

ACC-515

(GPS Module for SD-160 Series)

Technical Manual

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Maxon Telecom Co., Ltd

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1. Introduction

As one of methods to satisfy various requests for user, SD-160 Series (hereinafter called SD-160) basically supports GPS data treatment. That might help your easy implementation for GPS related system. Nevertheless, if it's not enough for your each application, received position data from GPS module of SD-160 can be reprocessed by your own application. ACC-515 is GPS module for SD-160, which releases some of 11 different output data according to NMEA-0183 format. Output data from ACC-515 can be also selected by user, but it should be processed by user's application. More detail information for program of GPS will be described in each chapter.

Received data from ACC-515 will be released via DB-15 connector of SD-160 or/and transmitted to other system through installed modem option board. User can utilize this for following applications:

- a. To check if a vehicle is inside or outside a fence
- b. Timed position reports
- c. Vehicle tracking system

SD-160 offers two methods to handle received data from installed GPS receiver. One is automatic GPS data transmission by programmed schedule, the other is manual control through serial command. In case of automatic GPS data transmission, user easily sends position data to other radios or base station every scheduled time by programming a few parameters. It doesn't need additional equipment to control radio.

In manual control, user can directly control GPS by serial commands regardless of programmed parameters. So, it provides maximum flexibility for application of GPS receiver. In this case, GPS can be controlled by user's own program, but additional equipment to input serial commands into radio is needed. Therefore, user should select proper operation mode for GPS control according to his applications.

To assist development of applications for user, this document provides an application information for ACC-515 and introduces many functions for GPS control of SD-160.

2. Installation of ACC-515

To install ACC-515 in SD-160, this chapter explains, step-by-step, how to disassemble radio, set ACC-515 and reassemble radio.

Important

Before disassembling and reassembling the radio, wear a conduction wrist strap to prevent any components on its main board from being damaged by electrostatic discharge.

Opening the Upper Cover :

1. Unfasten the four mounting screws located on the bottom cover of the radio.

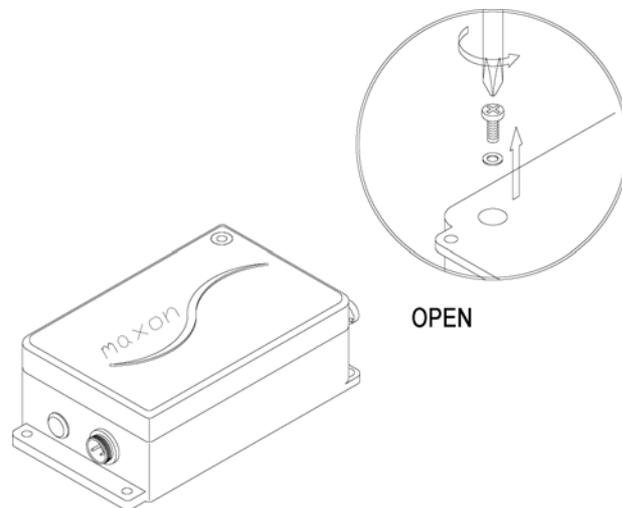
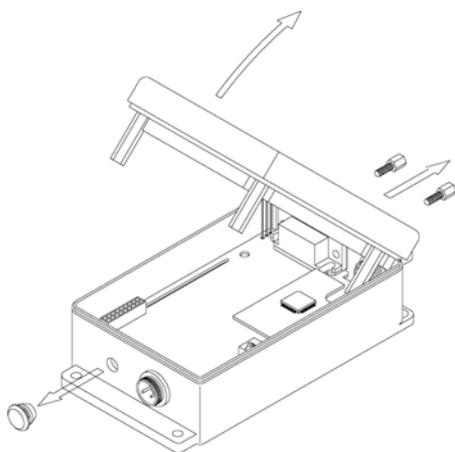


Figure 2.1. Loosing the four mounting screws



2. Eliminate a rubber lid from hole of GPS ANT. connector located on the beside of the power connector.
3. Unfasten the hexagonal screws from DB-15 connector.
4. Open slowly the upper cover from the side of power connector

Caution : Do not open the upper cover from the side of DB-15 connector.

