS (B)**	Satellite visibility
54	**101**	**TIME (B)**	Board time information
55	**83**	**TRACKSTAT (B)**	Satellite tracking status
56	**37**	**VERSION (A, B or Abb)**	Board software and hardware version
57			

NMEA message

COMPASS boards also support NMEA messages. Please reference the NMEA protocol manual for details of them.

5.3.2 Log Type Triggers

Refer to the LOG command on page 6 for details about requesting logs.

The receiver is capable of generating many different logs. These logs are divided into three types: synchronous, asynchronous, and polled.

- ☞ The data for synchronous logs is generated on a regular schedule.
- ☞ Asynchronous data is generated at irregular intervals. If asynchronous logs were collected on a regular schedule, they would not output the most current data as soon as it was available.
- ☞ The data in polled logs is generated on demand. An example would be RXCONFIG. It would be polled because it changes only when commanded to do so. Therefore, it would not make sense to log this kind of data ONCHANDED, or ONNEW.

The following table outlines the log types and the valid triggers to use:

Table 17.Log Type Triggers

TYPE	RECOMMENDED TRIGGER	ILLEGAL TRIGGER
Synch	ONTIME	ONNEW, ONCHANGED
Asynch	ONCHANGED	-
Polled	ONCE or ONTIME	ONNEW,ONCHANGED

5.3.3 Log Examples

For example, if the receiver supports 5 Hz logging, the minimum logging period is 1/5 Hz or 0.2 s. The following are valid examples for a synchronous or asynchronous log, on a receiver that can log at rates up to 5 Hz:

```
log bestposb 0.2                [5 Hz]
log bestposb 0.5                [2 Hz]
log bestposb ontime 1           [1 Hz]
log bestposb ontime 2           [0.5 Hz]
log bestposb ontime 10          [0.1 Hz]
```

5.3.4 Log List by Function

Table 18.Logs by Function

GENERAL RECEIVER CONTROL AND STATUS			
LOGS	DESCRIPTIONS	TYPE	SUPPORT
COMCONFIG	**Current COM port configuration**	**Polled**	**Y**
EXTRXHWLEVELS	**Extended receiver hardware levels**	**Polled**	**N**
LOGLIST	**List of system logs**	**Polled**	**N**
PASSCOM1, PASSXCOM1,	**Pass-through log, also PASSCOM2, PASSCOM3,PASSXCOM2, PASSXCOM3, PASSUSB2 andPASSUSB3**	**Asynch**	**N**

PASSAUX, **PASSUSB1**			
PORTSTATS	**COM and, if applicable, USB port statistics**	**Polled**	**N**
RXCONFIG	**Receiver configuration status**	**Polled**	**N**
RXHWLEVELS	**Receiver hardware levels**	**Polled**	**N**
RXSTATUS	**Self-test status**	**Asynch**	**N**
RXSTATUSEVENT	**Status event indicator**	**Asynch**	**N**
VALIDMODELS	**Model and expiry date information for receiver**	**Asynch**	**N**
VERSION	**Receiver hardware and software version numbers**	**Polled**	**Y**
POSITION, PARAMETERS, AND SOLUTION FILTERING CONTROL			
LOGS	DESCRIPTIONS	TYPE	SUPPORT
AVEPOS	**Position averaging log**	**Asynch**	**N**
BESTPOS	**Best position data**	**Synch**	**Y**
BESTUTM	**Best available UTM data**	**Synch**	**N**
BESTXYZ	**Cartesian coordinates position data**	**Synch**	**Y**
BSLNXYZ	**RTK XYZ baseline**	**Synch**	**N**
DIFFCODEBIASES	**Differential code biases being applied**	**Polled**	**N**
GPGGA	**NMEA ,fix and position data**	**Synch**	**Y**
GPGGARTK	**NMEA, global position system fix data**	**Synch**	**Y**
GPGLL	**NMEA, position data**	**Synch**	**Y**
GPGRS	**NMEA, range residuals**	**Synch**	**N**
GPGSA	**NMEA, DOP information**	**Synch**	**Y**
GPGST	**NMEA, measurement noise statistics**	**Synch**	**Y**
GPHDT	**NMEA, heading from True North**	**Synch**	**Y**
HEADING	**Heading information with the ALIGN feature**	**Asynch**	**Y**
IONUTC	**Ionosphere and UTC model information**	**Asynch**	**Y**
MATCHEDPOS	**Computed position**	**Asynch**	**N**
MATCHEDXYZ	**Cartesian coordinates computed position data**	**Asynch**	**N**

MARKPOS, MARK2POS	**Position at time of mark input event**	**Asynch**	**N**
MARKTIME, MARK2TIME	**Time of mark input event**	**Asynch**	**N**
OMNIHPPOS	**OmniSTAR HP/XP position data**	**Synch**	**N**
PSRDOP	**DOP of SVs currently tracking**	**Asynch**	**Y**
RTKDOP	**Values from the RTK fast filter**	**Synch**	**N**
RTKPOS	**RTK low latency position**	**Synch**	**N**
RTKVEL	**RTK Velocity**	**Synch**	**N**
RTKXYZ	**RTK Cartesian coordinate position**	**Synch**	**N**
WAYPOINT NAVIGATION			
LOGS	DESCRIPTIONS	TYPE	SUPPORT
BESTPOS	**Best position data**	**Synch**	**Y**
BESTVEL	**Velocity data**	**Synch**	**N**
GPHDT	**NMEA, heading from True North**	**Synch**	**Y**
GPRMB	**NMEA, waypoint status**	**Synch**	**Y**
GPRMC	**NMEA, navigation information**	**Synch**	**Y**
GPVTG	**NMEA, track made good and speed**	**Synch**	**Y**
NAVIGATE	**Navigation waypoint status**	**Synch**	**N**
OMNIHPPOS	**OmniSTAR HP position data**	**Synch**	**N**
PSRPOS	**Pseudorange position**	**Synch**	**Y**
PSRVEL	**Pseudorange velocity**	**Synch**	**N**
PSRXYZ	**Pseudorange artesian coordinate position**	**Synch**	**N**
GPNTR	**information about navigate to reference station**		**Y**
CLOCK INFORMATION, STATUS, AND TIME			
LOGS	DESCRIPTIONS	TYPE	SUPPORT
CLOCKMODEL	**Range bias information**	**Synch**	**N**

CLOCKSTEERING	**Clock steering status**	**Asynch**	**N**
GLOCLOCK	**GLONASS clock information**	**Asynch**	**N**
GPZDA	**NMEA, UTC time and data**	**Synch**	**Y**
PSRTIME	**Time offsets from thepseudorange filter**	**Synch**	**N**
TIME	**Receiver time information**	**Synch**	**Y**
TIMESYNC	**Synchronize time between receivers**	**Synch**	**N**
GPCDT	**Differential timing result**	**Synch**	**Y**
POST PROCESSING DATA			
LOGS	DESCRIPTIONS	TYPE	SUPPORT
GPSEPHEM	**Decoded GPS ephemeris information**	**Asynch**	**Y**
IONUTC	**Ionosphere and UTC modelinformation**	**Asynch**	**N**
RAWEPHEM	**Raw ephemeris**	**Asynch**	**Y**
RANGE	**Satellite range information**	**Synch**	**Y**
RANGECMP	**Compressed version of the RANGElog**	**Synch**	**Y**
RANGEGPSL1	**L1 version of the RANGE log**	**Synch**	**Y**
RTKDATA	**RTK related data such as baselinesand satellite counts.**	**Synch**	**N**
TIME	**Receiver clock offset information**	**Synch**	**Y**
SATELLITE TRACKING AND CHANNEL CONTROL			
LOGS	DESCRIPTIONS	TYPE	SUPPORT
ALMANAC	**Current decoded almanac data**	**Asynch**	**Y**
GLMLA	**NMEA GLONASS almanac data**	**Asynch**	**N**
GLOALMANAC	**GLONASS almanac data**	**Asynch**	**N**
GLOEPHEMERIS	**GLONASS ephemeris data**	**Asynch**	**N**
GLORAWALM	**Raw GLONASS almanac data**	**Asynch**	**N**
GLORAWEPHEM	**Raw GLONASS ephemeris data**	**Asynch**	**Y**
GLORAWFRAME	**Raw GLONASS frame data**	**Asynch**	**N**
GLORAWSTRING	**Raw GLONASS string data**	**Asynch**	**N**

GPALM	**NMEA, almanac data**	**Asynch**	**N**
GPGSV	**NMEA, satellite-in-view information**	**Synch**	**Y**
GPSEPHEM	**Decoded GPS ephemeris information**	**Asynch**	**Y**
OMNIVIS	**OmniSTAR satellite visibility list**	**Synch**	**N**
PSRDOP	**DOP of SVs currently tracking**	**Asynch**	**Y**
RANGE	**Satellite range information**	**Synch**	**Y**
RANGEGPSL1	**L1 version of the RANGE log**	**Synch**	**Y**
RAWALM	**Raw almanac**	**Asynch**	**N**
RAWEPHEM	**Raw ephemeris**	**Asynch**	**Y**
RAWGPSSUBFRAME	**Raw sub frame data**	**Asynch**	**N**
RAWGPSWORD	**Raw navigation word**	**Asynch**	**N**
RAWWAASFRAME	**Raw SBAS frame data**	**Asynch**	**N**
SATVIS	**Satellite visibility**	**Synch**	**Y**
SATXYZ	**SV position in ECEF Cartesiancoordinates**	**Synch**	**N**
TRACKSTAT	**Satellite tracking status**	**Synch**	**Y**
DIFFERENTIAL BASE STATION			
LOGS	DESCRIPTIONS	TYPE	SUPPORT
ALMANAC	**Current almanac information**	**Asynch**	**Y**
BESTPOS	**Best position data**	**Synch**	**Y**
BESTVEL	**Velocity data**	**Synch**	**N**
BSLNXYZ RTK	**XYZ baseline**	**Asynch**	**N**
GPGGA	**NMEA, position fix data**	**Synch**	**Y**
GPGGARTK	**NMEA, global position system fix data**	**Synch**	**Y**
PSRPOS	**Pseudorange position**	**Synch**	**Y**
PSRVEL	**Pseudorange velocity**	**Synch**	**N**
RANGE	**Satellite range information**	**Synch**	**N**
RANGECMP	**Compressed version of the RANGElog**	**Synch**	**Y**
RAWLBANDFRAME	**Raw L-band frame data**	**Asynch**	**N**

RAWLBANDPACKET	**Raw L-band data packet**	**Asynch**	**N**
REFSTATION	**Base station position and health**	**Asynch**	**Y**
RTKPOS	**RTK low latency position**	**Synch**	**N**
NMEA FORMAT LOGS			
LOGS	DESCRIPTIONS	TYPE	SUPPORT
GPALM	**Almanac Data**	**Asynch**	**N**
GPGGA	**GPS Fix Data and Undulation**	**Asynch**	**Y**
GPGGARTK	**GNSS Fix Data with Extra Precision**	**Asynch**	**Y**
GPGLL	**Geographic Position - latitude/longitude**	**Asynch**	**Y**
GPGRS	**GPS Range Residuals for Each Satellite**	**Asynch**	**N**
GPGSA	**GPS DOP and Active Satellites**	**Asynch**	**Y**
GPGST	**Pseudorange Measurement Noise Statistics**	**Asynch**	**Y**
GPGSV	**GPS Satellites in View**	**Asynch**	**Y**
GPHDT	**Heading in Degrees True**	**Asynch**	**Y**
GPRMB	**Generic Navigation Information**	**Asynch**	**Y**
GPRMC	**GPS Specific Information**	**Asynch**	**Y**
GPVTG	**Track Made Good and Ground Speed**	**Asynch**	**Y**
GPZDA	**UTC Time and Date**	**Asynch**	**Y**
CMR FORMAT LOGS			
LOGS	DESCRIPTIONS	TYPE	SUPPORT
CMROBS	**Base station satellite observation information**	**Synch**	**Y**
CMRREF	**Base station position information**	**Synch**	**Y**
CMRPLUS	**CMR+ output message**	**Synch**	**Y**
RTCM FORMAT LOGS			
LOGS	DESCRIPTIONS	TYPE	SUPPORT
RTCM3	**Base Station Parameters**	**Synch**	**Y**

RTCM1819	**Type18 and Type 19 Raw Measurements**	**Synch**	**Y**
RTCMV3 FORMAT LOGS			
LOGS	DESCRIPTIONS	TYPE	SUPPORT
RTCM1002	**Extended L1 GPS RTK Observables**	**Synch**	**Y**
RTCM1004	**Extended L1/L2 GPS RTK Observables**	**Synch**	**Y**
RTCM1005	**RTK Base Station ARP**	**Synch**	**Y**
RTCM1006	**RTK Base Station ARP with Antenna Height**	**Synch**	**Y**
RTCM1007	**Extended Antenna Descriptor and Setup**	**Synch**	**Y**
RTCM1008	**Extended Antenna Reference Station description and Serial Number**	**Synch**	**Y**
RTCM1010	**Extended L1 GLONASS RTK Observables**	**Synch**	**Y**
RTCM1033	**Receiver and Antenna descriptors**	**Synch**	**Y**
RTCM1104	**Extended B1/B2 BD2 RTK Observables**	**Synch**	**Y**
RTCM4044	**Extended B1/B2 BD2 RTK Observables**	**Synch**	**Y**

5.4 LOG REFERENCE

5.4.1 BD2EPHEM BD2 Ephemeris

Description

This message contains the bd2 ephemeris parameters.

MESSAGE ID	*71*
RECOMMENDED INPUT	*log bd2ephemb onchanged*
SUPPORTED FORMAT	*binary*

Reply (Binary):

Refer to 5.4.20.

5.4.2 BD2RAWALM Raw BD2 Almanac

Description

This message contains raw almanac sub frames received from BDS satellites.

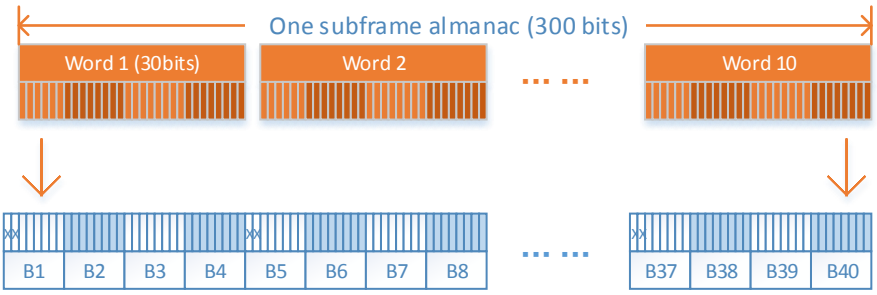
Message ID	*741*
Recommended Input	*log bd2rawalmb ontime 1*
Supported Format	*binary*

Replay (Binary)

Field#	Field Type	Data Description	Format	Binary Byte	Binary Offset
1	BD2RAWALM header	Log header		H	0
2	ref week	Almanac reference week number	Ulong	4	H
3	ref secs	Almanac reference time (s)	Ulong	4	H+4
4	subframes	Number of subframes to follow	Ulong	4	H+8
5	svid	SV ID (satellite vehicle ID)	UShort	2	H+12
6	data	Subframe page data Note	Hex	40	H+14
7...	Next subframe offset = H + 12 + (subframe x 42)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H + 12 + (42 x subframes)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

☞ ***Note.*** Length of one subframe almanac is 10 words (30 bits per word, MSB first). Subframe 4 Page 1~24 and Subframe 5 Page 1~6 contain 30 frames BDS satellites' almanac (Refer to Beidou-ICD-1.0 Table 5-11-1 and 5-11-2). One word (30 bits) is

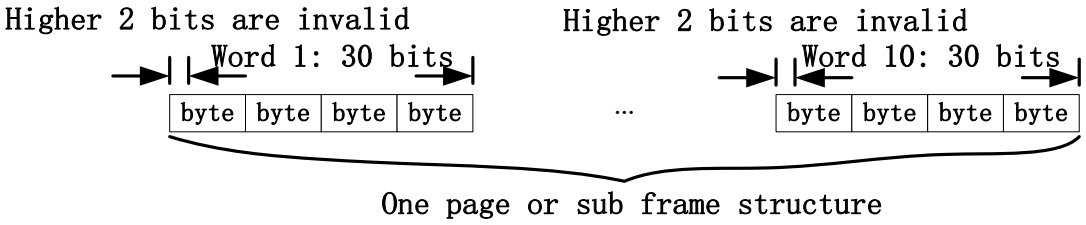
split into 4 bytes data (first two bits of 1st byte is unused), then one almanac subframe data is expressed in 40 bytes as following figures shows:



5.4.3 BD2RAWEPHEM Raw BD2 Ephemeris

Description

This log contains the raw ephemeris of BD2 satellites, and each raw ephemeris message is 400 bytes long. Each ephemeris page is 300 bits long, and the log contains all bits, although some bits are not used in current definition. For GEO satellites, ephemeris bits are all in sub frame 1, which is composed of 10 pages, each page is 10 words long and there are 30 bits in each word. Notice, just higher 150 valid bits are used in page, so all pages are needed to be decoded. For IGSO and MEO satellites, ephemeris bits are in sub frame 1, 2 and 3 and each sub frame is 10 words long and all 300 bits are valid, the other sub frames are invalid in the log. The page or sub frame structure in bytes arrays are showed in the below figure. If detailed information needed, please refer to BD2 ICD.



