

RYS8838 Software Guide

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1 What this document contains

This document sets forth the RYS8838 host controller command specifications.

It describes the command protocol used when the RYS8838 is controlled from the host controller, and the specifications of these commands.

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2 Host controller interface specifications

The RYS8838 is connected to the host controller using UART or I²C. This section describes the communication specification.

2.1 UART interface

The settings of the UART interface are listed below.

- Baud rate : 115,200 bps
- Data length : 8 bits
- Parity : None
- Stop bit : 1 bit
- Flow control : None

2.2 I²C interface

The RYS8838 is operated as I²C slave device. The settings of the I²C interface are listed below.

- I²C clock frequency : 400kHz
- Address length : 7 bits
- Slave address : 0x24

When connecting to I²C, one additional GPIO pin in the RYS8838 is required to input host controller as “data output request” in addition to SDA and SCL. When output data is available in the RYS8838, the RYS8838 outputs “H” from data output request GPIO. When output data is not available in the RYS8838, the RYS8838 outputs “L” from data output request GPIO. For handling the data from the RYS8838, data output request GPIO should be connected to host controller’s interrupt port. When the host controller updates the firmware via I²C interface, the host controller have to send 256bytes data per packet at least.

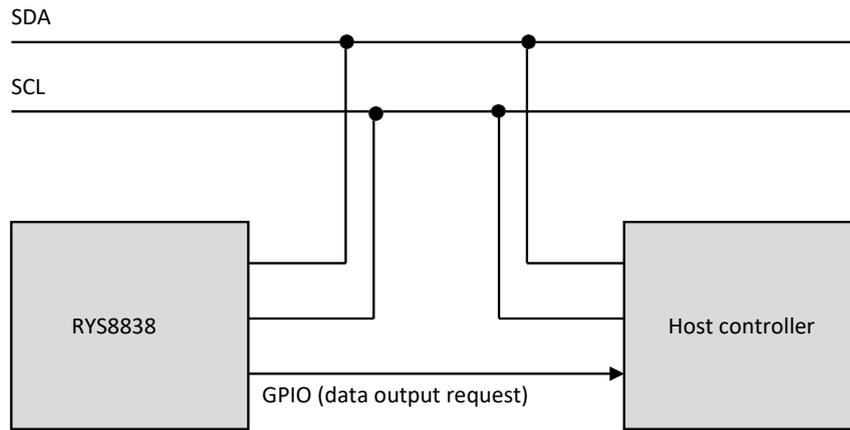


Fig.1 The connection with host controller using

2.2.1 The structure of data from host controller

The data that is sent from host controller is either:

- Command, or
- Data associated with command

They are called “data attribute”.

When sending data with I²C, the entire data is being divided into the packet(s) which size is 28 bytes or less. The host controller must wait over 2ms every time sending one packets. One packet shall include one “data attribute”.

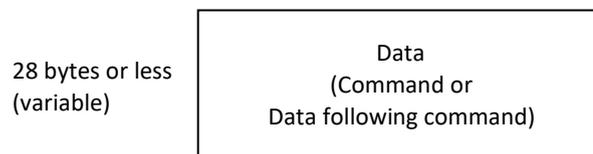


Fig.2 The structure of data from host controller

2.2.2 The structure of data from RYS8838

The data that is sent from RYS8838 is either:

- Command responses
- Data following commands
- NMEA sentences

They are called “data attribute”.

The data length that is sent in one I²C transaction is 74 bytes (fixed value). It includes more than one packet of any attributes. Below is the structure of 74 bytes data from RYS8838.

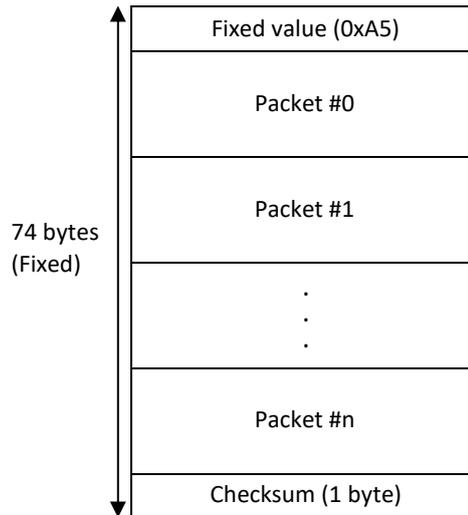


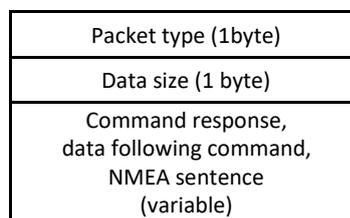
Fig.3 The structure of data from RYS8838

Each data chunk is followed by the preamble data (0xA5). The packet type is described at the top of each packet. Data size is determined by the packet type. When the packet type is 0x0F, data size field is inserted to accommodate variable data size.

Table 1. The type of packets

Packet type	Contents	Data size
0x00-0x04	Reserved	
0x0F	Command response, data following commands, NMEA sentence	Variable (described in data size field)

The structures of each packet types are below:



Packet type: 0x0F

Fig.4 The structure of the packet of each packet type

Any type, any number of packets is included in one transaction data (74 bytes) . Command (specified at “Command specification” section) / data following command (specified at “Command specification” section) /

NMEA sentence (specified at “NMEA sentences” section) are stored in the packet of packet type=0x0F. These data are divided if needed and sent by more than one transaction.

If the total data size which is transmitted from RYS8838 is less than 74bytes, Dummy data is added to 74 bytes of remaining area.

The host must retrieve data in a timely manner or the data may be lost. Please design the host controller’s system with consideration for enough bandwidth. When host controller receives the sensor data with high frequency, please do the transmission and reception alternately.

Checksum for whole of the data is added at the end of data. Checksum is the lower 1 byte of the 1’s complement of the sum for whole of the data (74 bytes, excluding checksum itself)

3 Command specifications

This section describes the protocol for the commands used between the host controller and RYS8838.

3.1 Command format

Commands are described in ASCII code.

The format for the control commands transmitted to the RYS8838 is given below.

```
@xxx <arg 1> <arg2> ... <CR><LF>
```

On receipt of a command from the host controller, the RYS8838 transmits the command reply message in accordance with the result yielded by executing the command.

When communication is successful: [xxx] Done<CR><LF> (where "xxx" is the command name)

When communication has failed: [xxx] Err n<CR><LF> (where "xxx" is the command name, and n is the error code)

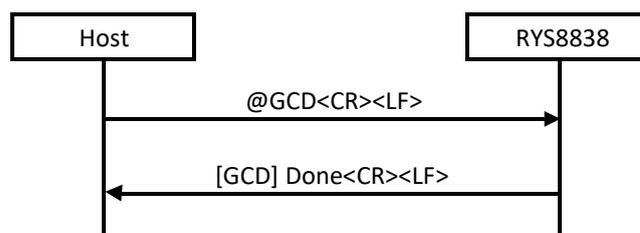
Take steps to prevent another command from being issued before the reply message (Done or Err) indicating the command completion has been returned from the RYS8838.

The period between the completion of sending the commands and the sending command responses varies according to commands and situations, but it may reach 5s at the worst case. The host controller should judge as a timeout after a lapse of 5s.

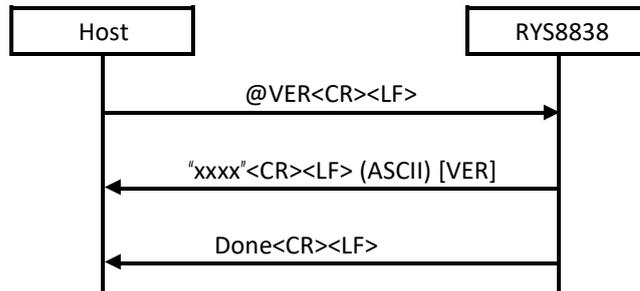
3.2 Command sequence

This section describes the sequence of the commands between the host controller and RYS8838 for each type of command.

3.2.1 Commands not entailing an exchange of data

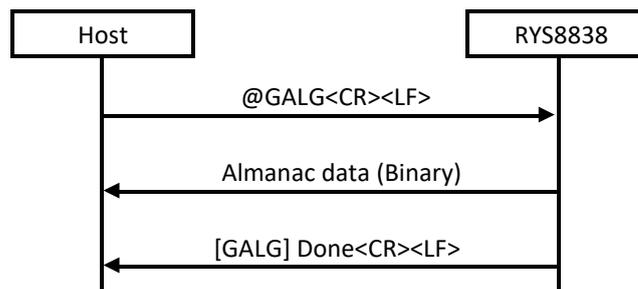


3.2.2 Commands that entail data (ASCII data) transmission from the RYS8838



The data to be transmitted is ASCII format data which is terminated using a line break code (<CR><LF>). The data length and data contents differ from one command to another so refer to the command specifications.

3.2.3 Commands that entail data (binary data) transmission from the RYS8838



A header and footer that describe the data length, checksum, etc. are inserted into the binary data transmitted from the RYS8838 before and after the data.

The binary data format is shown below.