Fig 2.2. Opening the upper cover

Removing the Digital Board :

1. Loosen the mounting screw located on the left side of digital board.
2. Remove two wires between power connector and digital board.
3. Pull digital board out of bottom cover.

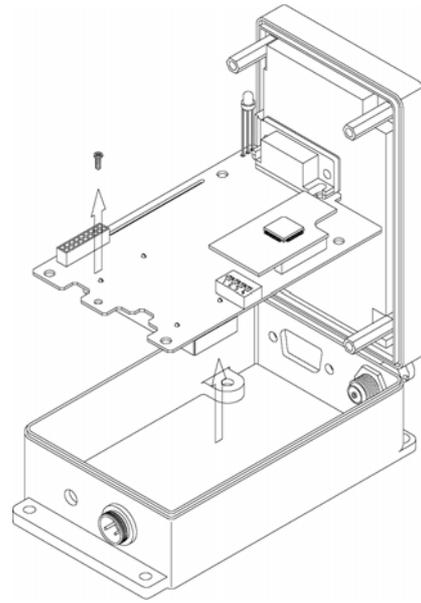


Fig 2.3. Pulling out digital board

Installation of ACC-515 :

1. Insert ACC-515 into the digital board.
2. Solder all of contact points between ACC-515 and digital board. (11 points)

Note : Maintain parallel distance between ACC-515 and digital board

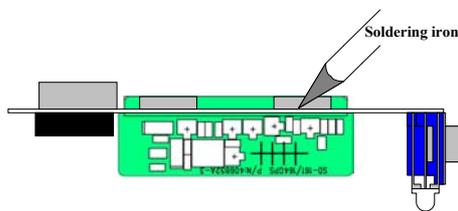
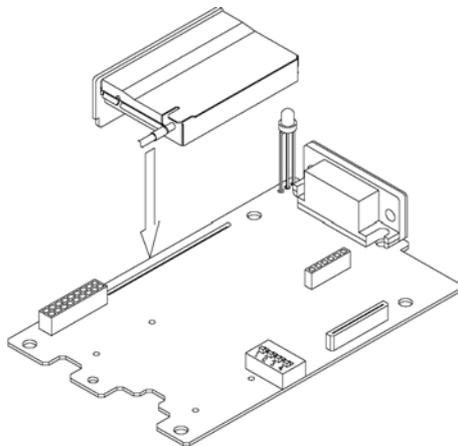


Fig 2.3. Installation of ACC-515

Reinstalling the digital board :

1. Insert the digital board into the bottom cover.
2. Insert screw into the digital board.
3. Insert GPS ANT. connector into the washer and then put in the hole located on the beside of power connector.
4. Fix GPS ANT. connector with hex nut.

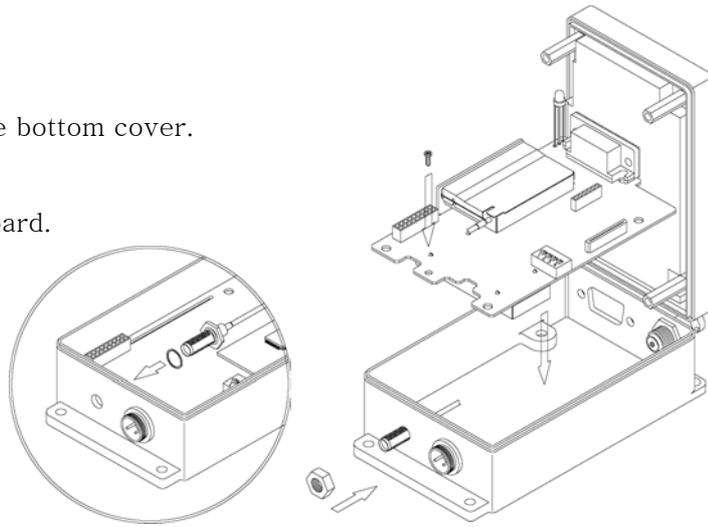
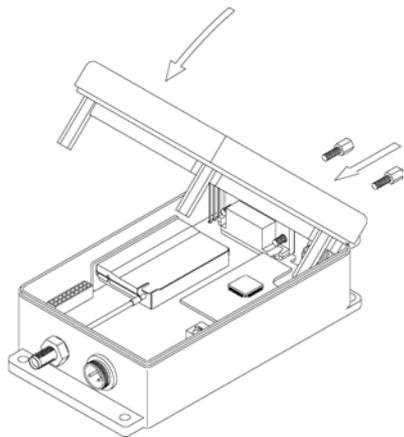


Fig 2.4. Reinstalling the digital board



Closing the Upper Cover :

1. Align the upper cover with the bottom cover.
2. Close the upper cover.
3. Insert the hexagonal screws onto DB-15 connector.