Reply (Binary)

FIELD#	FIELD TYPE	DATA DESCRIPTION	FORMAT	BINARY BYTE	BINARY OFFSET
1	RAWEPHEM header	Log header		H	0

2	prn	Satellite PRN number	Ulong	4	H
3	ref week	Ephemeris reference week number	Ulong	4	H+4
4	ref secs	Ephemeris reference time (s)	Ulong	4	H+8
5	Subframe1 or page1	Sub-frame 1 or page1 data	Hex	40	H+12
6	subframe2 or page2	Sub-frame 2 or page2 data	Hex	40	H+52
…	…	…	…	…	…
7	Subframe10or page 10	Sub-frame 10or page10data	Hex	40	H+372
8	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+412
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

5.4.4 BESTPOS Best Position

Description

This log contains the best available GNSS position (in meter) computed by the board. In addition, it reports several status indicators, including differential age, which is useful in predicting anomalous behavior brought about by outages in differential corrections. A differential age of 0 indicates that no differential correction was used.

Message ID	*42*
Recommended Input	*log bestposb ontime 1*
Supported Format	*binary*

Reply (Binary):

FIELD#	FIELD TYPE	DATA DESCRIPTION	FORMAT	BINARY BYTE	BINARY OFFSET
1	Bestpos Header	Log Header		H	0
2	Sol stat	Solution status (refer to Table 19)	Enum	4	H

FIELD#	FIELD TYPE	DATA DESCRIPTION	FORMAT	BINARY BYTE	BINARY OFFSET
3	Pos type	Position type (refer to Table 20)	Enum	4	H+4
4	Lat	Latitude	Double	8	H+8
5	Lon	Longitude	Double	8	H+16
6	hgt	Height above mean sea level	Double	8	H+24
7	undulation	Reserve Byte	Float	4	H+32
8	Datum id#	Datum id number	Enum	4	H+36
9	Lat σ	Latitude standard deviation	Float	4	H+40
10	Lon σ	Longitude standard deviation	Float	4	H+44
11	Hgt σ	Height standard deviation	Float	4	H+48
12	Stn id	Base station id	Char[4]	4	H+52
13	Diff_age	Differential age in seconds	Float	4	H+56
14	Sol_age	Solution age in seconds	Float	4	H+60
15	#SVs	Number of satellite tracked	UCHAR	1	H+64
16	#solnSVs	SV number used in solution	UCHAR	1	H+65
17	#ggL1	L1 number	UCHAR	1	H+66
18	#ggL1L2	L1 &L2 number	UCHAR	1	H+67
19	reserved	Reserved bytes	UCHAR	1	H+68
20	ext sol stat	Extended solution status	UCHAR	1	H+69
21	reserved	Reserved bytes	UCHAR	1	H+70
22	sig mask	Signals used mask - if 0, signals used in solution are unknown. (See Table 21)	UCHAR	1	H+71
23	CRC	32-bit CRC Code	Hex	4	H+72

Table 19.Solution Status

SOLUTION STATUS	DESCRIPTION

(BINARY)	(ASCII)	
0	SOL_COMPUTED	Solution computed
1	INSUFFICIENT_OBS	Insufficient observations
6	COLD_START	Not yet converged from cold start

Table 20.Position or Velocity Type

TYPE (BINARY)	TYPE (ASCII)	DESCRIPTION
0	NONE	No solution
1	FIXEDPOS	Position has been fixed by the FIX POSITION command
8	DOPPLER_VELOCITY Note	**Velocity computed using instantaneous Doppler**
16	SINGLE	Single point position
17	PSRDIFF	Pseudorange differential solution
34	NARROW_FLOAT	Floating narrow-lane ambiguity solution
49	WIDE_INT	Integer wide-lane ambiguity solution
50	NARROW_INT	Integer narrow-lane ambiguity solution
51	SUPER WIDE-LANE	Super wide-lane solution

☞ ***Note*. Herein, the instantaneous doppler used for velocity computation comes directly from the tracking loop of OEM board, which means this doppler velocity has not nearly latency. In theory, its latency is smaller than the timing accuracy of OEM board.**

Table 21.Signal-Used Mask

BIT	MASK	DESCRIPTION
0	0x01	GPS L1 used in Solution
1	0x02	GPS L2 used in Solution

2	0x04	GPS L5 used in Solution
3	0x08	BDS B1 used in Solution
4	0x10	GLONASS L1 used in Solution
5	0x20	GLONASS L2 used in Solution
6	0x40	BDS B2 used in Solution
7	0x80	BDS B3 used in Solution

5.4.5 BESTVEL Best Available Velocity Data

Description:

This message contains the best available velocity information computed by the receiver. In addition, it reports a velocity status indicator, which is useful in indicating whether or not the corresponding data is valid. The velocity measurements sometimes have a latency associated with them. The time of validity is the time tag in the log minus the latency value.

Message ID	*99*
Recommended Input	*log bestvelb ontime 1*
Supported Format	*ASCII, Binary*

Direction of motion over ground in this log is derived from north speed and east speed, so the direction error is related to motion status. Higher speed means less direction error, and lower speed means more direction error. For example, in Doppler frequency velocity mode, we could assume a typical velocity error of 0.2m/s, and carrier velocity is 70km/hour, or 19.4m/s, the maximum direction error is:

Dir_error = arctan (0.2/19.4) = 0.59 degree.

FIELD#	FIELD TYPE	DATA DESCRIPTION	FORMAT	BINARY BYTES	OFFSET
1	BESTVEL	Log header		H	0

	header				
2	sol status	Solution status, see Table 19	Enum	4	H
3	vel type	Velocity type, see Table 20	Enum	4	H+4
4	latency	A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results.	Float	4	H+8
5	age	Differential age in seconds	Float	4	H+12
6	hor spd	Horizontal speed over ground, in meters per second	Double	8	H+16
7	trk gnd	Actual direction of motion over ground (track over ground) with respect to True North, in degrees	Double	8	H+24
8	vert spd	Vertical speed, in meters per second, where positive values indicate increasing altitude (up) and negative values indicate decreasing altitude (down)	Double	8	H+32
9	Reserved		Float	4	H+40
10	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+44
11	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

5.4.6 BESTXYZ Best Available Cartesian Position and Velocity

Description:

This log contains the receiver's best available position and velocity in ECEF coordinates. The position and velocity status fields indicate whether or not the corresponding data is valid.

Message ID	*241*
Recommended Input	*log bestxyzb ontime 1*
Supported Format	*ASCII, Binary*

FIELD#	FIELD TYPE	DATA DESCRIPTION	FORMAT	BINARY BYTES	OFFSET
1	BESTXYZ header	Log header		H	0
2	P-sol status	Solution status, see Table 19	Enum	4	H
3	pos type	Position type, see Table 20	Enum	4	H+4
4	P-X	Position X-coordinate (m)	Double	8	H+8
5	P-Y	Position Y-coordinate (m)	Double	8	H+16
6	P-Z	Position Z-coordinate (m)	Double	8	H+24
7	P-X σ	Standard deviation of P-X (m)	Float	4	H+32
8	P-Y σ	Standard deviation of P-Y (m)	Float	4	H+36
9	P-Z σ	Standard deviation of P-Z (m)	Float	4	H+40
10	V-sol status	Solution status, see Table 19	Enum	4	H+44
11	vel type	Velocity type, see Table 20	Enum	4	H+48
12	V-X	Velocity vector along X-axis (m/s)	Double	8	H+52
13	V-Y	Velocity vector along Y-axis (m/s)	Double	8	H+60
14	V-Z	Velocity vector along Z-axis (m/s)	Double	8	H+68
15	V-X σ	Standard deviation of V-X (m/s)	Float	4	H+76
16	V-Y σ	Standard deviation of V-Y (m/s)	Float	4	H+80
17	V-Z σ	Standard deviation of V-Z (m/s)	Float	4	H+84
18	stn ID	Base station identification	Char[4]	4	H+88
19	V-latency	A measure of the latency in the velocity time tag in seconds. It should be subtracted from the time to give improved results.	Float	4	H+92
20	diff_age	Differential age in seconds	Float	4	H+96
21	sol_age	Solution age in seconds	Float	4	H+100

22	#SVs	Number of satellite vehicles tracked	Uchar	1	H+104
23	#solnSVs	Number of satellite vehicles used in solution	Uchar	1	H+105
24	#ggL1	Number of GPS plus BDS L1 used in solution	Uchar	1	H+106
25	#ggL1L2	Number of GPS plus BDS L1 and L2 used in solution	Uchar	1	H+107
26	Reserved		Char	1	H+108
27	ext sol stat	Extended solution status	Hex	1	H+109
28	Reserved		Hex	1	H+110
29	sig mask	Signals used mask - if 0, signals used in solution are unknown (See Table 21)	Hex	1	H+111
30	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+112
31	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

5.4.7 CMROBS Base Station Satellite Observation

Description:

This message is a standard log defined by Trimble Navigation Ltd. to transfer pseudorange and carrier-phase information for high-precision GPS, refer to corresponding document.

Message ID	*390*
Recommended Input	*log cmrobsb ontime 1*
Supported Format	*binary*

Reply (Binary):

Refer to corresponding document.

5.4.8 CMRREF Base Station Position

Description:

This message is a standard log defined by Trimble Navigation Ltd. to transfer base station position.

Message ID	*391*
Recommended Input	*log cmrrefb ontime 5*
Supported Format	*binary*

Reply (Binary):

Refer to corresponding document.

5.4.9 COMCONFIG COM Port Configuration

Description:

This message contains configurations of ports such as baud rate, COM ID and so on.

Message ID	*37*
Recommended Input	*log comconfigb*
Supported Format	*ASCII, binary*

Reply (Binary):

Field#	Field Type	Data Description	Format	Binary Bytes	Offset
1	COMCONFIG header	Log header		H	0
2	#port	Number of ports with information to follow	Long	4	H
3	port	Serial port identifier	Enum	4	H+4

4	baud	Communication baud rate	Ulong	4	H+8
5	parity	Parity	Enum	4	H+12
6	databits	Number of data bits	Ulong	4	H+16
7	stopbits	Number of stop bits	Ulong	4	H+20
8	handshake	Handshaking	Enum	4	H+24
9	echo	When echo is on, the port is transmitting any input characters as they are received. 0 = OFF 1 = ON	Enum	4	H+28
10	breaks	Breaks are turned on or off 0 = OFF 1 = ON	Enum	4	H+32
11	rx type	The status of the receive interface mode	Enum	4	H+36
12	tx type	The status of the transmit interface mode	Enum	4	H+40
13	response	Responses are turned on or off 0 = OFF 1 = ON	Enum	4	H+44
14	next port offset = H + 4 + (#port x 44)				
15	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+4+(#port x44)
16	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

5.4.10 GPCDT Self-defined data

Description:

This message is a self-defined log to indicate the time difference between reference PPS and rover PPS. GPS, BD2, GLONASS and GALILEO systems' information are all included in this message, if valid flag is 1, the corresponding data is valid, and otherwise the data should be ignored. **This log is only valid in rover's RTD mode**.

Message ID	*211*
Recommended Input	*log gpcdt ontime 1*
Supported Format	*ASCII*

Reply (ASCII):

Field#	Structure	Description	Format	Example
1	$GPCDT	Log header		$GPCDT
2	UTC Time	UTC time of position (hours/minutes/seconds/ decimal seconds)	hhmmss.ss	202134.00
3	GPS information	Difference between base station and rover station, in nanoseconds.	xx.x	3.2
4	GPS valid	Valid flag	x	1
5	BD2 information	Difference between base station and rover station, in nanoseconds.	xx.x	5.1
6	BD2 valid	Valid flag	x	1
7	GLONASS information	Difference between base station and rover station, in nanoseconds.	xx.x	0.0
8	GLONASS valid	Valid flag	x	0
9	GALILEO information	Difference between base station and rover station, in nanoseconds.	xx.x	0.0
10	GALILEO valid	Valid flag	x	0
11	*xx	Checksum	*hh	*1B
12	[CR][LF]	Sentence terminator		[CR][LF]

5.4.11 GPGGA GNSS Fix Data

Description:

This message is a standard NMEA log, but a little different from the standard one in position precision. The position precision of this log is the same as GPGGARTK, in order to be used in greater conditions.The header of GPGGA is always “GP” regardless if other GNSS information involved in solution computation.

Message ID	*218*

Recommended Input	*log gpgga ontime 1*
Supported Format	*ASCII*

Reply (ASCII):

```
$GPGGA,024941.00,3110.4693903,N,12123.2621695,E,
1,16,0.6,57.0924,M,0.000,M,99,AAAA*55
```

Field#	Structure	Description	Symbol	Example
1	$GPGGA	Log header		$GPGGA
2	utc	UTC time of position (hours/minutes/seconds/ decimal seconds)	hhmmss.ss	202134.00
3	lat	Latitude (DDmm.mm)	llll.lllllll	3110.4693903
4	latdir	Latitude direction (N = North, S = South)	a	N
5	lon	Longitude (DDDmm.mm)	yyyyy.yyyyyyy	121232621695
6	londir	Longitude direction (E = East, W = West)	a	W
7	GPS qual	GPS Quality indicator 0 = fix not available or invalid 1 = GPS fix 2 = C/A differential GPS, OmniSTAR HP, OmniSTAR XP, OmniSTAR VBS, or CDGPS 4 = RTK fixed ambiguity solution (RT2) 5 = RTK floating ambiguity solution (RT20), OmniSTAR HP or OmniSTAR XP 6 = Dead reckoning mode 7 = Manual input mode (fixed position) 8 =Super wide-lane mode 9 = WAAS	x	1

8	# sats	Number of satellites in use. May be different to the number in view	xx	10
9	hdop	Horizontal dilution of precision	x.x	1.0
10	alt	Antenna altitude above/below mean sea level	x.x	1062.22
11	a-units	Units of antenna altitude (M = meters)	M	M
12	undulation	Undulation - the relationship between the geoid and the WGS84 ellipsoid	x.x	-16.271
13	u-units	Units of undulation (M = meters)	M	M
14	age	Age of Differential GPS data (in seconds) b	xx	(empty when no differential data is present)
15	stn ID	Differential base station ID, 0000-1023	xxxx	(empty when no differential data is present)
16	*xx	Checksum	*hh	*48
17	[CR][LF]	Sentence terminator		[CR][LF]

5.4.12 GPGGARTK GNSS Fix Data

Description:

This message is the same as GPGGA; refer to GPGGA information in this document.

Message ID	*259*
Recommended Input	*log gpggartk ontime 1*
Supported Format	*ASCII*

Reply (ASCII):

```
$GPGGA,024941.00,3110.4693903,N,12123.2621695,E,
1,16,0.6,57.0924,M,0.000,M,99,AAAA*55
```

5.4.13 GPGLL Geographic Position

Description:

This message is a standard NMEA log, include information such as time, latitude, longitude and so on. Be different from GPGGA, if BD2or other GNSS information is involved in, the header of GLL would become “GN” instead of “GP” which is outputted in only GPS information used in solution computation.If only BD2 information is used, header becomes “BD”.

