REYAX
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RYS8830
RYS8833

GNSS Module Software Guide

GNSS Monitor software

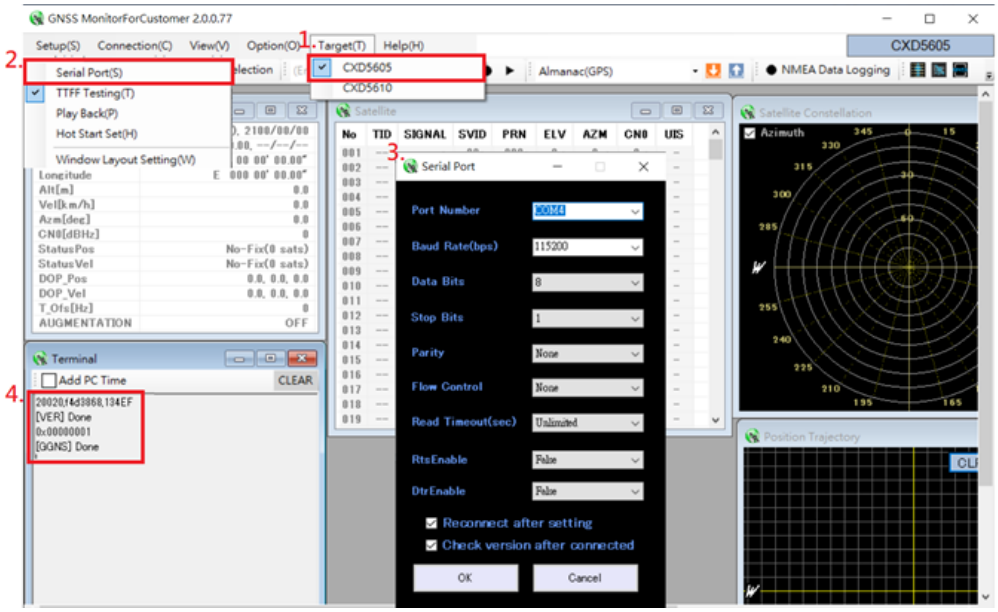
After Install GNSS_MonitorForCustomerSetup.exe, please open a dialog window by selecting "Setup(S)" → "Serial Port(S)", and set following parameter.

1.) Open GNSS_Monitor2_ForCustomer software, then click "Target" → "CXD5605."

2.) Click "Setup(S)" → "Serial Port"

3.) Set the COM port number and baud rate (Default is 115200bps).

4.) If the module connect-successfully, the FW version message will be shown as below.



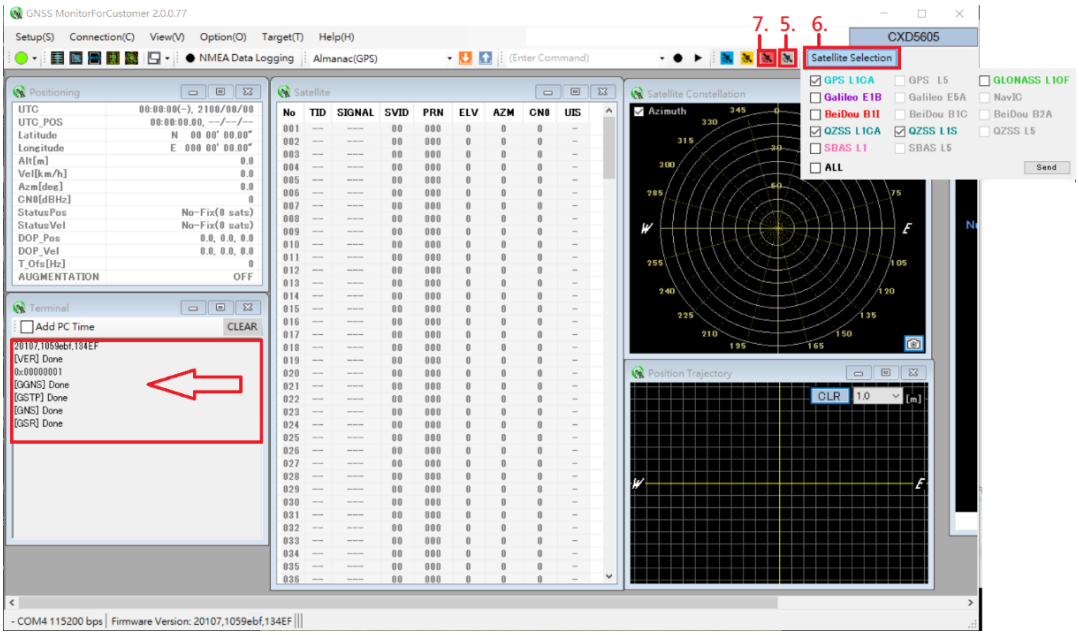
5.) Click "IDLE", [GSTP]Done will be shown in Terminal window.

6.) Click "Satellite Selection". After selecting Satellite, click "Send". [GNS]Done will be shown in Terminal window.

7.) Click "Hot start". [GSR]Done will be shown in Terminal window.

Module starts output NMEA log.

8.) Click "IDLE" for stop tracking.



Command Input Procedure

For test with communication terminal software, the operation of positioning will be executed after below commands settings. It is required to key in “enter” or “\r\n” in the end of all Commands.

