RYS8839 Software Guide

Table of Contents

1 What this document contains

This document sets forth the RYS8839 host controller command specifications.

It describes the command protocol used when the RYS8839 is controlled from the host controller, and the specifications of these commands.

2 Host controller interface specifications

The RYS8839 is connected to the host controller using UART/I²C. This section describes the communicationspecification.

2.1 UART interface

The default settings of the UART interface are listed below. These settings can be changed by the commands.

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

2.2 I²C interface

The RYS8839 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 (HIF_INT_OUT) in the RYS8839 is required to input host controller as “data output request” in addition to SDA and SCL. When output data is available in the RYS8839, theRYS8839 outputs “H” from data output request GPIO. When output data is not available in the RYS8839, the RYS8839 outputs “L” from data output request GPIO. For handling the data from the RYS8839, data output request GPIO should be connected to host controller’s interrupt port.

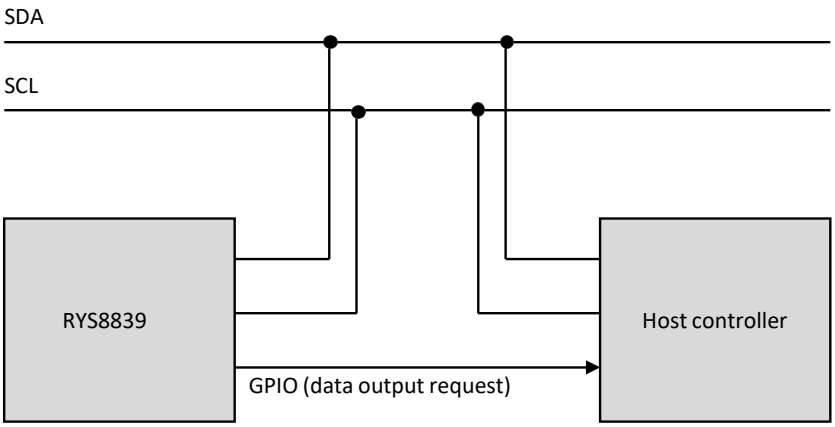


Fig.1 The connection with host controller using I²C

2.3 Communication protocol

There are 2 communication protocols – ASCII protocol and Binary protocol. Which one to use can be specified by the Configuration file. Refer to section 3 for ASCII protocol, section 4 for Binary protocol and section 6 for Configuration file.

I²C interface support Binary protocol only. Please refer to section 4.4 and for detail of thecommunication method.

3 ASCII protocol

The RYS8839 communicates with the host controller by the commands described in ASCII code. In this mode, theRYS8839 sends the positioning information with NMEA0183 (ver.4.11) protocol.

3.1 Command format

Commands are described in ASCII code.

The format for the control commands transmitted to the RYS8839 is given below.

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

On receipt of a command from the host controller, the RYS8839 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)

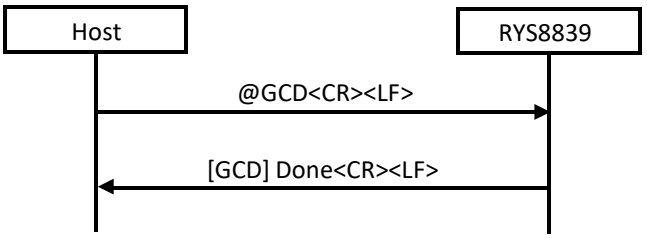
Take steps to prevent another command from being issued before the reply message (Done or Err) indicating the command completion has been returned from the RYS8839.

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.

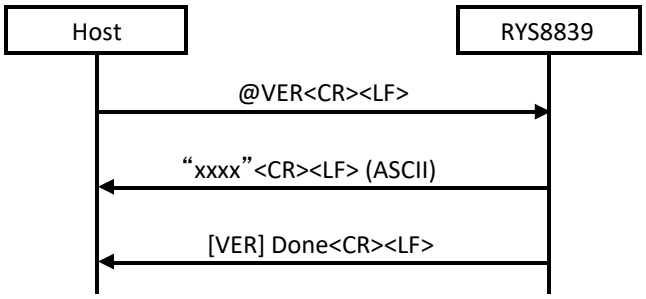
3.2 Command sequence

This section describes the sequence of the commands between the host controller and RYS8839 for each type ofcommand.

3.2.1 Commands not entailing an exchange of data

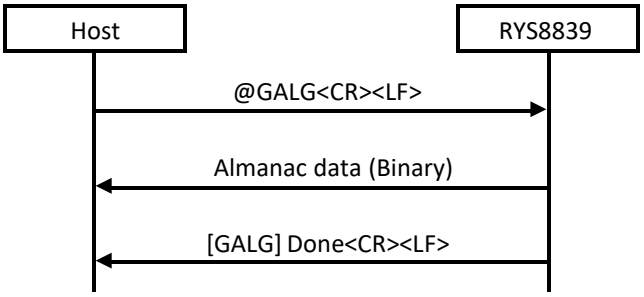


3.2.2 Commands that entail data (ASCII data) transmission from the RYS8839



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 RYS8839



A header and footer that describe the data length, checksum, etc. are inserted into the binary data transmitted from the RYS8839 before and after the data.

The binary data format is shown below.

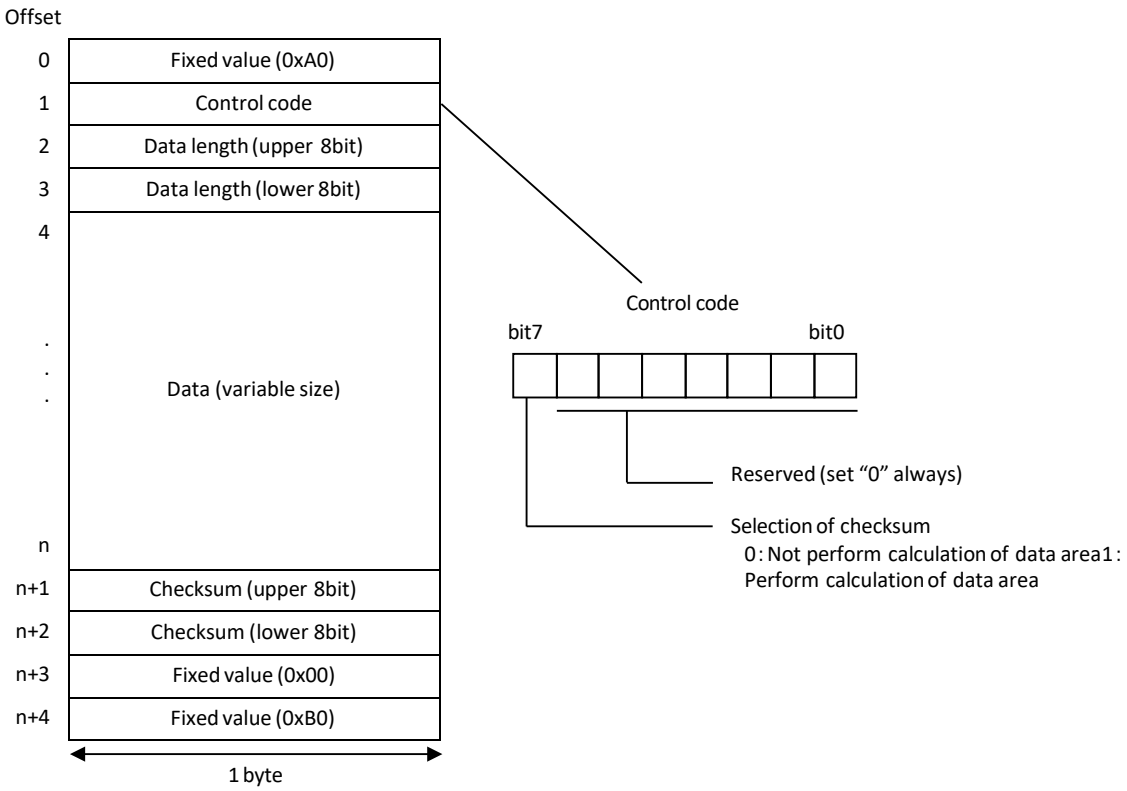
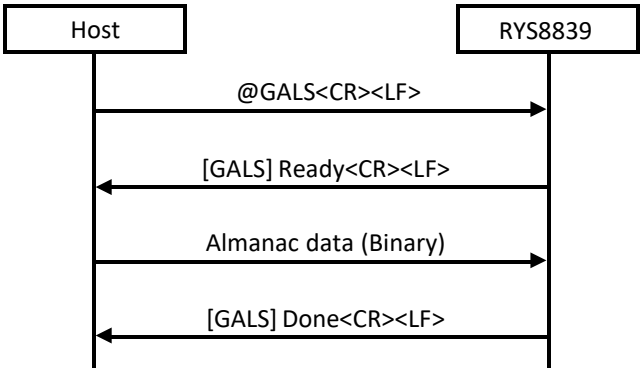


Fig.3 Binary data format

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 RYS8839



The same data format as for the binary data which is transmitted from the RYS8839 is used. As with the data transmitted from the RYS8839, 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 saving interval setting

This command is used to setting the interval of the automatic backup data saving 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 eMRAM when using this function.

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

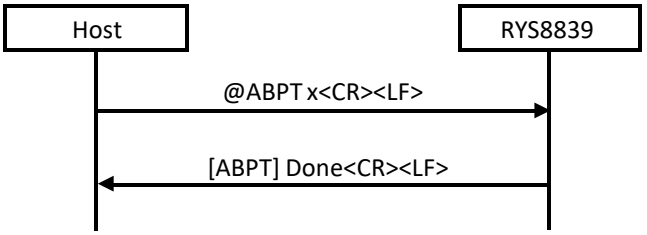
Argument:

Field	Description
arg 1	Set the interval of the automatic backup data saving. 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 saving ON/OFF

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

When “1” is specified for the argument, the backup data contents are saved in the eMRAM 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, an error be returned.

When the automatic backup data save is executing, the NMEA sentence may occasionally have erratic output.

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

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

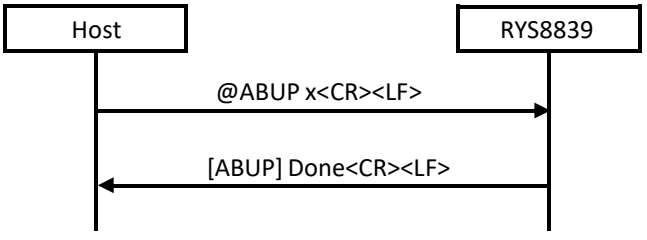
Argument:

Field	Description
arg 1	Control automatic backup data saving 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 @ALMG: Almanac data acquisition

This command is used to acquire the almanac data received by RYS8839. When the command is received, the RYS8839 transmits the almanac data (binary data) of the specified satellite system to the host controller.The satellite system is specified by the argument.

This command must be issued at “Idle” mode.

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

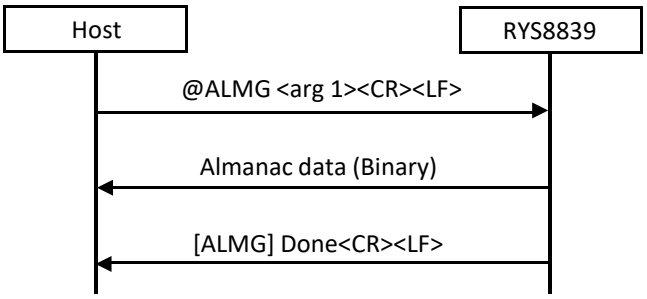
Argument:

Field	Description
arg 1	The satellite systems is specified. 0 : GPS L1-C/A 1 : GPS L5 2 : GLONASS L1OF 3 : QZSS L1-C/A 5 : QZSS L5 6 : BeiDou B1I D1 7 : BeiDou B1I D2 8 : BeiDou B1C 9 : BeiDou B2a 10 : Galileo E1B/C 11 : Galileo E5B 12 : NavIC

Response:

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

Sequence:



3.3.4 @ALMS: Almanac data injection

This command is used to inject the almanac data into the RYS8839. Transmit the almanac data (binary data) following the Ready response from the RYS8839.

The satellite system is specified by the argument.

This command must be issued at “Idle” mode.

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

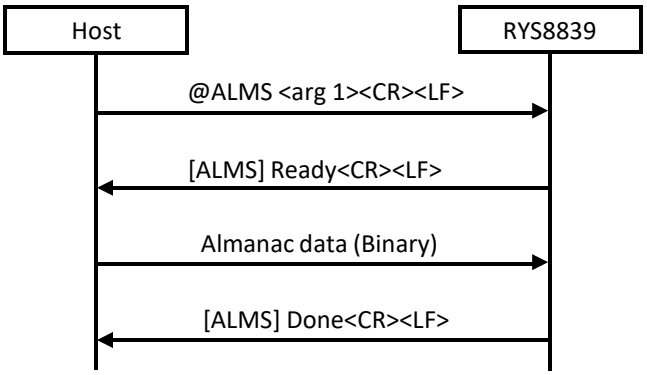
Argument:

Field	Description
arg 1	The satellite systems is specified. 0 : GPS L1-C/A 1 : GPS L5 2 : GLONASS L1OF 3 : QZSS L1-C/A 5 : QZSS L5 6 : BeiDou B1I D1 7 : BeiDou B1I D2 8 : BeiDou B1C 9 : BeiDou B2a 10 : Galileo E1B/C 11 : Galileo E5B 12 : NavIC

Response:

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

Sequence:



3.3.5 @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>`**

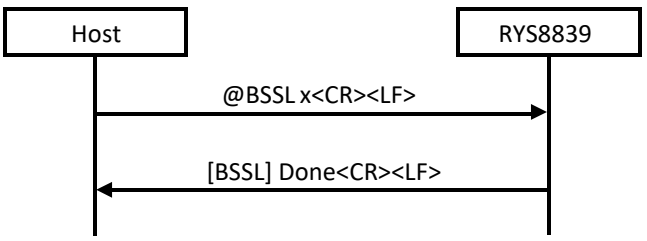
Argument:

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 bit18 : Reserved bit19 : Reserved bit20 : GST (Default value: 0x000000EF)

Response:

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

Sequence:



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
```

3.3.6 @BUP: Backup data saving

This command is used to save the backup data. The backup data contents are saved in the eMRAM. There are two types of the backup data – Navigation data (the receiver position, ephemeris, almanac, TCXO offset and other information required for hot start) and Command settings data (the parameters set by each commands). Navigation data are automatically restored at a boot-up and an wakeup from Deep Sleep. Command settings data are automatically restored only at an wakeup from Deep Sleep.

Navigation data is required for hot start, and by saving the backup data in the eMRAM using this command, hot start can be initiated even 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.

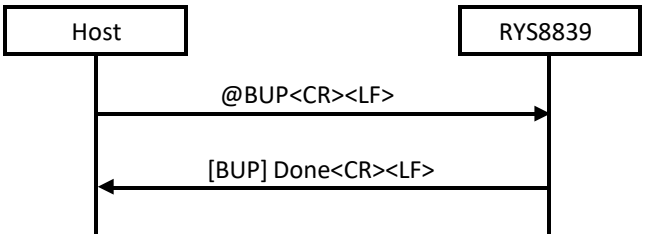
Format: **@BUP<CR><LF>**

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:



3.3.7 @BUPC: Backup data clear

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

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

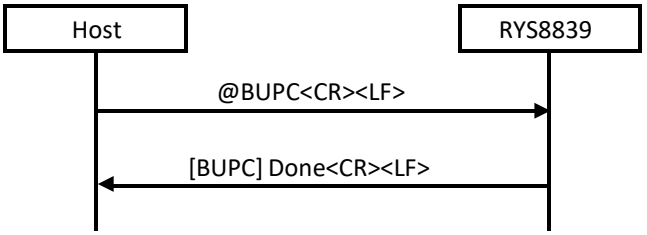
Format: **@BUPC<CR><LF>**

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:



3.3.8 @CSBR: UART0 baud rate setting

This command is used to set the UART0 baud rate of the RYS8839.

When the command is executed successfully, the RYS8839 changes the baud rate after 100ms waiting, then sends “Done” response.

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>**

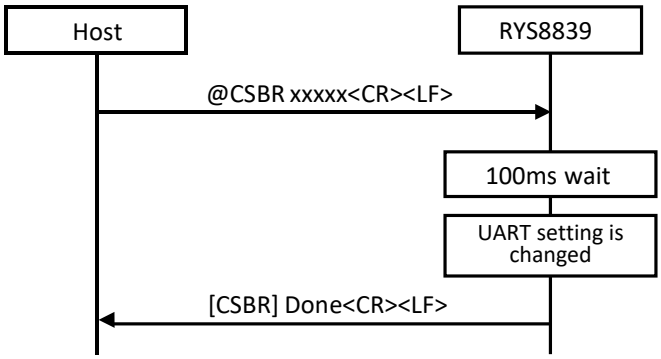
Argument:

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, 921600, 1000000, 2000000, 3000000, 4000000, 5000000, 6000000, 7000000, 8000000, 9000000, 10000000 (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:



3.3.9 @CSPS: UART0 communication parameter setting

This command is used to set the UART0 communication parameter (hardware flow control) of the RYS8839.

When the command is executed successfully, the RYS8839 changes the UART0 communication parameter after 100ms waiting, then sends “Done” response.

When the command has failed, the original settings are not changed. In the default status, the hardware flow control is none.

Format: **`@CSPS <arg 1><CR><LF>`**

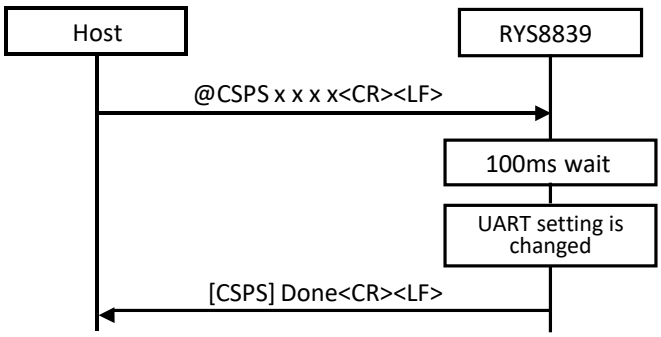
Argument:

Field	Description
arg 1	The hardware flow control type is specified. 0 : None (default value) 1 : Hardware (CTS/RTS)

Response:

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

Sequence:



3.3.10 @EPHG: Ephemeris data acquisition

This command is used to acquire the ephemeris data received by RYS8839. When the command is received, the RYS8839 transmits the ephemeris data (binary data) of the specified satellite system to the host controller. The satellite system is specified by the argument.

This command must be issued at “Idle” mode.

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

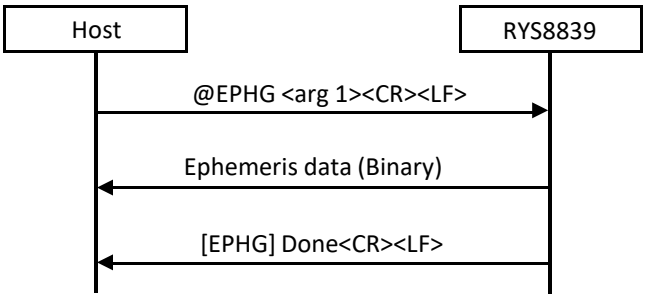
Argument:

Field	Description
arg 1	The satellite systems is specified. 0 : GPS L1-C/A 1 : GPS L5 2 : GLONASS L1OF 3 : QZSS L1-C/A 5 : QZSS L5 6 : BeiDou B1I D1 7 : BeiDou B1I D2 8 : BeiDou B1C 9 : BeiDou B2a 10 : Galileo E1B/C 11 : Galileo E5B 12 : NavIC

Response:

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

Sequence:



3.3.11 @EPHS: Ephemeris data injection

This command is used to inject the ephemeris data into the RYS8839. Transmit the ephemeris data (binarydata) following the Ready response from the RYS8839.

The satellite system is specified by the argument.

This command must be issued at “Idle” mode.

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

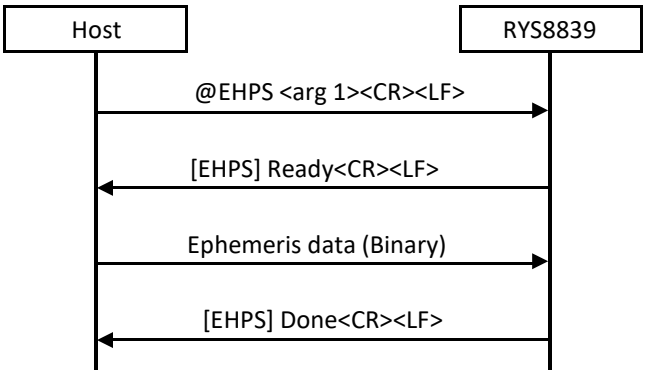
Argument:

Field	Description
arg 1	The satellite systems is specified. 0 : GPS L1-C/A 1 : GPS L5 2 : GLONASS L1OF 3 : QZSS L1-C/A 5 : QZSS L5 6 : BeiDou B1I D1 7 : BeiDou B1I D2 8 : BeiDou B1C 9 : BeiDou B2a 10 : Galileo E1B/C 11 : Galileo E5B 12 : NavIC

Response:

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

Sequence:



3.3.12 @FAER: Internal information initialization

This command is used to erase the whole of internal data and initialize the RYS8839. Ephemeris, almanac, receiver position/velocity, TCXO offset on the flash memory or eMRAM and time are erased. After erasing these data, the RYS8839 will reboot.

This command must be issued at Idle state.

Format: **`@FAER <arg 1><CR><LF>`**

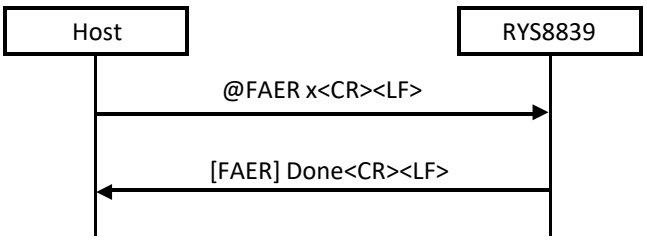
Argument:

Field	Description
arg 1	Set “1” always.

Response:

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

Sequence:



3.3.13 @GCD: Cold start

This command is used to start the positioning with cold start. Ephemeris and almanac are erased. Different from @GDCD, time, receiver position and TCXO offset are not erased.

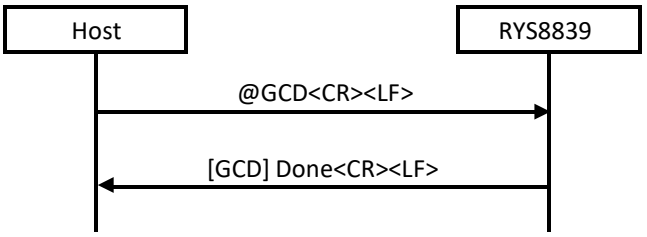
Format: **@GCD<CR><LF>**

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:



3.3.14 @GCLR: Internal information erase

This command is used to erase the internal data (e.g. the data received from the satellites, time) .

When issuing this command with setting “1” to the bits the data assigned, these data will be erased.

This command must be issued at “Idle” mode.

Format: **@GCLR <arg 1><CR><LF>**

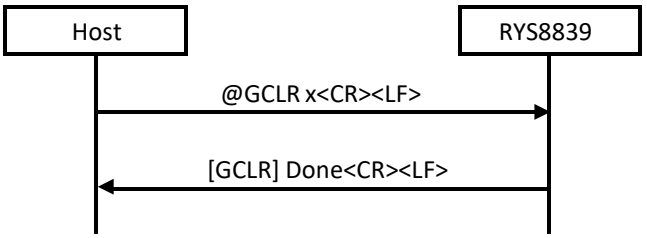
Argument:

Field	Description
arg 1	The erased data are set on a bit by bit basis (0: not erase, 1: erase). bit 0 : Ephemeris bit 1 : Almanac bit 2 : Receiver position and velocity bit 3 : Time bit 16 : TCXO offset

Response:

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

Sequence:



3.3.15 @GCNL: C/N0 limit value setting

This command is used to set the minimum C/N0 value for the satellites for position calculation. The satellites which C/N0 is under this setting will not be used for position calculation. The value from 0 to 50 can be specified. When 0 is specified, C/N0 limit value is set to the default value.

It is desirable to use the default setting, since this change may affect the performance.

Format: **`@GCNL <arg 1><CR><LF>`**

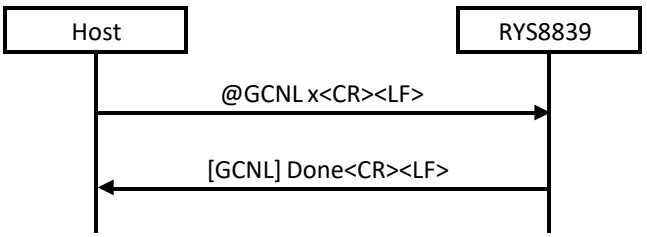
Argument:

Field	Description
arg 1	Specify the minimum C/N0 [dBHz] of the satellites for position calculation by integer. The value from 0 to 50 can be specified. When 0 is specified, C/N0 limit value will be the default value.

Response:

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

Sequence:



3.3.16 @GDCD: Deep cold start

This command is used to start the positioning with cold start. Different from @GCD, all information - ephemeris, almanac, time, receiver position and TCXO offset are erased.

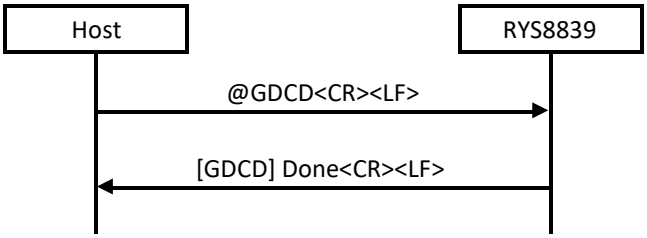
Format: **@GDCD<CR><LF>**

Argument: None

Response:

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

Sequence:



3.3.17 @GELV: Elevation limit value setting

This command is used to set the minimum elevation angle (0 to 90 degree) value for the satellites to track. The satellites which elevation angle is under this setting will not be tracked.

It is desirable to use the default setting, since this change may affect the performance.

Format: **@GCNL <arg 1><CR><LF>**

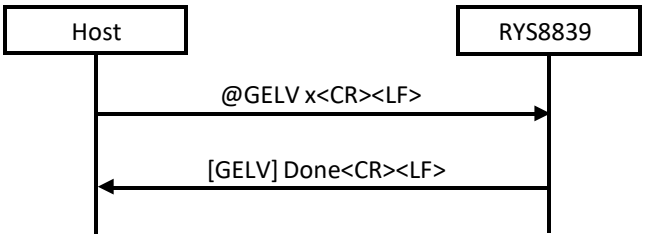
Argument:

Field	Description
arg 1	Specify the minimum elevation angle [degree] of the satellites to track by integer (Default value: 5). The value from 0 to 90 can be specified

Response:

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

Sequence:



3.3.18 @GEOA: Register the geofence region

This command is used to register the geofence region. Specify the longitude/latitude/radius of the center location of the region. 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.

Format: **`@GEOA <arg 1> <arg 2> <arg 3> <arg 4><CR><LF>`**

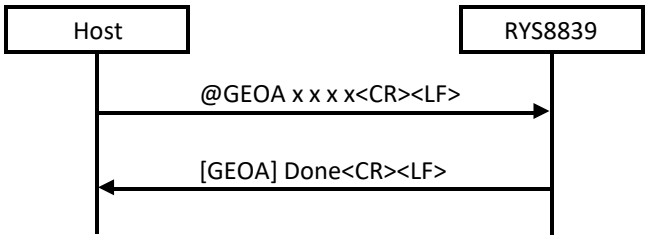
Argument:

Field	Description
arg 1	Region ID (0 – 19)
arg 2	This specifies the latitude (degrees) * 10^6 of the center location using an integer. e.g. 43.123456 degrees north: set “43123456”.
arg 3	This specifies the longitude (degrees) *10^6 of the center location using an integer. e.g.139.789000 degrees east: set “139789000”.
arg 4	This specifies the radius of the center location using an integer. The unit is [m].

Response:

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

Sequence:



3.3.19 @GEOC: Acquire the geofence region settings

This command is used to acquire the geofence region settings. The longitude/latitude/radius of the specified geofence region will return separated by a commas. When the unregistered region ID is specified, the error will returns.

Format: **`@GEOC <arg 1><CR><LF>`**

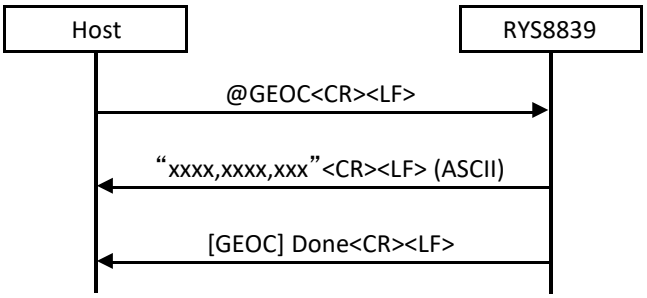
Argument:

Field	Description
arg 1	Region ID (0 – 19)

Response:

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

Sequence:



Examples of return value:

```
35123456,-139987650,100<CR><LF>        // North latitude 35.123456 degree,
                                       // west longitude 139.987650 degree,
                                       // radius 100m
```

3.3.20 @GEOE: Delete the geofence region

This command is used to delete the registered geofence region.

Format: **@GEOE <arg 1><CR><LF>**

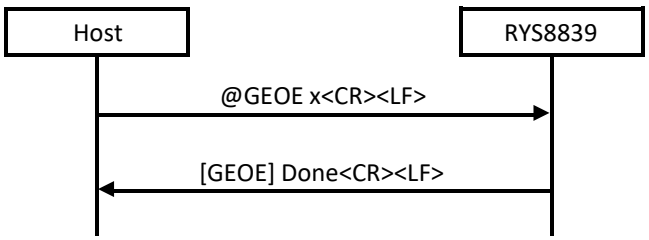
Argument:

Field	Description
arg 1	Region ID (0 – 19)

Response:

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

Sequence:



3.3.21 @GEOH: Geofence setting

This command is used to configure the geofence functionality settings.

This command must be issued at “Idle” mode.

Format: **@GEOH <arg 1> <arg 2> <arg 3><CR><LF>**

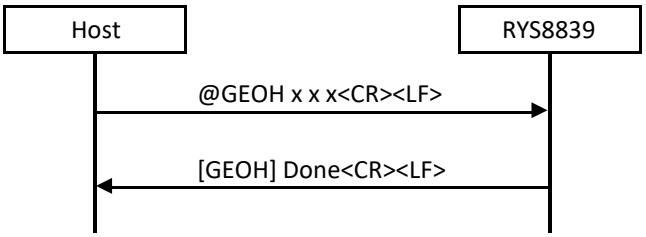
Argument:

Field	Description
arg 1	Specify the dead zone at the border of the regions in [m] as an integer (Default: 0).
arg 2	Specify the period to judge the receiver dwells in the regions in [sec] as an integer (Default: 0). When the receiver stays inside of the regions longer than specified time, the RYS8839 judges “DWELL”. When “0” is specified, the RYS8839 doesn’t detect “DWELL”.
arg 3	Specify the indication delay time in [sec] as an integer (Default: 1). The value from 0 to 5 can be specified. When the value from 1 to 5 is specified, $PSGEO sentence is output after specified time has passed from the status changing detected.

Response:

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

Sequence:



3.3.22 @GEOL: Delete all geofence region

This command is used to delete all registered geofence region.

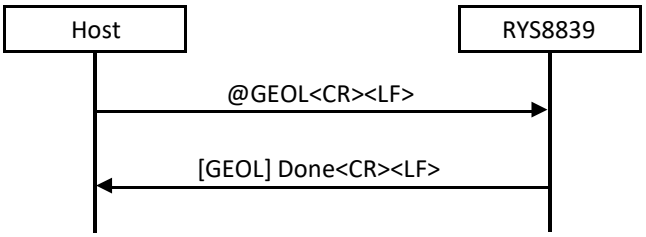
Format: **@GEOL<CR><LF>**

Argument: None

Response:

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

Sequence:



3.3.23 @GEOM: Modify the geofence region

This command is used to modify the registered geofence region. Specify the longitude/latitude/radius of the center location of the region. 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. When the unregistered region ID is specified, the error will returns.

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

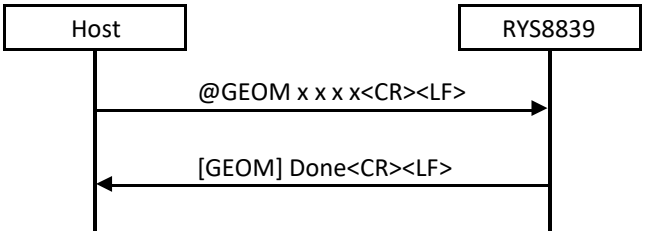
Argument:

Field	Description
arg 1	Region ID (0 – 19)
arg 2	This specifies the latitude (degrees) * 10^6 of the center location using an integer. e.g. 43.123456 degrees north: set “43123456”.
arg 3	This specifies the longitude (degrees) *10^6 of the center location using an integer. e.g.139.789000 degrees east: set “139789000”.
arg 4	This specifies the radius of the center location using an integer. The unit is [m].

Response:

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

Sequence:



3.3.24 @GEOP: Geofence region status output

This command is used to output the status of all registered geofence region by $PSGEO. When the RYS8839 receives this command, the RYS8839 output $PSGEO at a next timing of NMEA sentence output and informs the status of all registered geofence region even if there is no status changing.

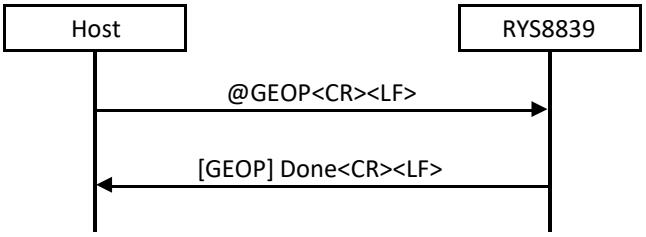
Format: **@GEOP<CR><LF>**

Argument: None

Response:

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

Sequence:



3.3.25 @GEOS: Acquire the registered geofence region

This command is used to acquire the registered geofence region. The 8-digit / hexadecimal integer in which the bits for the registered region is “1” will return with the prefix “0x”.

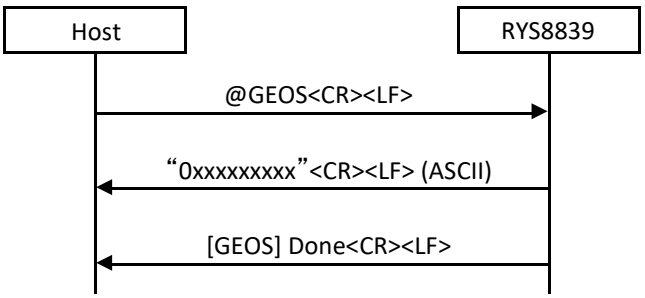
Format: **@GEOS<CR><LF>**

Argument: None

Response:

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

Sequence:



Examples of return value:

```
0x00080001<CR><LF>     // Region ID 0 and 19 are registered.
```

3.3.26 @GGCL: Acquire the C/N limit setting

This command is used to acquire the C/N limit setting by @GCNL command. It returns the argument of @GCNL.

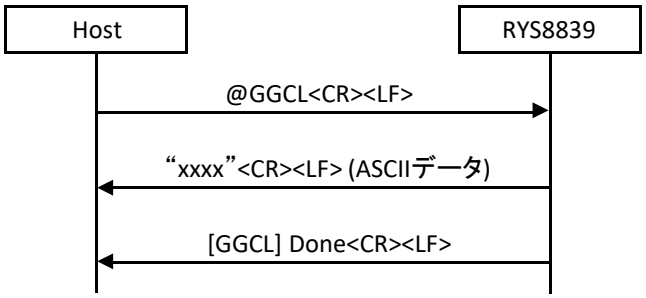
Format: **@GGCL<CR><LF>**

Argument: None

Response:

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

Sequence:



3.3.27 @GGCO: Acquire the cable offset setting

This command is used to acquire the cable offset setting for 1PPS output by @GSCO command. It returns the argument of @GSCO. The unit of the return value is ns.

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

Argument: None

Response:

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

Sequence:

3.3.28 @GGDL: Acquire the DOP limit setting

This command is used to acquire the DOP limit setting by @GSCO command. It returns the argument of @GSDL.

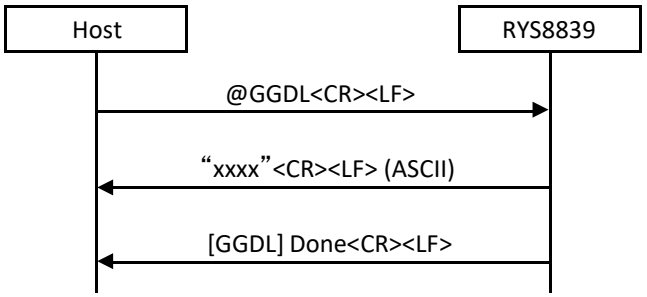
Format: **@GGDL<CR><LF>**

Argument: None

Response:

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

Sequence:



3.3.29 @GGDS: Acquire UTC correction seconds

This command is used to acquire the current UTC correction seconds value. This value is used to convert GPS time to UTC time. It returns the argument of @GSDS or the value received from the satellites in integer.

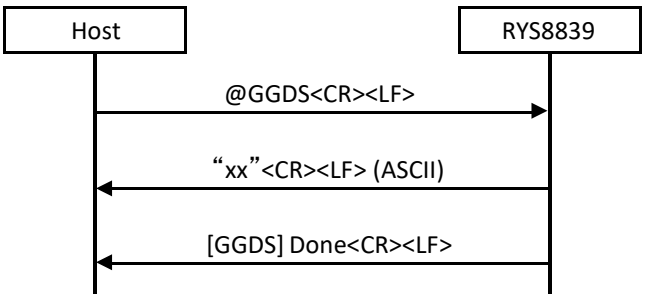
Format: **@GGDS<CR><LF>**

Argument: None

Response:

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

Sequence:



3.3.30 @GGEL: Acquire the elevation limit setting

This command is used to acquire the elevation limit setting by @GELV command. It returns the argument of @GELV.

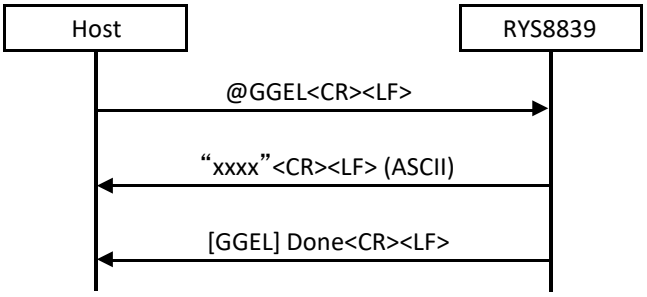
Format: **@GGEL<CR><LF>**

Argument: None

Response:

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

Sequence:



3.3.31 @GGHL: Acquire the altitude limit setting

This command is used to acquire the altitude limit setting by @GHLI command. It returns the argument of @GHLI.

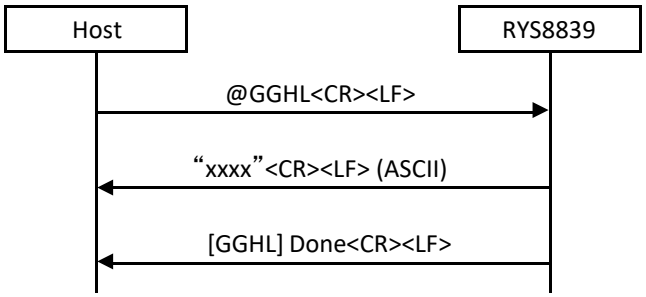
Format: **@GGHL<CR><LF>**

Argument: None

Response:

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

Sequence:



3.3.32 @GGLP: Acquire the leap second information

This command is used to acquire the leap second information that the receiver has. The RYS8839 returnscurrent leap second, next leap second update date and next leap second.

When the RYS8839 has not received the leap second information from the satellites, “next leap second update” and “next leap second” will be NULL.

The 2nd field of the return value is an invalid value. Please ignore it.

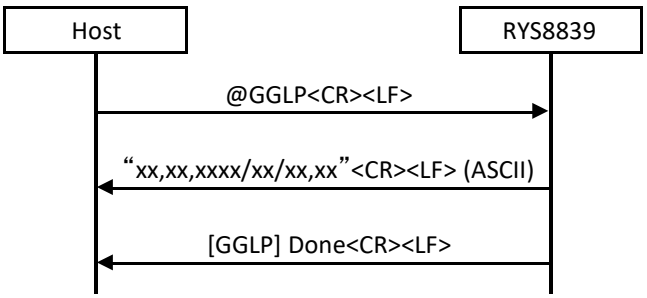
Format: **@GGLP<CR><LF>**

Argument: None

Response:

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

Sequence:



Examples of return value:

```
17,17,2017/1/3,18<CR><LF>       // Current leap second: 17s, (invalid value),
                                 // Next leap second update date: 3rd Jan. 2017,
                                 // Next leap second: 18s
```

3.3.33 @GGNS: Acquire the positioning-use satellite setting

This command is used to acquire the positioning-use satellite systems setting by @GNS command. It returns the argument of @GNS.

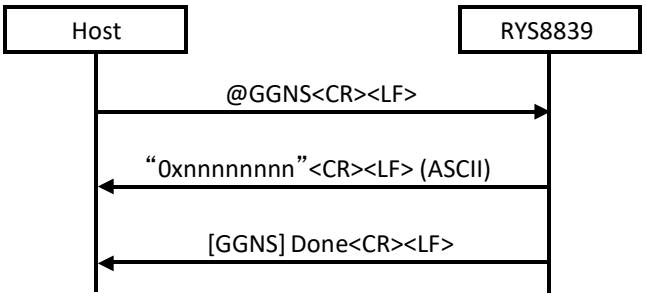
Format: **@GGNS<CR><LF>**

Argument: None

Response:

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

Sequence:



3.3.34 @GGOP: Acquire the operation mode setting

This command is used to acquire the operation mode setting by @GSOP command. It returns the argument of @GSOP separated by comma.

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

Argument: None

Response:

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

Sequence:

3.3.35 @GGSL: Acquire the velocity limit setting

This command is used to acquire the velocity limit setting by @GSSL command. It returns the argument of @GSSL.

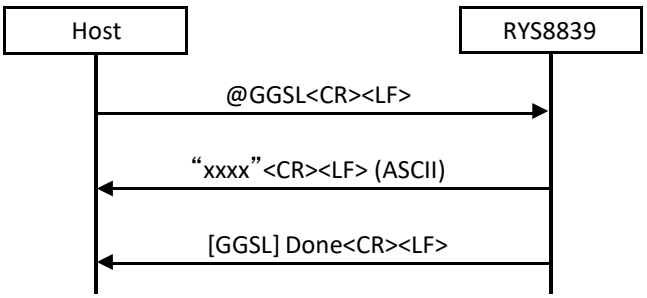
Format: **@GGSL<CR><LF>**

Argument: None

Response:

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

Sequence:



3.3.36 @GHLI: Altitude limit setting

This command is used to set the upper and lower limit of the altitude value at position calculation. When the calculated altitude was out of this range, the positioning calculation result is treated as “no fix”. The “+” or “-” direction can be specified by adding a sign to the arguments. If the sign is omitted, it is regarded as “+”.

It is desirable to use the default setting, since this change may affect the performance.

Format: **`@GHLI <arg 1> <arg 2><CR><LF>`**

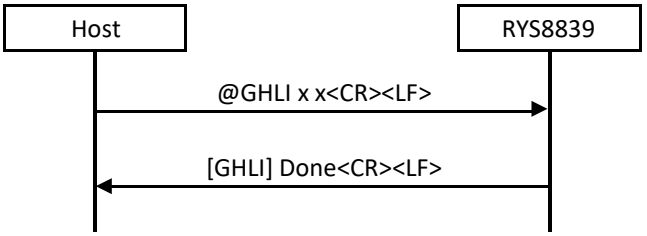
Argument:

Field	Description
arg 1	Specify the upper limit of the altitude [m] by integer. The value from -19,999 to 100,000 can be specified (Default value: 15,000).
arg 2	Specify the lower limit of the altitude [m] by integer. The value from -20,000 to 99,999 can be specified (Default value: -500).

Response:

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

Sequence:



3.3.37 @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.

This command must be issued at “Idle” mode.

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

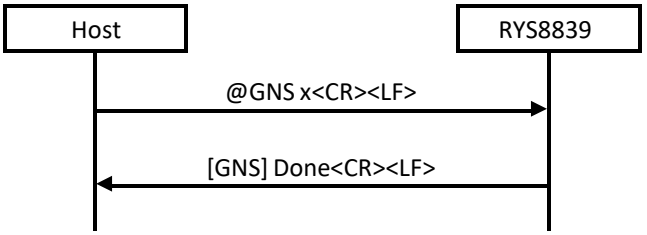
Argument:

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 L1-C/A bit 1: GLONASS L1OF bit 2: SBAS bit 3: QZSS L1-C/A bit 5: QZSS L1-S bit 6: BeiDou B1I bit 7: Galileo E1B/C bit 8: GPS L5 bit 9: QZSS L5 bit 10: BeiDou B1C bit 11: BeiDou B2a bit 12: Galileo E5a bit 13: NavIC (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:



3.3.38 @GPOS: Receiver position setting

This command is used to set the approximate position of the receiver in the RYS8839.

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 RYS8839 prior to hot start using this command. (This is not necessary if the position is backed up in the eMRAM.)

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

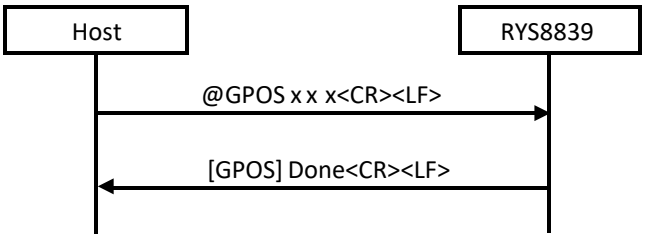
Argument:

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
```

3.3.39 @GPPS: 1PPS output setting

This command is used to control 1PPS output.

When 1PPS output is enabled, timing pulse output is 1s period from 1PPS output port. When “1” is set to the argument, the timing pulse outputs after clock information being received from GNSS. When “2” is set to the argument, the timing pulse outputs always during positioning operation. When “3” is set to the argument, the timing pulse outputs only during position is fixed.

When 1PPS output is disabled, timing pulse does not output from 1PPS output port.

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

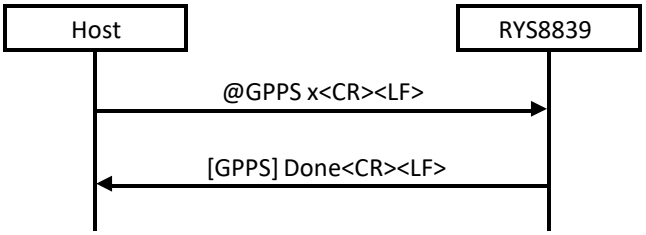
Argument:

Field	Description
arg 1	1PPS output control 0 : Disable 1PPS output (default value) 1 : Enable 1PPS output (output after clock information is received) 2 : Enable 1PPS output (output always while positioning operation) 3 : Enable 1PPS output (output only during position fix)

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:



3.3.40 @GPPW: 1PPS pulse width setting

This command is used to set the pulse width of 1PPS output. The pulse width value is set in ms as an integer. The range is from 125ms to 900ms. If the setting value exceeds this range, the error will return.

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

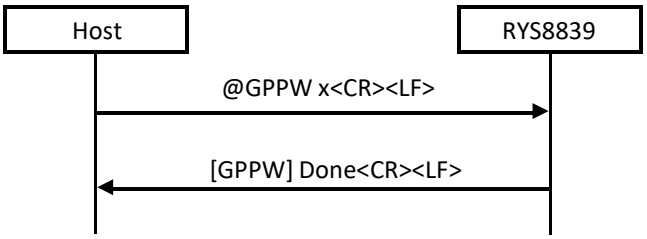
Argument:

Field	Description
arg 1	The 1PPS pulse width [ms] is set using an integer (Default value : 125).

Response:

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

Sequence:



3.3.41 @GPTC: TCXO offset acquisition

This command is used to acquire the TCXO offset value measured by the RYS8839. When the command is received, the RYS8839 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 * Nominal frequency of TCXO) / 1575420000.

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

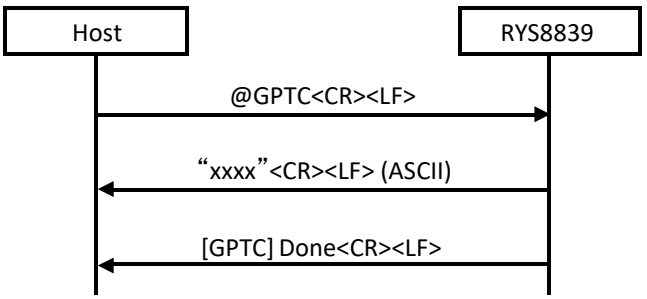
Format: **`@GPTC<CR><LF>`**

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:



3.3.42 @GSBA: Satellite usage setting at SBAS correction is valid

This command is used to select the satellite usage for positioning at SBAS correction is valid. This setting has no influence to the operation at SBAS and is not selected by @GNS command or SBAS correction is not valid.

Format: **`@GSBA <arg 1><CR><LF>`**

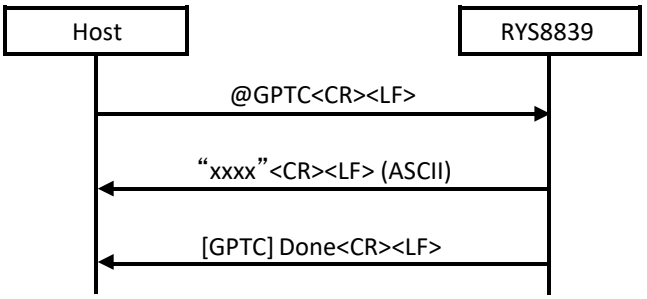
Arguent:

Field	Description
arg 1	0: Not use the satellites that are not supported by SBAS correction (default setting) . 1: Use the satellites that are not supported by SBAS correction.

Response:

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

Sequence:



3.3.43 @GSCO: Cable offset setting

PPS output timing can be adjusted by this command with considering the delay of the antenna cable. The cable offset value of the receiver is set in [ns]. The maximum value is 500,000,000ns (500ms).

Format: **`@GSCO <arg 1><CR><LF>`**

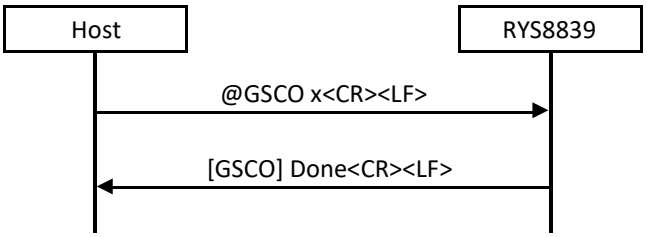
Argument:

Field	Description
arg 1	The cable offset value [ns] is set using an integer. (Default value: 0, Maximum value: 500,000,000)

Response:

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

Sequence:



3.3.44 @GSDL: DOP limit setting

This command is used to set the DOP limit value. When PDOP value exceeds this setting, it judged as non-fixed and the calculate position is not output. The value from 0 to 100 can be specified. The default value is 12.

It is desirable to use the default setting, since this change may affect the performance.

Format: **`@GSDL <arg 1><CR><LF>`**

Argument:

Field	Description
arg 1	Specify the DOP limit by integer. The value from 0 to 100 can be specified (default value: 12).