Message ID	*219*
Recommended Input	*log gpgll ontime 1*
Supported Format	*ASCII*

Reply (ASCII): GPS and BD2

```
$GNGLL,3110.4702936,N,12123.2629222,E,031449.00,
A,A*7C
```

Reply (ASCII): GPS only

```
$GPGLL,3110.4705303,N,12123.2635741,E,031544.00,
A,A*68
```

Reply (ASCII): BD2 only

```
$BDGLL,3110.4685408,N,12123.2615164,E,031628.00,
A,A*76
```

Field#	Structure	Description	Format	Example
1	$GPGLL	Log header		$GPGLL
2	lat	Latitude (DDmm.mm)	llll.lllllll	3110.4702936

3	latdir	Latitude direction (N = North, S = South)	a	N
4	lon	Longitude (DDDmm.mm)	yyyyy.yyyyyyy	12123.2629222
5	londir	Longitude direction (E = East, W = West)	a	W
6	utc	UTC time of position (hours/minutes/ seconds/decimal seconds)	hhmmss.ss	220152.50
7	data status	Data status: A = Data valid, V = Data invalid	A	A
8	mode ind	Positioning system mode indicator	a	A
9	*xx	Checksum	*hh	*1B
10	[CR][LF]	Sentence terminator		[CR][LF]

5.4.14 GPGSA GNSS DOP and Available Satellite

Description:

This message contains available satellites used in solution computation and DOP values.

Message ID	*221*
Recommended Input	*log gpgsa ontime 1*
Supported Format	*ASCII*

Reply (ASCII): GPS and BD2

```
$GNGSA,M,3,25,14,15,18,31,27,09,21,22,12,,,0.8,0
.6,0.5*2A

$GNGSA,M,3,141,143,144,146,147,148,149,150,,,,,0
.8,0.6,0.5*2C
```

Reply (ASCII): GPS only

```
$GPGSA,M,3,25,14,15,18,31,27,09,21,22,12,,,1.5,0
.9,1.3*30
```

Reply (ASCII): BD2 only

```
$BDGSA,M,3,141,143,144,146,147,148,149,150,,,,,2
.7,1.7,2.2*2B
```

Field#	Structure	Description	Symbol	Example
1	$GPGSA	Log header		$GPGSA
2	mode MA	A = Automatic 2D/3D M = Manual, forced to operate in 2D or 3D	M	M
3	mode 123	Mode: 1 = Fix not available; 2 = 2D; 3 = 3D	x	3
4 - 15	prn	PRN numbers of satellites used in solution (null for unused fields), total of 12 fields GPS = 1 to 32 SBAS = 33 to 64 (add 87 for PRN number) GLO = 65 to 96 BD2 =141 to 177	xx,xx,.....	25,14, 15,18, 31,27, 09,21, 22,12,,,,
16	pdop	Position dilution of precision	x.x	1.5
17	hdop	Horizontal dilution of precision	x.x	0.9
18	vdop	Vertical dilution of precision	x.x	1.2
19	*xx	Checksum	*hh	*3F
20	[CR][LF]	Sentence terminator		[CR][LF]

5.4.15 GPGST Pseudorange Measurement Noise Statistics

Description:

This message is a standard NMEA log. Pay attention to that rms, smjrstd, smnrstd and orient values are absent in the message currently.

Message ID	*222*
Recommended Input	*log gpgst ontime 1*
Supported Format	*ASCII*

Reply (ASCII):

Field#	Structure	Description	Symbol	Example
1	$GPGST	Log header		$GPGST
2	utc	UTC time of position (hours/minutes/seconds/ decimal seconds)	hhmmss.ss	173653.00
3	rms	RMS value of the standard deviation of the range inputs to the navigation process. Range inputs include pseudorange and DGPS corrections.	x.x	
4	smjrstd	Standard deviation of semi-major axis of error ellipse (m)	x.x	
5	smnrstd	Standard deviation of semi-minor axis of error ellipse (m)	x.x	
6	orient	Orientation of semi-major axis of error ellipse (degrees from true north)	x.x	
7	latstd	Standard deviation of latitude error (m)	x.x	2.51
8	lonstd	Standard deviation of longitude error (m)	x.x	1.94
9	alt std	Standard deviation of altitude error (m)	x.x	4.30
10	*xx	Checksum	*hh	*6E
11	[CR][LF]	Sentence terminator		[CR][LF]

Reply (ASCII): GPS and BD2

```
$GNGST,035330.00,,,,,0.22,2.37,1.44,*54
```

Reply (ASCII): GPS only

```
$GPGST,035330.00,,,,,0.22,2.37,1.44,*54
```

Reply (ASCII): BD2 only

```
$BDGST,035330.00,,,,,0.22,2.37,1.44,*54
```

5.4.16 GPGSV GNSS Satellites in View

Description:

This is a standard NMEA message which includes PRN numbers, elevation, azimuth, and SNR values of satellites in view. Messages of GPS satellites use header “GP” and BD2 use “BD”.

Message ID	*223*
Recommended Input	*log gpgsv ontime 1*
Supported Format	*ASCII*

Reply (ASCII):

```
$GPGSV,3,1,09,14,67,095,51,31,55,331,50,25,38,04
1,50,22,25,188,46*70

$GPGSV,3,2,09,30,43,228,49,29,29,096,47,32,29,30
3,45,16,17,219,43*7B

$GPGSV,3,3,09,20,07,318,41,,,,,,,,,,,,*4A

$BDGSV,2,1,08,141,49,145,47,143,36,237,45,144,34
,122,45,146,13,196,39*6E

$BDGSV,2,2,08,147,63,004,50,148,39,173,45,149,25
,222,42,150,51,324,46*6D
```

Field#	Structure	Description	Symbol	Example

1	$GPGSV	Log header		$GPGSV
2	# msgs	Total number of messages (1-9)	x	3
3	msg #	Message number (1-9)	x	1
4	# sats	Total number of satellites in view. May be different than the number of satellites in use	xx	09
5	prn	Satellite PRN number GPS = 1 to 32 SBAS = 33 to 64 (add 87 for PRN#s) GLO = 65 to 96 BD2 = 141~177	xx	03
6	elev	Elevation, degrees, 90 maximum	xx	51
7	azimuth	Azimuth, degrees True, 000 to 359	xxx	140
8	SNR	SNR (C/No) 00-99 dB, null when not tracking	xx	42
... ...	... ...	Next satellite PRN number, elev, azimuth, SNR, ... Last satellite PRN number, elev, azimuth, SNR,		
variable	*xx	Checksum	*hh	*72
variable	[CR][LF]	Sentence terminator		[CR][LF]

5.4.17 GPHDT Vessel Heading

Description:

This message is a standard log which includes actual vessel heading for True North in degrees.

Message ID	*228*
Recommended Input	*log gphdt ontime 1*
Supported Format	*ASCII*

Reply (ASCII): GPS and BD2

```
$GNHDT,89.2769,T*20
```

Reply (ASCII): GPS

```
$GPHDT,154.6566,T*06
```

Reply (ASCII): BD2

```
$BDHDT,47.8506,T*2C
```

Field#	Structure	Description	Symbol	Example
1	$GPHDT	Log header		$GPHDT
2	heading	Heading in degrees	x.x	89.2769
3	True	Degrees True	T	T
4	*xx	Checksum	*hh	*36
5	[CR][LF]	Sentence terminator		[CR][LF]

5.4.18 GPNTR information about navigate to reference station

Description:

This is a self-defined message in NMEA format, which includes distance between reference station and rover station, distance in east, distance in north, and in vertical dimension.

Message ID	*209*
Recommended Input	*Log gpntr ontime 1*
Supported Format	*ASCII*

Reply (ASCII):

```
$GPNTR,024404.00,1,17253.242,+5210.449,-
16447.587,-49.685,0004*40
```

Field#	Structure	Description	Symbol	Example
1	$GPNTR	Log header		$GPNTR
2	utc	UTC of position	hhmmss.ss	024404.00
3	pos status	GPS Quality indicator 0 = fix not available or invalid 1 = Single point position 2 = C/A differential GPS, OmniSTAR HP, OmniSTAR XP, OmniSTAR VBS, or CDGPS 4 = RTK fixed ambiguity solution (RT2) 5 = RTK floating ambiguity solution (RT20), OmniSTAR HP or OmniSTAR XP 6 = Dead reckoning mode 7 = Manual input mode (fixed position) 8 =Super wide-lane mode 9 = WAAS	I	1
4	distance	In meters	dddd.ddd	17253.242
5	distance in north	direction: +:North, -: South	dddd.ddd	+5210.449
6	distance in east	direction: +:East, -: West	dddd.ddd	-16447.587
7	Distance in Vertical dimension	direction: +:Up, -: Down	dddd.ddd	-49.685
8	Station ID	0~1023, or AAAA(No ref-station)	I	0004

9	*xx	Checksum	*hh	*12
10	[CR][LF]	Sentence terminator		[CR][LF]

5.4.19 GPRMC GNSS Specification Information

Description:

This is a standard NMEA message which includes time, date, speed and true heading.

Message ID	*225*
Recommended Input	*log gprmc ontime 1*
Supported Format	*ASCII*

Reply (ASCII): GPS and BD2

```
$GNRMC,065029.00,A,3110.4722495,N,12123.2644026,
E,0.456,330.1,050512,-0.0,W,A*12
```

Reply (ASCII): GPS

```
$GPRMC,065141.00,A,3110.4723882,N,12123.2636328,
E,0.657,140.7,050512,-0.0,W,A*00
```

Reply (ASCII): BD2

```
$BDRMC,064944.00,A,3110.4700351,N,12123.2651820,
E,0.862,89.6,050512,-0.0,W,A*26
```

Field#	Structure	Description	Symbol	Example
1	$GPRMC	Log header		$GPRMC
2	utc	UTC of position	hhmmss.ss	065029.00
3	pos status	Position status:	A	A

		A = data valid, V = data invalid		
4	lat	Latitude (DDmm.mm)	llll.ll	3110.4722495
5	latdir	Latitude direction: N = North, S = South	a	N
6	lon	Longitude (DDDmm.mm)	yyyyy.yy	12123.2644026
7	londir	Longitude direction: E = East W = West	a	E
8	speed Kn	Speed over ground, knots	x.x	0.456
9	track true	Track made good, degrees True	x.x	330.1
10	date	Date: dd/mm/yy	xxxxxx	050512
11	mag var	Magnetic variation, degrees	x.x	0.0
12	vardir	Magnetic variation direction E/W	a	W
13	mode ind	Positioning system mode indicator	a	A
14	*xx	Checksum	*hh	*12
15	[CR][LF]	Sentence terminator		[CR][LF]

5.4.20 GPSEPHEM GPS Ephemeris

Description:

A single set of decoded GNSS ephemeris whose message ID is different from NovAtel® definition.

Message ID	*71*
Recommended Input	*log gpsephemb onchanged*
Supported Format	*binary*

Reply (Binary):

Field#	Field Type	Data Description	Format	Binary Byte	Binary Offset
1	SATMSG Header[1]	Log Header		H	0
2	wSize	Struct size	unsigned short	2	H+0
3	blFlag	Eph valid flag	BYTE	1	H+2
4	bHealth	Satellite health flag	BYTE	1	H+3
5	ID	Satellite prn id(1~177)[2]	BYTE	1	H+4
6	bReserved	reserved	BYTE	1	H+5
7	uMsgID	ignored	unsigned short	2	H+6
8	m_wIdleTime	ignored	short	2	H+8
9	iodc	Issue of data clock	short	2	H+10
10	accuracy	Reference to URA in paga-84 [doc1][3]	short	2	H+12
11	week	Gps week	unsigned short	2	H+14
12	iode	Issue of data	int	4	H+16
13	tow	time of eph be sent	int	4	H+20
14	toe	Eph time	double	8	H+24
15	toc	Time of clock-para	double	8	H+32
16	af2	Reference to paga-86 [doc1]	double	8	H+40

[1]Message header

[2]GPS:1~32; BD2:141~177.

[3] Doc1:IS-GPS-200-vD.pdf

Field#	Field Type	Data Description	Format	Binary Byte	Binary Offset
17	af1	Reference to paga-86 [doc1]	double	8	H+48
18	af0	Reference to paga-86 [doc1]	double	8	H+56
19	Ms0	Mean Anomaly	double	8	H+64
20	deltan	Mean motion difference from computed value	double	8	H+72
21	es	Eccentricity	double	8	H+80
22	roota	square root	double	8	H+88
23	omega0	Longitude of ascending node of orbit plane at weekly epoch	double	8	H+96
24	i0	Inclination angle at ref. times.	double	8	H+104
25	ws	Argument of perigee	double	8	H+112
26	omegaot	Rate of right ascension	double	8	H+120
27	itoet	Rate of inclination angle	double	8	H+128
28	Cuc	Amplitude of the cosine harmonic correction term to the augument of latitude	double	8	H+136
29	Cus	Amplitude of the sine harmonic correction term to the augument of latitude	double	8	H+144
30	Crc	Amplitude of the cosine harmonic correction term to the orbit radius	double	8	H+152
31	Crs	Amplitude of the sine harmonic correction term to the orbit radius	double	8	H+160
32	Cic	Amplitude of the cosine harmonic correction term to the angle of inclination.	double	8	H+168
33	Cis	Amplitude of the sine harmonic	double	8	H+176

Field#	Field Type	Data Description	Format	Binary Byte	Binary Offset
		correction term to the angle of inclination.			
34	tgd	Reference to paga-90 [doc1]	double	8	H+184
35	tgd2[1]		double	8	H+192
36	CRC	32-bit CRC Code	Hex	4	H+200

5.4.21 GPVTG Track Make Good and Ground Speed

Description:

This is a standard NMEA message which includes make good and ground speed.

Message ID	*226*
Recommended Input	*log gpvtg ontime 1*
Supported Format	*ASCII*

Reply (ASCII): GPS and BD2

```
$GNVTG,304.723,T,304.723,M,0.365,N,0.677,K,A*3B
```

Reply (ASCII): GPS only

```
$GPVTG,213.710,T,213.710,M,0.304,N,0.563,K,A*24
```

Reply (ASCII): BD2 only

```
$BDVTG,29.710,T,29.710,M,0.836,N,1.548,K,A*37
```

[1]Only used in BD2 satellite, refer to BD2—ICD.

Field#	Structure	Description	Symbol	Example
1	$GPVTG	Log header		$GPVTG
2	track true	Track made good, degrees True	x.x	213.710
3	T	True track indicator	T	T
4	track mag	Track made good, degrees Magnetic; Track mag = Track true + (MAGVAR correction)	x.x	213.710
5	M	Magnetic track indicator	M	M
6	speed Kn	Speed over ground, knots	x.x	0.304
7	N	Nautical speed indicator (N = Knots)	N	N
8	speed Km	Speed, kilometers/hour	x.x	0.563
9	K	Speed indicator (K = km/hr)	K	K
10	mode ind	Positioning system mode indicator	a	A
11	*xx	Checksum	*hh	*24
12	[CR][LF]	Sentence terminator		[CR][LF]

5.4.22 GPZDA UTC Time and Date

Description:

This message is a standard NMEA log which includes UTC time and date.

Message ID	*276*
Recommended Input	*log gpzda ontime 1*
Supported Format	*ASCII*

Reply (ASCII):

```
$GPZDA,071642.00,05,05,2012,,*61
```

Field#	Structure	Description	Symbol	Example
1	$GPZDA	Log header		$GPZDA
2	utc	UTC time	hhmmss.ss	071642.000
3	day	Day, 01 to 31	xx	05
4	month	Month, 01 to 12	xx	05
5	year	Year	xxxx	2012
6	null	Local zone description - not available	xx	(empty when no data is present)
7	null	Local zone minutes description - not available a	xx	(empty when no data is present)
8	*xx	Checksum	*hh	*6F
9	[CR][LF]	Sentence terminator		[CR][LF]

5.4.23 GPHPR Parameters of Attitude angles

Description:

This message is a non-standard message, which includes heading, pitch or roll angle of carrier on which two antennas are placed on.