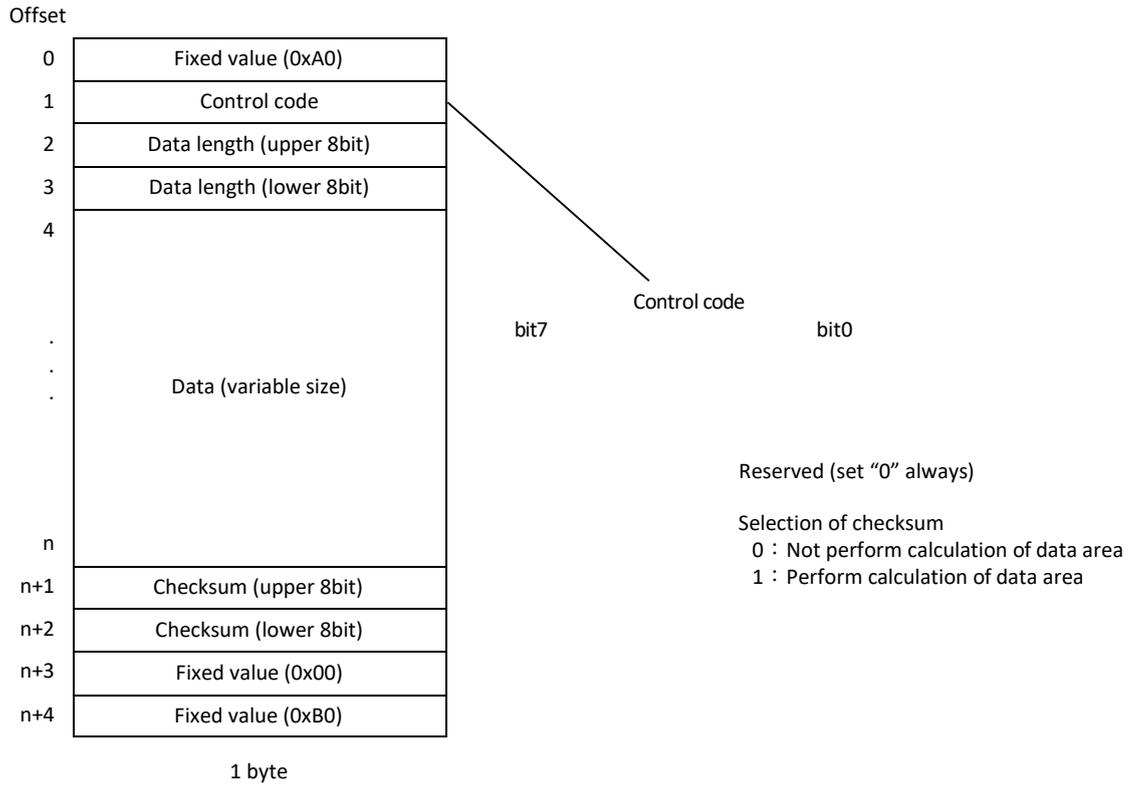
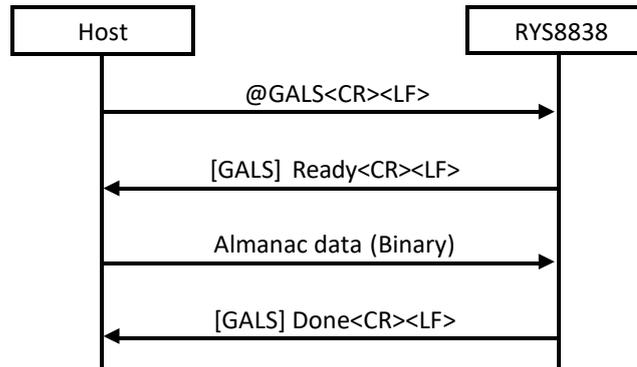


Fig.5 Binary data format

The size of the data excluding the header and footer is described in the "data length" area of the header.

If the data checksum is to be calculated, first the data checksum is described in the "checksum" area of the footer, and then "1" is described for bit 7 of the control code. When "0" is set for bit 7 of the control code, the data in the "checksum" area of the footer is invalid. The data checksum is the lower 16 bits of the sum of the header and the data area in 8 bits unit.

3.2.4 Commands that entail the injection of data (binary data) into the RYS8838



The same data format as for the binary data which is transmitted from the RYS8838 is used. As with the data transmitted from the RYS8838, insert a header and footer before and after the data, and set the appropriate values in the fields.

3.3 Command specifications

This section describes the specifications of each command in turn.

3.3.1 @ABPT: Automatic backup data save ON/OFF

This command is used to setting the interval of the automatic backup data save function. The unit is “minute” and the value from 1 to 1,440 min can be set (default value: 60min) .

This command must be issued at Idle state and the automatic backup data save function disabled.

Please take account to the life of the flash memory when using this function.

Format: @ABPT <arg 1><CR><LF>

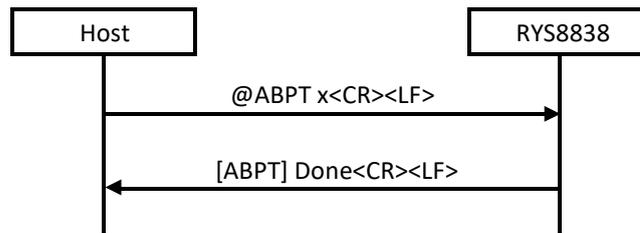
Argument:

Field	Description
arg 1	Set the interval of the automatic backup data save. The unit is minute (default value is 60min) .

Response:

Sentence	Description
“[ABPT] Done”	This indicates that the command has been executed successfully.
“[ABPT] Err n”	This indicates that an error has occurred.

Sequence:



3.3.2 @ABUP: Automatic backup data save ON/OFF

This command is used to control the automatic backup data save function.

When “1” is specified for the argument, the backup data contents are saved in the flash memory automatically at the first fix (This save is not executed if the time specified by @ABPT has not elapsed since the last save). Then the backup data contents are saved in the flash memory automatically with specified interval set by @ABPT beginning at the first fix.

For information about the backup data, see “@BUP”.

This command must be issued at Idle state. When this command is issued at Exec state, error is returned. When the automatic backup data save is executing, the sentence may be output erratically sometimes.

Please take account to the life of the flash memory when using this function.

Format: @ABUP <arg 1><CR><LF>

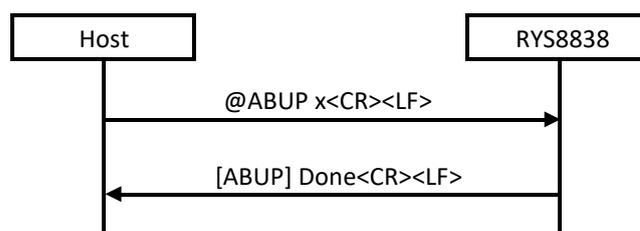
Argument:

Field	Description
arg 1	Control automatic backup data save function. 0: OFF (default value). 1: ON.

Response:

Sentence	Description
“[ABUP] Done”	This indicates that the command has been executed successfully.
“[ABUP] Err n”	This indicates that an error has occurred.

Sequence:



3.3.3 @BSSL: Output sentence select

This command is used to select the NMEA sentence to be output.

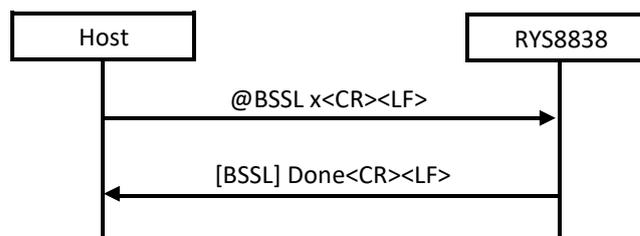
The sentences are assigned to each of the bits of the argument. "1" is set for the bits of the sentences which are to be output, and "0" is set for the bits of the sentences whose output is not required. Arguments can be specified in decimal or hexadecimal notation. With hexadecimal notation, add '0x' in front of the numeral.

Format: @BSSL <arg 1><CR><LF>

Argument:

Field	Description
arg 1	Output NMEA sentence bit0 : GGA bit1 : GLL bit2 : GSA bit3 : GSV bit4 : GNS bit5 : RMC bit6 : VTG bit7 : ZDA bit8 : Reserved bit9 : Reserved bit10 : Reserved bit11 : Reserved bit12 : Reserved bit13 : Reserved bit14 : Reserved bit15 : Reserved bit16 : Reserved bit17 : Reserved (Default value: 0x000000EF)

Sentence	Description
"[BSSL] Done"	This indicates that the command has been executed successfully.
"[BSSL] Err n"	This indicates that an error has occurred.



Examples of commands:

```
@BSSL 5<CR><LF> // Output of GSA, GGA sentences only permitted
```

```
@BSSL 12<CR><LF> // Output of GSV, GSA sentences only permitted
@BSSL 0x7<CR><LF> // Output of GSA, GLL, GGA sentences only permitted
```

3.3.4 @BUP: Backup data save

This command is used to save the backup data. The backup data contents are saved in the flash memory.

The backup data saved in the flash memory is automatically restored at boot-up from power OFF.

The receiver position, ephemeris, almanac, TCXO offset and other information required for hot start are included in the backup data, and by saving the backup data in the flash memory using this command, hot start can be initiated when the system is booted from power OFF. (The time must be injected.)

This command must be issued at Idle state. When this command is issued at Exec state, error is returned. For information about the operation status, see 5.1.

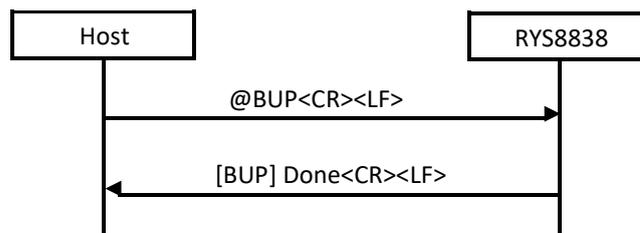
Format: @BUP<CR><LF>

Argument: None

Response:

Sentence	Description
"[BUP] Done"	This indicates that the command has been executed successfully.
"[BUP] Err n"	This indicates that an error has occurred.

Sequence:



3.3.5 @BUPC: Backup data clear

This command is used to clear the backup data saved in the flash memory by @BUP.

This command must be issued at Idle state and the automatic backup data save function disabled.

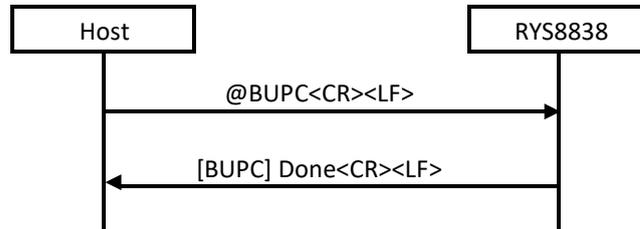
Format: @BUPC<CR><LF>

Argument: None

Response:

Sentence	Description
"[BUPC] Done"	This indicates that the command has been executed successfully.
"[BUPC] Err n"	This indicates that an error has occurred.

Sequence:



3.3.6 @CSBR: UART0 baud rate setting

This command is used to set the UART0 baud rate of the RYS8838.

When the command is executed successfully, UART0 is changed to the baud rate specified by the argument.