Response:

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

Sequence:

3.3.45 @GSDS: UTC correction seconds setting

This command is used to set the correction seconds for converting GPS time to UTC time. This is a total number of leap second insertions from 1980/1/6 (starting time of GPS time). This value is used to convert GPS time to UTC time.

When the UTC correction seconds are received from the satellites, it is overwritten.

Format: **`@GSDS <arg 1><CR><LF>`**

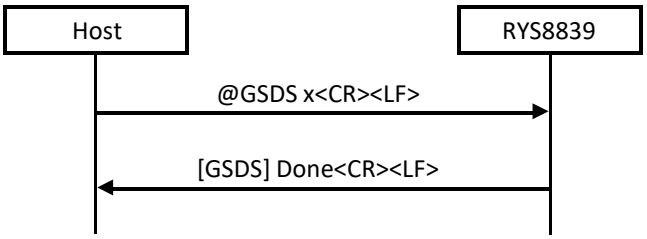
Argument:

Field	Description
arg 1	Specify the UTC correction seconds value by integer (default value: 17).

Response:

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

Sequence:



3.3.46 @GSOP: Operation mode setting

This command is used to set the positioning cycle of the RYS8839.

The sleep time can be specified for the intermittent operation. The positioning operation is performed during the remaining time of the positioning cycle after operation has transferred to the Deep Sleep state for the time specified with each specified positioning cycle.

When Power Config-1, 2 and 3 are applied to the RYS8839 power configuration, less than 1,000ms cannot be specified to the positioning cycle (the error will return).

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

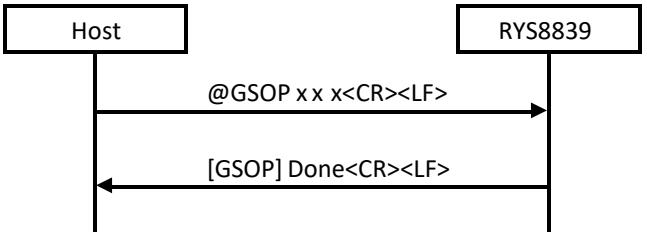
Argument:

Field	Description
arg 1	Reserved. Always specify “1” for this.
arg 2	This specifies the positioning cycle [ms] using an integer. Configurable values are 40, 50, 100, 125, 200, 250, 500, 1000 and multiple of 1000 (Default value: 1000).
arg 3	This specifies the sleep time [ms] using an integer. When “0” is specified, the sleep operation is not performed, and positioning is executed continuously (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:



3.3.47 @GSSR: 1PPS reference setting

This command is used to select the reference of 1PPS. 1PPS is generated and output in synchronization with the time set by this command.

Format: **`@GSPR <arg 1><CR><LF>`**

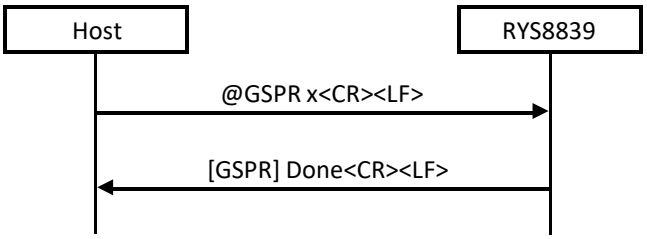
Argument:

Field	Description
arg 1	1PPS reference 0 : UTC (USNO) (default) 1 : GPS time

Response:

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

Sequence:



3.3.48 @GSR: Hot start

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

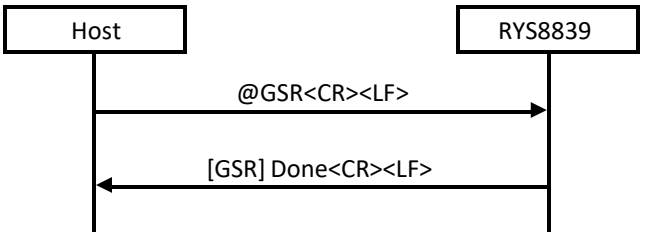
Format: **@GSR<CR><LF>**

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:



3.3.49 @GSSD: Rollover origin date setting

This command is used to set the origin date for detecting GPS week number rollover. From the date set by this command to 1,024 weeks later, the RYS8839 can calculate GPS week number correctly. Refer to 8.1 for the detail of GPS week number rollover.

Format: **@GSSD <arg 1> <arg 2> <arg 3><CR><LF>**

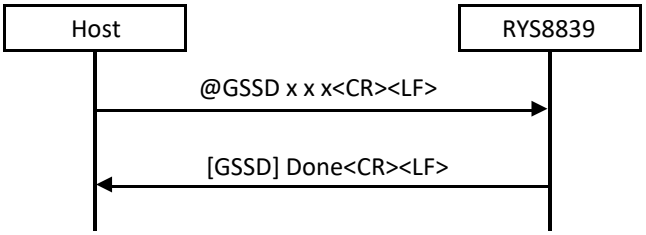
Argument:

Field	Description
arg 1	This specifies the origin date (year) using an integer.
arg 2	This specifies the origin date (month) using an integer.
arg 3	This specifies the origin date (day) using an integer.

Response:

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

Sequence:



3.3.50 @GSSL: Velocity limit setting

This command is used to set the velocity limit value. The unit is m/s. When the calculated velocity exceeds this setting, it judged as non-fixed and the calculate velocity is not output. The value from 1 to 600 can be specified. The default value is 150.

It is desirable to use the default setting, since this change may affect the performance.

Format: **`@GSSL <arg 1><CR><LF>`**

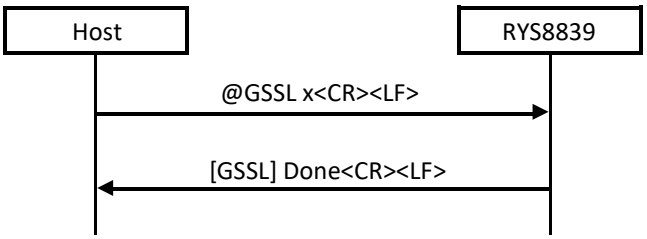
Argument:

Field	Description
arg 1	Specify the velocity limit by integer. The unit is [m/s]. The value from 1 to 600 can be specified (default value: 150).

Response:

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

Sequence:



3.3.51 @GSTP: Positioning stop

This command is used to stop the positioning. The RYS8839 transfers to the Idle state.

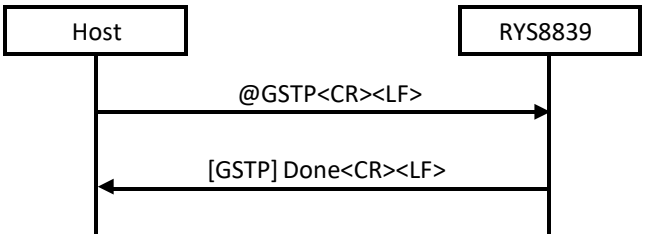
Format: **@GSTP<CR><LF>**

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:



3.3.52 @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.

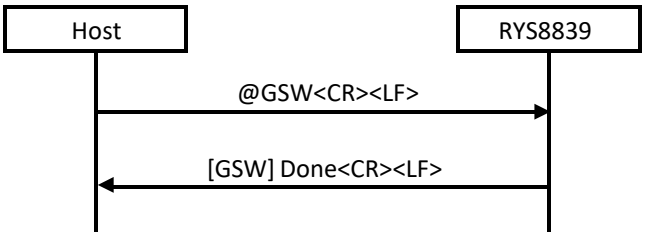
Format: **@GSW<CR><LF>**

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:



3.3.53 @GTCX: TCXO offset setting

This command is used to set the TCXO offset value of the receiver in the RYS8839. The TCXO offset value ofthe 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 RYS8839 prior to hot start using this command (This is not necessary if the time is backed up on the eMRAM).

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

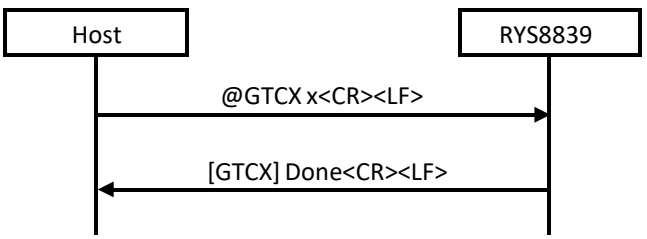
Argument:

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
```

3.3.54 @GTE: GNSS test end

This command is used to end the GNSS test. When the test is ended using the command, the RYS8839 returns to the state in which normal commands can be received.

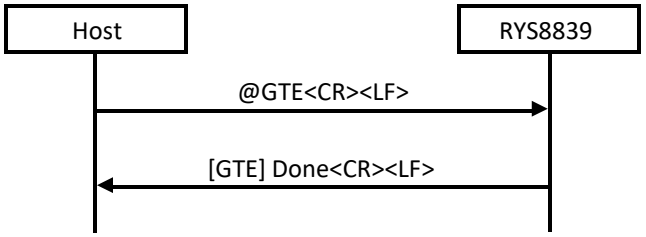
Format: **@GTE<CR><LF>**

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:



3.3.55 @GTIM: Time setting

This command is used to set the time of the receiver in the RYS8839. 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 RYS8839 prior to hot start using this command.

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

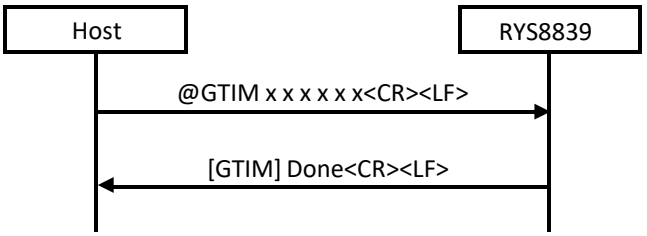
Argument:

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”
```

3.3.56 @GTR: GNSS test result output

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

The CN level [dBHz] and Doppler frequency [Hz] of specified 2 satellites are returned as the test results.

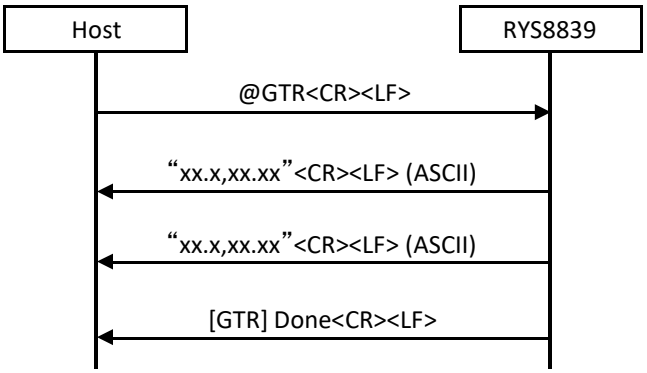
Format: **`@GTR<CR><LF>`**

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:



3.3.57 @GTS: GNSS test start

This command is used to start the GNSS test. The test results will be output by issuing the @GTR command.

2 satellites can be specified and used for testing.

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>`**

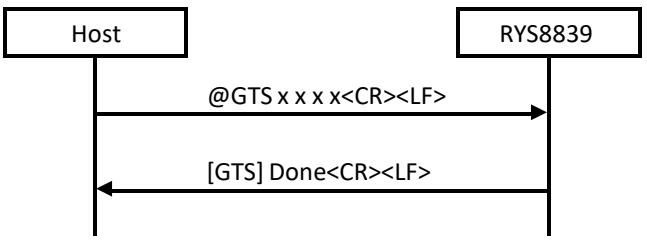
Argument:

Field	Description
arg 1	This specifies the satellite ID of the 1st satellite used for the test.
arg 2	The satellite system of the 1st satellite used for the test are set on a bit by bit basis. Only 1 bit can be set to “1”. When duplicated bits are set, the error will return. bit 0 : GPS L1-C/A bit 1 : GLONASS L1OF bit 3 : QZSS L1-C/A bit 6 : BeiDou B1I bit 7 : Galileo E1B/C bit 8 : GPS L5 bit 9 : QZSS L5 bit 10 : BeiDou B1C bit 11 : BeiDou B2a bit 12 : Galileo E5B bit 13 : NavIC
arg 3	This specifies the satellite ID of the 1st satellite used for the test.
arg 4	The satellite system of the 1st satellite used for the test are set on a bit by bit basis. Only 1 bit can be set to “1”. When duplicated bits are set, the error will return. bit 0 : GPS L1-C/A bit 1 : GLONASS L1OF bit 3 : QZSS L1-C/A bit 6 : BeiDou B1I bit 7 : Galileo E1B/C bit 8 : GPS L5 bit 9 : QZSS L5 bit 10 : BeiDou B1C bit 11 : BeiDou B2a bit 12 : Galileo E5B bit 13 : NavIC