Message ID	*237*
Recommended Input	*log gphpr ontime 1*
Supported Format	*ASCII*

Reply (ASCII):

```
$GPHPR,070901.00,090.10,000.20,000.00,4,14,1.00,
0004*42
```

Field#	Structure	Description	Symbol	Example
1	$GPHPR	Log header		$GPHPR
2	utc	UTC time	hhmmss.ss	070901.00
3	heading	Heading, 0~360 degree	hhh.hh	090.10
4	pitch	Pitch, -90~90 degree	ppp.pp	000.20
5	roll	Roll, -90~90 degree	rrr.rr	000.00
6	QF	GPS Quality indicator 0 = fix not available or invalid 1 = GPS fix 2 = C/A differential 4 = RTK fixed ambiguity solution 5 = RTK floating ambiguity solution 6 = Dead reckoning mode 7 = Manual input mode (fixed position) 8 =Super wide-lane mode 9 = WAAS	q	4
7	sat No.	satellite number	n	14
8	age	differential age	dd.dd	1.00
9	stn ID	reference station ID	xxxx	0004
10	*xx	Checksum	*hh	*42
11	[CR][LF]	Sentence terminator		[CR][LF]

5.4.24 HEADING Heading Information

Description:

The heading is the angle from True North of the base to rover vector in a clockwise direction.

Message ID	*971*

Recommended Input	*log headingb onchanged*
Supported Format	*ASCII and Binary*

Replay:

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
1	HEADING header	Log header		H	0
2	sol stat	Solution status, see Table 19	Enum	4	H
3	pos type	Position type, see Table 20	Enum	4	H+4
4	length	Baseline length (0 to 3000 m)	Float	4	H+8
5	heading	Heading in degrees (0 to 360.0 degrees)	Float	4	H+12
6	pitch	Pitch (±90 degrees)	Float	4	H+16
7	Reserved		Float	4	H+20
8	hdg std dev	Heading standard deviation in degrees	Float	4	H+24
9	ptch std	Pitch standard deviation in degrees	Float	4	H+28
10	stn ID	Station ID string	Char[4]	4	H+32
11	#SVs	Number of observations tracked	Uchar	1	H+36
12	#solnSVs	Number of satellites in solution	Uchar	1	H+37
13	#obs	Number of satellites above the elevation mask	Uchar	1	H+38
14	#multi	Number of satellites above the mask angle with L2	Uchar	1	H+39
15	Reserved		Uchar	1	H+40
16	ext sol stat	Extended solution status (default: 0)	Uchar	1	H+41
17	Reserved		Uchar	1	H+42
18	sig mask	**Signals used mask - if 0, signals used in solution are unknown** (See Table 21)	Uchar	1	H+43
19	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+44

Field #	Field type	Data Description	Format	Binary Bytes	Binary Offset
20	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

5.4.25 IONUTC Ionospheric and UTC Data

Description:

The Ionospheric Model parameters (ION) and the Universal Time Coordinated parameters (UTC) are provided.

Message ID	*8*
Recommended Input	*log ionutcb onchanged*
Supported Format	*ASCII, Binary and Abb-ASCII*

Field#	Field Type	Data Description	Format	Binary Byte	Binary Offset
1	IONUTC header	Log header		H	0
2	a0	Alpha parameter constant term	Double	8	H
3	a1	Alpha parameter 1st order term	Double	8	H+8
4	a2	Alpha parameter 2nd order term	Double	8	H+16
5	a3	Alpha parameter 3rd order term	Double	8	H+24
6	b0	Beta parameter constant term	Double	8	H+32
7	b1	Beta parameter 1st order term	Double	8	H+40
8	b2	Beta parameter 2nd order term	Double	8	H+48
9	b3	Beta parameter 3rd order term	Double	8	H+56
10	utc wn	UTC reference week number	Ulong	4	H+64
11	tot	Reference time of UTC parameters	Ulong	4	H+68
12	A0	UTC constant term of polynomial	Double	8	H+72

13	A1	UTC 1st order term of polynomial	Double	8	H+80
14	wn lsf	Future week number	Ulong	4	H+88
15	dn	Day number (the range is 1 to 7 where Sunday = 1 and Saturday = 7)	Ulong	4	H+92
16	deltat ls	Delta time due to leap seconds	Long	4	H+96
17	deltat lsf	Future delta time due to leap seconds	Long	4	H+100
18	deltat utc	Time difference	Ulong	4	H+104
19	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+108
20	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

5.4.26 PJKPARA Parameters Used in Message PTNLPJK

Description:

This message is used to check the six parameters used in PTNLPJK message;for detailed information and definition please refer to Table 13.

Message ID	*2013*
Recommended Input	*log pjkpara*
Supported Format	*ASCII*

Reply (ASCII):

```
A:6378137.000, 1/F:298.257, B0:0.000000deg,
L0:120.000000, N0:0.000, E0:500000.000
```

5.4.27 PSRDOP Pseudorange DOP

Description:

The dilution of precision data is calculated using the geometry of only those satellites that arecurrently being tracked and used in the position solution by the board. This log is updated onceevery 60 seconds or whenever a change in the satelliteconstellation occurs. Therefore, the totalnumber of data fields output by the log isvariable and depends on the number of SVs that are beingtracked.

Message ID	*174*
Recommended Input	*log psrdopb ontime 1*
Supported Format	*binary*

Reply (Binary)

Field#	Field Type	Data Description	Format	Binary Byte	Binary Offset
1	PSRDOP Header	Log Header		H	0
2	gdop	Geometric dilution of precision	Float	4	H
3	Pdop	Position dilution of precision	Float	4	H+4
4	Hdop	horizontal dilution of precision	Float	4	H+8
5	Htdop	Horizontal position and time dilution of precision	Float	4	H+12
6	Tdop	Time dilution of precision	Float	4	H+16
7	Cutoff	Elevation cut-off angle	Float	4	H+20
8	#prn	Number of satellites PRNs to follow	Long	4	H+24
9	Prn	PRN of SV PRN tracking	Ulong	4	H+28
10	Next prn offset = H+28+(#prn*4)				
11	CRC	32-bit CRC	Hex	4	H+28+(#prn*4)

5.4.28 PSRPOS Pseudorange Position

Description:

This message includes position calculated using pseudorange and other information such as differential age, station id and so on.

Message ID	*47*
Recommended Input	*log psrposb ontime 1*
Supported Format	*binary*

Reply (Binary):

Field#	Field Type	Data Description	Format	Binary Byte	Binary Offset
1	PSRPOS header	Log header		H	0
2	sol status	Solution status (refer to Table 19)	Enum	4	H
3	pos type	Position type (refer to Table 20)	Enum	4	H+4
4	lat	Latitude	Double	8	H+8
5	lon	Longitude	Double	8	H+16
6	hgt	Height above mean sea level	Double	8	H+24
7	undulation	Undulation - the relationship between the geoids and the WGS84 ellipsoid (m)	Float	4	H+32
8	datum id#	Datum ID number	Enum	4	H+36
9	lat σ	Latitude standard deviation	Float	4	H+40
10	lon σ	Longitude standard deviation	Float	4	H+44
11	hgt σ	Height standard deviation	Float	4	H+48
12	stn id	Base station ID	Char[4]	4	H+52
13	diff_age	Differential age in seconds	Float	4	H+56
14	sol_age	Solution age in seconds	Float	4	H+60
15	#SVs	Number of satellite vehicles tracked	Uchar	1	H+64

16	#solnSVs	Number of satellite vehicles used in solution	Uchar	1	H+65
17	Reserved		Uchar	1	H+66
18			Uchar	1	H+67
19			Uchar	1	H+68
20	ext sol stat	Extended solution status (default: 0)	Hex	1	H+69
21	Reserved		Hex	1	H+70
22	sig mask	Signals used mask - if 0, signals used in solution are unknown. (See Table 21)	Hex	1	H+71
23	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+72
24	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

5.4.29 PTNLPJK Local Coordinates Calculated in Specified Parameters

Description:

This message is used to make local measurement in specified PJK parameters configured by user such as A0, F, N0, E0, B0, L0.(refer to Table 13)

Message ID	*229*
Recommended Input	*log ptnlpjk ontime 1*
Supported Format	*ASCII*

Reply (ASCII):

```
$PTNL,PJK,090856.00,050712,+3451152.262,N,+63229
5.897,E,1,13,0.9,EHT+58.181,M*7D
```

5.4.30 RANGE Detailed observation information

Description:

This message includes detailed observation information such as pseudorange, carrier phase, Doppler, signal to noise ration and so on. At the same time, detailed channel states are involved.

Message ID	*43*
Recommended Input	*log rangeb ontime 1*
Supported Format	*binary*

#Field	Field Type	Description	Format	Binary Byte	Offset
1	RANGE header	Log header		H	0
2	# obs	Number of observations with information to follow a	Long	4	H
3	PRN/ slot	Satellite PRN number of range measurement (see Table 23)	UShort	2	H+4
4	glofreq	(GLONASS Frequency + 7)	UShort	2	H+6
5	psr	Pseudorange measurement (m)	Double	8	H+8
6	psrstd	Pseudorange measurement standard deviation (m)	Float	4	H+16
7	adr	Carrier phase, in cycles (accumulated Doppler range)	Double	8	H+20
8	adrstd	Estimated carrier phase standard deviation (cycles)	Float	4	H+28
9	dopp	Instantaneous carrier Doppler frequency (Hz)	Float	4	H+32
10	C/No	Carrier to noise density ratio C/No = 10[log10(S/N0)] (dB-Hz)	Float	4	H+36
11	locktime	# of seconds of continuous tracking (no cycle	Float	4	H+40

		slipping)			
12	ch-tr-status	Tracking status (seeTable 22, Channel Tracking Status)	ULong	4	H+44
13...	Next PRN offset = H + 4 + (#obs x 44)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+4+ (#obs x 44)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

5.4.31 RANGECMP Compressed Range Information

Description:

This message contains the channel measurements for the currently tracked satellites.

Message ID	*140*
Recommended Input	*log rangecmpb ontime 1*
Supported Format	*binary*

Reply (Binary):

Table 22.Channel Tracking Status

DATA	BIT(S) FIRST TO LAST	LENGTH (BITS)	SCALE FACTOR	UNITS
Channel Tracking Status	0-31	32	See Table 26	-
Doppler Frequency	32-59	28	1/256	Hz
Pseudorange (PSR)	60-95	36	1/128	m

ADR a	96-127	32	1/256	cycles
StdDev-PSR	128-131	4		m
StdDev-ADR	132-135	4	(n + 1)/512	cycles
PRN/Slot c	136-143	8	1	-
Lock Time d	144-164	21	1/32	s
C/No e	165-169	5	(20 + n)	dB-Hz
Reserved	170-191	22		

Field#	Field Type	Data Description	Format	Binary Byte	Binary Offset
1	RANGECMP header	Log header		H	0
2	#obs	Number of satellite observations with information to follow.	Long	4	H
3	1st range record	Compressed range log in above format	Hex	24	H+4
4	Next rangecmp offset = H + 4 + (#obs x 24)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H + 4 + (#obs x 24)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Table 23.PRN Definition in Binary Message

GNSS	PRN
GPS	1~32
GLONASS	38~61
SBAS	120~138
BD2	141~177

Table 24.Tracking State

STATE	DESCRIPTION	STATE	DESCRIPTION
0	dle	7	Frequency-lock loop
2	Wide frequency band pull-in	9	Channel alignment
3	Narrow frequency band pull-in	10	Code search
4	Phase lock loop	11	Aided phase lock loop

Table 25.Correlator Type

STATE	DESCRIPTION
0	N/A
1	Standard Correlator: spacing = 1 chip
2	Narrow Correlator: spacing < 1 chip
3	Reserved
4	Pulse Aperture Correlator (PAC)
5-6	Reserved

Table 26.Channel Tracking

NIBBLE #	BIT #	MASK	DESCRIPTION	RANGE VALUE
N0	0	0x00000001	Tracking state	Refer to **Table 24.** Tracking State
	1	0x00000002		
	2	0x00000004		
	3	0x00000008		
N1	4	0x00000010		
	5	0x00000020	SV channel number	Tracking channel ID
	6	0x00000040		
	7	0x00000080		

NIBBLE #	BIT #	MASK	DESCRIPTION	RANGE VALUE
N2	8	0x00000100		
	9	0x00000200		
	10	0x00000400	Phase lock flag	0 = Not locked, 1 = Locked
	11	0x00000800	Parity known flag	0 = Not known1 = Known
N3	12	0x00001000	Code locked flag	0 = Not locked 1 = Locked
	13	0x00002000	Correlator type	Refer to Table 25
	14	0x00004000		
	15	0x00008000		
N4	16	0x00010000	Satellite system	0 = GPS 1= GLONASS 2 = WAAS 3 = GALILEO 4 = BD2 5-6 = Reserved 7 = Other
	17	0x00020000		
	18	0x00040000		
	19	0x00080000	Reserved	
N5	20	0x00100000	Grouping	0 = Not grouped, 1 = Grouped
	21	0x00200000	Signal type	Dependent on satellite system above: GPS: 0 = L1 C/A 2 = L5 5 = L2 P 9 = L2 P codeless 17 = L2C
	22	0x00400000		
	23	0x00800000		
N6	24	0x01000000		
	25	0x02000000		

NIBBLE #	BIT #	MASK	DESCRIPTION	RANGE VALUE
				GLONASS: 0 = L1 C/A 1 = L2 C/A 5 = L2 P BD2: 0 = L1 C/A 17 = L2 C/A 2 = L3 C/A SBAS: 0 = L1 C/A Other: 19 = OmniSTAR 23 = CDGPS
	26	0x04000000	Forward Error Correction	0 = Not FEC, 1 = FEC
	27	0x08000000	Primary L1 channel	0 = Not primary, 1 = Primary
N7	28	0x10000000	Carrier phase measurement	0 = Half Cycle Not Added, 1 = Half Cycle Added
	29	0x20000000	Reserved	
	30	0x40000000	PRN lock flag	0 = PRN Not Locked Out 1 = PRN locked Out
	31	0x80000000	Channel assignment	0 = Automatic, 1 = Forced

5.4.32 RAWALM Raw Almanac Information

Description:

This message contains raw almanac sub frames received from GPS satellite.

Message ID	*74*
Recommended Input	*log rawalmb*
Supported Format	*binary*

Reply (Binary):

Field#	Field Type	Data Description	Format	Binary Byte	Binary Offset
1	RAWALM header	Log header		H	0
2	ref week	Almanac reference week number	Ulong	4	H
3	ref secs	Almanac reference time (s)	Ulong	4	H+4
4	subframes	Number of subframes to follow	Ulong	4	H+8
5	svid	SV ID (satellite vehicle ID)	UShort	2	H+12
6	data	Subframe page data	Hex	30	H+14
7...	Next subframe offset = H + 12 + (subframe x 32)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H + 12 + (32 x subframes)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

5.4.33 RAWPEHEM Raw Ephemeris Information

Description:

This message contains raw ephemeris information received from GPS satellite.

Message ID	*41*
Recommended Input	*log rawephemb onchanged*
Supported Format	*binary*

Reply (Binary):

Field#	Field Type	Data Description	Format	Binary Byte	Binary Offset
1	RAWEPHEM header	Log header		H	0
2	prn	Satellite PRN number	Ulong	4	H
3	ref week	Ephemeris reference week number	Ulong	4	H+4
4	ref secs	Ephemeris reference time (s)	Ulong	4	H+8
5	subframe1	Subframe 1 data	Hex	30	H+12
6	subframe2	Subframe 2 data	Hex	30	H+42
7	subframe3	Subframe 3 data	Hex	30	H+72
8	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+102
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

5.4.34 REFSTATION Base Station Position and Health

Description:

This message includes base station position and health information received from differential messages.

Message ID	*175*
Recommended Input	*log refstationb onchanged*
Supported Format	*binary*

Reply (Binary):

Table 27.Base Station Status

BIT #	MASK	DESCRIPTION	BIT = 0	BIT = 1
0	0x00000001	Validity of the base station.	Valid	Invalid

Table 28.Base Station Type

Base Station Type (Binary) (ASCII)		Description
0	NONE	Base station is not used
1	RTCM	Base station is RTCM
2	RTCA	Base station is RTCA
3	CMR	Base station is CMR
4	RTCMV3	Base station is RTCMV3

Field#	Field Type	Data Description	Format	Binary Byte	Binary Offset
1	REFSTATION header	Log header		H	0
2	status	Status of the base station information (refer to Table 27)	ULong	4	H
3	x	ECEF X value	Double	8	H+4
4	y	ECEF Y value	Double	8	H+12
5	z	ECEF Z value	Double	8	H+20
6	health	Base station health(0:Health OK)	Ulong	4	H+28
7	stn type	Base station type (Table 28)	Enum	4	H+32
8	stn ID	Base station ID	Char[5]	8a	H+36
9	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+44

10	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

5.4.35 RTCM1002 Extended L1 GPS Observables

Description:

This message is a standard log of RTCM3 which contains extended L1 GPS observables of reference station.