Fig 2.5. Closing the upper cover

4. Screw down the bottom cover of the radio.

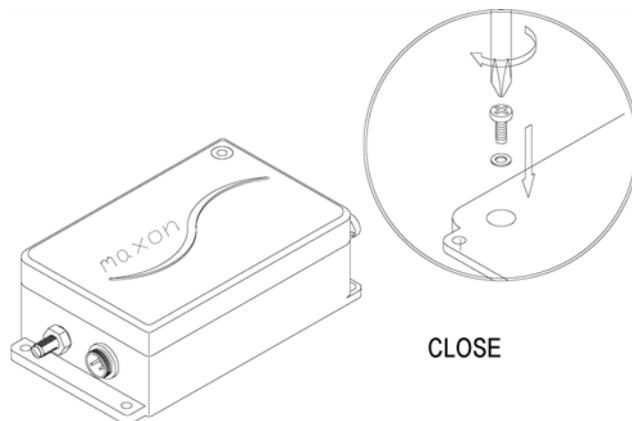


Figure 2.6. Inserting the four mounting screws

3. Theory of operation

This chapter will describe two methods about GPS data handling of SD-160. In case of Automatic GPS data transmission mode, simplest use of GPS will be given for user. In manual control mode, direct control for GPS engine by user is available, which means that SD-160 can provide proper solution for user own GPS system according to their applications. Each mode is determined by radio programming software (ACC-916). If you check on GPS option box in System/GPS option window of ACC-916, automatic GPS data transmission mode will be active. Otherwise, manual control mode will be applied to control GPS. But, GPS control by serial commands is also available even if automatic GPS data transmission mode is active.

3.1. Automatic GPS data transmission mode

This mode is useful when application needs timed position reports. It can be easily performed by programming a few parameters to control GPS receiver. Each parameter is the following.

- a. Data delay time (GPS start time)
- b. GPS Data release time
- c. GPS Data transmission cycle

Data Delay time

The GPS receiver works by triangulating its position in relation to the satellites, by solving for four unknowns: direction X, direction Y, direction Z, and time. Hence, certainly at start-up, the receiver will want four satellites in a good geometry to achieve a 3D fix. Here is where we need a brief aside.

For the sake of brevity we will talk of lock as being when the receiver knows where the satellites are, can see them with a good geometry (good triangulation) and hence calculate its position.

There are different times quoted for the time to achieve this lock: cold, warm and hot (often shown as time to first fix).

- Cold is generally meant as when the receiver has no idea where it is, what time it is and has no extra details like its almanac.
- Hot may be taken as re-acquiring lock, i.e. the receiver had a known position but has lost a few satellites (they have moved out of coverage) and is trying to get a new position.
- Warm is somewhere in-between, maybe the GPS receiver was asleep for example, but has valid almanac and ephemeris data.

Original GPS engine for SD-160 releases NMEA-0183 format data every 1sec. from the moment of supply of power. To prevent transmission of invalid position data before lock, GPS data output is controlled by Data Delay time. In other words, position data will be released after an elapse of Data Delay time since power is applied to GPS (GPS Enable). Figure 3.1. indicates detail timing for this parameter.