Ex.) Baud rate : 115200bps, Positioning-use satellite setting, Hot Start

@GSTP (Set IDLE Mode)

@GNS 0x** (Set search mode)

01 : GPS

02 : GLONASS

03 : GPS+GLONASS

Ex: @GNS 47 (GPS+GLONASS+SBAS+QZSS)

@GSR (Hot start)

Table of Contents

COMMAND

Default: Key in <CR><LF> at the end of all Commands.

1. Automatic backup data save interval setting

Syntax	Response
@ABPT <arg 1>	[ABPT] Done
This command is used to setting the interval of the automatic backup data save function. The unit is "minute" and the value from 1 to 1,440 min can be set (default value: 60min) . **This command must be issued at Idle state and the automatic backup data save function disabled.** Please take account to the life of the flash memory when using this function.	

Argument:

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

2. Automatic backup data save ON/OFF

Syntax	Response
@ABUP <arg 1>	[ABUP] Done
This command is used to control the automatic backup data save function. When "1" is specified for the argument, the backup data contents are saved in the flash memory automatically at the first fix (This save is not executed if the time specified by @ABPT has not elapsed since the last save). Then the backup data contents are saved in the flash memory automatically with specified interval set by @ABPT beginning at the first fix. For information about the backup data, see "@BUP". **This command must be issued at Idle state.** When this command is issued at Exec state, error is returned. When the automatic backup data save is executing, the sentence may be output erratically sometimes. Please take account to the life of the flash memory when using this function.	

Argument:

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

3. Output sentence select

Syntax	Response
@BSSL <arg 1>	[BSSL] Done
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.	

Argument:

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

4. Backup data save

Syntax	Response
@BUP	[BUP] Done

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

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

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

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

Argument: None

5. Backup data clear

Syntax	Response
@BUPC	[BUPC] Done
This command is used to clear the backup data saved in the flash memory by @BUP. **This command must be issued at Idle state and the automatic backup data save function disabled.**	

Argument: None

6. UART0 baud rate setting

Syntax	Response
@CSBR <arg 1>	[CSBR] Done
This command is used to set the UART0 baud rate of the RYS8830/RYS8833. When the command is executed successfully, UART0 is changed to the baud rate specified by the argument. Therefore, ensure that the Done response is received at the original baud rate. When the command has failed, the original baud rate is not changed. In the default status, the baud rate is set to 115200 bps.	

Argument:

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

7. GPS almanac data acquisition

Syntax	Response
@GALG	[GALG] Done
This command is used to acquire the GPS almanac data received by RYS8830/RYS8833. When the command is received, the RYS8830 transmits the GPS almanac data (binary data) to the host controller. The GPS almanac data size is 2048 bytes. In addition, the data which is actually transferred has the header and footer added. **This command must be issued at "Idle" mode.**	

Argument: None

8. GPS almanac data injection

Syntax	Response
@GALS	[GALS] Done [GALS] Ready
This command is used to inject the GPS almanac data into the RYS8830/RYS8833. Transmit the GPS almanac data (binary data) following the Ready response from the RYS8830/RYS8833. The GPS almanac data size is 2048 bytes. In addition, the data which is actually required has the header and footer added. **This command must be issued at "Idle" mode.**	

Argument: None

9. Cold start

Syntax	Response
@GCD	[GCD] Done
This command is used to start the positioning with cold start.	

Argument: None

10. GPS ephemeris data acquisition

Syntax	Response
@GEMG	[GEMG] Done
This command is used to acquire the GPS ephemeris data which has been received by the RYS8830. When the command is received, the RYS8830 transmits the GPS ephemeris data (binary data) to the host controller. The GPS ephemeris data size is 3072 bytes. In addition, the data which is actually transferred has the header and footer added. **This command must be issued at "Idle" mode.**	

11. GPS ephemeris data injection

Syntax	Response
@ GEMS	[GEMS] Done [GEMS] Ready
This command is used to inject the GPS ephemeris data into the RYS8830. Transmit the GPS ephemeris data (binary data) following the Ready response from the RYS8830. The GPS ephemeris data size is 3072 bytes. In addition, the data which is actually required has the header and footer added. **This command must be issued at "Idle" mode.**	

Argument: None

12. Positioning-use satellite setting

Syntax	Response
@GNS	[GNS] Done
This command is used to select the satellite systems to be used for positioning. The satellite systems are assigned to the bits of the argument. "1" is set for the bits of the systems which are to be used and "0" is set for the bits of the systems which are not be used. Arguments can be specified in decimal or hexadecimal notation. With hexadecimal notation, add "0x" in front of the numeral. Only 2 satellite systems can be selected from GLONASS, BeiDou and Galileo. If over 2 satellite systems are selected from these satellite systems, error will return (-EINVAL) . Furthermore, GLONASS and BeiDou cannot be selected at the same time. **This command must be issued at "Idle" mode.**	

Argument:

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

13. Receiver position setting (ellipsoidal coordinates)

Syntax	Response
@GPOE <arg 1> <arg 2> <arg 3> <arg 4> <arg5> <arg 6>	[GPOE] Done
This command is used to set the approximate position of the receiver in the RYS8830. The receiver position is set using ellipsoidal coordinates (latitude, longitude). The north latitude and east longitude directions are "+" values so when specifying the receiver position using a south latitude and west longitude, add a "-" (minus) sign in front to the values. The receiver position, current time and TCXO offset value are required in order to initiate a hot start so the receiver position must have been set in the RYS8830/RYS8833 prior to hot start using this command. (This is not necessary if the position is backed up in the flash memory.)	