Therefore, ensure that the Done response is received at the original baud rate. When the command has failed, the original baud rate is not changed. In the default status, the baud rate is set to 115200 bps.

Format: @CSBR <arg 1><CR><LF>

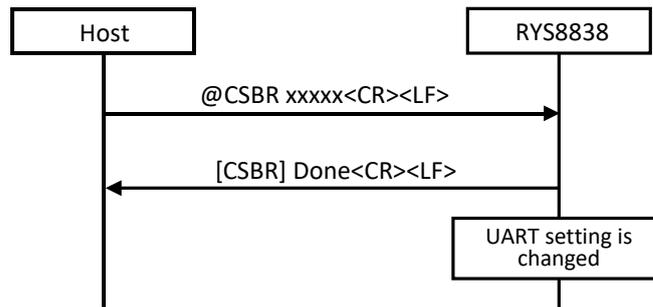
Argument:

Field	Description
arg 1	The baud rate is specified using an integer. The unit used is bps. Specify one of the following as the baud rate. 4800, 9600, 14400, 19200, 38400, 57600, 115200, 230400, 460800 (Default value: 115200)

Response:

Sentence	Description
"[CSBR] Done"	This indicates that the command has been executed successfully.
"[CSBR] Err n"	This indicates that an error has occurred.

Sequence:



3.3.7 @DCR: Backup fused position clear

This command is used to clear the backup fused position saved in flash memory by @BUP.

This command must be issued at "Idle" mode.

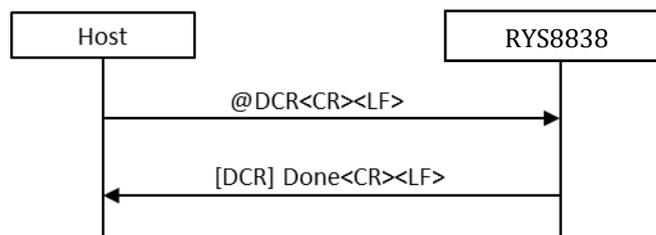
Format: @DCR<CR><LF>

Argument: None

Response:

Sentence	Description
"[DCR] Done"	This indicates that the command has been executed successfully.
"[DCR] Err n"	This indicates that an error has occurred.

Sequence:



3.3.8 @DEAC: Auto orientation offset estimation enable/disable setting

This command is used to enable or disable the auto orientation offset estimation.

This command must be issued at "Idle" mode.

Format: @DEAC <arg 1><CR><LF>

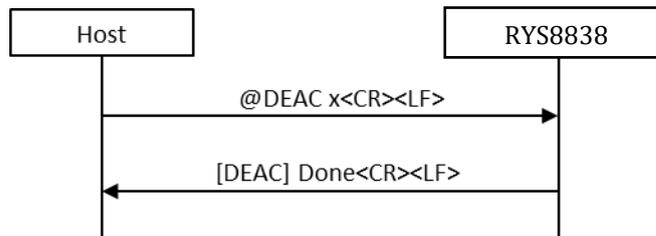
Argument:

Field	Description
arg 1	Disable/Enable the auto orientation offset estimation. (0: Disabled, 1: Enabled). (Default 1)

Response:

Sentence	Description
"[DEAC] Done"	This indicates that the command has been executed successfully.
"[DEAC] Err n"	This indicates that an error has occurred.

Sequence:



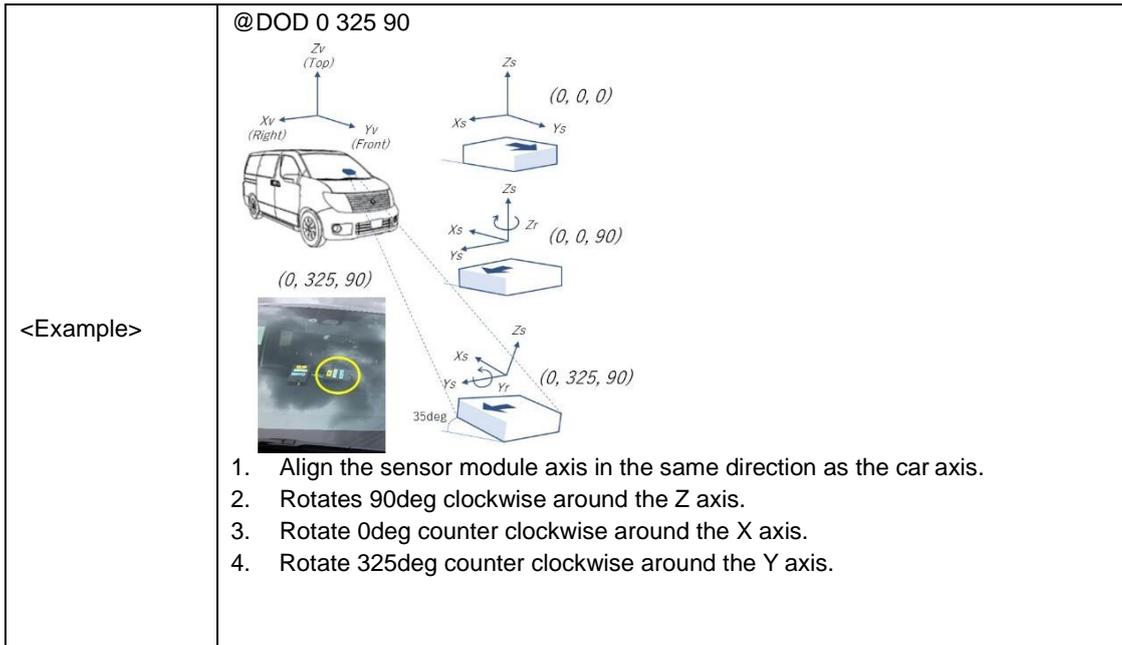
3.3.9 @DOD: Device orientation setting

This command is used to set the orientation of a device (an IMU (Inertial Measurement Unit) actually). This command can define the orientation around x, y and z-axis separately. The device orientation can be set only in Idle state. UDR doesn't work properly if the actual device orientation is different from the setting by this command. This command must be issued at "Idle" mode.

Format: @DOD <arg 1> <arg 2> <arg 3><CR><LF>

Argument:

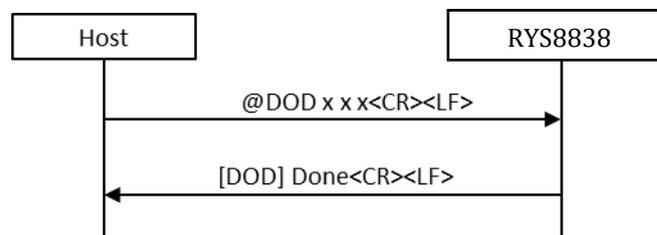
Field	Description
arg 1	The orientation around x-axis [Default: 0] The value is the integer from 0 to 359 degree.
arg 2	The orientation around y-axis [Default: 0] The value is the integer from 0 to 359 degree.
arg 3	The orientation around z-axis [Default: 0] The value is the integer from 0 to 359 degree.



Response:

Sentence	Description
"[DOD] Done"	This indicates that the command has been executed successfully.
"[DOD] Err n"	This indicates that an error has occurred.

Sequence:



3.3.10 @DSHR: Position Calculation Rate Selection

This command is used to select the position calculation rate.

This command must be issued at "Idle" mode.

Format: @DSHR <arg 1><CR><LF>

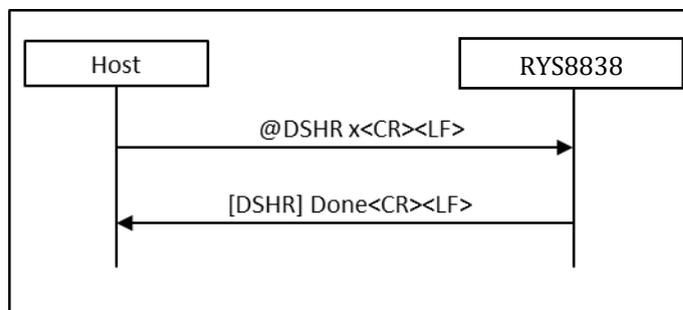
Argument:

Field	Description
arg 1	This position calculation rate is selected. 0 : 1Hz positioning 1 : 10Hz positioning (Default 0)

Response:

Sentence	Description
"[DSHR] Done"	This indicates that the command has been executed successfully.
"[DSHR] Err n"	This indicates that an error has occurred.

Sequence:



3.3.11 @DSOM: Position Output Selection

This command is to select the position, velocity, heading and so on. results for NMEA output from UDR or GNSS.

In the UDR mode, the results will be selected automatically from UDR or GNSS dependent on the calibration status. In the GNSS mode, only GNSS results will be output to NMEA.

Format: @DSOM <arg 1><CR><LF>

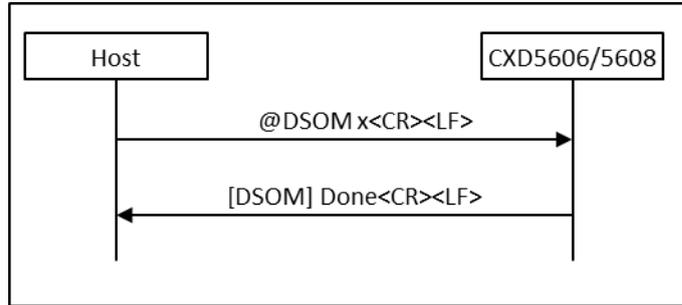
Argument:

Field	Description
arg 1	This output result to NMEA is selected from UDR or GNSS. 0 : Select GNSS result 1 : Select UDR result (Default 1)

Response:

Sentence	Description
"[DSOM] Done"	This indicates that the command has been executed successfully.
"[DSOM] Err n"	This indicates that an error has occurred.

Sequence:



3.3.12 @DSUM: UDR function enable/disable setting

This command is used to enable or disable the UDR function. If the UDR function is disabled, the internal sensor driver is also disabled and all of the UDR calculation are disabled. The output result on NMEA is generated by using only GNSS positioning.

This command must be issued at "Idle" mode.