Message ID	*785*
Recommended Input	*log rtcm1002b ontime 1*
Supported Format	*Binary*

Reply (Binary):

If detailed information about this message is needed, please refer to standard RTCM SC104 3.X documents.

5.4.36 RTCM1004 Extended L1/L2 GPS Observables

Description:

This message is a standard log of RTCM3 which contains extended L1 and L2 GPS observables of reference station.

Message ID	*787*
Recommended Input	*log rtcm1004b ontime 1*
Supported Format	*Binary*

Reply (Binary):

If detailed information about this message is needed, please refer to standard RTCM SC104 3.X documents.

5.4.37 RTCM1005 Base Station Position

Description:

This message is a standard log of RTCM3 which includes position information of reference station.

Message ID	*788*
Recommended Input	*log rtcm1005b ontime 5*
Supported Format	*binary*

Reply (Binary):

If detailed information about this message is needed, please refer to standard RTCM SC104 3.X documents.

5.4.38 RTCM1006 Base Station Position and Antenna Height

Description:

This message is a standard log of RTCM3 which includes position information and antenna height of reference station.

Message ID	*789*
Recommended Input	*log rtcm1006b ontime 5*
Supported Format	*binary*

Reply (Binary):

If detailed information about this message is needed, please refer to standard RTCM SC104 3.X documents.

5.4.39 RTCM1007 Extended Information about Base Station

Description:

This message is a standard log of RTCM3 which includes position, antenna height and descriptions of reference station.

Message ID	*856*
Recommended Input	*log rtcm1007b ontime 5*
Supported Format	*binary*

Reply (Binary):

If detailed information about this message is needed, please refer to standard RTCM SC104 3.X documents.

5.4.40 RTCM1008 Extended Information about Base Station

Description:

This message is a standard log of RTCM3 which includes position, antenna height and descriptions of reference station.

Message ID	*857*
Recommended Input	*log rtcm1008b ontime 5*
Supported Format	*binary*

Reply (Binary):

If detailed information about this message is needed, please refer to standard RTCM SC104 3.X documents.

5.4.41 RTCM1010 Extended L1-Only GLONASS Observables

Description:

This message is a standard log of RTCM3 which contains extended L1 GLONASS observables of reference station.

Message ID	*898*
Recommended Input	*log rtcm1010b ontime 1*
Supported Format	*Binary*

Reply (Binary):

If detailed information about this message is needed, please refer to standard RTCM SC104 3.X documents.

5.4.42 RTCM1033 Extended Information about Base Station

Description:

This message is a standard log of RTCM3 which includes position, antenna height and descriptions of reference station.

Message ID	*999*
Recommended Input	*log rtcm1033b ontime 5*
Supported Format	*binary*

Reply (Binary):

If detailed information about this message is needed, please refer to standard RTCM SC104 3.X documents.

5.4.43 RTCM1104 BD2 RTK Message

Description:

Because no available message could be applied to involve BD2 observables in RTCM3, a non-standard message is defined for currently applications. The message might be disabled if a standard RTCM3 message which includes BD2 observables is published. Just like messages about GPS RTK, a similar message style is adopted to encode information of BD2 satellites, as descript in Table 29 to

Table 33.

Message ID	*781*
Recommended Input	*log rtcm1104b ontime 1*
Supported Format	*binary*

Reply (Binary):

Each frequency of BD2 is independent of the others, so an indicator should be defined to reflect which frequency is involved. Be different from standard RTCM3 message header, an additional 3 bits are added to descript the involved frequency, refer to the last content-line in Table 31.

Table 29.BD2 RTK Message

MESSAGE TYPE	MESSAGE CONTENTS	MESSAGE ID
Observations	BD2 B1/B2/B3 observables	1104

Table 30.BD2 RTK Message Data Field

DF #	DF NAME	DF RANGE	DFRESOLUTION	DATATYPE	DATA FIELD NOTES
DF001	Reserved				
DF002	Message Number	0-4095		uint12	
DF003	Reference StationID	0-4095		uint12	
DF004	BD2 Epoch Time(TOW)	0-604,799,999	1 ms	uint30	

DF #	DF NAME	DF RANGE	DFRESOLUTION	DATATYPE	DATA FIELD NOTES
		ms			
DF005	Synchronous GNSS MessageFlag			bit(1)	
DF006	No. of BD2Satellite SignalsProcessed	0-31		uint5	The Number of BD2 Satellite Signals Processed refers to the numberof satellites in the message. It does not necessarily equal thenumberof satellites visible to the Reference Station.
DF007	BD2 Divergence-free SmoothingIndicator			bit(1)	
DF008	Smoothing Interval			bit(3)	
DF009	BD2B1/B2/B3 Indicator			bit(3)	Indicator CombineB1B2B3 B1=0 No B1 Observations B2=0 No B1 Observations B3=0 No B1 Observations
DF010	BD2 Satellite ID	0-63		uint6	
DF011	BD2 Code Indicator			bit(2)	0= C/A
DF012	BD2 Pseudorange	0-299,792.46 m	0.02 m	uint24	The BD2 B1/B2/B3 Pseudorange field provides the raw pseudorangemeasurement at the reference station in meters, modulo one light-millisecond(299,792.458 meters). The BD2 B1/B2/B3

DF #	DF NAME	DF RANGE	DFRESOLUTION	DATATYPE	DATA FIELD NOTES
					pseudorangemeasurement is reconstructed by the user receiver from the B1/B2/B3pseudorange field by: (BD2 B1/B2/B3 pseudorange measurement) = (BD2 B1/B2/B3 pseudorange field)modulo (299,792.458 m) + integer as determined from the userreceiver's estimate of the reference station range, or as provided by theextended data set. If DF013 is set to 80000h, this field does notrepresent a valid BD2 B1/B2/B3 pseudorange.
DF013	BD2 B1/B2/B3 PhaseRange – B1/B2/B3 Pseudorange	± 262.1435 m	0.0005 m	int20	
DF014	BD2 B1/B2/B3 Time Indicator			uint7	
DF015	BD2 Integer B1/B2/B3Pseudorange ModulusAmbiguity		299,792.458 m	uint8	The BD2 Integer B1/B2/B3 Pseudorange Modulus Ambiguity represents theinteger number of full

DF #	DF NAME	DF RANGE	DFRESOLUTION	DATATYPE	DATA FIELD NOTES
					pseudorange modulus divisions (299,792.458m) of the raw B1/B2/B3 pseudorange measurement.
DF016	BD2 B1/B2/B3 CNR		0.25 dB-Hz	uint8	
DF017	BD2 BLOCK				Refer to **Table 33**

The Type 1104 Message supports single-frequency, dual-frequency and triple-frequency RTK operation. The frequency number included in each satellite is referred to DF009.

Table 31.Contents of BD2 RTK Message Header

DATA FIELD	DF NUMBER	DATA TYPE	BIT NO.
Message Number (e.g.,"1001"= 0011 1110 1001)	DF002	Uint12	12
Reference Station ID	DF003	uint12	12
BD2 Epoch Time (TOW)	DF004	Uint30	30
Synchronous GNSS Flag	DF005	bit(1)	1
No. of BD2 Satellite Signals Processed	DF006	uint5	5
BD2 Divergence-free Smoothing Indicator	DF007	bit(1)	1
BD2 Smoothing Interval	DF008	bit(3)	3
BD2B1/B2/B3 Indicator	DF009	bit(3)	3
TOTAL			67

Table 32.Contents of the Satellite-Specific Portion, Each Satellite

DATA FIELD	DF NUMBER	DATA TYPE	NO. OF BITS
BD2 Satellite ID	DF010	Uint6	6
BD2 Block(according to DF009)	DF017		69
BD2 Block(according to DF009)	DF017		69

BD2 Block(according to DF009)	DF017		69
TOTAL			6+69*n

Table 33.DF017(BD2 Block)-Frequency Contents of BD2 Satellite

DATA FIELD	DF NUMBER	DATA TYPE	BIT NO.
BD2 Code Indicator	DF011	bit(2)	2
BD2 Pseudorange	DF012	uint24	24
BD2 PhaseRange– Pseudorange	DF013	int20	20
BD2 Lock time Indicator	DF014	uint7	7
BD2 Integer Pseudorange Modulus Ambiguity	DF015	uint8	8
BD2CNR	DF016	uint8	8
TOTAL			69

5.4.44 RTCM1819 Raw Measurement

Description:

This message is a standard log of RTCM2.X which contains GPS dual frequency observables.

Message ID	*399*
Recommended Input	*log rtcm1819b ontime 1*
Supported Format	*binary*

Reply (Binary):

If detailed information about this message is needed, please refer to standard RTCM SC104 2.X documents.

5.4.45 RTCM3 Base Station Information

Description:

This message is a standard log of RTCM2.X which contains base station parameters.

Message ID	*402*
Recommended Input	*log rtcm3b ontime 5*
Supported Format	*binary*

Reply (Binary):

If detailed information about this message is needed, please refer to standard RTCM SC104 2.X documents.

5.4.46 RTCMDATA1 Pseudorange Correction

This message is used for pseudorange differential corrections, include all information of RTCM1 message of standard RTCM2.3.

Message ID	*396*
Recommended Input	*log rtcmdata1b ontime 1*
Supported Format	*binary*

#Field	Field type	Data Description	Format	Binary Byte	Offset
1	RTCMDATA1 header	Log header	-	H	0
2	RTCM header	RTCM message type	Ulong	4	H
3		Base station ID	Ulong	4	H+4
4		Modified Z count where the Z count week number is the week number from subframe	Ulong	4	H+8

#Field	Field type	Data Description	Format	Binary Byte	Offset
		1 of the ephemeris			
5		Sequence number	Ulong	4	H+12
6		Length of frame	Ulong	4	H+16
7		Base station health, see REFSTATION.	Ulong	4	H+20
8	#prn	Number of PRNs with information to follow	Ulong	4	H+24
9	scale	Scale where 0 = 0.02 m and 0.002 m/s 1 = 0.32 m and 0.032 m/s	Ulong	4	H+28
10	UDRE	User differential range error	Ulong	4	H+32
11	PRN/slot	Satellite PRN number of range measurement (GPS: 1-32 and BD2: 141~177)	Ulong	4	H+36
12	psrcorr	Scaled pseudorange correction (meters)	Long	4	H+40
13	rate corr	Scaled range rate correction	Long	4	H+44
14	IOD	Issue of data	Long	4	H+48
15...	Next PRN offset = H+28 + (#prns x 24)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	variable
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

5.4.47 SATMSG Satellite Information

Description:

This log provides both the information of satellites, like PRN numbers, elevation, azimuth, and some board's information, including signal strength and battery status. This log type is defined by COMPASS, and you can't find it in NovAtel® manual.

For integrative receivers, much information should be collected from numbers of messages to display in screen or other media, so this message involved nearly all the information you need is strongly recommended.

Message ID	*911*
Recommended Input	*log satmsgb*
Supported Format	*binary*

Reply (Binary):

Field#	Field Type	Data Description	Format	Binary Byte	Binary Offset
1	SATMSG Header	Log Header		H	0
2	Sat Number	Satellite number	Byte	1	H
3	Ver Number[1]	Version number	Byte	1	H+1
4	GPRS Str	GPRS signal strength	Byte	1	H+2
5	BlueToothStr	Bluetooth signal strength	Byte	1	H+3
6	Battery Status	Battery status	Byte	1	H+4
7	Fre Flag[2]	Frequencyflag	Byte	1	H+5
8	PRN[3]	Satellite ID (1~177)	Byte	1	H+6
9	Azimuth	Degree (°)	Short	2	H+7
10	Elevation	Degree (°)	Byte	1	H+9
11	L1 Status[4]	Frequency status about L1	Byte	1	H+10
12	L1 SNR	L1 signal noise ratio	Byte	1	H+11
13	L1 RMS	L1 RMS	Byte	1	H+12
14	L1 Lost Counter	L1 track lost counter	Byte	1	H+13

[1] From Version Number: 2, frequency flag and frequency status become effective

[2] **Frequency flag identification** refers to the table Frequency Flag

[3] PRN: GPS(1~32), GLONASS(~), WAAS(~), BD(141~177)

[4] Frequency status identification refers to the table Frequency Status Table

15	Next FreInfor	May be L2 Infor, according to fre-flag		4	H+14
16	Next FreInfor	May be L5 infor, according to fre-flag		4	H+18
17	Next Sat Offset: H + 10 + Sat × (4 + Fre No*4)				
18	CRC	32-bit CRC Code	Hex	4	H+10+ Sa×(4+ Fre No*4)

Table 34.Frequency Flag (Version 2)

BIT	DESCRIPTION
BIT7	Reserved
BIT6	Reserved
BIT5	Reserved
BIT4	Reserved
BIT3	Reserved
BIT2	L3 information involved (GPS: L5; BD2: B3)
BIT1	L2 information involved (GPS: L2; BD2: B2)
BIT0	L1 information involved (GPS: L1; BD2: B1)

Table 35.Frequency Status

BIT	DESCRIPTION	VALUE
BIT7	In RTK calculation, if reference satellite	1: reference satellite 0: not
BIT6	Reserved	
BIT5	Reserved	
BIT4	In RTK calculation, if involved in combined ambiguity	1: used 0: not used
BIT3	In RTK calculation, if ambiguity fixed	1: used

		0: not used
BIT2	In RTK calculation, if carrier-phase used	1: used 0: not used
BIT1	In RTK calculation, if pseudorange used	1: used 0: not used
BIT0	This frequency information if valid	1: valid 0: invalid

5.4.48 SATVIS Satellite Visibility

Description:

This message contains satellite visibility information such as elevation and azimuth.

Message ID	*48*
Recommended Input	*log satvisb ontime 5*
Supported Format	*binary*

Reply (Binary)

FIELD#	FIELD TYPE	DATA DESCRIPTION	FORMAT	BINARY BYTE	BINARY OFFSET
1	SATVIS Header	Log Header		H	0
2	Sat vis	Satellite visibility valid? 0 = false, 1 = true	Enum	4	H
3	Comp alm	Complete GPS almanac used? 0=false, 1= true;	Enum	4	H+4
4	#sat	Number of satellites	Ulong	4	H+8
5	PRN/slot	PRN number of range measurement	Short	2	H+12

		(GPS: 1-32)			
6	glofreq	Not used	Short	2	H+14
7	health	Satellite health	Ulong	4	H+16
8	Elev	Elevation (degrees)	Double	8	H+20
9	Az	Azimuth (degrees)	Double	8	H+28
10	True dop	Theoretical Doppler of satellite	Double	8	H+36
11	App dop	Apparent Doppler for this board	double	8	H+44
12	Next satellite offset = H+12+(#sat*40)				
13	CRC	32-bit CRC	Hex	4	H+12+(#sat*40)

5.4.49 TIME Time Data

Description:

This log provides several time related pieces of information including board clock offset and UTCtime and offset. It can also be used to determine any offset in the PPS signal relative to GPS time.

Message ID	*101*
Recommended Input	*log timeb ontime 1*
Supported Format	*binary*

Reply (Binary)

Field#	Field Type	Data Description	Format	Binary Byte	Binary Offset

1	TIME Header	Log Header		H	0
2	Clock status	Clock model status, refer to **Table 36**	Enum	4	H
3	Offset	Board clock offset	Double	8	H+4
4	Offset std	Board clock offset standard deviation.	Double	8	H+12
5	Utc offset	The offset of GPS time from UTC time	Double	8	H+20
6	Utc year	UTC year	Ulong	4	H+28
7	Utc month	UTC month (0-12)	Uchar	1	H+32
8	Utc day	UTC day (0-31)	Uchar	1	H+33
9	Utc hour	UTC hour (0-23)	Uchar	1	H+34
10	Utc min	UTC minute (0-59)	Uchar	1	H+35
11	Utcms	UTC millisecond (0-60999)	Ulong	4	H+36
12	Utc status	UTC status, 0 = Invalid 1 = Valid, 2 = Warningc	Enum	4	H+40
13	CRC	32-bit CRC	Hex	4	H+44

Table 36.Clock Model Status

VALUE	CLOCK STATUS	DESCRIPTION
0	VALID	The clock model is valid
1	CONVERGING	The clock model is near validity
2	ITERATING	The clock model is iterating towards validity
3	INVALID	The clock model is not valid
4	ERROR	Clock model error

5.4.50 TRACKSTAT Tracking State

Description:

This log provides channel tracking status information for each of the receiver parallel channels.