Argument:

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

Examples of commands:

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

14. Receiver position setting (ellipsoidal coordinates)

Syntax	Response
@GPOS <arg 1> <arg 2> <arg 3>	[GPOS] Done
This command is used to set the approximate position of the receiver in the RYS8830. This command supports higher-accuracy position than @GPOE. The receiver position is set using ellipsoidal coordinates (latitude, longitude) and altitude. The north latitude and east longitude directions are "+" values so when specifying the receiver position using a south latitude and west longitude, add a "-" (minus) sign in front to the values. The receiver position, current time and TCXO offset value are required in order to initiate a hot start so the receiver position must have been set in the RYS8830/RYS8833 prior to hot start using this command. (This is not necessary if the position is backed up in the flash memory.)	

Argument:

Field	Description
arg 1	This specifies the latitude (degrees) * 106 of the receiver using an integer. e.g. 43.123456 degrees north: set “43123456”.
arg 2	This specifies the longitude (degrees) *106 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”.

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

15. 1PPS output setting

Syntax	Response
@GPPS <arg 1>	[GPPS] Done
This command is used to control 1PPS output. When 1PPS output is enabled, timing pulse is output in 1 sec period from 1PPS output port after clock information being received from GNSS. When 1PPS output is disabled, timing pulse is not output from 1PPS output port.	

Argument:

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

16. Operation mode setting

Syntax	Response
@ GSOP <arg 1> <arg 2> <arg 3>	[GSOP] Done

This command is used to set the operation mode of the RYS8830/RYS8833. The operation mode and positioning cycle can be specified.

The sleep time can be specified but only when the Normal mode has been specified. The positioning operation is performed during the remaining time of the positioning cycle after operation has transferred to the Sleep state for the time specified with each specified positioning cycle. When the fix is not valid, some satellites are tracked and the operation time (equal to the positioning cycle minus the sleep time) is less than 1 minute, the RYS8830/RYS8833 does not transit to the Sleep state in this usage. If the sleep time must be kept certainly, set the parameters so that the operation time may be 1 minute or more.

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

Argument:

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

Examples of commands:

@GSOP 1 3000 0<CR><LF> // Normal mode, positioning cycle of 3 seconds (no sleep
// operation)

@GSOP 1 10000 5000<CR><LF> // Normal mode, positioning cycle of 10 seconds (sleep
// time of 5 seconds)
// (The pattern of a sleep time of 5 seconds and the
// positioning operation of 5 seconds is repeated.)

@GSOP 2 30000 0<CR><LF> // Low power mode, positioning cycle of 30 seconds

17. Hot start for position accuracy

Syntax	Response
@GSP	[GSP] Done
This command is used to start positioning using a hot start. The position accuracy is prioritized until first fix. TTFF is about 1s longer than @GSR. There is no difference with @GSR after first fix. When the conditions for the hot start have not been met, positioning is started automatically using a warm start or cold start.	

Argument: None

18. Hot start for TTFF

Syntax	Response
@ GSR	[GSR] Done
This command is used to start positioning using a hot start. The TTFF is prioritized until first fix. TTFF is about 1s shorter than @GSP but the position accuracy is somewhat worse than @GSP. There is no difference with @GSP after first fix. When the conditions for the hot start have not been met, positioning is started automatically using a warm start or cold start.	

Argument: None

19. Positioning stop

Syntax	Response
@GSTP	[GSTP] Done
This command is used to stop the positioning. The RYS8830/RYS8833 transfers to the Idle state.	

Argument: None

20. Time setting

Syntax	Response
@ GTIM <arg 1> <arg 2> <arg 3> <arg 4> <arg 5> <arg 6>	[GTIM] Done
This command is used to set the time of the receiver in the RYS8830/RYS8833. 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 RYS8830/RYS8833 prior to hot start using this command.	

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.

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”

21. GPS test result output

Syntax	Response
@ GTR	[GTR] Done
This command is used to output the GPS test results. Wait one second after the @GTS command is issued, and then issue the command. The CN level and Doppler frequency are returned as the test results.	

Argument: None

22. GPS test start

Syntax	Response
@ GTS <arg 1> <arg 2> <arg 3> <arg 4>	[GTS] Done
This command is used to start the GPS test. The test results are output by issuing the @GTR command after a wait of one second after the @GTS command has been issued. **This command can be issued only in the Idle state.**	

Argument:

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

Examples of commands:

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

23. Positioning algorithm setting

Syntax	Response
@GUSE <arg 1>	[GUSE] Done
This command is used to select the GNSS positioning algorithm for the special use case. Select the algorithm by the argument. In normal use case, select the default algorithm by setting "0x0000" for the argument.	

Argument:

Field	Description
arg 1	GNSS positioning algorithm are set on a bit by bit basis (0: not used, 1:used). 0x00000 : Fitness mode (default value) 0x00000 : Fitness mode 0x00080: Swimming mode 0x08000: Driving mode 0x10000: Airborne mode 0x20000: High speed driving mode 0x400000: Livestock mode

24. GLONASS almanac data acquisition

Syntax	Response
@ LALG	[LALG] Done
This command is used to acquire the GLONASS almanac data received by RYS8830/RYS8833. When the command is received, the RYS8830/RYS8833 transmits the GLONASS almanac data (binary data) to the host controller. The GLONASS almanac data size is 576 bytes. In addition, the data which is actually transferred has the header and footer added. **This command must be issued at "Idle" mode.**	