Format: @DSUM <arg 1><CR><LF>

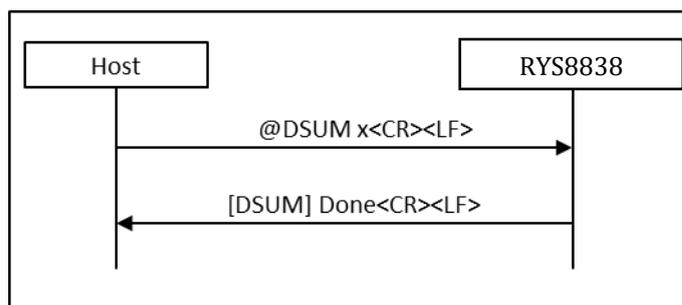
Argument:

Field	Description
arg 1	The UDR function is enabled or disabled by this. 0 : Disable UDR function 1 : Enable UDR function (Default 1)

Response:

Sentence	Description
"[DSUM] Done"	This indicates that the command has been executed successfully.
"[DSUM] Err n"	This indicates that an error has occurred.

Sequence:



3.3.13 @FER: Program erase

This command is used to erase the program on the flash memory and eMRAM. Both of the program on the flash memory and the program on eMRAM are erased. The RYS8838 re-start after this command issued in special mode.

This command must be issued at "Idle" mode.

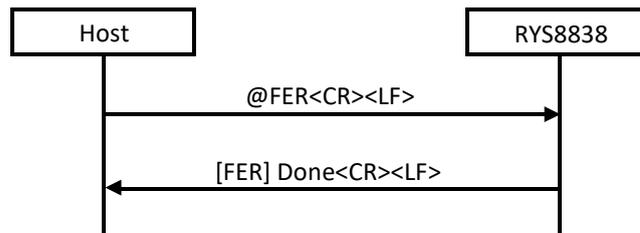
Format: @FER<CR><LF>

Argument: None

Response:

Sentence	Description
"[FER] Done"	This indicates that the command has been executed successfully.
"[FER] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.14 @GALG: GPS almanac data acquisition

This command is used to acquire the GPS almanac data received by RYS8838. When the command is received, the RYS8838 transmits the GPS almanac data (binary data) to the host controller.

The GPS almanac data size is 2048 bytes. In addition, the data which is actually transferred has the header and footer added.

This command must be issued at "Idle" mode.

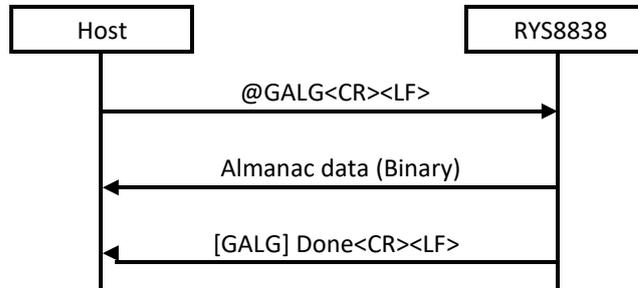
Format: @GALG<CR><LF>

Argument: None

Response:

Sentence	Description
"[GALG] Done"	This indicates that the command has been executed successfully.
"[GALG] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.15 @GALS: GPS almanac data injection

This command is used to inject the GPS almanac data into the RYS8838. Transmit the GPS almanac data (binary data) following the Ready response from the RYS8838.

The GPS almanac data size is 2048 bytes. In addition, the data which is actually required has the header and footer added.

This command must be issued at "Idle" mode.

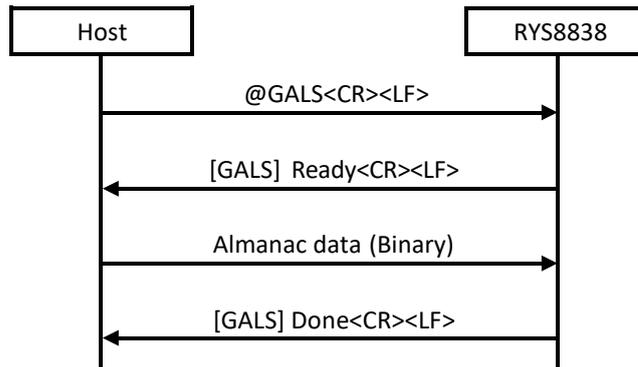
Format: @GALS<CR><LF>

Argument: None

Response:

Sentence	Description
"[GALS] Done"	This indicates that the command has been executed successfully.
"[GALS] Ready"	This indicates that the preparations for receiving the almanac data have been completed.
"[GALS] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.16 @GCD: Cold start

This command is used to start the positioning with cold start.

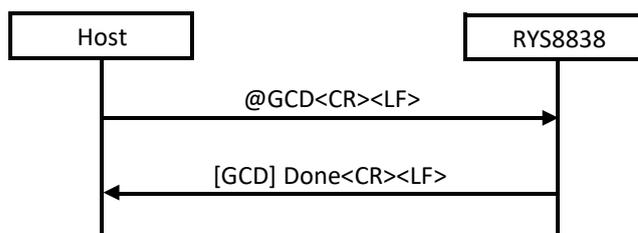
Format: @GCD<CR><LF>

Argument: None

Response:

Sentence	Description
"[GCD] Done"	This indicates that the command has been executed successfully.
"[GCD] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.17 @GEMG: GPS ephemeris data acquisition

This command is used to acquire the GPS ephemeris data which has been received by the RYS8838. When the command is received, the RYS8838 transmits the GPS ephemeris data (binary data) to the host controller.

The GPS ephemeris data size is 3072 bytes. In addition, the data which is actually transferred has the header and footer added.

This command must be issued at "Idle" mode.

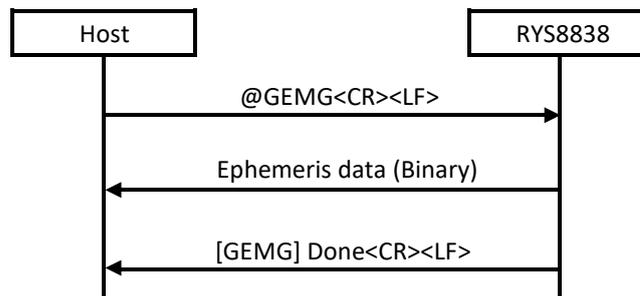
Format: @GEMG<CR><LF>

Argument: None

Response:

Sentence	Description
"[GEMG] Done"	This indicates that the command has been executed successfully.
"[GEMG] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.18 @GEMS: GPS ephemeris data injection

This command is used to inject the GPS ephemeris data into the RYS8838. Transmit the GPS ephemeris data (binary data) following the Ready response from the RYS8838.

The GPS ephemeris data size is 3072 bytes. In addition, the data which is actually required has the header and footer added.

This command must be issued at "Idle" mode.

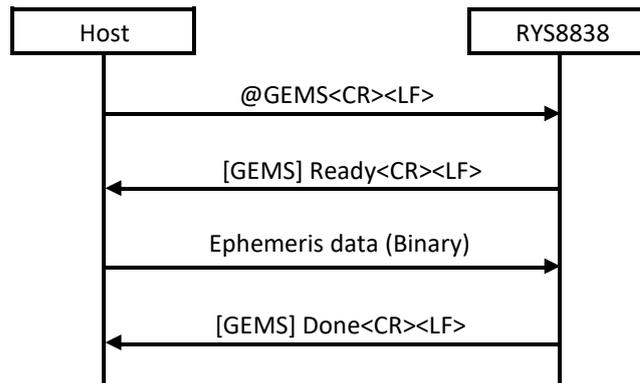
Format: @GEMS<CR><LF>

Argument: None

Response:

Sentence	Description
"[GEMS] Done"	This indicates that the command has been executed successfully.
"[GEMS] Ready"	This indicates that the preparations for receiving the almanac data have been completed.
"[GEMS] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.19 @GNS: Positioning-use satellite setting

This command is used to select the satellite systems to be used for positioning.

The satellite systems are assigned to the bits of the argument. “1” is set for the bits of the systems which are to be used and “0” is set for the bits of the systems which are not be used. Arguments can be specified in decimal or hexadecimal notation. With hexadecimal notation, add “0x” in front of the numeral.

Only one satellite system can be selected from GLONASS, BeiDou and Galileo. If over 2 satellite systems are selected from these satellite systems, error will return (-EINVAL) .

This command must be issued at “Idle” mode.

Format: @GNS <arg 1><CR><LF>

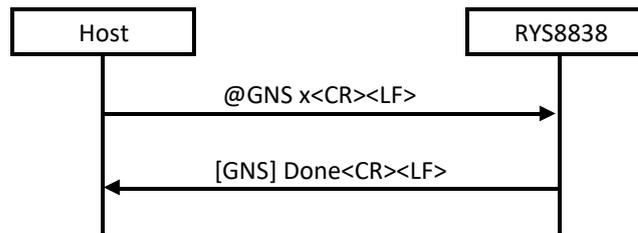
Argument:

Field	Description
arg 1	The satellite systems used for positioning are set on a bit by bit basis (0: system not used, 1: system used). bit 0 : GPS bit 1 : GLONASS bit 2 : SBAS bit 3 : QZSS L1-CA bit 5 : QZSS L1-S bit 6 : BeiDou bit 7 : Galileo (Default value: 0x01)

Response:

Sentence	Description
“[GNS] Done”	This indicates that the command has been executed successfully.
“[GNS] Err n”	This indicates that an error has occurred. “n” is where the error code is entered.

Sequence:



Examples of commands:

```

@GNS 3<CR><LF>           // Use the GPS and GLONASS systems.
@GNS 0x7<CR><LF>        // Use the GPS, GLONASS and SBAS systems.
    
```

3.3.20 @GPOE: Receiver position setting (ellipsoidal coordinates)

This command is used to set the approximate position of the receiver in the RYS8838. The receiver position is set using ellipsoidal coordinates (latitude, longitude). The north latitude and east longitude directions are “+” values so when specifying the receiver position using a south latitude and west longitude, add a “-” (minus) sign in front to the values.

The receiver position, current time and TCXO offset value are required in order to initiate a hot start so the receiver position must have been set in the RYS8838 prior to hot start using this command. (This is not necessary if the position is backed up in the flash memory.)