Message ID	*83*
Recommended Input	*log trackstatb ontime 1*
Supported Format	*binary*

Reply (Binary):

Field#	Field Type	Data Description	Format	Binary Byte	Binary Offset
1	TRACKSTAT header	Log header		H	0
2	sol status	Solution status (refer to Table 19)	Enum	4	H
3	pos type	Position type (refer to Table 20)	Enum	4	H+4
4	cutoff	Tracking elevation cut-off angle	Float	4	H+8
5	# chans	Number of hardware channels with information to follow	Long	4	H+12
6	PRN/slot	Satellite PRN number of range measurement (refer to Table 9)	Short	2	H+16
7	glofreq	Only used in GLONASS, null yet	Short	2	H+18
8	ch-tr-status	Channel tracking status (refer to Table 24)	ULong	4	H+20
9	psr	Pseudorange (m) - if this field is zero but the channel tracking status in the previous field indicates that the card is phase locked and code locked, the pseudorange has not been calculated yet.	Double	8	H+24
10	Doppler	Doppler frequency (Hz)	Float	4	H+32
11	C/No	Carrier to noise density ratio (dB-Hz)	Float	4	H+36

12	locktime	Number of seconds of continuous tracking (no cycle slips)	Float	4	H+40
13	psr res	Pseudorange residual from pseudorange filter (m)	Float	4	H+44
14	reject	Range reject code from pseudorange filter	Enum	4	H+48
15	psr weight	Pseudorange filter weighting	Float	4	H+52
16...	Next PRN offset = H + 16 + (#chans x 40)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+16+ (#chans x 40)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

5.4.51 VERSION Version Information

Description:

This log contains the version information of aboard.

Message ID	*37*
Recommended Input	*log version*
Supported Format	*ASCII, binary and abbreviated ASCII*

Reply (Abbreviated ASCII)

```
<VERSION COM1 0 60.0 UNKNOWN    0      0.000
00000000 0000 1114

<     1
```

```
<         GPSCARD "S2002" "00902165          "
"CARD-501AA-22" "1.10A-1.10A" "1.000" "2012/May/
5" "18:18:52"
```

Field#	Field Type	Data Description	Format	Binary Byte	Binary Offset
1	VERSION Header	Log Header		H	0
2	#comp	Number of components, value =1	Long	4	H
3	type	Component type, value = 0	Enum	4	H+4
4	model	Model Information (refer to **Figure 2. Model**)	Char[]	16	H+8
5	PSN	Product serial number (refer to **Figure 3**)	Char[]	16	H+24
6	Hw version	Hardware version (refer to **Figure 4**)	Char[]	16	H+40
7	Sw version	Software version (refer to **Figure 5**)	Char[]	16	H+56
8	Boot version	Boot code version	Char[]	16	H+72
9	Comp date	Firmware compile date (refer to **Table 40**)	Char[]	12	H+88
10	Comp time	Firmware compile time (refer to **Table 41**)	Char[]	12	H+100
11	CRC	32-bit CRC	Hex	4	H+112

In Figure 2, each number denotes frequency No. in corresponding GNSS system; the first denotes GPS, GLONASS, GALILEO and BD2 in turns.

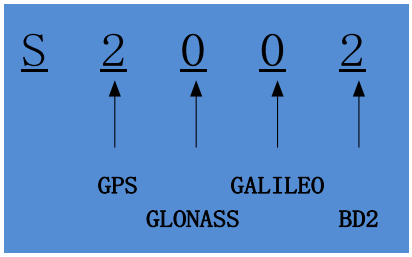


Figure 2. Model

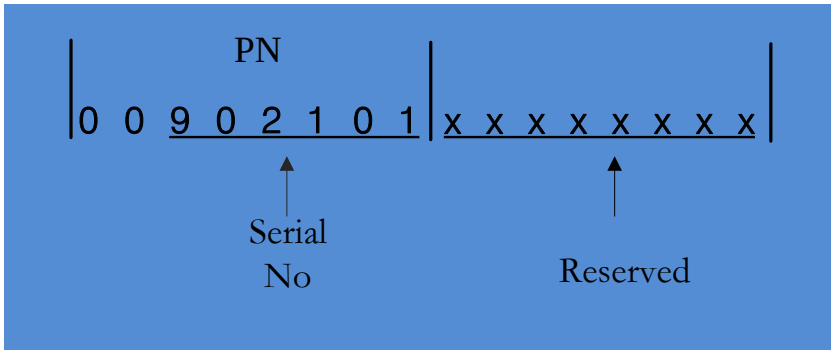


Figure 3. Product Serial No.

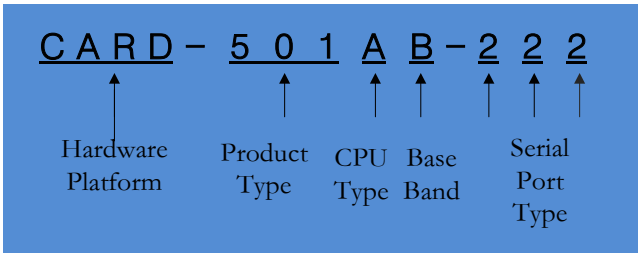


Figure 4. Hardware Version

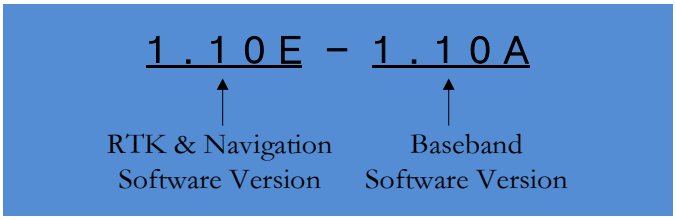


Figure 5. Software Version

Table 37.CPU Type

CPU FLAG	CPU MODEL
A	
B	
C	

Table 38.Base Band Type

FPGA FLAG	FPGA MODEL

A	
B	
C	
D	

Table 39.Serial Port Type

SERIAL PORT FLAG	PORT CONFIGURATION
2	RS232
4	RS422
T	LV TTL
X	Selectable configuration

Table 40.Compile Date

YYYY/MM/DD	YYYY: Year MM: Month DD: Day

Table 41.Compile Time

HH:MM:SS	HH: Hour MM: Minute SS: Second

5.5 OTHER LOGS

Some log commands are designed for requesting and checking system configuration parameters, such as cut-angle, reference mode and so on.

To set up a reference station, a group of logs are needed, some examples are demonstrated.

5.5.1 Parameters can be requested

Description:

Below key words could be added after key word 'log' to request the corresponding parameters.

KEY WORD	DESCRIPTION
BD2ECUTOFF	BD2 cutoff angle.
ECUTOFF	GPS cutoff angle.
REFMODE	Reference mode, auto-started, SPP or fixed position.
RTKTIMEOUT	Time thresh of differential data could be used.
PJKPARA	PJK configuration parameters.
GLOECUTOFF	GLONASS cutoff angle.
MAGVAR	Magnetic variation correction.
PVTFREQ	PVT frequency.
RTKFREQ	RTK frequency.
SYSCONFIG	Main system configuration parameters.
REGLIST	Registered functions list
REFPJKXYH	Ref-Station position in PJK mode.

5.5.2 CMR

Description:

The published CMR messages are only about GPS, so currently we could not broadcast BD2 information in CMR format. An example is given below to show how to setup a CMR base station.

LOG TYPE	SYNCH	NOTE
Recommended	interfacemode com2 none cmr	Configure port

Input	fix position 30.123 121.456 50.789 log com2 cmrrefb ontime 10 log com2 cmrobsb ontime 1	Identify station position Set position message Set observables message

5.5.3 RTCM 2.3

Description:

Just like above example, the way to set up a RTCM2 base station is as below.

LOG TYPE	SYNCH	NOTE
Recommended Input	interfacemode com2 none rtcm fix position 30.123 121.456 50.789 log com2 rtcm3b ontime 10 log com2 rtcm1819b ontime 1	Configure port Identify station position Set position message Set observables message

5.5.4 RTCM V3

Description:

Because BD2 differential messages are not involved in RTCMV3 official documents, we define message: 1104 to encode BD2 observations currently.

BD2 differential data not defined in RTCMV3 official documents, so message 1104 may be updated or disabled in the future.

LOG TYPE	SYNCH	NOTE
Recommended Input	interfacemode com2 none rtcm fix position 30.123 121.456 50.789	Configure port Identify station position

	log com2 rtcm1005b ontime 10	Set position message
	log com2 rtcm1104b ontime 1	Set BD2 observables message
	log com2 rtcm1004b ontime 1	Set GPS observables message

5.6 COMMANDS FOR TEST

CHAPTER 6. OPERATIONS FREQUENTLY-USED

6.1 START BASE STATION

```
Command1: Log port obsdata ontime x

Command2: Log port refdata ontime x

Command3: Fix position / Refautosetup on

Command4: Saveconfig
```

NOTICE:

- ☞ PORT TYPE: COM1/COM2/BLUETOOTH/GPRS DEFAULT CURRENT PORT
- ☞ ONTIME X: MAX = 5HZ NORMAL 0.2/1/5/10/15/30/60 S
- ☞ OBSDATA TYPE: RTCM1819B/ RTCM1004B /RTCM1104B /CMROBSB
- ☞ REFDATA TYPE: RTCM3B /RTCM1005B /CMRREFB

Set up reference station in RTCM2 format, outputted from COM1:

```
Command1: LOG COM1 RTCM3B ONTIME 5
```

Message 3 outputted from COM1 every 5 second

```
Command2: LOG COM1 RTCM1819B ONTIME 1
```

Message 1819 outputted from COM1 every 1 second

```
Command3: FIX AUTO
```

Fix reference station coordinates in auto mode

```
Command3: FIX POSITION 30.0 150.0 50
```

Fix reference station coordinates in manual mode

```
Command4: SAVECONFIG
```

Save configurations in flash

Set up reference station in RTCMV3 format, outputted from COM2:

```
Command1: LOG COM2 RTCM1004B ONTIME 1
```

Message 1004 outputted from COM2 every 1 second

```
Command2: LOG COM2 RTCM1005B ONTIME 5
```

Message1005 outputted from COM2 every 5 second

```
Command3: FIX AUTO
```

Fix reference station coordinates in auto mode

```
Command4: SAVECONFIG
```

Save configurations in flash

Set up reference station in CMR format, outputted from current port:

```
Command1: LOG CMRREFB ONTIME 5
```

Message cmrrefb outputted from current port every 5 second

```
Command2: LOG CMROBSB ONTIME 1
```

Message cmrobsb outputted form current port every 1 second

```
Command3: FIX AUTO
```

Fix reference station coordinates in auto mode

```
Command4: SAVECONFIG
```

Save configurations in flash

Set up reference station in RTCMV3 using BD2 observations:

```
Command1: LOG COM3 RTCM1104B ONTIME 1
```

Message 1104 outputted from COM3 every 1 second

```
Command2: LOG COM3 RTCM1005B ONTIME 5
```

Message 1105 outputted from COM3 every 5 second

```
Command3: REFAUTOSETUP ON
```

Fix reference station coordinates in auto mode

```
Command4: SAVECONFIG
```

Save configurations in flash

6.2 LOG RAW DATA

```
Command1: ecutoff y
```

```
Command2: log port rangecmpb ontime z
```

```
Command3: log port rawephemb onchanged
```

```
Command3: log port bd2rawephemb onchanged
```

```
Command4: log port rawalmb onchanged
```

NOTICE:

PORT TYPE:	COM1/COM2/COM3/BLUETOOTH	DEFAULT CURRENT PORT
ONTIME Z:	MAX = 2HZ	NORMAL 0.5/1/5/10/15/30/60 S

6.3 STOP ALL OUTPUT

```
Command1: unlogall
```

NOTICE:

Shut down all data output

Change dynamic differential data format

6.4 SET BAUDRATE OF COM PORT

```
Command 1：com port baudrate
```

NOTICE:

- ☞ PORT TYPE: COM1/COM2/BLUETOOTH/GPRS DEFAULT COM1
- ☞ BAUDRATE: 4800/9600(BLUETOOTH 9600)/19200/38400/57600/115200 (COM1 DEFAULT)

6.5 SET COMMON-VIEW TIME TRANSFER MODE

NOTICE:

Not all kinds of GNSS cards support the common-view time transfer mode, the detailed information about this is needed, please consult COMPASS Inc.

Setup reference station:

```
Command1: log com2 rtcmcompassb ontime 1
Command2: fix auto
```

Command 1 configures com2 to output message “rtcmcompassb”, which is a self-defined message including position, observations and some hardware information of reference station.

Command 2 configures reference to work on auto-setup mode.

Setup rover station:

```
Command1: interfacemode com2 auto generic on
Command2: set diffmatchmode 100
Command3: rtksolution 1
Command4: log gpcdt ontime 1
```

Command 1 configures com2 to work on auto input mode to confirm differential message type automatically. Currently, the output mode is always ‘**GENERIC**’ (refer to Sec. 5.2.22)

Command 2 configures GNSS cards to work on synchronous mode.

Command 3 configures GNSS cards to work on RTD mode.

Command 4 configures GNSS cards to output message “gpcdt”.

If all the settings are configured correctly, the GNSS board who works as a rover station should output message “gpcdt” to indicate the PPS time difference between reference station and rover station. Just like below:

```
$GNCDT,063631.00,1.9,1,-12.5,1,0.0,0,0.0,0*4A
```

If message “gpgga” is logged, the time-lag should be 0, and position status flag should be 2, just like below:

```
$GPGGA,063631.00,3110.4709438,N,12123.2629884,E,
2,12,1.6,59.3650,M,0.000,M,00,0004*5C
```

CHAPTER 7. APPLICATION CASES

In some applications, a group of commands should be input to configure GNSS cards; this is a tough problem for some users to configure GNSS boards correctly. This chapter introduces these scenes and explains these commands and functions in detail.

7.1 VEHICLE ATTITUDE DETERMINATION

In vehicle attitude determination, a normal base station (B0), a main rover station (R1) and a vice-rover station (R2) are involved. B0 is a fixed base station, it broadcasts differential messages to R1. Using B0's differential messages, R1 make a normal RTK calculation, at the same time, R1 sends differential messages to R2, and so R1 is a normal rover station and a moving base station. R2 is a vice rover station. Notice, the base station coordinates in R1's differential messages are changeable, not as B0's.

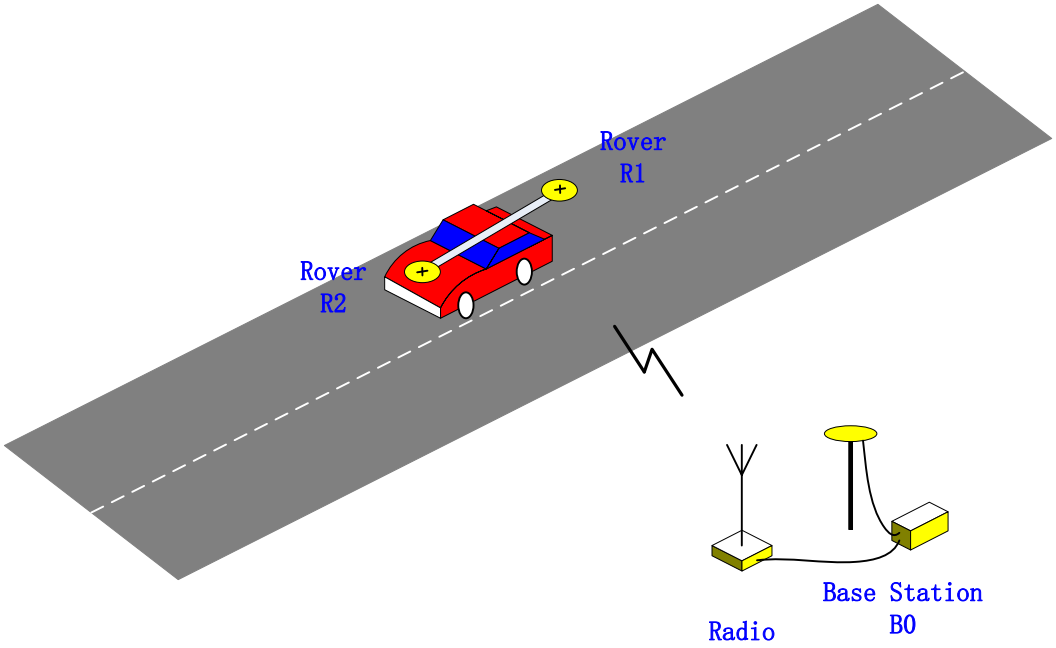


Figure 6. Attitude Determination System

7.2 TIMING

In PVT mode, the precision of PPS is about 20ns. A typical figure is shown below. If higher precision is needed, please contact us.