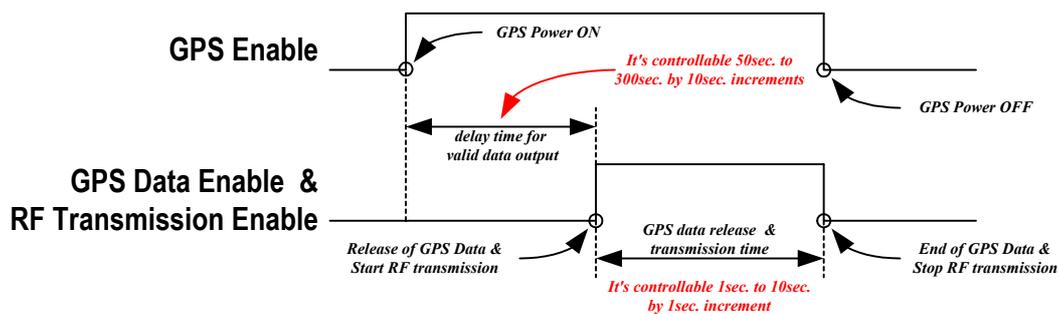


Figure 3.1. Basic timing for manual control mode

Generally, our GPS receiver needs about 40 sec. for cold start, but it's affected by geographical environment. To ensure time margin, it can be programmed from 50sec. to 300sec. by 10sec. increments.

GPS data release time

GPS receiver releases position data every 1sec. after GPS data enabled. It always occupies RF channel if user transmits these data to other radio or system. Therefore, GPS data release time controls outputted data from GPS. It can be programmed from 1sec. to 10sec. by 1sec. increment. Figure 3.1. also shows detail timing for this parameter. After release of position data, GPS receiver enters sleep mode to save power because it consumes too much power in working mode (over 120mA under working voltage). It doesn't calculate position data in sleep mode, but it saves last position data in its memory. If it wakes up to send position data after one transmission cycle, it should follow assigned data delay time like a cold start, but reliability for position data is increased because warm start is processed by saved last position data and so fast re-acquiring lock is achieved.

GPS data transmission cycle

To offer timed position reports, GPS receiver releases position data every programmed time, called GPS data transmission cycle. For this cycle, it works as much as the sum of data delay time and GPS data release time and then enters sleep mode to save power. Figure 3.2. shows detail timing for timed position reports. For reference, to avoid data conflict, GPS receiver doesn't wake up until SD-160 enters stand-by mode if it is receiving or transmitting any information. This procedure is automatically controlled by MCU, so user doesn't need any effort to handle GPS data. GPS data transmission cycle can be programmed from 1hour to 1day by 1hour increment.