Format: @GPOE <arg 1> <arg 2> <arg 3> <arg 4> <arg 5> <arg 6><CR><LF>

Argument:

Field	Description
arg 1	This specifies the latitude (degrees) of the receiver using an integer.
arg 2	This specifies the latitude (minutes) of the receiver using an integer.
arg 3	This specifies the latitude (seconds) of the receiver using an integer.
arg 4	This specifies the longitude (degrees) of the receiver using an integer.
arg 5	This specifies the longitude (minutes) of the receiver using an integer.
arg 6	This specifies the longitude (seconds) of the receiver using an integer.

Response:

Sentence	Description
“[GPOE] Done”	This indicates that the command has been executed successfully.
“[GPOE] Err n”	This indicates that an error has occurred. “n” is where the error code is entered.

Examples of commands:

```
@GPOE 35 37 09 139 43 51<CR><LF> // North latitude 35°37'09", east longitude 139°43'51"
@GPOE 33 07 19 -117 19 18<CR><LF> // North latitude 33°07'19", west longitude 117°19'18"
```

3.3.21 @GPOS: Receiver position setting (ellipsoidal coordinates)

This command is used to set the approximate position of the receiver in the RYS8838. This command supports higher-accuracy position than @GPOE.

The receiver position is set using ellipsoidal coordinates (latitude, longitude) and altitude. The north latitude and east longitude directions are "+" values so when specifying the receiver position using a south latitude and west longitude, add a "-" (minus) sign in front to the values.

The receiver position, current time and TCXO offset value are required in order to initiate a hot start so the receiver position must have been set in the RYS8838 prior to hot start using this command. (This is not necessary if the position is backed up in the flash memory.)

Format: @GPOS <arg 1> <arg 2> <arg 3><CR><LF>

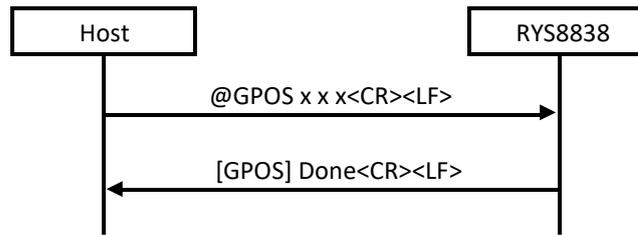
Argument:

Field	Description
arg 1	This specifies the latitude (degrees) * 10 ⁶ of the receiver using an integer. e.g. 43.123456 degrees north: set "43123456".
arg 2	This specifies the longitude (degrees) * 10 ⁶ of the receiver using an integer. e.g. 139.789000 degrees east: set "139789000".
arg 3	This specifies the altitude * 10 of the receiver using an integer. e.g. 102.0m : set "1020".

Response:

Sentence	Description
"[GPOS] Done"	This indicates that the command has been executed successfully.
"[GPOS] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



Examples of commands:

```

@GPOS 35123456 139987650 0<CR><LF> // North latitude 35.123456 degree,
// east longitude 139.987650 degree,
// altitude 0m

@GPOS 33070710 -117121310 -15<CR><LF> // North latitude 33.070710 degree,
// west longitude 117.121310 degree,
// altitude -1.5m
    
```

3.3.22 @GPPS: 1PPS output setting

This command is used to control 1PPS output.

When 1PPS output is enabled, timing pulse is output in 1 sec period from 1PPS output port after clock information being received from GNSS. When 1PPS output is disabled, timing pulse is not output from 1PPS output port.

Format: @GPPS <arg 1><CR><LF>

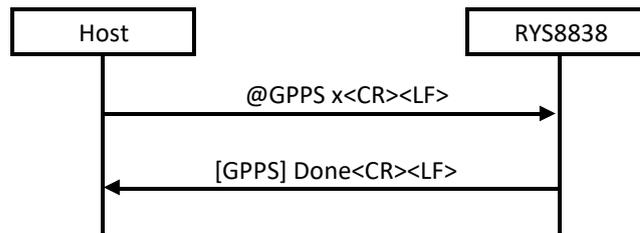
Argument:

Field	Description
arg 1	1PPS output control 0 : Disable 1PPS output (default value) 1 : Enable 1PPS output

Response:

Sentence	Description
"[GPPS] Done"	This indicates that the command has been executed successfully.
"[GPPS] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.23 @GPTC: TCXO offset acquisition

This command is used to acquire the TCXO offset value measured by the RYS8838. When the command is received, the RYS8838 transmits the TCXO offset value (ASCII data) . The unit of the TCXO offset value is “Hz” and the sign (+ or -) is added at the top.

The value converted by GPS L1 frequency is acquired. When getting TCXO frequency offset, this value must be multiplied by $(-1 * \text{Nominal frequency of TCXO}) / 1575420000$.

When the TCXO offset has not been calculated, the text “INVALID” returns.

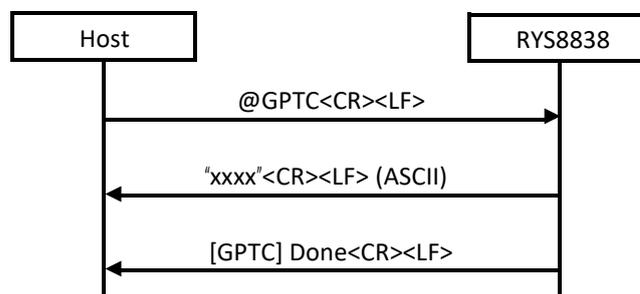
Format: @GPTC<CR><LF>

Argument: None

Response:

Sentence	Description
“[GPTC] Done”	This indicates that the command has been executed successfully.
“[GPTC] Err n”	This indicates that an error has occurred. “n” is where the error code is entered.

Sequence:



3.3.24 @GSOP: Operation mode setting

This command is used to set the operation mode of the RYS8838. The operation mode and positioning cycle can be specified.

The sleep time can be specified but only when the Normal mode has been specified. The positioning operation is performed during the remaining time of the positioning cycle after operation has transferred to the Sleep state for the time specified with each specified positioning cycle. When the fix is not valid, some satellites are tracked and the operation time (equal to the positioning cycle minus the sleep time) is less than 1 minute, the RYS8838 doesn't transit to the Sleep state in this usage. If the sleep time must be kept certainly, set the parameters so that the operation time may be 1 minute or more.

When the Low power mode is used, set the positioning cycle to the value over 1sec.

Format: @GSOP <arg 1> <arg 2> <arg 3><CR><LF>

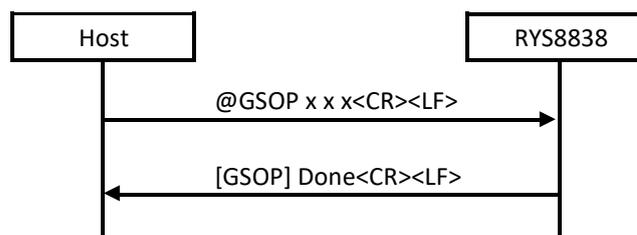
Argument:

Field	Description
arg 1	This specifies the operation mode of the receiver. 1 : Normal (default value) 2 : Low Power
arg 2	This specifies the positioning cycle [ms] using an integer. (Default value: 1000)
arg 3	This specifies the sleep time [ms] in the Normal mode using an integer. When "0" is specified, the sleep operation is not performed, and positioning is executed continuously. In modes other than Normal, this is an invalid parameter. (Default value: 0)

Response:

Sentence	Description
"[GSOP] Done"	This indicates that the command has been executed successfully.
"[GSOP] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



Examples of commands:

```

@GSOP 1 3000 0<CR><LF> // Normal mode, positioning cycle of 3 seconds (no sleep
                        // operation)
@GSOP 1 10000 5000<CR><LF> // Normal mode, positioning cycle of 10 seconds (sleep
                        // time of 5 seconds)
                        // (The pattern of a sleep time of 5 seconds and the
                        // positioning operation of 5 seconds is repeated.)
@GSOP 2 30000 0<CR><LF> // Low power mode, positioning cycle of 30 seconds
    
```

3.3.25 @GSP: Hot start for position accuracy

This command is used to start positioning using a hot start. The position accuracy is prioritized until first fix. TTFF is about 1s longer than @GSR. There is no difference with @GSR after first fix.

When the conditions for the hot start have not been met, positioning is started automatically using a warm start or cold start.

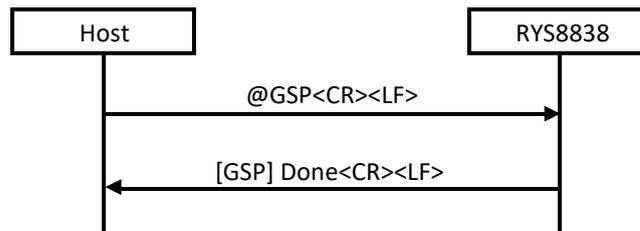
Format: @GSP<CR><LF>

Argument: None

Response:

Sentence	Description
"[GSP] Done"	This indicates that the command has been executed successfully.
"[GSP] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.26 @GSR: Hot start for TTFF

This command is used to start positioning using a hot start. The TTFF is prioritized until first fix. TTFF is about 1s shorter than @GSP but the position accuracy is somewhat worse than @GSP. There is no difference with @GSP after first fix.

When the conditions for the hot start have not been met, positioning is started automatically using a warm start or cold start.

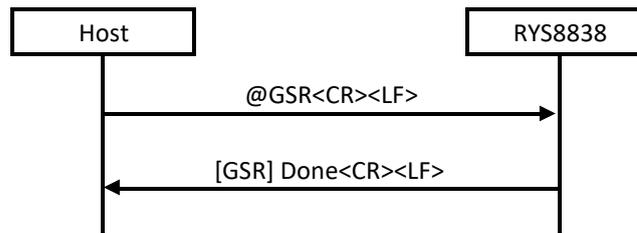
Format: @GSR<CR><LF>

Argument: None

Response:

Sentence	Description
"[GSR] Done"	This indicates that the command has been executed successfully.
"[GSR] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.27 @GSTP: Positioning stop

This command is used to stop the positioning. The RYS8838 transfers to the Idle state.