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 0x00 2 0x40<CR><LF> // The test is started using SV1 of GPS L1/A and SV2 of
BeiDou B1I.
```

3.3.58 @GUSE: Positioning algorithm setting

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

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

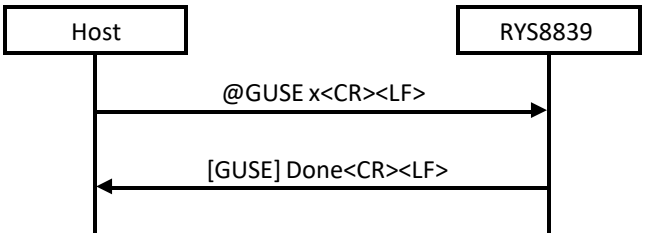
Argument:

Field	Description
arg 1	GNSS positioning algorithm are set. 0 : Fitness mode (default) 1 : Swimming mode 2 : Driving mode 3 : High speed driving mode 4 : Airborne mode 5 : Floating mode

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:



3.3.59 @PLB: PVT log acquisition suspension

This command is used to suspend the PVT log acquisition.

The RYS8839 suspends the PVT log data output if this command is issued while the PVT log data is being output from the RYS8839 by the @PLD command. If PVT log acquisition is then performed again using the @PLD command, the PVT logs are output again starting with the first log.

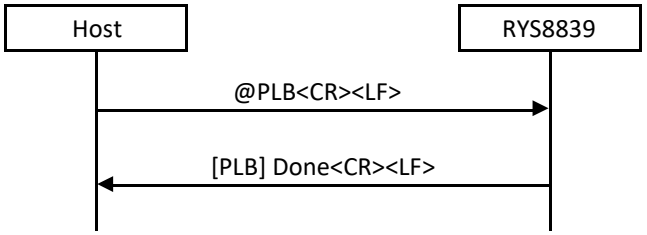
Format: **@PLB<CR><LF>**

Argument: None

Response:

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

Sequence:



3.3.60 @PLC: PVT log ON/OFF

This RYS8839 command is used to control the starting or stopping of PVT log recording.

When recording start has been specified, PVT log recording is started in accordance with the recording cycle.

The PVT logs are recorded in the flash memory. Data is added to the PVT logs if it was already recorded up to a midway point. When the recording area is full, recording stops automatically. Before any further data is recorded, the data area must be deleted.

If recording stop has been specified, the recording of the PVT logs is stopped.

Format: **`@PLC <arg 1><CR><LF>`**

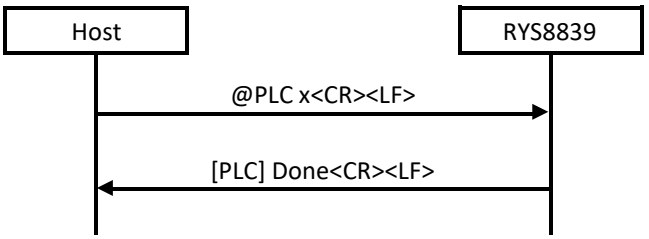
Argument:

Field	Description
arg 1	This controls the recording of the PVT logs. 0: Recording is stopped. 1: Recording is started.

Response:

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

Sequence:



3.3.61 @PLD: PVT log data acquisition

This command is used to acquire the PVT log data from the RYS8839. When the RYS8839 receives the command, the command reply response is transmitted to the host controller, and then the PVT log data (asynchronous data) is transmitted to the host controller.

In terms of the PVT log transmission size, the data is divided into packets in accordance with the recording capacity of the logs concerned, and the data is transmitted. The data divided into packets is transmitted following the $PSPLD sentence (PID = “0”). When the transmission of all the PVT log data is completed, the $PSPLD sentence (PID = “1”) which indicates the packet end is transmitted. Furthermore, the $PSPLD sentence output cannot be controlled using the @BSSL command (It is output at all times).

The PVT log data is 18 bytes data per log in the binary format, and when it is output as asynchronous data, data equivalent to a maximum of 10 logs (180 bytes + 1 byte for checksum) per packet is transmitted.

Even when the PVT log data is acquired using this command, the PVT log data recorded in the flash memory is not erased. Therefore, when this command is issued again, the PVT logs are acquired again starting with the PVT log data at the start. Issue the @PLE command when PVT log data is to be erased.

Issue this command in the state when PVT log recording has stopped.

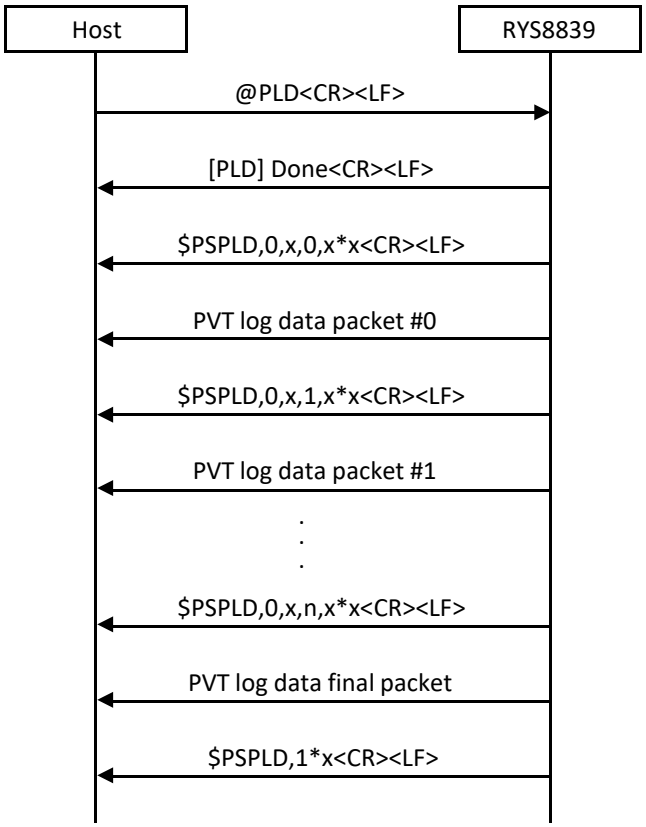
Format: **`@PLD<CR><LF>`**

Argument: None

Response:

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

Sequence:



3.3.62 @PLE: PVT log data erase

This command is used for the RYS8839 to erase the PVT log data area. When the RYS8839 receives thiscommand, it erases all the already recorded PVT log data.

Issue this command in the state when PVT log recording has stopped.

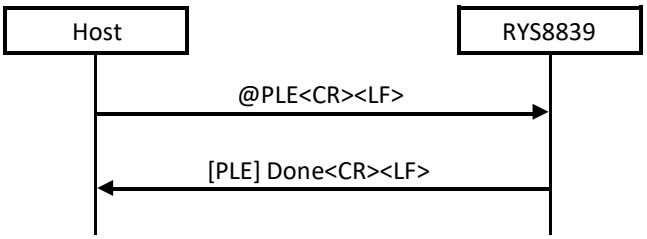
Format: **`@PLE<CR><LF>`**

Argument: None

Response:

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

Sequence:



3.3.63 @PLG: PVT capacity acquisition

This command is used to acquire the capacity of the already recorded PVT logs. When the RYS8839 receivesthis command, it transmits the PVT log recording capacity (in byte size increments) to the host controller.

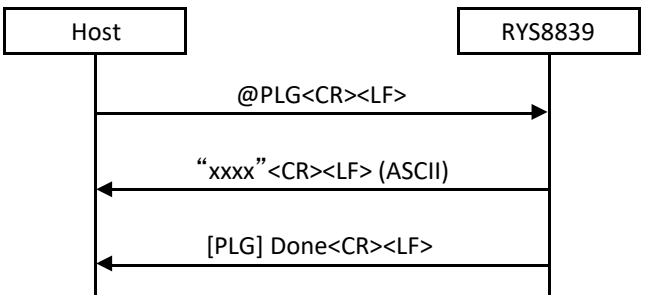
Format: **@PLG<CR><LF>**

Argument: None

Response:

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

Sequence:



3.3.64 @PLS: PVT log cycle setting

This command is used to set the recording cycle of the PVT logs. The recording cycle is specified as a multiple of the NMEA output cycle.

The default setting is “1” in cases where PVT logs have been recorded without establishing this setting using this command.

Issue this command in the state when PVT log recording has stopped.

Format: **@PLS <arg 1><CR><LF>**

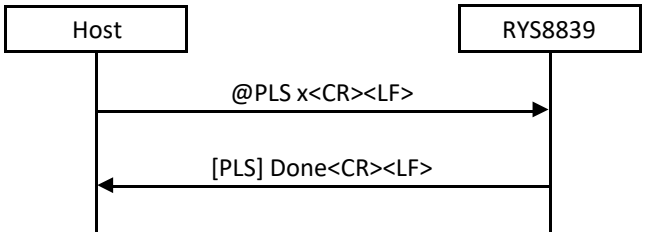
Argument:

Field	Description
arg 1	This specifies the recording cycle of the PVT logs using a multiple of NMEA output cycle. (Default setting: 1)

Response:

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

Sequence:



3.3.65 @RST: Reset

This command is used to reset the RYS8839. All setting is clear and the RYS8839 is re-booted.

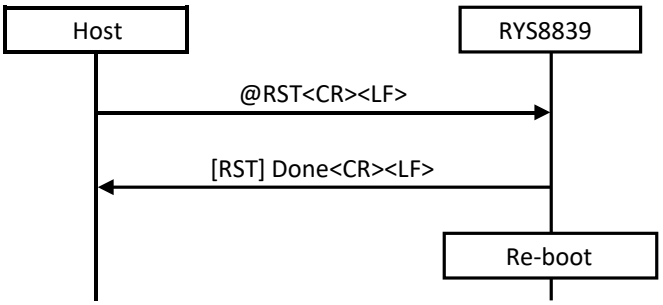
Format: **@RST<CR><LF>**

Argument: None

Response:

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

Sequence:



3.3.66 @RTCM: RTCM message output setting

This command is used to enable/disable RTCM message output.

The message types are assigned to each the bits of the argument. “1” is set for the bits of the message types which are to be output, and “0” is set for the bits of the message types whose output is not required. The selected RTCM message types are output with the frequency specified by @GSOP command.

Arguments can be specified in decimal or hexadecimal notation. With hexadecimal notation, add ‘0x’ in front of the numeral.

Format: **`@RTCM <arg 1><CR><LF>`**

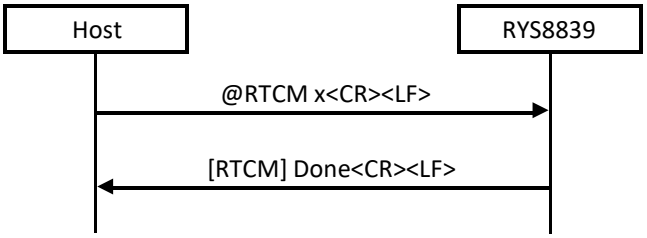
Argument:

Field	Description
arg 1	The RTCM message types to output are set on a bit by bit basis (0: Not output, 1: Output). RTCM message output control bit 0: 1074 (GPS MSM4) bit 1: 1077 (GPS MSM7) bit 2: (Reserved) bit 3: (Reserved) bit 4: 1084 (GLONASS MSM4) bit 5: 1087 (GLONASS MSM7) bit 6: (Reverved) bit 7: (Reverved) bit 8: 1094 (Galileo MSM4) bit 9: 1097 (Galileo MSM7) bit 10: (Reserved) bit 11: (Reserved) bit 12: 1114 (QZSS MSM4) bit 13: 1117 (QZSS MSM7) bit 14: (Reserved) bit 15: (Reserved) bit 16: 1124 (BeiDou MSM4) bit 17: 1127 (BeiDou MSM7) bit 18: (Reserved) bit 19: (Reserved) bit 20: 1019 (GPS Ephemeris) bit 21: 1020 (GLONASS Ephemeris) bit 22: 1041 (NavIC Ephemeris) bit 23: 1042 (BeiDou Ephemeris) bit 24: 1044 (QZSS Ephemeris) bit 25: 1045 (Galileo F/NAV Ephemeris) bit 26: 1046 (Galileo I/NAV Ephemeris) (Default value: 0x0000)

Response:

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

Sequence:



3.3.67 @SBSP: SBAS satellite select

This command is used to select which SBAS satellite to be used when SBAS is used. Only one satellite from

GAGAN, WAAS, EGNOS, MSAS, SDCM and BDSBAS can be selected. The RYS8839 will search just the specified SBAS satellite and not search the other SBAS satellites.

Format: **`@SBSP <arg 1><CR><LF>`**

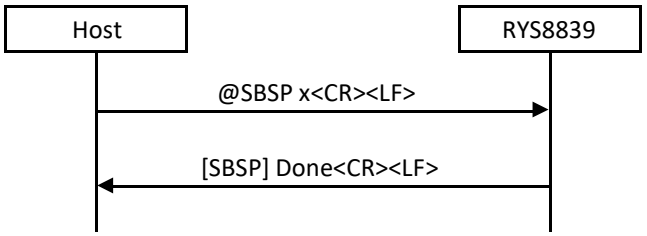
Argument:

Field	Description
arg 1	The SBAS satellite is specified. 0: GAGAN (default) 1: WAAS 2: EGNOS 3: MSAS 4: SDCM 5: BDSBAS

Response:

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

Sequence:



3.3.68 @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	RAM	RTC	After wake up
Sleep	Retained	Operation	Re-start with previous settings
Deep Sleep	OFF	Operation	Reboot

The parameters set by each commands are erased at Deep Sleep since RAM stops operation. If these parameter are needed to be retained, issue @BUP before entering Deep Sleep mode by this command. Please also refer to the explanation of @BUP.

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

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

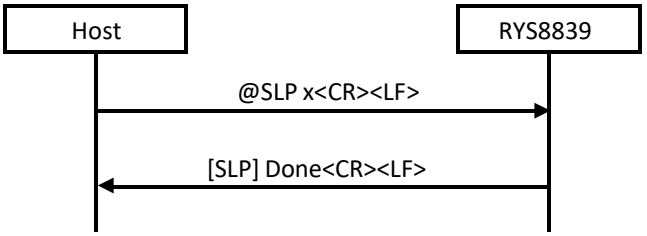
Argument:

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

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:



3.3.69 @VER: Firmware revision number acquisition

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

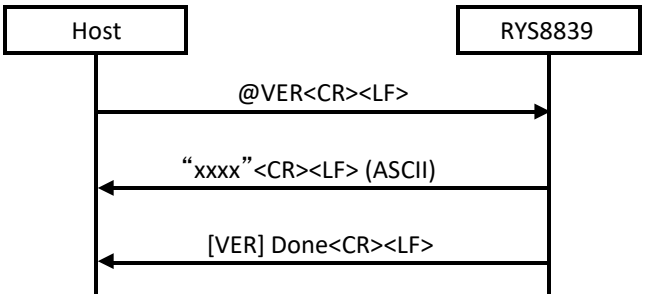
Format: **@VER<CR><LF>**

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:



3.3.70 @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 will not respond until the transfer to the Idle state is completed. Repeat the command until the command reply is received.

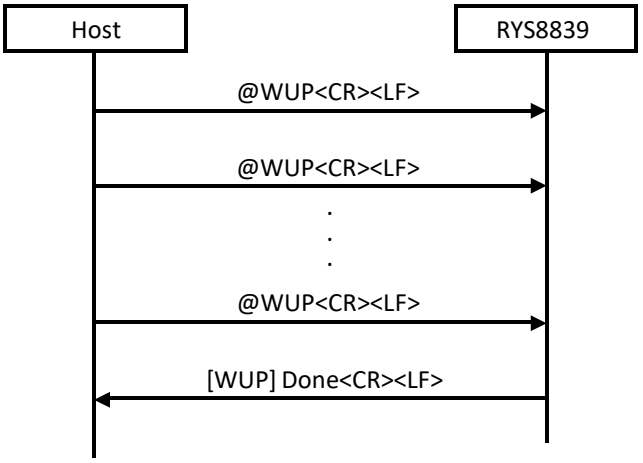
Format: **@WUP<CR><LF>**

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:



3.4 NMEA protocol

The RYS8839 supports NMEA compliant sentence output.

The following NMEA 0183 (ver 4.11) sentences are supported. Which sentences to output can be selected with @BSSL command. Output frequency can be set with @GSOP command.

3.4.1 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	yyyyy.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>	

3.4.2 GLL : Geographic Position – Latitude / Longitude

Format : `$--GLL,llll.ll,a,yyyyy.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 GI : Using only NavIC 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	yyyyy.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>	

3.4.3 GNS: GNSS Fix Data

Format:

`$--GNS,hhmmss.ss,llll.ll,a,yyyyy.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 GI : Using only NavIC 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	yyyyy.yy	ddd [degree] mm.mmmm [min]
Longitude – E/W	a	E : East longitude, W : West longitude
Mode indicator	c--c	Positioning system Mode Indicator (1st character: GPS, 2nd character: GLONASS, 3rd character: Galileo, 4th character: BeiDou, 5th character: QZSS, 6th character: NavIC) A : Autonomous mode/Used in solution D : Differential mode E : Dead reckoning mode N : Data not valid/Not used in solution
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	V: Navigation status not valid
Checksum	*hh	
Termination	<CR><LF>	

3.4.4 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 GI : Using only NavIC 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>	

3.4.5 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 GI : NavIC 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>	

3.4.6 RMC: Recommended Minimum Specific GNSS Data

Format : `$--RMC,hhmmss.ss,A,llll.ll,a,yyyyy.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 GI : Using only NavIC 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	yyyyy.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>	

3.4.7 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 GI : Using only NavIC 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>	

3.4.8 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 GI : Using only NavIC for positioning GN : Using combined satellite systems 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>	

3.4.9 GST: GNSS Pseudorange Error Statistics

Format : `$--GST,hhmmss.ss,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x*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 GI : Using only NavIC for positioning GN : Using combined satellite systems for positioning
Sentence ID	GST	
UTC	hhmmss.ss	hh [hour] mm [min] ss.ss [sec] (UTC time of the GGA/GNS fix associated with this sentence)
RMS value of the standard deviation of the range data	x.x	[m]
Semi-major axis of error ellipse	x.x	[m]
Semi-minor axis of error ellipse	x.x	[m]
Orientation of semi-major axis of error ellipse	x.x	[degree] (from true north)
Standard deviation of latitude error	x.x	[m]
Standard deviation of longitude error	x.x	[m]
Standard deviation of altitude error	x.x	[m]
Checksum	*hh	
Termination	<CR><LF>	

3.4.10 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	65～99
Galileo	GA	1～36
BeiDou	BD	1～64
QZSS (L1 C/A)	GQ	1～10
QZSS (L1S)	GQ	55～63
NavIC	GI	1～15

The following proprietary sentences are supported. The talker ID of every sentences is “$PS”.

3.4.11 GEO : Geofence Indication

This sentence is output when the status of the registered geofence region changed. Information will be notified only for the regions whose status has changed. 5 IDs can be included in one sentence. When over 5 IDs status changed, multiple sentences will be output.

Below status changing is informed.

- EXIT Exited from inside of the region to outside.
- ENTER Entered to inside of the region from outside.
- DWELL Dwelled inside of the region for a period of time specified by @GEOH.

This sentence is output in synchronization with the other NMEA sentences. This sentence output cannot be stopped.

Format : `$--GEO,x,x,xx,x,xx,x,xx,x,xx,x,xx,x*hh`**<CR><LF>**

Fields:

Field		Format	Description
Header		$	
Talker ID		--	PS
Sentence ID		GEO	
Total number of sentences		x	
Sentence number		x	
Total number of satellites in view		xx	
ID1	Region ID	xx	
	Status	x	0: EXIT, 1: ENTER, 2: DWELL
ID2	Region ID	xx	
	Status	x	0: EXIT, 1: ENTER, 2: DWELL
ID3	Region ID	xx	
	Status	x	0: EXIT, 1: ENTER, 2: DWELL
ID4	Region ID	xx	
	Status	x	0: EXIT, 1: ENTER, 2: DWELL
ID5	Region ID	xx	
	Status	x	0: EXIT, 1: ENTER, 2: DWELL
Checksum		*hh	
Termination		<CR><LF>	

3.4.12 PLD : PVT Log Data

This sentence indicates the beginning of PVT log data transfer. This sentence is output when PVT log data transfer is initiated by “@PLD” command. When “@PLD” is issued, one packet of PVT log data is output after this sentence (Packet ID = 0) . The checksum (1byte) follows the packet of PVT log data when bit 3 of “Control” field is “1”.

When all of PVT log has been retrieved, the completion of PVT log data transfer is informed by this sentence (Packet ID = 1) .

The output of this sentence is not controlled by “@BSSL” command.

Please also refer the section of “@PLD” command.

Format : `$--PLD,x,a,x,hhhh*hh`**`<CR><LF>`**

Fields :

Field	Format	Description
Header	$	
Talker ID	--	PS
Sentence ID	PLD	
Packet ID	x	0 : Data, 1 : Completion of data transfer
Control	a	This field indicates if valid data is stored in each fields (0 : Not valid, 1 : Valid) Bit 0 : “Sequence No.” field Bit 1 : “Size” field Bit 2 : (Reserved) Bit 3 : Checksum at the end of data packet
Sequence No.	x	Sequential serial No. of this packet.
Size	hhhh	Size of data packet following this sentence (not including checksum)
Checksum	*hh	
Termination	<CR><LF>	

* When “Packet ID” is “1”, “Control”, “Sequence No.” and “Size” are not output.

3.5 RTCM protocol

The RYS8839 supports RTCM version 3.3 compliant messages.

RTCM message output can be enabled/disabled by @RTCM command. RTCM message output frequency can be set by @GSOP command.

RTCM message input is not supported

3.5.1 RTCM version 3.3 frame structure

The frame structure of RTCM version 3.3 messages is below.

Data	Bit length
Preamble	8 bits (0xD3)
(Reserved)	6 bits
Message length [bytes]	10 bits
Message	Variable
CRC	24 bits

3.5.2 RTCM input messages

The RTCM version 3.3 input messages are not supported.

3.5.3 RTCM output messages

The following RTCM version 3.3 output messages are supported.

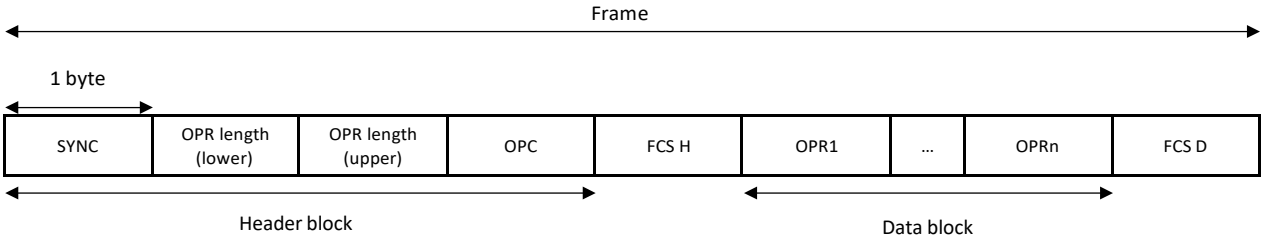
Message type	Description
1019	GPS Ephemeris
1020	GLONASS Ephemeris
1041	NavIC Ephemeris
1042	BeiDou Ephemeris
1044	QZSS Ephemeris
1045	Galileo F/NAV Ephemeris
1046	Galileo I/NAV Ephemeris
1077	GPS MSM7
1084	GLONASS MSM4
1087	GLONASS MSM7
1094	Galileo MSM4
1097	Galileo MSM7
1114	QZSS MSM4
1117	QZSS MSM7
1124	BeiDou MSM4
1127	BeiDou MSM7

4 Binary protocol

The RYS8839 communicates with the host controller by the proprietary binary protocol.

4.1 Frame format

The frame format of the binary protocol is as below.



Field	Description
SYNC	Synchronization frame. Always “0x7F”.
OPR length (lower)	The lower 1 byte of the length of OPR (operand) .
OPR length (upper)	The upper 1 byte of the length of OPR (operand) .
OPC	Opcode. The operation is specified.
FCS H	Checksum of the header block.
OPR1～OPRn	Operand defined for each OPC is specified. The length of OPR is up to 4,090 bytes.
FCS D	Checksum of the data block.

Fig.4 Frame format of binary protocol

The frame length is variable up to 4,096 bytes.