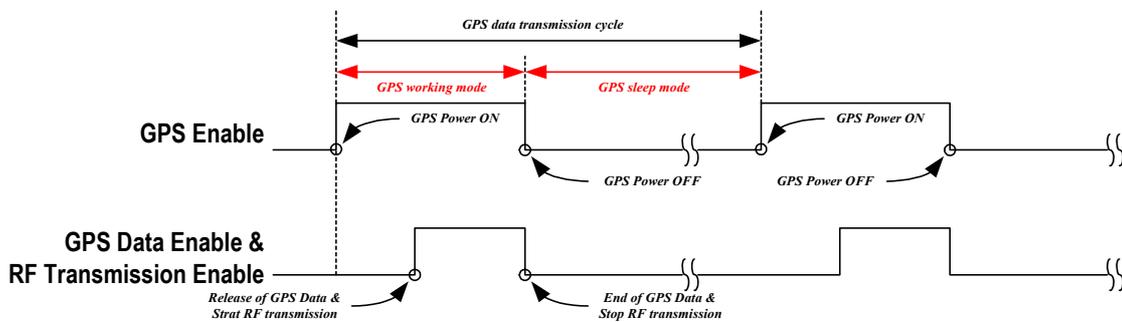


Figure 3.2. Overall timing for manual control mode

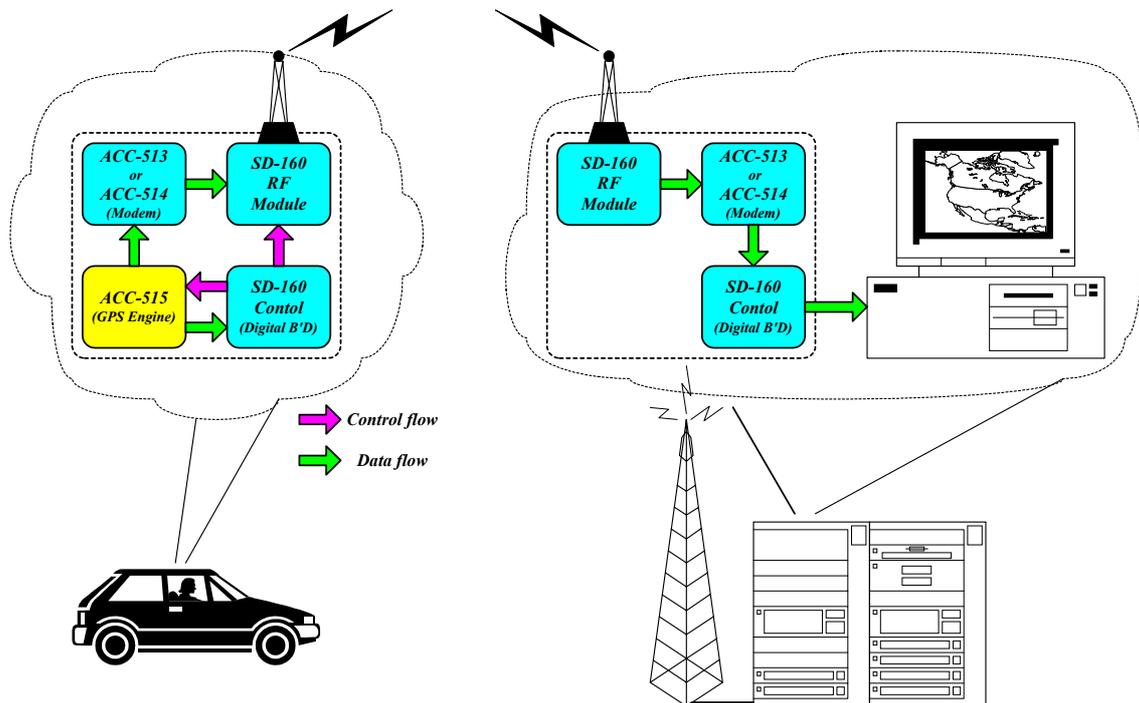


Figure 3.3. Application of Automatic GPS data transmission mode

3.2. Manual control mode

To provide maximum flexibility, SD-160 permits direct control of GPS receiver through serial commands. In other words, if user doesn't want to use automatic GPS data transmission mode, he can control it by his own program. So, SD-160 offers five kinds of serial commands such as GPS Power Enable, GPS Power Disable, GPS Data Enable, RF transmission Enable and GPS Data Disable. User can make his own program by combination of these commands, but additional equipment is needed to input commands. The meaning of each command is the following. But, more detail usage is written in the section of serial command of user's manual.

GPS Power Enable (GPS Enable)

Even though power is supplied with GPS receiver, our GPS module doesn't release position data until the input of GPS Data Enable command.

GPS Power Disable (GPS Disable)

As turning off the power of GPS receiver, last position data will be saved in its memory only if SD-160 doesn't lose power.

GPS Data Enable (External Output through DB15 connector)

Received position data is released and it's available only when GPS is powered. It's offered to control flow of position data because original GPS engine releases NMEA-0183 format data every 1sec from the very moment when power is applied. So, to avoid overload of data handling by continuously released data from GPS, output of GPS can be controlled by this command if there is no reason to monitor position data every time.

RF transmission Enable (available only for above version 1.1)

To prevent RF transmission of invalid position data, this command controls data flow forward input of modem (ACC-513 or ACC-514). In case of firmware version 1.0 of MCU of SD-160, prior function is processed by GPS Data Enable. But, since firmware version 1.1, RF transmission of position data via modem will be controlled only by this command. For your reference, typical elapse times up to first fix (Under no signal loss) for each start case are the following.

Cold start : 40 sec. Typical

Warm start : 33 sec. Typical

Hot start : 8 sec. Typical

GPS Data Disable

This blocks output signal path to stop release of received position data. It's only available when GPS is enabled because signal path for data output is automatically closed when GPS is disabled.

3.3. Use of serial command in automatic GPS data transmission mode

Even if user selects automatic GPS data transmission mode, serial commands is available. But, to avoid conflict with among orders, SD-160 follows some rules according to the status of inputted commands such as the following.

GPS Enable, GPS Data Enable

GPS releases continuously position data until reception of command of GPS data disable or SD-160 is reset. But, this data is only outputted through pin # 15 of DB-15 connector of SD-160 without RF transmission (in case of above version 1.1).