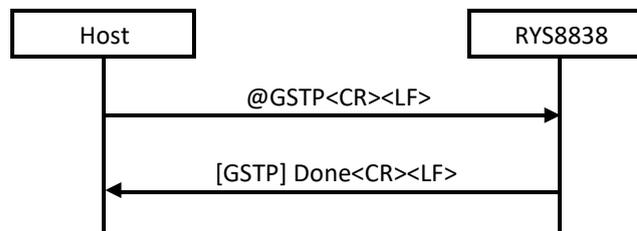
Format: @GSTP<CR><LF>

Argument: None

Response:

Sentence	Description
"[GSTP] Done"	This indicates that the command has been executed successfully.
"[GSTP] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.28 @GSUC: Positioning algorithm setting

This command is used to select the GNSS positioning algorithm for the special use case.

When enabling some algorithm, set the appropriate bits of argument 1 and set "1 (enable)" to argument 2. When disabling some algorithm, set the appropriate bits of argument 1 and set "0 (disable)" to argument 2.

Format: @GSUC <arg 1> <arg 2><CR><LF>

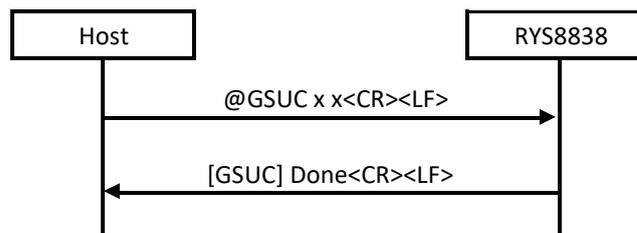
Argument:

Field	Description
arg 1	Select the algorithm to enable or disable. The set algorithms can be enabled/disabled by setting of argument 2. The setting of the other algorithm does not change. GNSS positioning algorithm are set on a bit by bit basis (0: not used, 1: used). bit 7 : Swimming mode bit 14 : Trail mode bit 15 : Driving mode
arg 2	Select enabling or disabling of the algorithm selected by argument 1. 0 : Disable 1 : Enable

Response:

Sentence	Description
"[GSUC] Done"	This indicates that the command has been executed successfully.
"[GSUC] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.29 @GSW: Warm start

This command is used to start positioning using a warm start. When the conditions for the warm start have not been met, positioning is started automatically using a cold start.

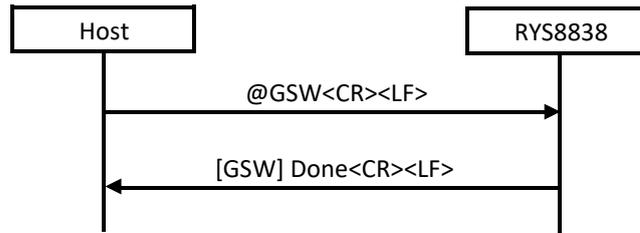
Format: @GSW<CR><LF>

Argument: None

Response:

Sentence	Description
"[GSW] Done"	This indicates that the command has been executed successfully.
"[GSW] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.30 @GTCX: TCXO offset setting

This command is used to set the TCXO offset value of the receiver in the RYS8838. The TCXO offset value of the receiver is set in Hz. The “+” or “-” direction can be specified by adding a sign to the argument.

The receiver position, current time and TCXO offset value are required in order to initiate a hot start so the time must have been set in the RYS8838 prior to hot start using this command (This is not necessary if the time is backed up on the flash memory).

Format: @GTCX <arg 1><CR><LF>

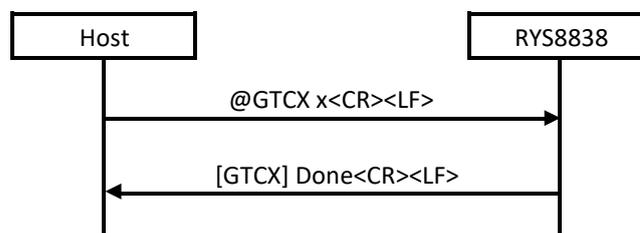
Argument:

Field	Description
arg 1	The TCXO offset value (Hz) is set using an integer. (Default value: 0)

Response:

Sentence	Description
“[GTCX] Done”	This indicates that the command has been executed successfully.
“[GTCX] Err n”	This indicates that an error has occurred. “n” is where the error code is entered.

Sequence:



Examples of commands:

```

@GTCX -250<CR><LF> // TCXO offset: -250Hz
@GTCX 100<CR><LF> // TCXO offset: +100Hz
    
```

3.3.31 @GTE: GPS test end

This command is used to end the GPS test. When the test is ended using the command, the RYS8838 returns to the state in which normal commands can be received.

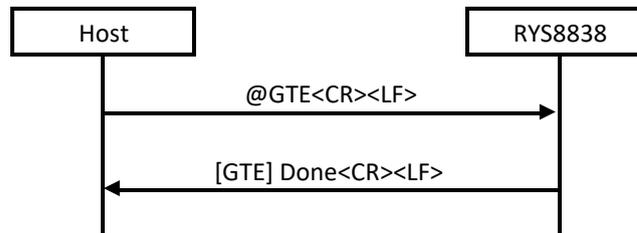
Format: @GTE<CR><LF>

Argument: None

Response:

Sentence	Description
"[GTE] Done"	This indicates that the command has been executed successfully.
"[GTE] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.32 @GTIM: Time setting

This command is used to set the time of the receiver in the RYS8838. The UTC time standard is used for the receiver time which employs the format of year, month, day, hours, minutes and seconds.

The receiver position, current time and TCXO offset value are required in order to initiate a hot start so the time must have been set in the RYS8838 prior to hot start using this command.

Format: @GTIM <arg 1> <arg 2> <arg 3> <arg 4> <arg 5> <arg 6><CR><LF>

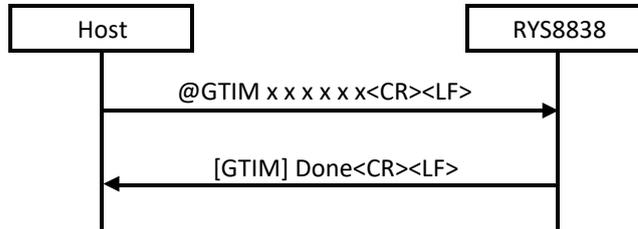
Argument:

Field	Description
arg 1	This specifies the UTC time (year) using an integer.
arg 2	This specifies the UTC time (month) using an integer.
arg 3	This specifies the UTC time (day) using an integer.
arg 4	This specifies the UTC time (hour) using an integer.
arg 5	This specifies the UTC time (minutes) using an integer.
arg 6	This specifies the UTC time (seconds) using an integer.

Response:

Sentence	Description
"[GTIM] Done"	This indicates that the command has been executed successfully.
"[GTIM] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



Examples of commands:

```

@GTIM 2013 02 01 13 30 30<CR><LF> // 2013/2/1 13:30:30
@GTIM 2013 07 10 00 00 00<CR><LF> // 2013/7/10 00:00:00"
    
```

3.3.33 @GTR: GPS test result output

This command is used to output the GPS test results. Wait one second after the @GTS command is issued, and then issue the command.

The CN level [dBHz] and Doppler frequency [Hz] are returned as the test results.

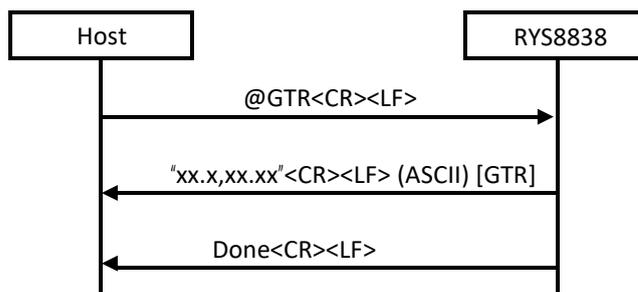
Format: @GTR<CR><LF>

Argument: None

Response:

Sentence	Description
"[GTR] Done"	This indicates that the command has been executed successfully.
"[GTR] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.34 @GTS: GPS test start

This command is used to start the GPS test. The test results are output by issuing the @GTR command after a wait of one second after the @GTS command has been issued.

This command can be issued only in the Idle state. When it is issued, no subsequent commands except for the @GTR and @GTE commands are accepted.

Format: @GTS <arg 1> <arg 2> <arg 3> <arg 4><CR><LF>

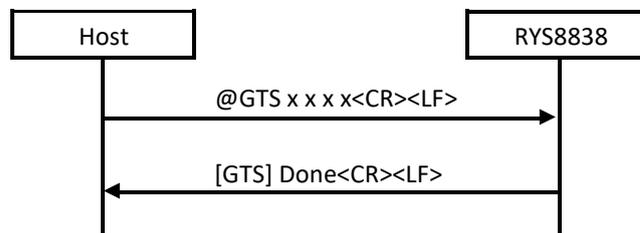
Argument:

Field	Description
arg 1	This specifies the number of the satellite used for the test.
arg 2	Reserved · Always specify "0" for this.
arg 3	Reserved · Always specify "0" for this.
arg 4	Reserved · Always specify "0" for this.

Response:

Sentence	Description
"[GTS] Done"	This indicates that the command has been executed successfully.
"[GTS] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



Examples of commands:

```
@GTS 1 0 0 0<CR><LF> // The test is started using satellite no.1.
```

3.3.35 @GUSE: Positioning algorithm setting

This command is used to select the GNSS positioning algorithm for the special use case.

In normal use case, select the default algorithm by setting "0x00" for the argument. When the special algorithm should be used, set the appropriate bits.