There are 3 types of binary message: 1. Command from the host controller to RYS8839, 2. Command responsefrom RYS8839, and 3. Indication from RYS8839.

The message content is specified in OPC (opcode) . OPR (operand) is defined for each OPC. When the over 2 bytes value is assigned to the multiple OPRs, its order is a little endian (OPR n: lower byte … OPR n+x: upper byte).

When the command from the host controller is received and executed by the RYS8839, the RYS8839 sendsthe response with same OPC. Please refer to section 8 for error code stored in the response. The maximum response time to the commands is deferent from each OPC. Please see below.

OPC	Maximum response time
System status changing (0x00)	1s
Program code injection (0x01)	10s
Program execution (0x02)	5s
UART setting (0x03)	1s
Program writing (0x09)	30s
Communication error indication (0xFF)	—

4.2 Binary message specifications

The spec of each message is described below in detail.

4.2.1 System status changing (OPC: 0x00)

This message is used for changing the system status of the RYS8839. The operation is specified in OPR1 (just the rebooting is supported now). When the status changing has finished, the RYS8839 sends the response. Thestatus can be seen in OPR in the response message.

When “0x00” is set in OPR1, the firmware on eMRAM is erased and the RYS8839 reboots in the special mode.

When “0x01” is set in OPR1, the RYS8839 reboots with the firmware written in eMRAM.

When “0xFF” is set in OPR1, the force firmware update is initiated. Please refer to .

When the RYS8839 changed the system status autonomously, the RYS8839 sends the indication sameformat with the response.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x00
OPR1	Operation	0x00: Erasing the firmware on eMRAM and rebooting with the special mode 0x01: Rebooting with the firmware in eMRAM. 0x02: (Reserved) 0x03: (Reserved) 0xFF: Rebooting with the special mode (force firmware update).

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x00
OPR1	Result of the system status changing	0x00: Rebooted with the special mode 0x01: (Reserved) 0x02: (Reserved) 0x03: (Reserved)

3. Indication from RYS8839:

Field	Description	Data
OPC	Opcode	0x00
OPR1	Indication of the system status changing	0x00: Rebooted with the special mode 0x01: (Reserved) 0x02: (Reserved) 0x03: (Reserved)

4.2.2 Program code injection (OPC: 0x01)

This message is used for injecting the program code to the RYS8839 at the firmware updating. The program code is stored in OPR and sent to the RYS8839. The sent program code is stored in internal RAM of the RYS8839. The RYS8839 sends the response in which the operation result is written.

When the program code is sent by a multiple frames, total number of the frame is written in OPR1 and 2, and serial number of the frame is written in OPR3 and 4. The program code will be divided by 4,086 bytes since the frame size is up to 4,096 bytes.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x01
OPR1	Total frame number	
OPR2		
OPR3	Serial number of the frame	
OPR4		
OPR5 ~ OPRn	Program code	

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x01
ORP1	Error code	

3. Indication from RYS8839: N/A

4.2.3 Program execution (OPC: 0x02)

This message is used for executing the injected program at the firmware updating. No OPR.

The RYS8839 sends the response in which the operation result is written.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x02

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x02
ORP1	Error code	

3. Indication from RYS8839: N/A

4.2.4 UART setting (OPC: 0x03)

This message is used for changing the setting of the UART communication. Baud rate is 115,200 bps and the flow control is disabled at the default. The RYS8839 changes the UART setting when receiving the command and sends a response with new UART setting.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x03
OPR1	Baud rate	0x00: 4,800bps 0x01: 9,600bps 0x02: 14,400bps 0x03: 19,200bps 0x04: 38,400bps 0x05: 57,600bps 0x06: 115,200bps 0x07: 230,400bps 0x08: 460,800bps 0x09: 921, 600bps 0x0A: 1Mbps 0x0B: 2Mbps 0x0C: 3Mbps 0x0D: 4Mbps 0x0E: 5Mbps 0x0F: 6Mbps 0x10: 7Mbps 0x11: 8Mbps 0x12: 9Mbps 0x13: 10Mbps 0x14～0xFF: (Reserved)
OPR2	Hardware flow control	0x00: Disable 0x01: Enable

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x03
ORP1	Error code	

3. Indication from RYS8839: N/A

4.2.5 Firmware revision number acquisition (OPC: 0x06)

This message is used for acquiring the firmware revision number. The RYS8839 returns the ASCII characterswhich express the firmware revision number. Then length of response data is variable.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x06

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x06
ORP1	1st digit of ASCII character	
ORP1	2nd digit of ASCII character	
. .		
ORPn	nth digit of ASCII character	

3. Indication from RYS8839:

4.2.6 Binary data injection (OPC: 0x07)

This message is used for injecting the binary data as the ephemeris data, the almanac data and LLE data from the host controller. Specify what data to inject with the OPR1.

Sending the message with the binary data in OPR4 – OPRn, the binary data is sent to the RYS8839. Theexecution results will be sent by the response from the RYS8839.

When the binary data is sent by a multiple frames, total number of the frame is written in OPR2, and serial number of the frame is written in OPR3. The binary data will be divided by 4,086 bytes since the frame size is up to 4,096 bytes.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x07
OPR1	Type of the binary data	0x00: GPS L1C/A ephemeris 0x01: GPS L5 ephemeris 0x02: GLONASS ephemeris 0x03: QZSS L1C/A ephemeris 0x04: QZSS L1S ephemeris 0x05: QZSS L5 ephemeris 0x06: BeiDou B1I ephemeris 0x07: BeiDou B1C ephemeris 0x08: BeiDou B2a ephemeris 0x09: Galileo E1B/E1C ephemeris 0x0A: Galileo E5 ephemeris 0x0B: NavIC ephemeris 0x0C: SBAS L1 ephemeris 0x0D: SBAS L5 ephemeris 0x0E: (Reserved) 0x10: GPS L1C/A almanac 0x11: GPS L5 almanac 0x12: GLONASS almanac 0x13: QZSS L1C/A almanac 0x14: QZSS L1S almanac 0x15: QZSS L5 almanac 0x16: BeiDou B1I almanac 0x17: BeiDou B1C almanac 0x18: BeiDou B2a almanac 0x19: Galileo E1B/E1C almanac 0x1A: Galileo E5 almanac 0x1B: NavIC almanac 0x1C: SBAS L1 almanac 0x1D: SBAS L5 almanac 0x1E (Reserved) 0x20: GPS LLE data 0x21: QZSS LLE data 0x22: GLONASS LLE data 0x23: Galileo LLE data 0x24: BeiDou LLE data
OPR2	Total frame number	
OPR3	Serial number of the frame	
OPR4 ～ OPRn	Binary data	

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x07
OPR1	Error code	
OPR2	Size of received binary data	
OPR3		
OPR4	Checksum of received binary data	

3. Indication from RYS8839: N/A

4.2.7 Binary data output (OPC: 0x08)

This message is used for output the binary data as the ephemeris data and the almanac data from the RYS8839tcontroller. Specify what data to inject with the OPR1. The maximum data size for 1 frame can be specified with OPR2 and OPR3.

When this message is received by the RYS8839, the RYS8839 will send the execution result and the specifiedbinary data.

When the size of the binary data is larger than the specified size in OPR2 and OPR3, the binary data will be divided and sent by a multiple frames. In this case, the total number of the frame will be written in OPR2 and the serial number of the frame will be written in OPR3.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x08
OPR1	Type of the binary data	0x00: GPS L1C/A ephemeris 0x01: GPS L5 ephemeris 0x02: GLONASS ephemeris 0x03: QZSS L1C/A ephemeris 0x04: QZSS L1S ephemeris 0x05: QZSS L5 ephemeris 0x06: BeiDou B1I ephemeris 0x07: BeiDou B1C ephemeris 0x08: BeiDou B2a ephemeris 0x09: Galileo E1B/E1C ephemeris 0x0A: Galileo E5 ephemeris 0x0B: NavIC ephemeris 0x0C: SBAS L1 ephemeris 0x0D: SBAS L5 ephemeris 0x0E: (Reserved) 0x10: GPS L1C/A almanac 0x11: GPS L5 almanac 0x12: GLONASS almanac 0x13: QZSS L1C/A almanac 0x14: QZSS L1S almanac 0x15: QZSS L5 almanac 0x16: BeiDou B1I almanac 0x17: BeiDou B1C almanac 0x18: BeiDou B2a almanac 0x19: Galileo E1B/E1C almanac 0x1A: Galileo E5 almanac 0x1B: NavIC almanac 0x1C: SBAS L1 almanac 0x1D: SBAS L5 almanac 0x1E (Reserved)
OPR2	The maximum data size for 1 frame	[bytes]
OPR3		

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x08
OPR1	Error code	
OPR2	Total frame number	
OPR3	Serial number of the frame	
OPR5 ~ OPRn	Binary data	

3. Indication from RYS8839: N/A

4.2.8 Program writing (OPC: 0x09)

This message is used for writing the injected program at the firmware updating. The destination is specified by OPR (just eMRAM is supported now) .

The RYS8839 sends the response in which the operation result is written.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x09
OPR1	Type of the program #1	0x00: Firmware body (RYS8839_sdk.efpk)0x01: Application (RYS8839_app.efpk) 0x02: Library for application (RYS8839_lib.efpk) 0x03: Configuration file
OPR2	Type of the program #2	0x00: File with extension “.efpk” 0x01: File with extension “.fpk” or configuration file
OPR3	Destination	0x00: eMRAM

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x09
ORP1	Error code	

3. Indication from RYS8839: N/A

4.2.9 Internal information initialization (OPC: 0x0A)

This message is used to erase the whole of internal data and initialize the RYS8839. Ephemeris, almanac, receiver position/velocity, TCXO offset on the flash memory or eMRAM and time are erased. After erasing these data, the RYS8839 will reboot.

This command must be issued at Idle state.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x0A
OPR1		Set “1” always.

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x0A
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.10 Backup data saving (OPC: 0x10)

This message is used to save the backup data. When “1” is set to the OPR1, the backup data contents are saved in the eMRAM. There are two types of the backup data – Navigation data (the receiver position, ephemeris, almanac, TCXO offset and other information required for hot start) and Command settings data (the parameters set by each commands). Navigation data are automatically restored at a boot-up and an wakeup from Deep Sleep. Command settings data are automatically restored only at an wakeup from Deep Sleep.Navigation data is required for hot start, and by saving the backup data in the eMRAM using this command, hot start can be initiated even when the system is booted from power OFF. (The time must be injected.)

When “0” is set to the OPR1, the backup data which is saved on eMRAM are erased.

This message 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.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x10
OPR1	Operation	0: Erase backup data 1: Backup data saving

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x10
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.11 Automatic backup data saving setting (OPC: 0x11)

This message is used to enable/disable the automatic backup data saving function and set the interval of automatic backup data saving.

When this function is enabled, the backup data contents are saved in the eMRAM automatically at the first fix (this saving is not executed if the time specified by OPR2 has not elapsed since the last save). Then the backup data contents are saved in the flash memory automatically with specified interval set by OPR2 beginning at the first fix.

For information about the backup data, see the explanation of OPC: 0x10.

This command must be issued at Idle state. When this command is issued at Exec state, an error be returned. When the automatic backup data saving is executing, the NMEA sentence may occasionally have erratic output.

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

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x11
OPR1	Operation	0: Erase backup data 1: Backup data saving

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x11
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.12 GNSS test start (OPC: 0x12)

This message is used to start the GNSS signal reception test. The result of GNSS signal reception test will be acquired by OPC: 0x13.

Specify the satellite system and SVID with OPR1 and OPR2.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x12
OPR1	SVID to test	
OPR2	Satellite system to test	0x00: GPS L1C/A 0x01: GLONASS 0x02: SBAS L1 0x03: QZSS L1C/A 0x04: QZSS L1S 0x05: BeiDou B1I 0x06: Galileo E1B/C 0x10: GPS L5 0x11: QZSS L5 0x12: BeiDou B1C 0x13: BeiDou B2a 0x14: Galileo E5a 0x15: NavIC
OPR3	(Reserved)	Set “0” always.
OPR4	(Reserved)	Set “0” always.

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x12
ORP1	Error code	

3. Indication from RYS8839: N/A

4.2.13 GNSS test result output (OPC: 0x13)

This message is used to output the GNSS signal reception test results. Wait one second after OPR: 0x12 issued, and then issue this command.

The CN level [dBHz] and Doppler frequency [Hz] of specified satellite are stored in OPR1 – 3.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x13

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x13
OPR1	CN level	[dBHz]
OPR2	Doppler frequency	[Hz]

3. Indication from RYS8839: N/A

4.2.14 GNSS test end (OPC: 0x14)

This message is used to end the GNSS signal reception test results. When the test is ended using the command, the RYS8839 returns to the state in which normal commands can be received.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x14

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x14
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.15 1PPS output setting (OPC: 0x15)

This message is used to control 1PPS output.

When 1PPS output is enabled, timing pulse output is 1s period from 1PPS output port. When “1” is set to the argument, the timing pulse outputs after clock information being received from GNSS. When “2” is set to the argument, the timing pulse outputs always during positioning operation. When “3” is set to the argument, the timing pulse outputs only during position is fixed.

When 1PPS output is disabled, timing pulse does not output from 1PPS output port.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x15
OPR1	1PPS output control	0 : Disable 1PPS output (default value) 1 : Enable 1PPS output (output after clock information is received) 2 : Enable 1PPS output (output always while positioning operation) 3 : Enable 1PPS output (output only during position fix)

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x15
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.16 1PPS pulse width setting (OPC: 0x16)

This message is used to set the pulse width of 1PPS output. The pulse width value is set in ms as an integer. The range is from 125ms to 900ms. If the setting value exceeds this range, the error will return.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x16
OPR1	1PPS pulse width	[ms] (125 - 900. Default value: 125)

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x16
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.17 Cable offset setting (OPC: 0x17)

PPS output timing can be adjusted by this message with considering the delay of the antenna cable. The cable offset value of the receiver is set in [ns]. The maximum value is 500,000,000ns (500ms).

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x17
OPR1	Cable offset value	[ns] (0 - 500,000,000. Default value: 0)
OPR2		
OPR3		
OPR4		

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x17
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.18 Positioning start (OPC: 0x30)

This message is used to start positioning. The start mode can be specified by OPR1.

When the cold start is specified, the RYS8839 will start positioning with erasing the ephemeris and almanac. Time, receiver position and TCXO offset will be retained. When the deep cold start is specified, the RYS8839 will start

positioning with erasing whole of these data (ephemeris, almanac, time, receiver position and TCXO offset).

When the hot start is specified even though the hot start condition is not ready, the RYS8839 will start positioning with the warm start or cold start or deep cold start.