Argument: None

25. GLONASS almanac data injection

Syntax	Response
@ LALS	[LALS] Done [LALS] Ready
This command is used to inject the GLONASS almanac data into the RYS8830/RYS8833. Transmit the GLONASS almanac data (binary data) following the Ready response from the RYS8830/RYS8833. The GLONASS almanac data size is 576 bytes. In addition, the data which is actually required has the header and footer added. **This command must be issued at "Idle" mode.**	

Argument: None

26. GLONASS ephemeris data acquisition

Syntax	Response
@ LEMG	[LEMG] Done
This command is used to acquire the GLONASS ephemeris data which has been received by RYS8830. When the command is received, the RYS8830/RYS8833 transmits the GLONASS ephemeris data (binary data) to the host controller. The GLONASS ephemeris data size is 1152 bytes. In addition, the data which is actually transferred has the header and footer added. **This command must be issued at "Idle" mode.**	

Argument: None

27. GLONASS ephemeris data injection

Syntax	Response
@LEMS	[LEMS] Done [LEMS] Ready
This command is used to inject the GLONASS ephemeris data into the RYS8830/RYS8833. Transmit the GLONASS ephemeris data (binary data) following the Ready response from the RYS8830/RYS8833. The GLONASS ephemeris data size is 1152 bytes. In addition, the data which is actually required has the header and footer added. **This command must be issued at "Idle" mode.**	

Argument: None

28. QZSS almanac data acquisition

Syntax	Response
@ QALG	[QALG] Done
This command is used to acquire the QZSS almanac data received by RYS8830/RYS8833. When the command is received, the RYS8830/RYS8833 transmits the QZSS almanac data (binary data) to the host controller. The QZSS almanac data size is 672 bytes. In addition, the data which is actually transferred has the header and footer added. **This command must be issued at "Idle" mode.**	

Argument: None

29. QZSS almanac data injection

Syntax	Response
@ QALS	[QALS] Done [QALS] Ready
This command is used to inject the QZSS almanac data into the RYS8830/RYS8833. Transmit the QZSS almanac data (binary data) following the Ready response from the RYS8830/RYS8833. The QZSS almanac data size is 672 bytes. In addition, the data which is actually required has the header and footer added. **This command must be issued at "Idle" mode.**	

Argument: None

30. QZSS ephemeris data acquisition

Syntax	Response
@ QEMG	[QEMG] Done
This command is used to acquire the QZSS ephemeris data which has been received by RYS8830/RYS8833. When the command is received, the RYS8830/RYS8833 transmits the QZSS ephemeris data (binary data) to the host controller. The QZSS ephemeris data size is 960 bytes. In addition, the data which is actually transferred has the header and footer added. **This command must be issued at "Idle" mode.**	

Argument: None

31. QZSS ephemeris data injection

Syntax	Response
@ QEMS	[QEMG] Done
This command is used to inject the QZSS ephemeris data into the RYS8830/RYS8833. Transmit the QZSS ephemeris data (binary data) following the Ready response from the RYS8830/RYS8833. The QZSS ephemeris data size is 960 bytes. In addition, the data which is actually required has the header and footer added. **This command must be issued at "Idle" mode.**	

Argument: None

32. Sleep

Syntax	Response
@ SLP <arg 1>	[SLP] Done
This command is used to transfer operation to the Sleep state. It specifies transfer to each sleep state using an argument. The status at sleeping differs according to Sleep states.	

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

Argument:

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

33. Firmware revision number acquisition

Syntax	Response
@VER	"xxxx" <CR><LF>(ASCII)
This command is used to acquire the revision number of the firmware.	

Argument: None

34. Wake-up

Syntax	Response
@ WUP	[WUP] Done
This command is used to transfer to the Idle state from the Sleep state. When this command has been issued in the Sleep state, the command reply message is not output until the transfer to the Idle state is completed. Repeatedly issue this command until the command reply message is output.	

Argument: None

35. AEP function control

Syntax	Response
@AEPS <arg 1>	[AEPS] Done
This command is used to enable and disable AEP function. This command enables AEP function. The CXD5603GF generates AEP data and uses it for the position calculation automatically. This command can also disable AEP function, AEP data are not used for the position calculation.	

Argument:

Field	Description
arg 1	Controlling AEP function. 0 : Disable (default) 1 : Enable

36. AEP generation status acquisition

Syntax	Response
@AEPG	[AEPG] Done
This command is used to acquire the status of AEP data generation. When this command is issued, the CXD5603GF returns 2 of 32 bits data in ASCII strings. AAAAAAAA,BBBBBBBB "AAAAAAAA" indicates the satellites that are waiting for their AEP data generated. The satellites are assigned to each of the bits of this string (bit 0: SV1, bit 1: SV2, … , bit 31: SV32) . "BBBBBBBB" indicates the satellites which AEP data has already been generated. The satellites are assigned to each of the bits of this string. It takes time to generate AEP data for each satellite, and the CXD5603GF should not be turned off or transferred to sleep mode until AEP data generation finished. It is desirable that the host controller checks the status with this command and wait for AEP data generation finished. AEP data is always updated when new ephemeris is received. So, there is the case that the same bits of both "AAAAAAAA" and "BBBBBBBB" are set to "1" .	

NMEA sentence specifications

This section describes the specifications of NMEA sentences. RYS8830/RYS8833 outputs NMEA0183(ver 4.10) compliant sentences, IMES sentences and proprietary sentences whose talker ID is "$PS".