GPS Enable, RF transmission Enable

Position data from GPS is continuously transmitted through RF module until reception of command of GPS data disable or GPS Data Enable.

Note : In case of firmware version 1.0 of MCU of SD-160, position data from GPS are only transmitted through RF module by command of GPS data enable. So, if user only wants to monitor position data using output of DB-15 connector, inner modem should be disabled or LK412 of digital board should be opened.

GPS Enable, GPS Data Disable

Generally, GPS follows automatic GPS data transmission mode. If it is re-enabled after disabled by serial command, all programmed times in MCU are initialized.

GPS Disable, (GPS Data is automatically disabled when GPS is disabled)

GPS doesn't wake up until reception of GPS data enable command or SD-160 is reset.

3.4. Simple applications for ACC-515

To supply various and easy applications for SD-160 series, MAXON has prepared accessories such as ACC-513(GMSK Modem), ACC-514(FFSK Modem) and ACC-515(GPS module). Each accessory can be used individually or together, which will be decided by application for user. This section describes easy application for GPS system.

Simple installment of ACC-515 in SD-160 enables user to monitor their location through external control system such as PDA or Data Equipment Terminal or etc. If external control system of user includes GIS (Geographic Information System) program, released position data from ACC-515 can be easily displayed on the its map (refer to Fig 3.4.). Moreover, in case of application to vehicle location system, SD-160 basically offers time-scheduled position reports as described in automatic GPS data transmission mode. The advantage of this mode is that there is no need for extra circuitry for radio control (refer to Fig 3.3.). But, if this is not proper for user system, user can make his own program by combining serial commands for direct control of ACC-515, which is also offered by MAXON. In this case, external control device for radio control is needed to input serial command and receive its response (refer to Fig 3.4.). This is more expensive and complex solution compared with automatic GPS data transmission mode, but user can obtain additional benefits like the following.

Before transmission, validity of received data from ACC-515 can be identified by external control device.

Received data can be simultaneously used for different applications such as navigation, telematics, control of direction/speed and etc.

Selective transmission for received position data from ACC-515 is possible by reprocessing through user application software. Normally, output of ACC-515 contains lots of unnecessary data, which causes to prolong of transmission time, consequently, frequency occupancy and power consumption are increased. To solve this problem, wanted data can be selected by user application before the transmission and then will be transmitted by modem (ACC-513 or ACC-514). Fig 3.5. describes transmission flow of received position data from ACC-515.