When the warm start is specified even though but the warm start condition is not ready, the RYS8839 will start positioning with the cold start or deep cold start.

4. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x30
OPR1	Start mode	0x00: Deep cold start 0x01: Cold start 0x02: Warm start 0x03: Hot start

5. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x30
OPR1	Error code	

6. Indication from RYS8839: N/A

4.2.19 Positioning stop (OPC: 0x31)

This message is used to stop positioning. The RYS8839 transfers to the Idle state.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x31

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x31
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.20 Positioning-use satellite setting (OPC: 0x32)

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

The satellite systems are assigned to the bits of the OPR1 and OPR2. “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.

When the non-configurable combination is specified, the error will return.

This command must be issued at Idle state.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x32
OPR1	The satellite systems used for positioning are set on a bit by bit basis. bit 0: GPS L1-C/A bit 1: GLONASS L1OF bit 2: SBAS bit 3: QZSS L1-C/A bit 5: QZSS L1-S bit 6: BeiDou B1I bit 7: Galileo E1B/C	0: Not used 1: Used
OPR2	The satellite systems used for positioning are set on a bit by bit basis. bit 0: GPS L5 bit 1: QZSS L5 bit 2: BeiDou B1C bit 3: BeiDou B2a bit 4: Galileo E5a bit 5: NavIC	0: Not used 1: Used

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x32
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.21 Acquire the positioning-use satellite setting (OPC: 0x33)

This message is used to acquire the positioning-use satellite systems setting by OPC: 0x32.

The each satellite systems are assigned the each bits of OPR1 and OPR2. The bits of non-used satellite system are set to “0” and the bits of used satellite system are set to “1”.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x33

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x33
OPR1	Error code	
OPR1	The satellite systems used for positioning are set on a bit by bit basis. bit 0: GPS L1-C/A bit 1: GLONASS L1OF bit 2: SBAS bit 3: QZSS L1-C/A bit 5: QZSS L1-S bit 6: BeiDou B1I bit 7: Galileo E1B/C	0: Not used 1: Used
OPR2	The satellite systems used for positioning are set on a bit by bit basis. bit 0: GPS L5 bit 1: QZSS L5 bit 2: BeiDou B1C bit 3: BeiDou B2a bit 4: Galileo E5a bit 5: NavIC	0: Not used 1: Used

3. Indication from RYS8839: N/A

4.2.22 Positioning indication select (OPC: 0x34)

Positioning information is indicated periodically by the RYS8839 with OPC: 0x80 – 0x89. This message is used to

select which indication to enable. Set OPC to enable in OPR1 – n (variable length). The RYS8839 will indicate the OPCs selected in these fields.

OPCs which indicates the positioning information are below. When the other OPC was specified, it will be ignored.

OPC	Messages
0x80	Current time indication
0x81	Receiver position indication
0x82	Receiver velocity indication
0x83	Visible satellite information indication
0x84	RTCM message indication
0x89	Accuracy index indication

At the default, OPC: 0x80, 0x81 and 0x83 are enabled.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x34
OPR1	OPC #1	
OPR2	OPC #2	
. .		
OPRn	OPC #n	

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x34
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.23 Receiver position setting (OPC: 0x35)

This message is used to set the approximate position of the receiver in the RYS8839.

The receiver position is set using ellipsoidal coordinates (latitude, longitude) and altitude. The each parameters are set to OPR with signed integer.

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 RYS8839 prior to hot start using this command. (This is not necessary if the position is backed up in the eMRAM.)

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x35
OPR1	Latitude	Latitude [deg] multiplied by 10^7. Set the value with signed integer (Positive: North latitude, Negative: South latitude)
OPR2		
OPR3		
OPR4		
OPR5	Longitude	Longitude [deg] multiplied by 10^7. Set the value with signed integer (Positive: East longitude, Negative: West longitude)
OPR6		
OPR7		
OPR8		
OPR9	Altitude	[cm] Set the value with signed integer. Upper limit is 2,000km (200,000,000cm).
OPR10		
OPR11		
OPR12		

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x35
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.24 Time setting (OPC: 0x36)

This message is used to set the time of the receiver in the RYS8839. The UTC time standard is used for thereceiver 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 RYS8839 prior to hot start using this command.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x36
OPR1	(Reserved)	Set “1” always.
OPR2	Year	Lower 1 byte of year.
OPR3	bit 0- 3: Month	
	bit 4 - 7: Year	Upper 4 bits of year.
OPR4	Day	
OPR5	Hour	
OPR6	Minute	
OPR7	Second	
OPR8	1/100 second	

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x36
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.25 TCXO offset setting (OPC: 0x37)

This message is used to set the TCXO offset value of the receiver in the RYS8839. The TCXO offset value of the receiver is set to OPR1 – 4 (OPR1 is highest … OPR4 is lowest) with signed integer in Hz. The value is the frequency converted to GPS L1 carrier frequency.

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 RYS8839 prior to hot start using this command (This is not necessary if the time is backed up on the eMRAM).

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x37
OPR1	TCXO offset	[Hz] Set the value with signed integer.
OPR2		
OPR3		
OPR4		

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x37
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.26 TCXO offset acquisition (OPC: 0x38)

This message is used to acquire the TCXO offset value measured by the RYS8839.TCXO offset is stored in OPR1 – 4 with signed integer in Hz.

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

When the TCXO offset has not been calculated, the error will return.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x38
OPR1	TCXO offset	[Hz] Set the value with signed integer.
OPR2		
OPR3		
OPR4		

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x38
OPR1	Error code	
ORP2	TCXO offset	[Hz] The value with signed integer is stored.
OPR3		
OPR4		
OPR5		

3. Indication from RYS8839: N/A

4.2.27 Internal information erase (OPC: 0x39)

This message is used to erase the internal data (e.g. the data received from the satellites, time) .

When issuing this command with setting “1” to the bits the data assigned, these data will be erased.

This command must be issued at “Idle” mode.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x39
OPR1	The erased data are set on a bit by bit basis. bit 0-1: (Reserved) bit 2: Receiver position and velocity bit 3: Time bit 4: (Reserved) bit 5: TCXO offset bit 6-7: (Reserved)	0: Not erase 1: Erase
OPR2	The erased data are set on a bit by bit basis. bit 0: GPS L1C/A ephemeris bit 1: GLONASS ephemeris bit 2: SBAS L1 ephemeris bit 3: QZSS L1C/A ephemeris bit 4: QZSS L1S ephemeris bit 5: (Reserved) bit 6: BeiDou B1I ephemeris bit 7: Galileo E1B/C ephemeris	0: Not erase 1: Erase
OPR3	The erased data are set on a bit by bit basis. bit 0: GPS L5 ephemeris bit 1: QZSS L5 ephemeris bit 2: BeiDou B1C ephemeris bit 3: BeiDou B2a ephemeris bit 4: Galileo E5a ephemeris bit 5: NavIC ephemeris bit 6-7: (Reserved)	0: Not erase 1: Erase
OPR4	The erased data are set on a bit by bit basis. bit 0: GPS L1C/A almanac bit 1: GLONASS almanac bit 2: SBAS L1 almanac bit 3: QZSS L1C/A almanac bit 4: QZSS L1S almanac bit 5: (Reserved) bit 6: BeiDou B1I almanac bit 7: Galileo E1B/C almanac	0: Not erase 1: Erase
OPR5	The erased data are set on a bit by bit basis. bit 0: GPS L5 almanac bit 1: QZSS L5 almanac bit 2: BeiDou B1C almanac bit 3: BeiDou B2a almanac bit 4: Galileo E5a almanac bit 5: NavIC almanac bit 6-7: (Reserved)	0: Not erase 1: Erase
OPR6	The erased data are set on a bit by bit basis. bit 0: GPS LLE data bit 1: QZSS LLE data bit 2: GLONASS LLE data bit 3: Galileo LLE data bit 4: BeiDou LLE data bit 5-7: (Reserved)	0: Not erase 1: Erase

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x39
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.28 Elevation, C/N0 and altitude limit value setting (OPC: 0x3A)

This message is used to set the limit value of elevation, C/N0 and altitude. Select parameter to set by OPR1 and set the limit value by OPR2 – 6.

The minimum elevation angle (0 to 90 degree) for the satellites to track is set to OPR2 with integer. The satellites which elevation angle is under this setting will not be tracked.

The minimum C/N0 value for the satellites for position calculation is set to OPR3. The satellites which C/N0 is under this setting will not be used for position calculation. The value from 0 to 50 can be specified. When 0 is specified, C/N0 limit value is set to the default value.

The upper limit and lower limit of the altitude is set to OPR4 – 7. When the calculated altitude was out of this range, the positioning calculation result is treated as “no fix”.

It is desirable to use the default setting, since this change may affect the performance

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x3A
OPR1	The parameters to set are set on a bit by bit basis. bit 0: Elevation bit 1: C/N0 bit 2: Altitude bit 3-7: (Reserved)	0: Not make settings 1: Make settings
OPR2	Elevation limit	[degree] (from 0 to 90)
OPR3	C/N0 limit	[dB-Hz] (from 0 to 50, When “0” is specified, C/N0 limit value will be the default value. Default value: 5)
OPR4	Altitude upper limit	[m] (Default value: 15,000)
OPR5		
OPR6	Altitude lower limit	[m] (Default value: 0)
OPR7		

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x3A
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.29 Acquire the elevation, C/N0 and altitude limit value setting (OPC: 0x3B)

This message is used to acquire the elevation, C/N0 and altitude limit settings.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x3B
OPR1	The parameters to set are set on a bit by bit basis. bit 0: Elevation bit 1: C/N0 bit 2: Altitude bit 3-7: (Reserved)	0: Not make settings 1: Make settings
OPR2	Elevation limit	[degree] (from 0 to 90)
OPR3	C/N0 limit	[dB-Hz] (from 0 to 50, When “0” is specified, C/N0 limit value will be the default value. Default value: 5)
OPR4	Altitude upper limit (integer part)	[m] (Default value: 15,000)
OPR5		
OPR6	Altitude upper limit (first decimal place)	
OPR7	Altitude lower limit (integer part)	[m] (Default value: 0)
OPR8		
OPR9	Altitude lower limit (first decimal place)	

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x3B
OPR1	Elevation limit	[degree]
OPR2	C/N0 limit	[dB-Hz]
OPR3	Altitude upper limit (integer part)	[m]
OPR4		
OPR5	Altitude upper limit (first decimal place)	
OPR6	Altitude lower limit (integer part)	[m]
OPR7		
OPR8	Altitude lower limit (first decimal place)	

3. Indication from RYS8839: N/A

4.2.30 Rollover origin date setting (OPC: 0x3C)

This message is used to set the origin date for detecting GPS week number rollover. From the date set by this command to 1,024 weeks later, the RYS8839 can calculate GPS week number correctly. Refer to 8.1 for thedetail of GPS week number rollover.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x3C
OPR1	Year	Lower 1 byte of year.
OPR2	bit 0- 3: Month	
	bit 4 - 7: Year	Upper 4 bits of year.
OPR3	Day	

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x3C
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.31 Operation mode setting (OPC: 0x3D)

This message is used to set the positioning cycle of the RYS8839.

The sleep time can be specified for the intermittent operation. The positioning operation is performed during the remaining time of the positioning cycle after operation has transferred to the Deep Sleep state for the time specified with each specified positioning cycle.

When Power Config-1, 2 and 3 are applied to the RYS8839 power configuration, less than 1,000ms cannot be specified to the positioning cycle (the error will return).

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x3D
OPR1		Set “1” always.
OPR2	Positioning cycle	[ms] Configurable values are 40, 50, 100, 125, 200, 250, 500, 1000 and multiple of 1000 (Default value: 1000).
OPR3		
OPR4	Sleep time	[ms] When “0” is specified, the sleep operation is not performed, and positioning is executed continuously (Default value: 0)
OPR5		

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x3D
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.32 Acquire the operation mode setting (OPC: 0x3E)

This message is used to acquire the operation mode setting by OPC: 0x3D.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x3E

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x3E
OPR1	Error code	
OPR2	Positioning cycle	[ms]
OPR3		
OPR4	Sleep time	[ms]
OPR5		

3. Indication from RYS8839: N/A

4.2.33 Satellite usage setting at SBAS correction is valid (OPC: 0x3F)

This message is used to select the satellite usage for positioning at SBAS correction is valid. This setting has no influence to the operation at SBAS and is not selected by OPC: 0x32 (Positioning-use satellite setting) or SBAS correction is not valid.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x3F
OPR1	Satellite usage at SBAS correction is valid.	0: Not use the satellites that are not supported by SBAS correction (default setting) . 1: Use the satellites that are not supported by SBAS correction.

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x3F
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.34 Positioning algorithm setting (OPC: 0x40)

This message is used to select the GNSS positioning algorithm for special use cases.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x40
OPR1	Positioning algorithm	0 : Fitness mode (default) 1 : Swimming mode 2 : Driving mode 3 : High speed driving mode 4 : Airborne mode 5 : Floating mode

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x40
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.35 Acquire the positioning algorithm setting (OPC: 0x41)

This message is used to acquire the positioning algorithm setting by OPC: 0x40.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x41

OPR1	Positioning algorithm	0 : Fitness mode (default) 1 : Swimming mode 2 : Driving mode 3 : High speed driving mode 4 : Airborne mode 5 : Floating mode

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x41
OPR1	Error code	
OPR2	Positioning algorithm	0 : Fitness mode 1 : Swimming mode 2 : Driving mode 3 : High speed driving mode 4 : Airborne mode 5 : Floating mode

3. Indication from RYS8839: N/A

4.2.36 RTCM message type setting (OPC: 0x45)

This message is used to enable/disable RTCM message output.

The message types are assigned to each the bits of OPR1 - 4. “1” is set for the bits of the message types which are to be output, and “0” is set for the bits of the message types whose output is not required. The selected RTCM message types are output with the frequency specified by OPC: 0x3D.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x45
OPR1	The RTCM message types to output are set on a bit by bit basis. bit 0: 1074 (GPS MSM4) bit 1: 1077 (GPS MSM7) bit 2: (Reserved) bit 3: (Reserved) bit 4: 1084 (GLONASS MSM4) bit 5: 1087 (GLONASS MSM7) bit 6: (Reserved) bit 7: (Reserved)	0: Not output 1: Output
OPR2	The RTCM message types to output are set on a bit by bit basis. bit 0: 1094 (Galileo MSM4) bit 1: 1097 (Galileo MSM7) bit 2: (Reserved) bit 3: (Reserved) bit 4: 1114 (QZSS MSM4) bit 5: 1117 (QZSS MSM7) bit 6: (Reserved) bit 7: (Reserved)	0: Not output 1: Output
OPR3	The RTCM message types to output are set on a bit by bit basis. bit 0: 1124 (BeiDou MSM4) bit 1: 1127 (BeiDou MSM7) bit 2: (Reserved) bit 3: (Reserved) bit 4: 1019 (GPS Ephemeris) bit 5: 1020 (GLONASS Ephemeris) bit 6: 1041 (NavIC Ephemeris) bit 7: 1042 (BeiDou Ephemeris)	0: Not output 1: Output