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>**

Field	Format	Description
Header	$	
Talker ID	--	GP : Using single system or combined satellite systems for positioning.
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>	

2. GLL : Geographic Position – Latitude / Longitude

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

Field	Format	Description
Header	$	
Talker ID	--	GP : Using only GPS for positioning GL : Using only GLONASS for positioning. GA : Using only Gailieo for positioning. BD : Using only BeiDou for positioning. GQ : Using only QZSS 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. 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*hh<CR><LF>

Field	Format	Description
Header	$	
Talker ID	--	GP : Using only GPS for positioning GL : Using only GLONASS for positioning. GA : Using only Gailieo for positioning. BD : Using only BeiDou for positioning. GQ : Using only QZSS 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) A : Autonomous mode D : Differential mode E : Dead reckoning mode N : Data not valid
Number of satellites in use	xx	
HDOP	x.x	
Altitude (mean-sea-level)	x.x,M	[m]
Geoidal separation, meters	x.x,M	[m]
Age of DGPS data	x.x	
Differential reference station ID	xxxx	NULL
Checksum	*hh	
Termination	<CR><LF>	

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,xx,x.x,x.x,x.x*hh<CR><LF>

Field	Format	Description
Header	$	
Talker ID	--	GP : Using only GPS for positioning GL : Using only GLONASS for positioning. GA : Using only Gailieo for positioning. BD : Using only BeiDou for positioning. GQ : Using only QZSS 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	
Checksum	*hh	
Termination	<CR><LF>	

5. GSV: GNSS Satellites In View

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

Field		Format	Description
Header		$	
Talker ID			GP : Using only GPS for positioning GL : Using only GLONASS for positioning. GA : Using only Gailieo for positioning. BD : Using only BeiDou for positioning. GQ : Using only QZSS for positioning.
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>	

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>

Field	Format	Description
Header	$	
Talker ID	--	GP : Using only GPS for positioning GL : Using only GLONASS for positioning. GA : Using only Gailieo for positioning. BD : Using only BeiDou for positioning. GQ : Using only QZSS 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>	

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**>

Field	Format	Description
Header	$	
Talker ID	--	GP : Using only GPS for positioning GL : Using only GLONASS for positioning. GA : Using only Gailieo for positioning. BD : Using only BeiDou for positioning. GQ : Using only QZSS 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,T	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>	

8. ZDA: Time & Date

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

Field	Format	Description
Header	$	
Talker ID	--	GP : Using only GPS for positioning GL : Using only GLONASS for positioning. GA : Using only Gailieo for positioning. BD : Using only BeiDou for positioning. GQ : Using only QZSS 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>	

Operation states

The operation status of the RYS8830/RYS8833 has five states, and the RYS8830/RYS8833 transits between these states as shown in Fig.

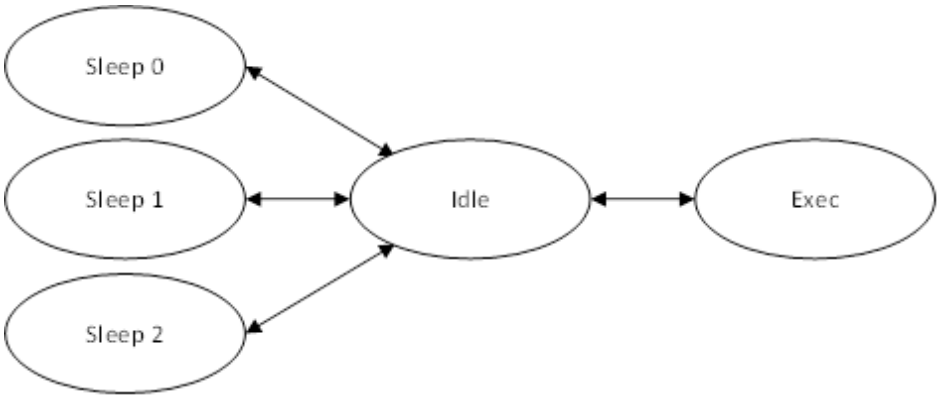


Fig Transition between the RYS8830/RYS8833 states

Each of the states is defined below.

Sleep 0

In this state, the power is supplied only to CPU, RAM, the backup RAM and real-time clock. CPU is in WFI state. The program and data in RAM and clock are retained. After wakeup, the program re-starts with previous status before entered sleep.

Sleep 1

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

Sleep 2

In this state, the power of all the blocks except for the real-time clock has been turned off so the power consumption is the lowest. The real-time clock continues to operate so the time is 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 GPS has started positioning and the Low Power mode has been selected as the operation mode, the receiver state is being selected automatically to minimize the power consumption.

Operation modes

There are three operation modes in the positioning, and they can be specified using the @GSOP command. These operation modes can be switched during operation.

Normal

In this mode, all the GPS-related circuits are activated, and the positioning operation is performed continuously. In this mode, the GPS circuits and positioning processing are operating so the power consumption is the highest but the performance is also the highest.

The Sleep time can be specified only when the Normal mode has been selected. Operation transfers to the Sleep mode only for the specified time with each positioning cycle, and the positioning operation is performed continuously for the remaining time of the positioning cycle.

Low Power

In this mode, the positioning operation is performed at a low level of power consumption. Once the satellites are picked up and positioning starts, some of the GPS circuits are set to OFF, and operation is performed intermittently at a low level of power consumption. If the positioning has failed or the number of satellites has decreased, some of the GPS circuits are set to ON, and the positioning operation is performed continuously.