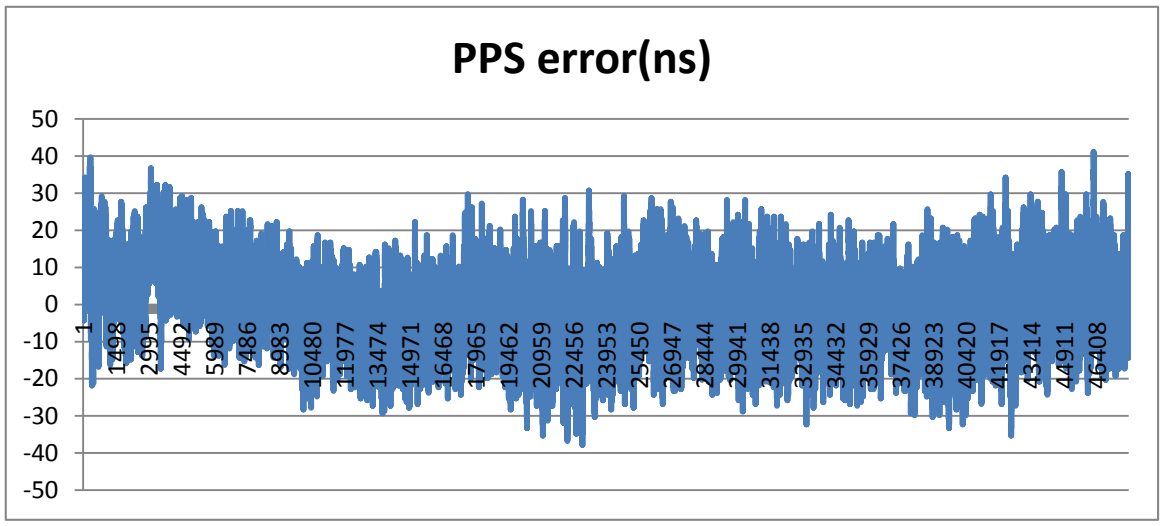


Figure 7. PPS error

7.3 COMMON-VIEW TIME TRANSFER

APPENDIX A. PHYSICAL INFORMATION

K501/K503 PHYSICAL DESCRIPTION

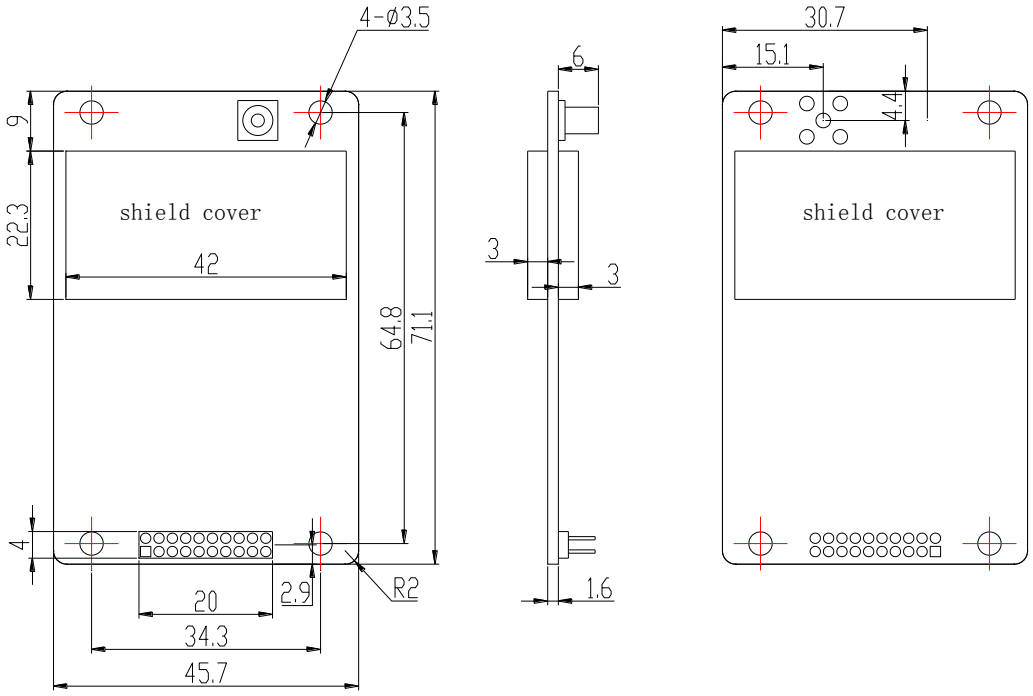


Figure 8. K501/K503 Board Dimensions

Table 42.K501/K50320Pin Definition (J2)

PIN	SIGNAL	TYPE	DESCRIPTION
1	LNA_PWR	PWR	Antenna power input
2	VIN	PWR	Supply voltage input
3	RFU	N/A	Reserved for use
4	COM3_Rx	Input	COM3 Receiver Data
5	RESETIN	Input	Reset Input
6	RFU	N/A	Reserved for use
7	Event	Input	Event Input
8	DIFF SIGNAL	Output	Differential signal output, 3.0V/3.3V compatible Low active, an external power source is needed

PIN	SIGNAL	TYPE	DESCRIPTION
9	COM3_Tx	Output	COM3 Transmit Data
10	GND	GND	Signal and Power Ground
11	COM1_Tx	Output	COM1 Transmit Data
12	COM1_Rx	Input	COM1 Receiver Data
13	GND	GND	Signal and Power Ground
14	COM2_Tx	Output	COM2 Transmit Data
15	COM2_Rx	Input	COM2 Received Data
16	GND	GND	Signal and Power Ground
17	PV	Output	Position Valid
18	GND	GND	Signal and Power Ground
19	1PPS	Output	1.8V Time mark Output
20	SATELLITE NO.	Output	Tracked satellite number output, 3.0V/3.3V compatible Low active, an external power source is needed

K502 PHYSICAL DESCRIPTION

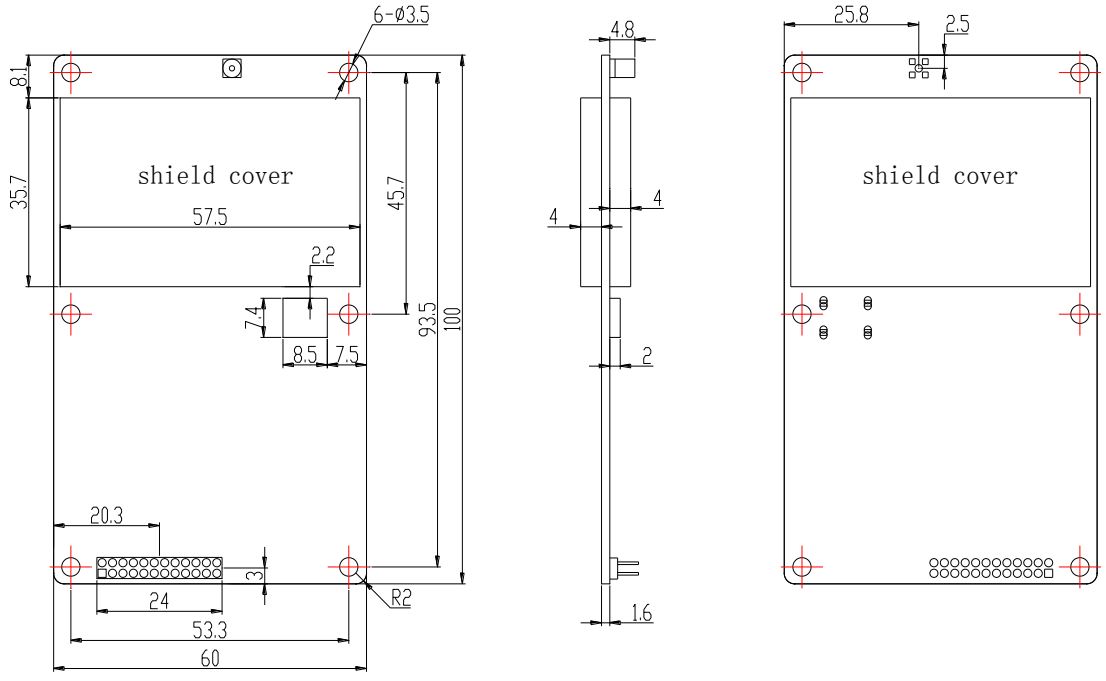


Figure 9. K502 Board Dimensions

Table 43.K502 24Pin Definition

PIN	SIGNAL	TYPE	DESCRIPTION
1	RFU	N/A	Reserved for use
2	DIFF SIGNAL	Output	Differential signal output, 3.0V/3.3V compatible Low active, an external power source is needed
3	RFU	N/A	Reserved for use
4	PPS	Output	Pulse per second, 1.8V compatible
5	VCC	PWR	+3.3 V~+5VDC power supply, +3.3V recommended
6	VCC	PWR	+3.3 V~+5VDC power supply, +3.3V recommended
7	RXD3	Input	UART3 RX, 3.0V/3.3V compatible
8	RFU	N/A	Reserved for use
9	RFU	N/A	Reserved for use
10	SATELLITE NO.	Output	Tracked satellite number output, 3.0V/3.3V compatible Low active, an external power source is needed
11	RFU	N/A	Reserved for use
12	RESET	IO	Hardware Reset, low active
13	I2C_SCL	IO	I2C Clock, 3.0V/3.3V compatible
14	RXD2	Input	UART2 RX, 3.0V/3.3V compatible
15	RFU	N/A	Reserved for use
16	TXD2	Output	UART2TX, 3.0V/3.3V compatible
17	I2C_SDA	IO	I2C Data, 3.0V/3.3V compatible
18	RXD1	Input	UART1 RX, RS-232 compatible
19	TXD3	Output	UART3 TX, 3.0V/3.3V compatible
20	TXD1	Output	UART1 TX, RS-232 compatible
21	D-	IO	USB D-
22	D+	IO	USB D+

PIN	SIGNAL	TYPE	DESCRIPTION
23	GND	GND	Ground Reference
24	GND	GND	Ground Reference

K505 PHYSICAL DESCRIPTION

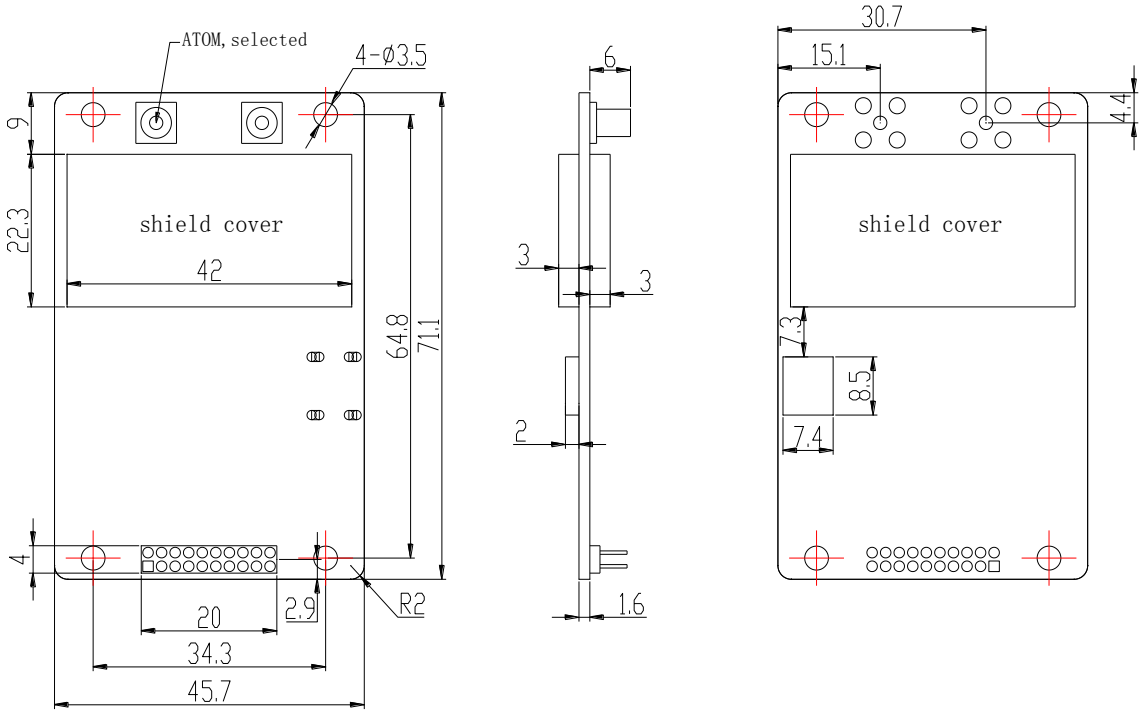


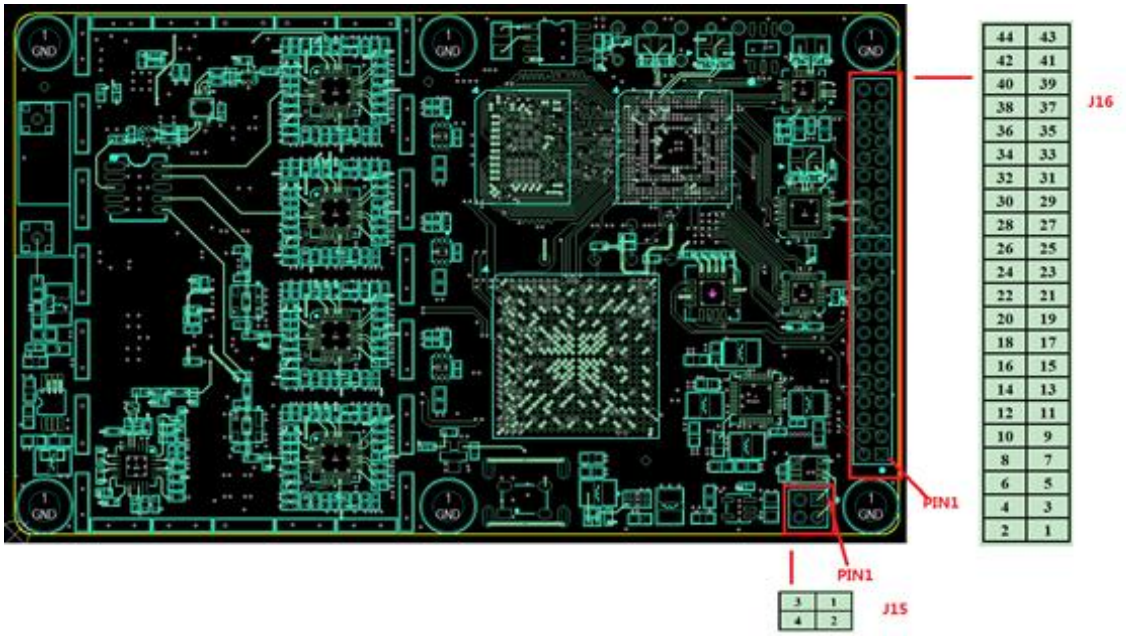
Figure 10. K502 Board Dimensions

Table 44.K505 20Pin Definition

PIN	SIGNAL	TYPE	DESCRIPTION
1	LNA_PWR	PWR	Antenna power input
2	VIN	PWR	Supply voltage input
3	N/C	Reserved	Reserved
4	COM3_Rx	Input	COM3 Receiver Data
5	RESETIN	Input	Reset Input