OPR4	The RTCM message types to output are set on a bit by bit basis. bit 0: 1044 (QZSS Ephemeris) bit 1: 1045 (Galileo F/NAV Ephemeris) bit 2: 1046 (Galileo I/NAV Ephemeris) bit 3: (Reserved) bit 4: (Reserved) bit 5: (Reserved) bit 6: (Reserved) bit 7: (Reserved)	0: Not output 1: Output

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x45
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.37 UTC correction seconds setting (OPC: 0x46)

This message is used to set the correction seconds for converting GPS time to UTC time. This is a total number of leap second insertions from 1980/1/6 (starting time of GPS time). This value is used to convert GPS time to UTC time.

When the UTC correction seconds are received from the satellites, it is overwritten.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x46
OPR1	UTC correction seconds	[s] (Default value: 17)

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x46
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.38 Velocity limit setting (OPC: 0x47)

This message is used to set the velocity limit value. Set the value in OPR1-4 as an integer. The unit is m/s. When the calculated velocity exceeds this setting, it judged as non-fixed and the calculate velocity is not output. The value from 1 to 600 can be specified. The default value is 150.

It is desirable to use the default setting, since this change may affect the performance.

4. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x47
OPR1	Velocity limit	[m/s] (1 - 600. Default value: 150)
OPR2		
OPR3		
OPR4		

5. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x47
OPR1	Error code	

6. Indication from RYS8839: N/A

4.2.39 DOP limit setting (OPC: 0x48)

This message is used to set the DOP limit value. Set the value with a floating point number in OPR1-4. When PDOP value exceeds this setting, it judged as non-fixed and the calculate position is not output. The value from 0 to 100 can be specified. The default value is 12.

It is desirable to use the default setting, since this change may affect the performance.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x48
OPR1	DOP limit	(0 - 100. Default value: 12.0)
OPR2		
OPR3		
OPR4		

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x48
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.40 SBAS satellite select (OPC: 0x4B)

This message is used to select which SBAS satellite to be used when SBAS is used. Only one satellite from GAGAN, WAAS, EGNOS, MSAS, SDCM and BDSBAS can be selected. The RYS8839 will search just the specified SBAS satellite and not search the other SBAS satellites.

1. Command from the host controller:

Field	Description	Data
OPC	Opcode	0x4B
OPR1	Positioning algorithm	0：GAGAN (default) 1：WAAS 2：EGNOS 3：MSAS 4：SDCM 5：BDSBAS

2. Command response from RYS8839:

Field	Description	Data
OPC	Opcode	0x4B
OPR1	Error code	

3. Indication from RYS8839: N/A

4.2.41 Time indication (OPC: 0x80)

This message is used to indicate the current date and time by the RYS8839. This indication is issued periodically when this OPC is enabled by OPC: 0x34 and the RYS8839 starts positioning.

1. Command from the host controller: N/A

2. Command response from RYS8839: N/A

3. Indication from RYS8839:

Field	Description	Data
OPC	Opcode	0x80
OPR1	(Reserved)	
OPR2	(Reserved)	
OPR3	Year	Lower 1 byte of year.
OPR4	bit 0- 3: Month	
	bit 4 - 7: Year	Upper 4 bits of year.
OPR5	Day	
OPR6	Hour	
OPR7	Minute	
OPR8	Second	
OPR9	1/100 second	

4.2.42 Receiver position indication (OPC: 0x81)

This message is used to indicate the receiver position calculated by the RYS8839. This indication is issued periodically when this OPC is enabled by OPC: 0x34 and the RYS8839 starts positioning.

1. Command from the host controller: N/A

2. Command response from RYS8839: N/A

3. Indication from RYS8839:

Field	Description	Data
OPC	Opcode	0x81
OPR1	(Reserved)	
OPR2	(Reserved)	
OPR3	bit 0- 3: Positioning status	0: Fix not available 1: Fix valid 2: Fix valid, Differential GPS 6: Dead reckoning
	bit 4-7: Satellite systems used for calculation	0: Using only GPS for positioning. 1: Using only GLONASS for positioning. 2: Using only Galileo for positioning. 3: Using only BeiDou for positioning. 4: Using only QZSS for positioning. 5: Using only NavIC for positioning. 6: Using combined satellite systems for positioning
OPR4	Latitude	Latitude [deg] multiplied by 10^7. Set the value with signed integer (Positive: North latitude, Negative: South latitude)
OPR5		
OPR6		
OPR7		
OPR8	Longitude	Longitude [deg] multiplied by 10^7. Set the value with signed integer (Positive: East longitude, Negative: West longitude)
OPR9		
OPR10		
OPR11		
OPR12	Altitude	[cm] Set the value with signed integer. Upper limit is 2,000km (200,000,000cm).
OPR13		
OPR14		
OPR15		

4.2.43 Receiver velocity indication (OPC: 0x82)

This message is used to indicate the receiver velocity and direction calculated by the RYS8839. This indication is issued periodically when this OPC is enabled by OPC: 0x34 and the RYS8839 starts positioning.

1. Command from the host controller: N/A

2. Command response from RYS8839: N/A

3. Indication from RYS8839:

Field	Description	Data
OPC	Opcode	0x82
OPR1	(Reserved)	
OPR2	bit 0- 1: Positioning mode	0: Fix not available 1: Fix valid 2: Fix valid, Differential GPS 3: Dead reckoning
	bit 2-7: (Reserved)	
OPR3	Course over ground - True	Course over ground [degree] multiplied by 10. Integer value.
OPR4		
OPR5	Course over ground – Magnetic	Course over ground [degree] multiplied by 10. Integer value.
OPR6		
OPR7	Speed over ground	Speed [km/h] multiplied by 10. Integer value.
OPR8		
OPR9	Climbing speed	Speed [km/h] multiplied by 10. Integer value.
OPR10		

4.2.44 Visible satellite information indication (OPC: 0x83)

This message is used to indicate the information of the visible satellites from the RYS8839. This indication is issued periodically when this OPC is enabled by OPC: 0x34 and the RYS8839 starts positioning. The data length is variable depending on the number of the visible satellites.

1. Command from the host controller: N/A

2. Command response from RYS8839: N/A

3. Indication from RYS8839:

Field	Description	Data
OPC	Opcode	0x83
OPR1	(Reserved)	
OPR2	bit 0- 1: Positioning mode	1: Fix not available 2: 2D fix 3: 3D fix
	bit 2-7: (Reserved)	
OPR3	Total number of satellites in view	1 - 409
OPR4		

OPR5	SV 1	bit 0-3: Signal ID	0: GPS L1C/A 1: GPS L5 2: GLONASS 3: QZSS L1C/A 4: QZSS L1S 5: QZSS L5 6: BeiDou B1I 7: BeiDou B1C 8: BeiDou B2a 9: Galileo E1B/C 10: Galileo E5a 11: NavIC
		bit 4: (Reserved)	
		bit 5: Tracked	0: Not tracked 1: Tracked
		bit 6: Used for velocity calculation	0: Not used 1: Used
		bit 7: Used for position calculation	0: Not used 1: Used
OPR6		SVID	
OPR7		C/N0	[dBHz]
OPR8		Elevation	[degree] (0 - 90)
OPR9		Azimuth	[degree] (0 - 359)
OPR10			
. .			
OPR(n*6-1)	SV n	bit 0-3: Signal ID	
		bit 4: (Reserved)	
		bit 5: Tracked	
		bit 6: Used for velocity calculation	
		bit 7: Used for position calculation	
OPR(n*6)		SVID	
OPR(n*6+1)		C/N0	
OPR(n*6+2)		Elevation	
OPR(n*5+3)		Azimuth	

4.2.45 RTCM message indication (OPC: 0x84)

This message is used to indicate the RTCM message from the RYS8839. This indication is issued periodicallywhen this OPC is enabled by OPC: 0x34 and the RYS8839 starts positioning. The data length is variable.

1. Command from the host controller: N/A

2. Command response from RYS8839: N/A

3. Indication from RYS8839:

Field	Description	Data
OPC	Opcode	0x84
OPR1	(Reserved)	
OPR2	Data size	[bytes] (1 - 4,090)
OPR3		
OPR4	Total frame number	
OPR5	Serial number of the frame	
OPR6	RTCM message	The data with RTCM version 3.3 frame format is stored. Refer to 4.3.
. .		
OPRn		

4.2.46 Accuracy index indication (OPC: 0x89)

This message is used to indicate the accuracy index from the RYS8839. This indication is issued periodicallywhen this OPC is enabled by OPC: 0x34 and the RYS8839 starts positioning. The data length is variable.

1. Command from the host controller: N/A

2. Command response from RYS8839: N/A

3. Indication from RYS8839:

Field	Description	Data
OPC	Opcode	0x89
OPR1	(Reserved)	
OPR2	Horizontal position accuracy index	[m]
OPR3		
OPR4	Vertical position accuracy index	[m]
OPR5		
OPR6	Horizontal velocity accuracy index	Accuracy index [km/h] multiplied by 10. Integer value.
OPR7		
OPR8	Vertical velocity accuracy index	Accuracy index [km/h] multiplied by 10. Integer value.
OPR9		
OPR10	PDOP	PDOP multiplied by 10. Integer value.
OPR11	HDOP	HDOP multiplied by 10. Integer value.
OPR12	VDOP	VDOP multiplied by 10. Integer value.
OPR13	Semi-major axis of error ellipse	[m]
ORP14		
OPR15	Semi-minor axis of error ellipse	[m]
OPR16		
OPR17	Orientation of semi-major axis of error ellipse	[degree] (from true north)

4.2.47 Communication error indication (OPC: 0xFF)

When the error occurred at the communication with a binary message protocol, this indication is sent from RYS8839.

1. Command from the host controller: N/A

2. Command response from RYS8839: N/A

3. Indication from RYS8839:

Field	Description	Data
OPC	Opcode	0xFF
OPR1	OPC of the received binary message	
OPR2	Error code	

4.3 RTCM protocol

The RYS8839 supports RTCM version 3.3 compliant messages.

The RTCM message output can be enabled/disabled by OPC: 0x34 (position indication select).

RTCM message input is not supported

4.3.1 RTCM version 3.3 frame structure

The frame structure of RTCM version 3.3 messages is below. The data with this frame format is stored in OPR6 – OPRn of OPC: 0x84 (RTCM message indication).

Data	Bit length
Preamble	8 bits (0xD3)
(Reserved)	6 bits
Message length [bytes]	10 bits
Message	Variable
CRC	24 bits

4.3.2 RTCM input messages

The RTCM version 3.3 input messages are not supported.

4.3.3 RTCM output messages

The following RTCM version 3.3 output messages are supported.

Message type	Description
1019	GPS Ephemeris
1020	GLONASS Ephemeris
1041	NavIC Ephemeris
1042	BeiDou Ephemeris
1044	QZSS Ephemeris
1045	Galileo F/NAV Ephemeris
1046	Galileo I/NAV Ephemeris
1074	GPS MSM4
1077	GPS MSM7
1084	GLONASS MSM4
1087	GLONASS MSM7
1094	Galileo MSM4
1097	Galileo MSM7
1114	QZSS MSM4
1117	QZSS MSM7
1124	BeiDou MSM4
1127	BeiDou MSM7

4.4 Binary protocol with I²C interface

This section explains the communication method with I²C interface.

4.4.1 Command from the host controller to RYS8839

Send the whole of the binary protocol frame format in one communication.

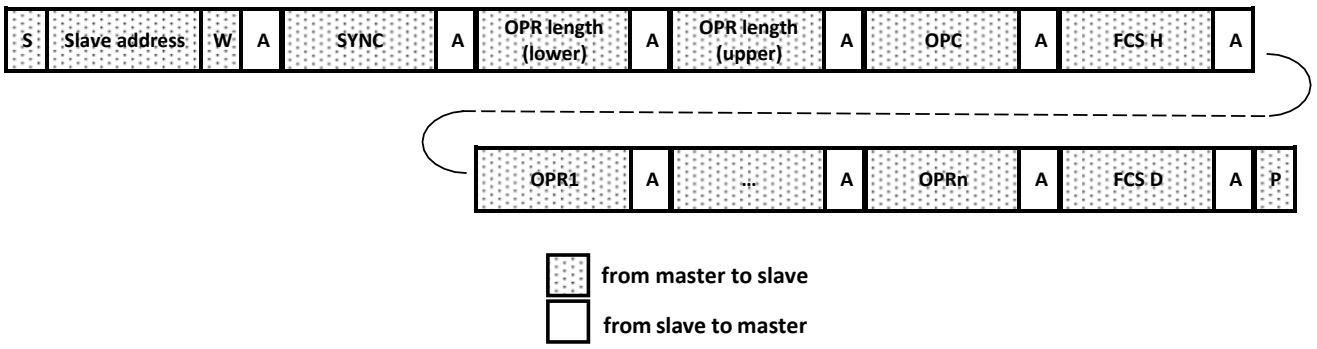


Fig.5 Command from the host controller to RYS8839

4.4.2 Command response from RYS8839 and indication from RYS8839

When the RYS8839 is ready to send a command response or indication, GPIO (HIF_INT_OUT) will set to “H” and the host controller can notice the RYS8839 is ready to send the data. In this case, send from “SYNC” to “FCS H” of binary protocol frame format in the first communication and receive “OPC” and the length of “OPR”. Then, send from “OPR (variable length)” to “FCS D” in the second communication.

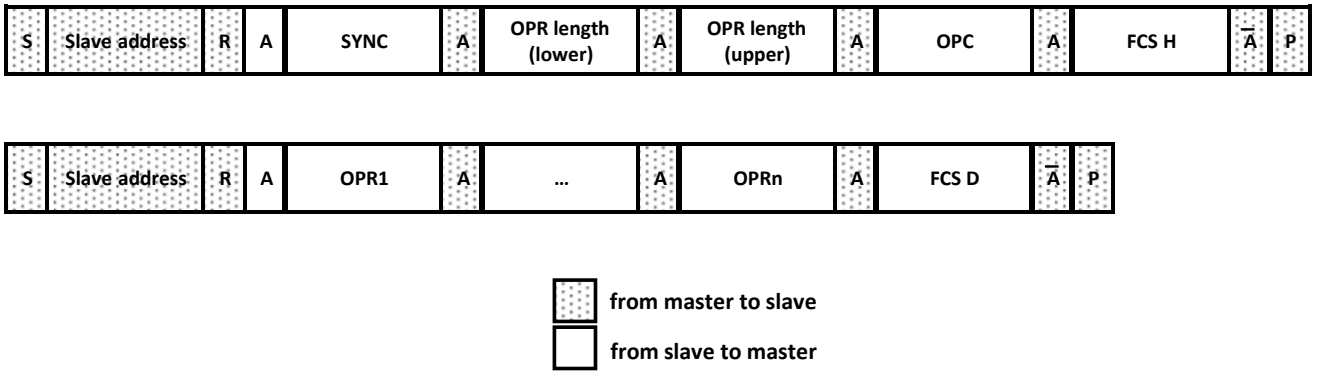


Fig.6 Command response from RYS8839 and indication from RYS8839

5 RYS8839 operation states

The operation of the RYS8839 has three states, and the transitions between these states are shown below.

5.1 Operation states

The operation status of the RYS8839 has three states, and the RYS8839 transits between these states asshown in Fig.2.

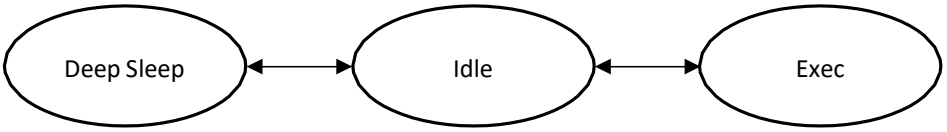


Fig.7 Transition between the RYS8839 states

Each of the states is defined below.

Deep Sleep
In this state, the power is supplied only to the real-time clock. The real-time clock continues to operate, and the values required to hot start (the receiver position, ephemeris, almanac, TCXO offset value, etc.) are stored in eMRAM so the conditions required for hot start are retained. After wakeup, the program is rebooted.

Idle
In this state, the power of all the blocks is supplied, and the GPS operation is stopped.

Exec
In this state, the power of all the blocks is supplied, and the GPS positioning operation is underway. Some blocks may be turned off depending on the conditions of positioning operation and satellite signal.

Transitions from one state to another can be initiated by issuing commands from the host controller.
When the RYS8839 is working with intermittent profile by @GSOP command, the RYS8839 work with Normalstate and Deep Sleep mode automatically.

6 Other operating specifications

6.1 GPS week number rollover

The GPS Week Number count began at the midnight of 05 January 1980 / 6 January 1980. Since then, the GPS week number has been incrementing steadily by one each week. Only the bottom 10 bits of the week number is transmitted. Hence, the GPS Week number field is given as a modulo 1024. This means that at the completion of week 1023, the GPS week number rolled over to 0 for the first time on midnight GPS Time of the evening of 21 August 1999 / morning of 22 August 1999. Note that this corresponded to 23:59:47 UTC on 21 August 1999. The next rollover will happen in 2019.

The RYS8839 solves the rollover issue by establishing its own origin date, week number, and rollover count. The origin week number acts as a reference rollover week number since all received week numbers must be at least as large as the RYS8839 reference rollover week number. This reference rollover week number is hard-coded into the RYS8839 firmware (e.g., Sunday, 1st 2009 – Week number 1513).

When the RYS8839 fixes the position and time, it updates the stored origin date, week number and rollover count (i.e., establish a new origin date to be used with later fixes). Updated information can be stored in the eMRAM by the @BUP command, and these are used from the next boot up.

The origin date can be set to any date with @GSSD command (the week number and the rollover count are also updated). In addition, the @GTIM command can be used to inject the time and date, which causes the RYS8839to update the RYS8839 stored origin date, week number and rollover count.

7 PVT log data format

The format of the PVT log data (18 bytes) is shown below. The data is stored using little endian ordering.

Bit	Contents		Remarks
0 - 13	Receiver latitude	Latitude (decimal places of minutes)	
14 - 19		Latitude (minutes)	
20 - 26		Latitude (degrees)	
27		Latitude symbol	0: Plus (north latitude), 1: minus (south latitude)
28 - 41	Receiver longitude	Longitude (decimal places of minutes)	
42 - 47		Longitude (minutes)	
48 - 55		Longitude (degrees)	
56		Longitude symbol	0: Plus (east longitude), 1: minus (west longitude)
57 - 60	Receiver altitude	Altitude (decimal places)	
61 - 74		Altitude (integer)	Unit: [m]
75		Altitude symbol	0: Plus, 1: minus
76 - 89	Receiver speed	Speed	Unit: [knots]
90 - 93	Bearing	Decimal	0～9
94 - 102		Integer	0 to 359, unit: [degree]
103 - 109	Time (UTC)	msec	
110 - 115		Seconds	
116 - 121		Minutes	
122 - 126		Hours	
127	Reserved		
128 - 134	Date (UTC)	Year	
135 - 139		Day	
140 - 143		Month	

8 Error codes

When the RYS8839 responds with an error reply to a command issued by the host, an error code indicating the nature of the error is transmitted with the reply. This is a negative value or “0” which is a POSIX standard subset. The error codes are listed in the table below.

Value	Definition	Significance
0	0	Command processing successful
-1	-EPERM	Internal error
-2	-ENOENT	A command which is not supported has been input.
-3	-ESRCH	The internal communication cancel process has failed.
-4	-EINTR	Internal error
-5	-EIO	Flash ROM access or DMA processing has failed
-6	-ENXIO	Internal error
-7	-E2BIG	The injection data is smaller than the requested size.
-8	-ENOEXEC	Internal error
-9	-EBADF	Internal error
-11	-EAGAIN	Power-on has failed.
-12	-ENOMEM	Memory allocation has failed.
-13	-EACCES	Power control has failed.
-16	-EBUSY	Processing was not requested in the correct status.
-17	-EEXIST	Internal error
-19	-ENODEV	Internal error
-22	-EINVAL	The argument is outside the specified range.
-28	-ENOSPC	Internal error
-35	-ENOMSG	The message data type is incorrect.
-36	-EIDRM	Internal error
-46	-ENOLCK	Internal error
-47	-ECANCELED	Internal error
-48	-ENOTSUP	UART/I^2C control has failed.
-54	-EBADRQC	The command argument is not correct.
-62	-ETIME	Processing failed due to a timeout.
-71	-EPROTO	The data injection content is not correct.