Normal mode

The RYS8830/RYS8833 works continuously with all GPS circuits activated and outputs NMEA sentences with the specified period by @GSOP as shown in Fig. NMEA sentence is output immediately after the first fix, then NMEA sentence is output with the specified period again from that point.

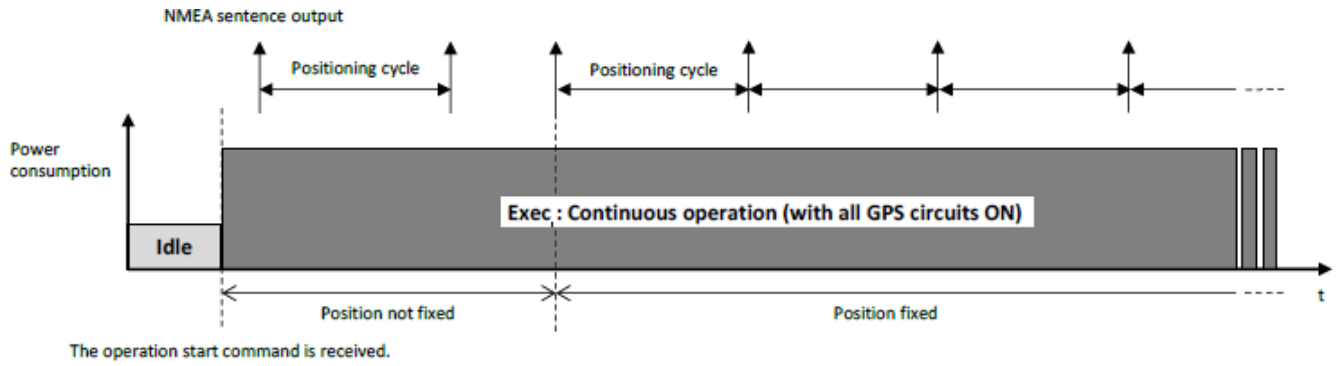
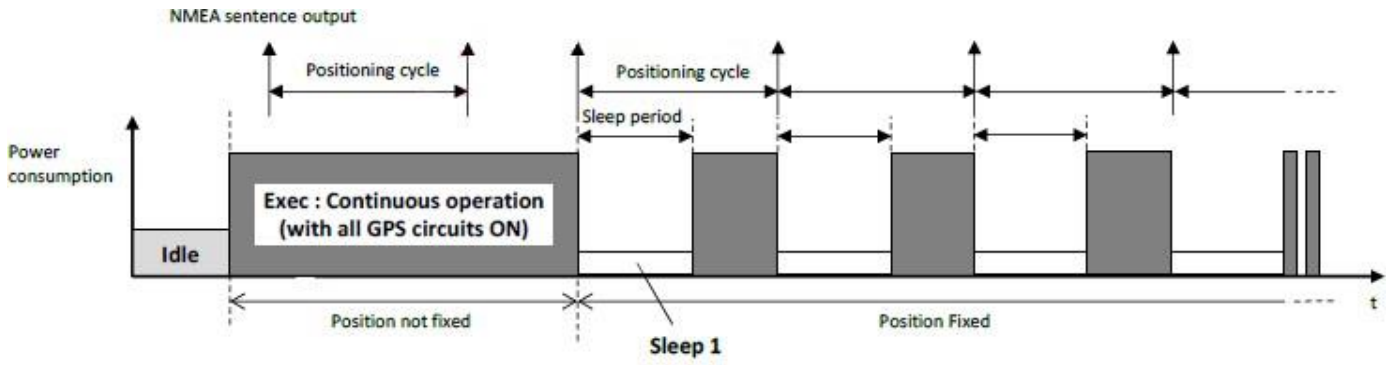


Fig. The operation sequence of Normal mode

When the Normal mode is selected and the other than "0" is set to sleep time of @GSOP, the RYS8830/RYS8833 works intermittently. The RYS8830/RYS8833 enters the Sleep state in specified time periodically and works at the Exec state in the rest of the time.
When the time subtracting sleep time from positioning cycle (that is operating time) is under 60sec, the RYS8830/RYS8833 continues to work at the Exec state until position fixed as shown in Fig. When position is not fixed in the middle of operation, the RYS8830/RYS8833 also continues to work at the Exec state until position fixed.



operation sequence of Normal mode with sleep (operating time is under 60sec)

On the other hand, when the operating time is equal or more than 60sec, the RYS8830/RYS8833 works by alternating between Sleep and Exec in the specified period as shown in Fig

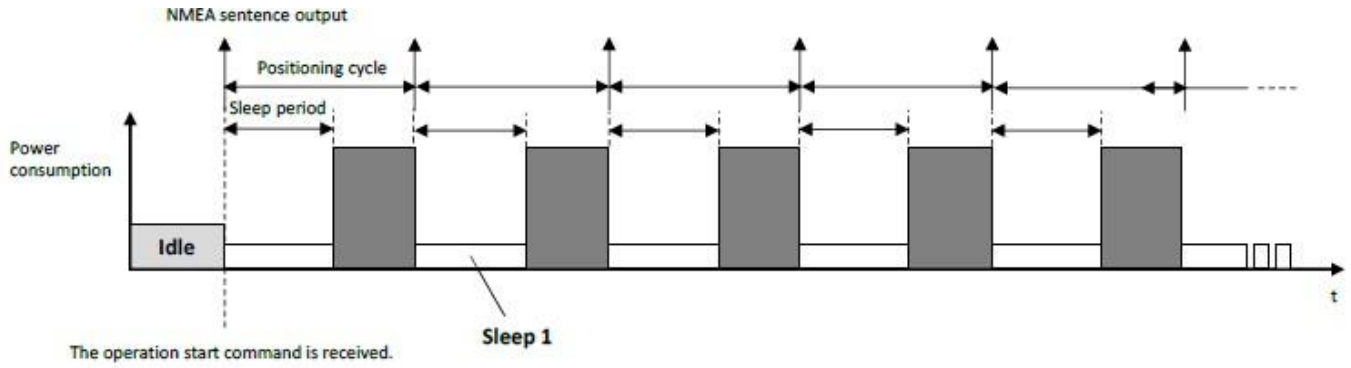


Fig The operation sequence of Normal mode with sleep (operating time is equal or more than 60sec)