Format: @GUSE <arg 1><CR><LF>

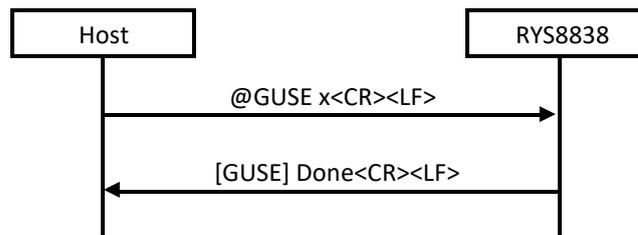
Argument:

Field	Description
arg 1	GNSS positioning algorithm are set on a bit by bit basis (0: not used, 1: used).
arg 2	GNSS positioning algorithm are set on a bit by bit basis (0: not used, 1: used). bit 0 : Special algorithm for swinging the receiver by the hand. bit 1 : reserved (always specify "0" for this) bit 2 : reserved (always specify "0" for this) bit 3 : reserved (always specify "0" for this) bit 4 : reserved (always specify "0" for this) bit 5 : reserved (always specify "0" for this) bit 6 : reserved (always specify "0" for this) bit 7 : reserved (always specify "0" for this) (Default value: 0x01)

Response:

Sentence	Description
"[GUSE] Done"	This indicates that the command has been executed successfully.
"[GUSE] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.36 @LALG: GLONASS almanac data acquisition

This command is used to acquire the GLONASS almanac data received by RYS8838. When the command is received, the RYS8838 transmits the GLONASS almanac data (binary data) to the host controller.

The GLONASS almanac data size is 576 bytes. In addition, the data which is actually transferred has the header and footer added.

This command must be issued at "Idle" mode.

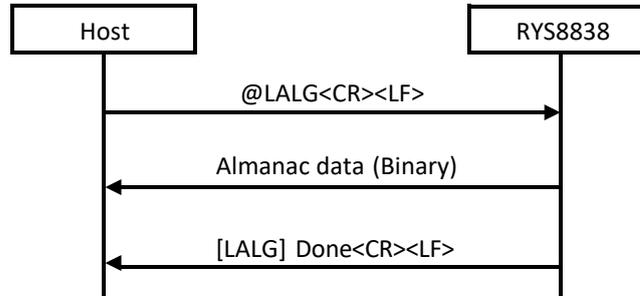
Format: @**LALG**<CR><LF>

Argument: None

Response:

Sentence	Description
"[LALG] Done"	This indicates that the command has been executed successfully.
"[LALG] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.37 @LALS: GLONASS almanac data injection

This command is used to inject the GLONASS almanac data into the RYS8838. Transmit the GLONASS almanac data (binary data) following the Ready response from the RYS8838.

The GLONASS almanac data size is 576 bytes. In addition, the data which is actually required has the header and footer added.

This command must be issued at "Idle" mode.

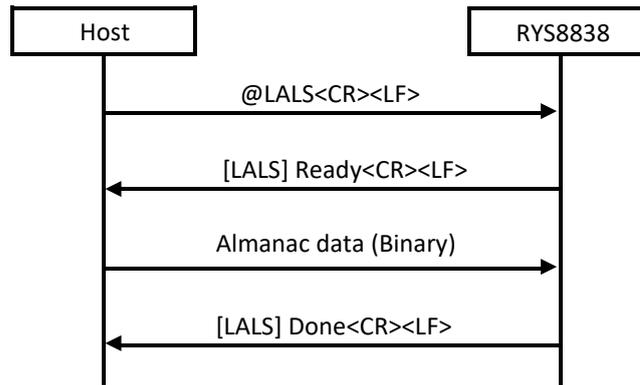
Format: @LALS<CR><LF>

Argument: None

Response:

Sentence	Description
"[LALS] Done"	This indicates that the command has been executed successfully.
"[LALS] Ready"	This indicates that the preparations for receiving the almanac data have been completed.
"[LALS] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.38 @LEMG: GLONASS ephemeris data acquisition

This command is used to acquire the GLONASS ephemeris data which has been received by RYS8838.

When the command is received, the RYS8838 transmits the GLONASS ephemeris data (binary data) to the host controller.

The GLONASS ephemeris data size is 1152 bytes. In addition, the data which is actually transferred has the header and footer added.

This command must be issued at “Idle” mode.

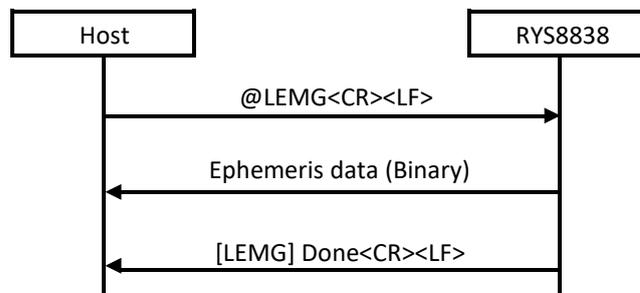
Format: @LEMG<CR><LF>

Argument: None

Response:

Sentence	Description
“[LEMG] Done”	This indicates that the command has been executed successfully.
“[LEMG] Err n”	This indicates that an error has occurred. “n” is where the error code is entered.

Sequence:



3.3.39 @LEMS: GLONASS ephemeris data injection

This command is used to inject the GLONASS ephemeris data into the RYS8838. Transmit the GLONASS ephemeris data (binary data) following the Ready response from the RYS8838.

The GLONASS ephemeris data size is 1152 bytes. In addition, the data which is actually required has the header and footer added.

This command must be issued at "Idle" mode.

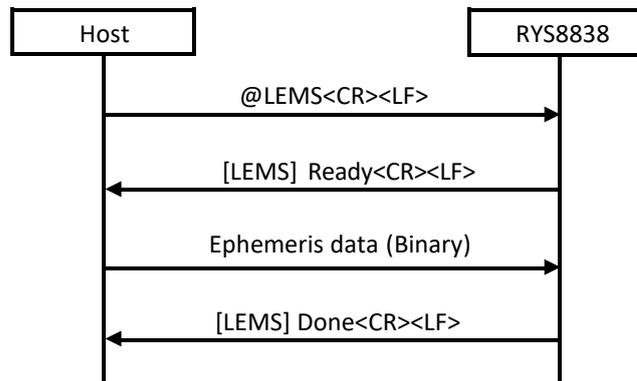
Format: @LEMS<CR><LF>

Argument: None

Response:

Sentence	Description
"[LEMS] Done"	This indicates that the command has been executed successfully.
"[LEMS] Ready"	This indicates that the preparations for receiving the almanac data have been completed.
"[LEMS] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.40 @SLP: Sleep

This command is used to transfer operation to the Sleep state. It specifies transfer to each sleep state using an argument. The status at sleeping differs according to Sleep states.

State	Main RAM	Backup RAM	RTC	After wake up
Sleep 0	Retained	Retained	Operation	Re-start with previous setting
Sleep 1	OFF	Retained	Operation	Reboot
Sleep 2	OFF	OFF	Operation	Reboot

This command must be issued at Idle state. When this command is issued at Exec state, error is returned.

Format: @SLP <arg 1><CR><LF>

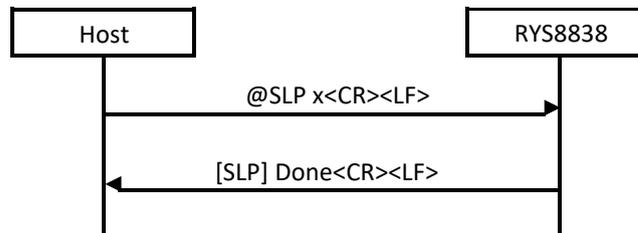
Argument:

Field	Description
arg 1	This selects whether to transfer to the Sleep state or Deep Sleep state. 0: Transfer to Sleep 0. 1: Transfer to Sleep 1. 2: Transfer to Sleep 2.

Response:

Sentence	Description
"[SLP] Done"	This indicates that the command has been executed successfully.
"[SLP] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.41 @VER: Firmware revision number acquisition

This command is used to acquire the revision number of the firmware.

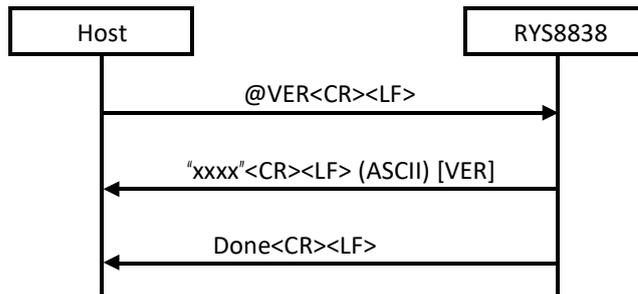
Format: @VER<CR><LF>

Argument: None

Response:

Sentence	Description
"[VER] Done"	This indicates that the command has been executed successfully.
"[VER] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



3.3.42 @WUP: Wake-up

This command is used to transfer to the Idle state from the Sleep state.

When this command has been issued in the Sleep state, the command reply message is not output until the transfer to the Idle state is completed. Repeatedly issue this command until the command reply message is output.

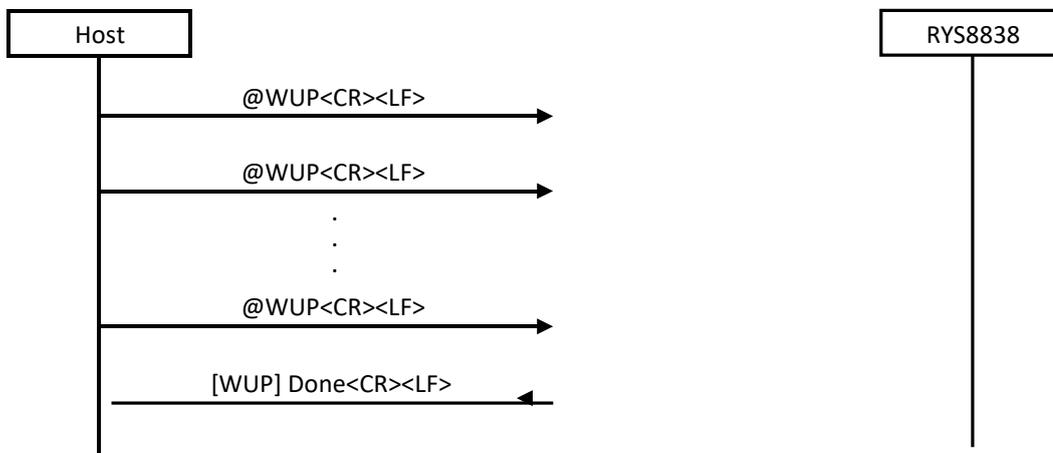
Format: @WUP<CR><LF>

Argument: None

Response:

Sentence	Description
"[WUP] Done"	This indicates that the command has been executed successfully.
"[WUP] Err n"	This indicates that an error has occurred. "n" is where the error code is entered.