PIN	SIGNAL	TYPE	DESCRIPTION
6	N/C	Reserved	Reserved
7	Event	Input	Event Input
8	DIFF SIGNAL	Output	Differential signal
9	COM3_Tx	Output	COM3 Transmit Data
10	GND	GND	Signal and Power Ground
11	COM1_Tx	Output	COM1 Transmit Data
12	COM1_Rx	Input	COM1 Receiver Data
13	GND	GND	Signal and Power Ground
14	COM2_Tx	Output	COM2 Transmit Data
15	COM2_Rx	Input	COM2 Received Data
16	GND	GND	Signal and Power Ground
17	PV	Output	Position Valid
18	GND	GND	Signal and Power Ground
19	1PPS	Output	1.8V Time mark Output
20	SATELLITE NO.	Output	Tracked Satellite Number

K508 PHYSICAL DESCRIPTION



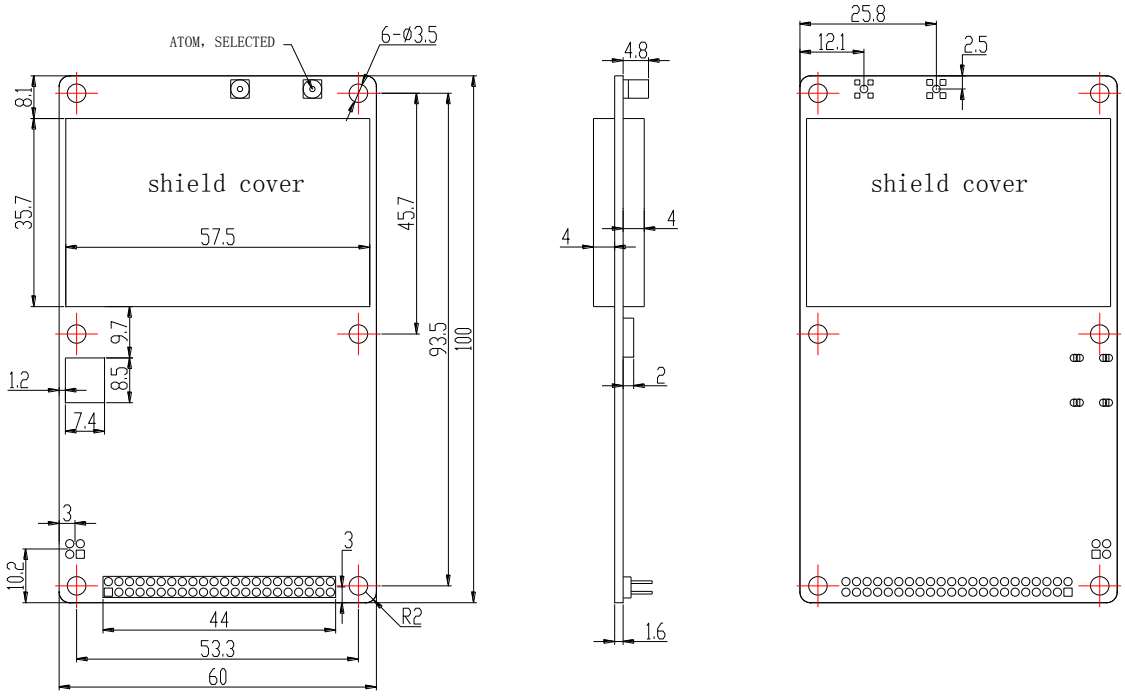


Figure 11. K508 Board Dimensions

Table 45.K508 Pin designator and definition (V1.0)

PIN	SIGNAL	TYPE	DESCRIPTION
1	GND	PWR	System GND
2	DIFF SIGNAL	O	Differential signal output, 3.0V/3.3V compatible Low active, an external power source is needed
3	PWR_ON	O	Power enable/disable output
4	PPS	O	Pulse per second, 1.8V compatible
5	VCC	PWR	System power supply, 3.3V
6	VCC	PWR	System power supply, 3.3V
7	COM3_RXD	I	UART3 RX, 3.0V/3.3V compatible
8	EVENT	I	Event input, 1.8V compatible
9	PWR_LED	O	PWR_LED output, 3.0V/3.3V compatible. Low active, an external power source is needed
10	SATELLITE NO.	O	Tracked satellite number output. 3.0V/3.3V compatible Low active, an external power source is needed
11	COLLECT	I	Data collection button pressing detection, 3.0V/3.3V compatible
12	OEM_RST	IO	System reset
13	BT_LED	O	Bluetooth on indicator, 3.0V/3.3V compatible. Low active, an external power source is needed
14	COM2_RXD	I	UART2 RX, 3.0V/3.3V compatible
15	RFU	N/A	Reserved for use
16	COM2_TXD	O	UART2 TX, 3.0V/3.3V compatible
17	RADIO_LED	O	Radio on indicator, 3.0V/3.3V compatible. Low active, an external power source is needed
18	COM1_RXD	I	UART1 RX, RS-232 compatible
19	COM3_TXD	O	UART3 TX, 3.0V/3.3V compatible

PIN	SIGNAL	TYPE	DESCRIPTION
20	COM1_TXD	O	UART1 TX, RS-232 compatible
21	D-_N	IO	USB interface data (-)
22	D+_P	IO	USB interface data (+)
23	GND	PWR	System GND
24	GND	PWR	System GND
25	MMC_CLK	IO	SD card clock signal, 3.0V compatible
26	MMC_CMD	IO	SD card command signal, 3.0V compatible
27	RX-_PHY	I	Ethernet receive signal (-)
28	RX+_PHY	I	Ethernet receive signal (+)
29	ETHER_PWR	PWR	RD magnetic center tap, 3.3V
30	TX+_PHY	O	Ethernet transmit signal (+)
31	TX-_PHY	O	Ethernet transmit signal (-)
32	ETHER_PWR	PWR	RD magnetic center tap, 3.3V
33	BT_RST	O	Bluetooth Reset, 3.0V/3.3V compatible
34	GPRS/RADIO_SW	O	GPRS and RADIO switch, 3.0V/3.3V compatible
35	GND	PWR	System GND
36	CAN_RX	I	CAN bus data receive data. A CAN transceiver is needed Vihmin=2V, Vilmax=0.45V
37	CAN_TX	O	CAN bus data transmit data. A CAN transceiver is needed. Volmax=0.6V, Vihmin=2.3V
38	MMC_DATA0	IO	SD card data0 signal, 3.0V compatible
39	MMC_DATA1	IO	SD card data1 signal, 3.0V compatible
40	PWR_DET	O	Power Button Pressing Detection, 3.0V/3.3V compatible.
41	MMC_PWR	PWR	SD card bus power supply,3.0V

PIN	SIGNAL	TYPE	DESCRIPTION
42	GND	PWR	System GND
43	MMC_DATA2	IO	SD card data2 signal, 3.0V compatible
44	MMC_DATA3	IO	SD card data3 signal, 3.0V compatible

APPENDIX B. TECHNICAL SPECIFICATIONS

K501 SPECIFICATION

Table 46.K501 Specification

K501 SPECIFICATION		
GNSS Signals	GPS: L1C/A & L1/L2 P	Maximum 12 GPS Satellites Tracked
	BD2: B1C, B2C	Maximum 12 BD2 Satellites Tracked
Time to First Fix	Cold	< 60s
	Warm	< 30s
	Hot	< 15s
Reacquisition	L1 or B1	< 3s
Measurement Precision	Pseudorange Precision	L1 = 10cm / L2 = 10cm B1 = 10cm / B2 = 10cm
	Carrier Phase Precision	L1 =1.0mm / L2 = 1.0mm B1 =1.0mm / B2 = 1.0mm
Accuracy	Time Accuracy	20ns
	SPP Accuracy	< 4m
	Static Differential Accuracy (Supported by software Compass Solution)	H: ±(2.5 +1×10-6×D)mm V: ±(5 + 1×10-6×D)mm
RTK	RTK Initiation time	< 10s
	Initiation Reliability	> 99%
	Dynamic Differential Accuracy	H: ±(10 +1×10-6×D)mm V: ±(20 + 1×10-6×D)mm
Data Rates	Measurements & Position	5Hz (Max:20Hz)
Electrical	Data Storage Space	100MB on Board
	Voltage	+3.3V ~ +5V±5%VDC
	Power Consumption	1.2W

K501 SPECIFICATION		
Environmental	Operating Temperature	-40℃— +80℃
	Storage Temperature	-45℃— +85℃
Data Formats	NMEA-0183	GPGGA, GPGGARTK, GPGSV, GPGLL, GPGSA, GPGST, GPHDT, GPRMC, GPVTG, GPZDA
	Compass Binary	Self-Defined
	CMR	CMROBS,CMRREF,CMRPLUS
	RTCM2.3	RTCM1, RTCM3,RTCM1819
	RTCM3.0	1004,1005, 1006,1008,1104,1033
Antenna Interface	Antenna Connector (J1)	MCX, 50Ω
	LNA Power (External)	+3.3VDC ~ +5VDC
Hardware Interface		2×10 pin male connector pin pitch 2mm
Physical	Size	46mm×71mm×13mm with connectors
	Weight	26 grams

K502 SPECIFICATION

Table 47.K502 Specification

K502 SPECIFICATION		
GNSS Signals	GPS: L1C/A & L1/L2 P	Maximum 12 GPS Satellites Tracked
	BD2: B1C, B2C	Maximum 12 BD2 Satellites Tracked
Time to First Fix	Cold	< 60s
	Warm	< 30s
	Hot	< 15s

K502 SPECIFICATION		
Reacquisition	L1 or B1	< 3s
Measurement Precision	Pseudorange Precision	L1 = 10cm / L2 = 10cm B1 = 10cm / B2 = 10cm
	Carrier Phase Precision	L1 = 1.0mm / L2 = 1.0mm B1 = 1.0mm / B2 = 1.0mm
Accuracy	Time Accuracy	20ns
	SPP Accuracy	< 4m
	Static Differential Accuracy (Supported by software Compass Solution)	H: ±(2.5 +1×10-6×D)mm V: ±(5 + 1×10-6×D)mm
RTK	RTK Initiation time	< 10s
	Initiation Reliability	> 99%
	Dynamic Differential Accuracy	H:±(10 +1×10-6×D)mm V:±(20 + 1×10-6×D)mm
Data Rates	Measurements & Position	5Hz (Max: 20Hz)
Electrical	Data Storage Space	100MB on Board
	Voltage	+3.3V ~ +5V±5%VDC
	Power Consumption	1.85W
Environmental	Operating Temperature	-40℃— +80℃
	Storage Temperature	-45℃— +85℃
Data Formats	NMEA-0183	GPGGA, GPGGARTK, GPGSV, GPGLL, GPGSA, GPGST, GPHDT, GPRMC, GPVTG, GPZDA
	Compass Binary	Self-Defined
	CMR	CMROBS, CMRREF, CMRPLUS
	RTCM2.3	RTCM1, RTCM3, RTCM1819
	RTCM3.0	1004, 1005, 1006, 1008, 1104, 1033
Antenna	Antenna Connector (J1)	MCX, 50Ω

K502 SPECIFICATION		
Interface	LNA Power (External)	+3.3VDC ~ +5VDC
Hardware Interface		2×12 pin male connector pin pitch 2mm
Physical	Size	60mm×100mm×13mm with connectors
	Weight	47 grams

K505 SPECIFICATION

Table 48.K505 Specification

K505 SPECIFICATION		
GNSS Signals	GPS: L1C/A & L1/L2 P	Maximum 12 GPS Satellites Tracked
	BD2: B1I, B2I, B3I	Maximum 12 BD2 Satellites Tracked
Time to First Fix	Cold	<60s
	Warm	<30s
	Hot	<15s
Requisition	L1 or B1	<3s
Measurement Precision	Pseudorange Precision	L1=10cm/L2=10cm B1=10cm/B2=10cm/B3=5cm
	Carrier Phase Precision	L1=1.0mm/L2=1.0mm B1=1.0mm/B2=1.0mm/B3=1.0mm
Accuracy	Time Accuracy	20ns
	SPP Accuracy	<4m
	Static Differential Accuracy (Supported by Software Compass Solution)	H:±(2.5 +1×10-6×D)mm V:±(5 + 1×10-6×D)mm
RTK	RTK Initiation Time	<10s
	E-RTK initiation Time	<1s

K505 SPECIFICATION		
	Initiation Reliability	> 99%
	Dynamic Differential Accuracy	H:±(10 +1×10-6×D)mm V:±(20 + 1×10-6×D)mm
	E-RTK Differential Accuracy	H:±(200 +1×10-6×D)mm V:±(400 + 1×10-6×D)mm
Data Rates	Measurements & Position	5Hz (Max: 20Hz)
Electrical	Data Storage Space	100MB on Board
	Voltage	+3.3V ~ +5V ±5%VDC
	Power Consumption	1.3W
Environmental	Operating Temperature	-40℃— +80℃
	Storage Temperature	-45℃— +85℃
Data Formats	NMEA-0183	GPGGA, GPGGARTK, GPGSV, GPGLL, GPGSA, GPGST, GPHDT, GPRMC, GPVTG, GPZDA
	Compass Binary	Self-Defined
	CMR	CMROBS,CMRREF,CMRPLUS
	RTCM 2.3	RTCM1, RTCM3,RTCM1819
	RTCM 3.0	1004,1005, 1006,1008,1104,1033
Antenna Interface	Connector	MCX female, 50Ω
	LNA Power (External)	+3.3VDC ~ +5VDC
Hardware Interface		2×10 pin male connector pin pitch 2mm
Physical	Size	46mm×71mm×13mm with connectors
	Weight	26 grams

K508 SPECIFICATION

Table 49.K508 Specification

K508 SPECIFICATION		
GNSS Signals	GPS: L1C/A & L1/L2 P	Maximum 14 GPS Satellites Tracked
	BD2: B1I, B2I, B3I	Maximum 14 BD2 Satellites Tracked
	GLONASS: G1C & G2C	Maximum 14GLONASS Satellites Tracked
Time to First Fix	Cold	<60s
	Warm	<30s
	Hot	<15s
Requisition	L1 or B1	<3s
Measurement Precision	Pseudorange Precision	GSP: L1=10cm/L2=10cm/L5=5cm BD2:B1=10cm/B2=10cm/B3=5cm GLONASS:G1=10cm/G2=10cm
	Carrier Phase Precision	GPS:L1=1.0mm/L2=1.0mm/L5=0.5mm BD2:B1=1.0mm/B2=1.0mm/B3=1.0mm GLONASS:G1=1.0mm/G2=1.0mm
Accuracy	Time Accuracy	20ns
	SPP Accuracy	<4m
	Static Differential Accuracy (Supported by Software Compass Solution)	H:±(2.5 +1×10-6×D)mm V:±(5 + 1×10-6×D)mm
RTK	RTK Initiation Time	<10s
	E-RTK initiation Time	<1s
	Initiation Reliability	> 99%
	Dynamic Differential Accuracy	H:±(10 +1×10-6×D)mm V:±(20 + 1×10-6×D)mm
	E-RTK Differential Accuracy	H:±(200 +1×10-6×D)mm V:±(400 + 1×10-6×D)mm
Data Rates	Measurements & Position	5Hz (Max: 20Hz)
Electrical	Data Storage Space	100MB on Board

K508 SPECIFICATION		
	Voltage	+3.3V ~ +5V ±5%VDC
	Power Consumption	1.8W (three satellite system)
Environmental	Operating Temperature	-40℃— +80℃
	Storage Temperature	-45℃— +85℃
Data Formats	NMEA-0183	GPGGA, GPGGARTK, GPGSV, GPGLL, GPGSA, GPGST, GPHDT, GPRMC, GPVTG, GPZDA
	Compass Binary	Self-Defined
	CMR	CMROBS, CMRREF, CMRPLUS
	RTCM 2.3	RTCM1, RTCM3, RTCM1819
	RTCM 3.0	1004, 1005, 1006, 1008, 1104, 1012, 1033
Antenna Interface	Connector	MCX female, 50Ω
	LNA Power (External)	+3.3VDC ~ +5VDC
Hardware Interface		2×12 pin male connector (could be extended to:2*22) pin pitch 2mm
Physical	Size	60mm×100mm×13mm with connectors
	Weight	44 grams

APPENDIX C. FIRMWARE UPDATES

Firmware updates are released on our website after they become available; user could download the newest firmware updates and keep your GNSS cards have a better performance.

NOTICE:

When process of firmware updates is completed, external three seconds should be waited to make sure the GNSS cards accomplish all the internal reconfigurations. Three seconds later, you could turn off the power and restart the GNSS cards to enjoy your new firmware! To confirm firmware have been updated successfully, command “log version” could be used to check the firmware information.