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Low power mode

The RYS8830/RYS8833 works intermittently and achieves low power consumption.

At the beginning, the RYS8830/RYS8833 works at the Exec state continuously for acquisition the satellites and positioning. The RYS8830/RYS8833 works with some GPS circuit activated / not- activated depending on the conditions of positioning and receiving signals in this period. When the position is fixed and the condition of receiving signals reaches a certain level, the RYS8830/RYS8833 transits to the intermittent operation and achieves low power consumption.

The actual operation of intermittent operation varies according to the positioning cycle. When the positioning cycle is under 30sec, the RYS8830/RYS8833 works by alternating between Exec (500ms) and Sleep (500ms) with a period of 1sec as shown in Fig. Some GPS circuits are not activated during the Exec state of this intermittent operation. The interval of NMEA sentence output is the positioning cycle period as specified by @GSOP.

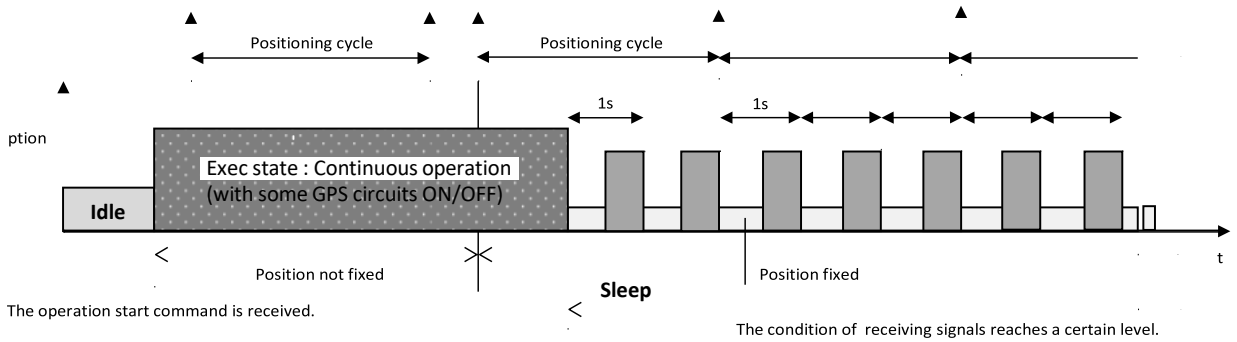

Fig.The operation sequence of Low Power mode (positioning cycle is under 30sec)

When the positioning cycle is equal or more than 30sec, the RYS8830/RYS8833 works by alternating between Sleep (the positioning cycle – 15sec) and Exec (15sec) with a period specified by @GSOP as shown in Fig. When the condition of receiving signals reaches a certain level for the first time, the RYS8830/RYS8833 transits to the intermittent operation by alternating between Sleep (500ms) and Exec (500ms) until the next period of positioning cycle

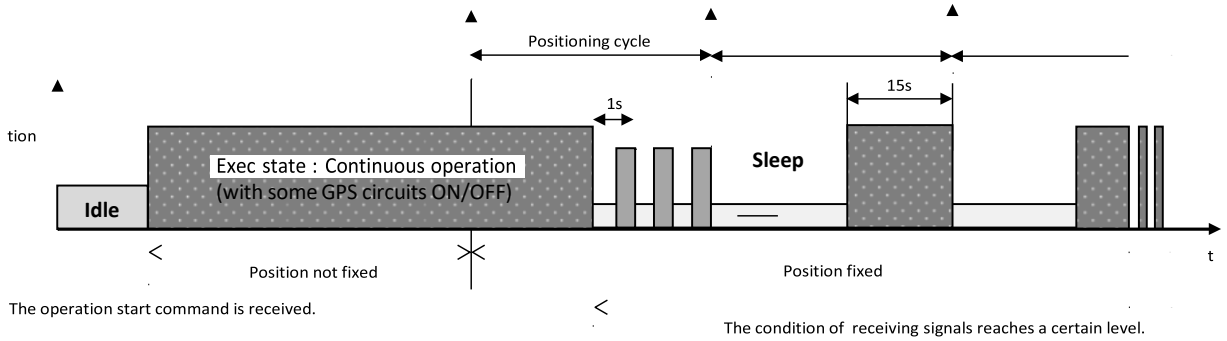

Fig. The operation sequence of Low Power mode (positioning cycle is equal or more than 30sec)

When position is not fixed in the middle of the intermittent operation, the RYS8830/RYS8833 works at the Exec state and tries positioning a certain period of time to avoid failing positioning forever.
In the case of the positioning cycle being under 30sec, when the position if fixed and the condition of receiving signals reaches a certain level, the RYS8830/RYS8833 transits to the intermittent operation as shown in Fig. In the case of the positioning cycle being equal or more than 30sec, when the position is fixed and the condition of receiving signals reaches a certain level, the RYS8830/RYS8833 transits to the intermittent operation with changing Sleep (500ms) / Exec (500ms) until next period of positioning cycle and transit to the usual intermittent operation after that as shown in Fig.