Sequence:



4 NMEA sentence specifications

This section describes the specifications of NMEA sentences. RYS8838 outputs NMEA0183 compliant sentences, IMES sentences and proprietary sentences whose talker ID is "\$PS".

4.1 NMEA 0183 compliant sentences

RYS8838 outputs below sentences of NMEA0183 (ver 4.10) compliant sentences. When the 10Hz positioning is selected by @DSHR 1 command, GGA and RMC sentences are output at 10Hz and other sentences are output at 1Hz.

4.1.1 GGA : Global Positioning System Fix Data

Format: \$--GGA, hhmmss.ss, llll.ll, a, yyyyy.yy, a, x, xx, x.x, x.x, M, x.x, M, x.x, xxxx*hh<CR><LF>

Fields:

Field	Format	Description
Header	\$	
Talker ID	--	GP
Sentence ID	GGA	
UTC of position	hhmmss.ss	hh [hour] mm [min] ss.ss [sec]
Latitude	llll.ll	dd [degree] mm.mmmm [min]
Latitude – N/S	a	N : North latitude, S : South latitude
Longitude	yyyy.yy	ddd [degree] mm.mmmm [min]
Longitude – E/W	a	E : East longitude, W : West longitude
Quality indicator	x	0 : Fix not available 1 : Fix valid 2 : Fix valid, Differential GPS 6 : Dead reckoning
Number of satellites in use	xx	
HDOP	x.x	
Altitude (mean-sea-level), meters	x.x,M	[m]
Geoidal separation, meters	x.x,M	[m]
Age of DGPS data	x.x	NULL
Differential reference station ID	xxxx	NULL
Checksum	*hh	
Termination	<CR><LF>	

4.1.2 GLL : Geographic Position – Latitude / Longitude

Format : \$--GLL, llll.ll, a, yyyy.yy, a, hhmmss.ss, A, a*hh<CR><LF>

Fields:

Field	Format	Description
Header	\$	
Talker ID	--	GP : Using only GPS for positioning GL : Using only GLONASS for positioning GA : Using only Galileo for positioning BD : Using only BeiDou for positioning GQ : Using only QZS for positioning GN : Using combined satellite systems for positioning
Sentence ID	GLL	
Latitude	llll.ll	dd [degree] mm.mmmm [min]
Latitude – N/S	a	N : North latitude, S : South latitude
Longitude	yyyy.yy	ddd [degree] mm.mmmm [min]
Longitude – E/W	a	E : East longitude, W : West longitude
UTC of position	hhmmss.ss	hh [hour] mm [min] ss.ss [sec]
Status	A	A : Data valid, V : Data not valid
Mode Indicator	a	Positioning system Mode Indicator : A : Autonomous mode D : Differential mode E : Dead reckoning mode N : Data not valid
Checksum	*hh	
Termination	<CR><LF>	

4.1.3 GNS: GNSS Fix Data

Format:

```
$--GNS,hhmmss.ss,llll.ll,a,yyyy.yy,a,c--c,xx,x.x,x.x,M,x.x,M,x.x,xxxx,a*hh<CR><LF>
```

Fields:

Field	Format	Description
Header	\$	
Talker ID	--	GP : Using only GPS for positioning GL : Using only GLONASS for positioning GA : Using only Galileo for positioning BD : Using only BeiDou for positioning GQ : Using only QZS for positioning GN : Using combined satellite systems for positioning
Sentence ID	GNS	
UTC of position	hhmmss.ss	hh [hour] mm [min] ss.ss [sec]
Latitude	llll.ll	dd [degree] mm.mmmm [min]
Latitude – N/S	a	N : North latitude, S : South latitude
Longitude	yyyy.yy	ddd [degree] mm.mmmm [min]
Longitude – E/W	a	E : East longitude, W : West longitude
Mode indicator	c--c	Positioning system Mode Indicator (1 st character : GPS, 2 nd character : GLONASS) A : Autonomous mode D : Differential mode E : Dead reckoning mode N : Data not valid
Number of satellites in use	xx	
HDOP	x.x	
Altitude (mean-sea-level)	x.x,M	[m]
Geoidal separation, meters	x.x,M	[m]
Age of DGPS data	x.x	
Differential reference station ID	xxxx	NULL
Navigation status	a	
Checksum	*hh	
Termination	<CR><LF>	

4.1.4 GSA: GNSS DOP and Active Satellites

When the combined satellite systems are used for positioning, the sentences from each satellite system are output one by one (Talker ID of each sentences are “GN”).

Format:\$--GSA, a, x, xx, xx, xx, xx, xx, xx, xx, xx, xx, xx, xx, xx, x.x, x.x, x.x, h*hh<CR><LF>

Fields:

Field	Format	Description
Header	\$	
Talker ID	--	GP : Using only GPS for positioning GL : Using only GLONASS for positioning GA : Using only Galileo for positioning BD : Using only BeiDou for positioning GQ : Using only QZS for positioning GN : Using combined satellite systems for positioning
Sentence ID	GSA	
2D / 3D Mode	a	A : Automatically switch 2D / 3D
Mode	x	1 : Fix not available, 2 : 2D, 3 : 3D
Used satellite #1	xx	
.		
.		
.		
Used satellite #12	xx	
PDOP	x.x	
HDOP	x.x	
VDOP	x.x	
GNSS system ID	h	1 : GPS 2 : GLONASS 3 : Galileo 4 : BeiDou 5 : QZSS
Checksum	*hh	
Termination	<CR><LF>	

4.1.5 GSV: GNSS Satellites In View

Format : \$--GSV,x,x,xx,xx,xx,xxx,xx, ,xx,xx,xxx,xx,h*hh<CR><LF>

Fields:

Field		Format	Description
Header		\$	
Talker ID		--	GP : GPS satellites in view GL : GLONASS satellites in view GA : Galileo satellites in view BD : BeiDou satellites in view GQ : QZS satellites in view
Sentence ID		GSV	
Total number of sentences		x	
Sentence number		x	
Total number of satellites in view		xx	
SV1	Satellite ID	xx	
	Elevation	xx	[degree]
	Azimuth	xxx	[degree]
	SNR (C/N)	xx	[dB-Hz] (NULL at no acquisition)
SV2	Satellite ID	xx	
	Elevation	xx	[degree]
	Azimuth	xxx	[degree]
	SNR (C/N)	xx	[dB-Hz] (NULL at no acquisition)
SV3	Satellite ID	xx	
	Elevation	xx	[degree]
	Azimuth	xxx	[degree]
	SNR (C/N)	xx	[dB-Hz] (NULL at no acquisition)
SV4	Satellite ID	xx	
	Elevation	xx	[degree]
	Azimuth	xxx	[degree]
	SNR (C/N)	xx	[dB-Hz] (NULL at no acquisition)
Signal ID		h	
Checksum		*hh	
Termination		<CR><LF>	

4.1.6 RMC: Recommended Minimum Specific GNSS Data

Format : \$--RMC,hhmmss.ss,A,llll.ll,a,yyyy.yy,a,x.x,x.x,xxxxxx,x.x,a,a,a*hh<CR><LF>

Fields:

Field	Format	Description
Header	\$	
Talker ID	--	GP : Using only GPS for positioning GL : Using only GLONASS for positioning GA : Using only Galileo for positioning BD : Using only BeiDou for positioning GQ : Using only QZS for positioning GN : Using combined satellite systems for positioning
Sentence ID	RMC	
UTC of position fix	hhmmss.ss	hh [hour] mm [min] ss.ss [sec]
Status	A	A : Data valid, V : Data not valid
Latitude	llll.ll	dd [degree] mm.mmmm [min]
Latitude – N/S	a	N : North latitude, S : South latitude
Longitude	yyyy.yy	ddd [degree] mm.mmmm [min]
Longitude – E/W	a	E : East longitude, W : West longitude
Speed over ground	x.x	[knot]
Course over ground	x.x	[degree]
Date	xxxxxx	dd [day] mm [month] yy [year]
Magnetic variation	x.x	[degree]
Magnetic variation – E/W	a	E : East, W : West
Mode Indicator	a	A : Autonomous mode D : Differential mode E : Dead reckoning mode N : Data not valid
Navigation status	a	
Checksum	*hh	
Termination	<CR><LF>	

4.1.7 VTG: Course Over Ground & Ground Speed

Format : \$--VTG, x.x,T, x.x,M, x.x,N, x.x,K, a*hh<CR><LF>

Fields:

Field	Format	Description
Header	\$	
Talker ID	--	GP : Using only GPS for positioning GL : Using only GLONASS for positioning GA : Using only Galileo for positioning BD : Using only BeiDou for positioning GQ : Using only QZS for positioning GN : Using combined satellite systems for positioning
Sentence ID	VTG	
Course over ground - True	x.x,T	[degrees]
Course over ground - Magnetic	x.x,M	NULL
Speed over ground	x.x,N	[knot]
Speed over ground	x.x,K	[km/h]
Mode Indicator	a	A : Autonomous mode D : Differential mode E : Dead reckoning mode N : Data not valid
Checksum	*hh	
Termination	<CR><LF>	

4.1.8 ZDA: Time & Date

Format : \$--ZDA,hhmmss.ss,xx,xx,xxxx,xx,xx*hh<CR><LF>

Fields :

Field	Format	Description
Header	\$	
Talker ID	--	GP : Using only GPS for positioning GL : Using only GLONASS for positioning GA : Using only Galileo for positioning BD : Using only BeiDou for positioning GQ : Using only QZS for positioning
Sentence ID	ZDA	
UTC	hhmmss.ss	hh [hour] mm [min] ss.ss [sec]
Day	xx	
Month	xx	
Year	xxxx	
Local zone hours	xx	NULL
Local zone minutes	xx	NULL
Checksum	*hh	
Termination	<CR><LF>	

4.2 Satellite ID

Below values are stored in satellite ID of GSA and GSV sentences.

Satellite system	Talker ID	Satellite ID
GPS	GP	1~32
SBAS	GP	33~64
GLONASS	GL	65~88
Galileo	GA	1~36
BeiDou	BD	1~30
QZSS (L1 C/A)	GQ	1~10
QZSS (L1S)	GQ	55~63