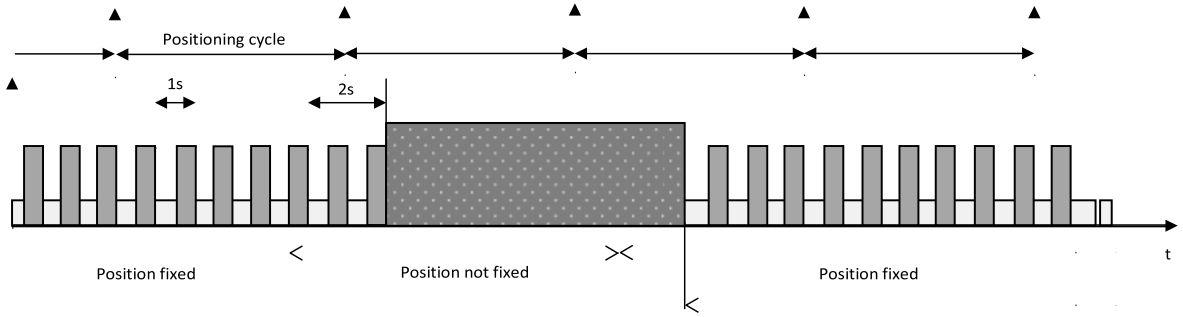

Fig. The case of position not fixed in the middle of Low Power mode (positioning cycle is under 30sec)

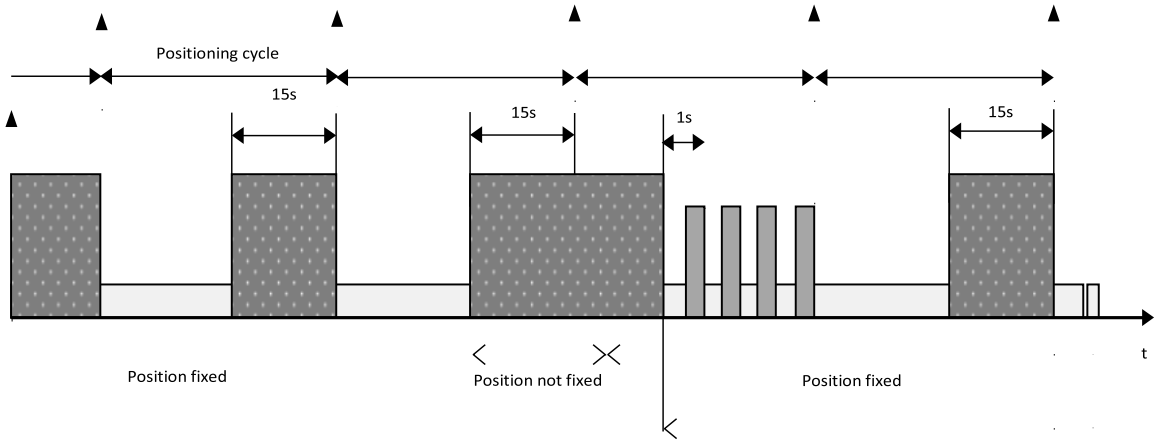

Fig. The case of position not fixed in the middle of Low Power mode (positioning cycle is equal or more than 30sec)

Only in the case of the positioning cycle being under 30sec, when the condition of receiving signals becomes bad, the RYS8830/RYS8833 works at the Exec state a certain period of time even if the position is fixed. The RYS8830/RYS8833 continues to work at the Exec state until the condition of receiving signals reaches a certain level.

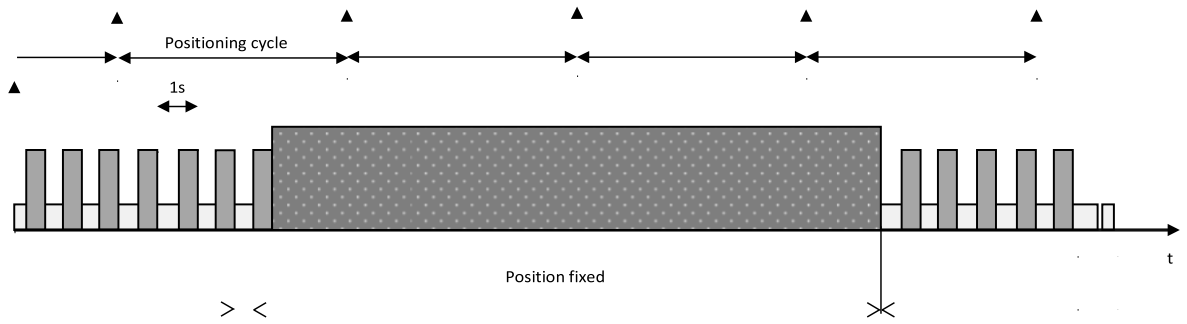

Fig.The case of the condition of receiving signals becomes bad (positioning cycle is under 30sec)

ERROR codes

When the RYS8830/RYS8833 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.
-79	-EOVERFLOW	Internal error
-132	-ENOBUFS	Internal error
-143	-ESHUTDOWN	Internal error
-145	-ETIMEDOUT	The command failed due to a timeout.
-151	-ESTALE	Internal error