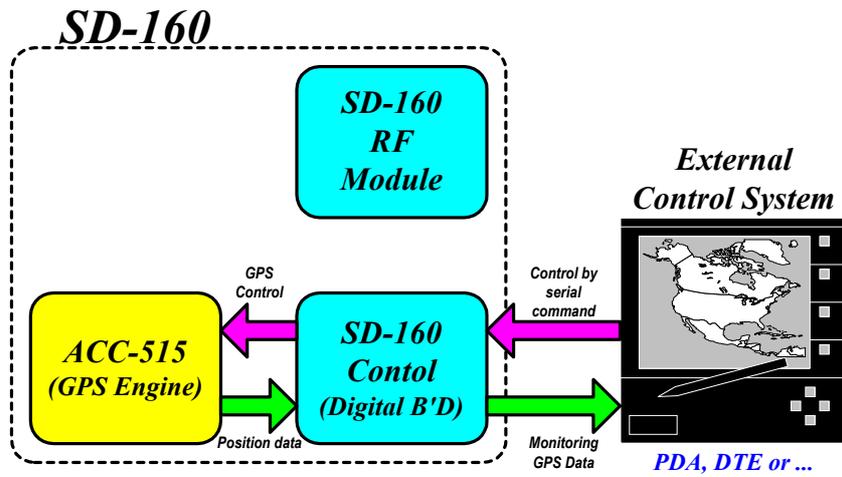


Figure 3.4. Application for navigation system

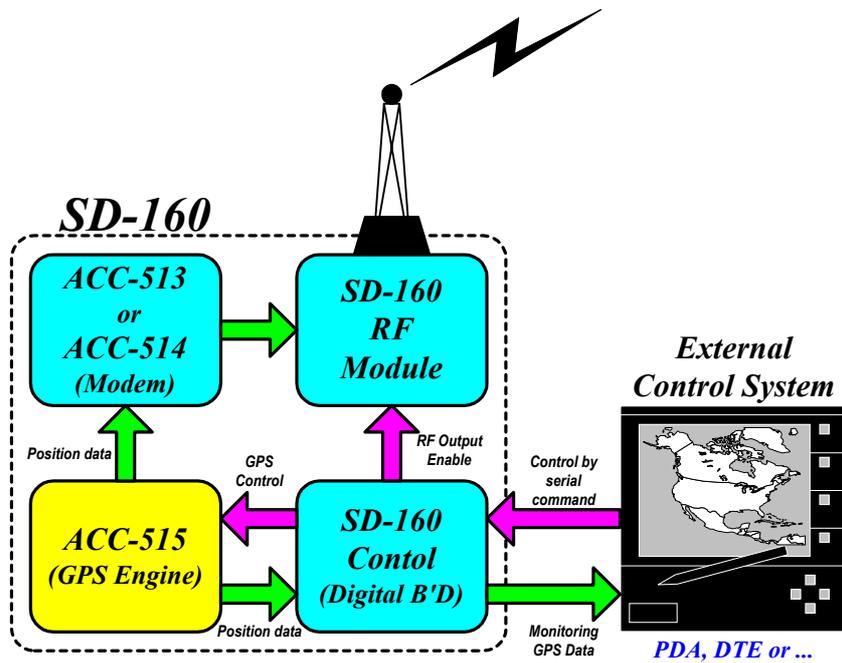


Figure 3.5. Application of full manual control mode

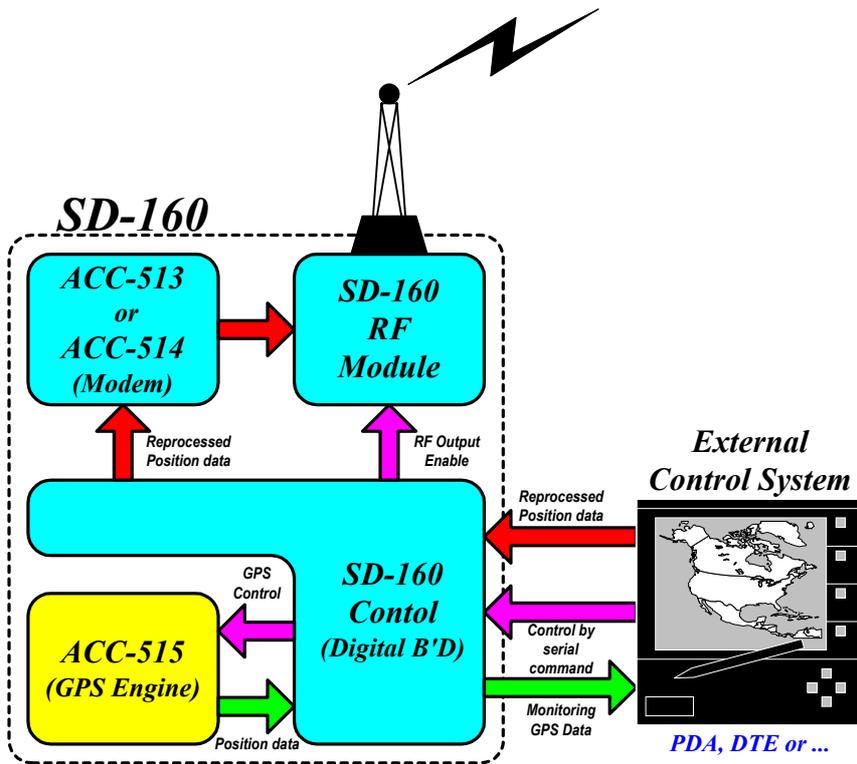


Figure 3.6. Selective transmission for received position data from ACC-515

4. Preparing application test for ACC-515

This chapter describes simple hardware constitution for test of ACC-515 and use of demonstration software which is available by MAXON. You can comprehend the operation of ACC-515 through following up below application test, which will help constitution of your application.

4.1. Installing the hardware

According to user application, required configuration for hardware will be decided. So, the following hardware configuration is only available for the simple test of ACC-515.

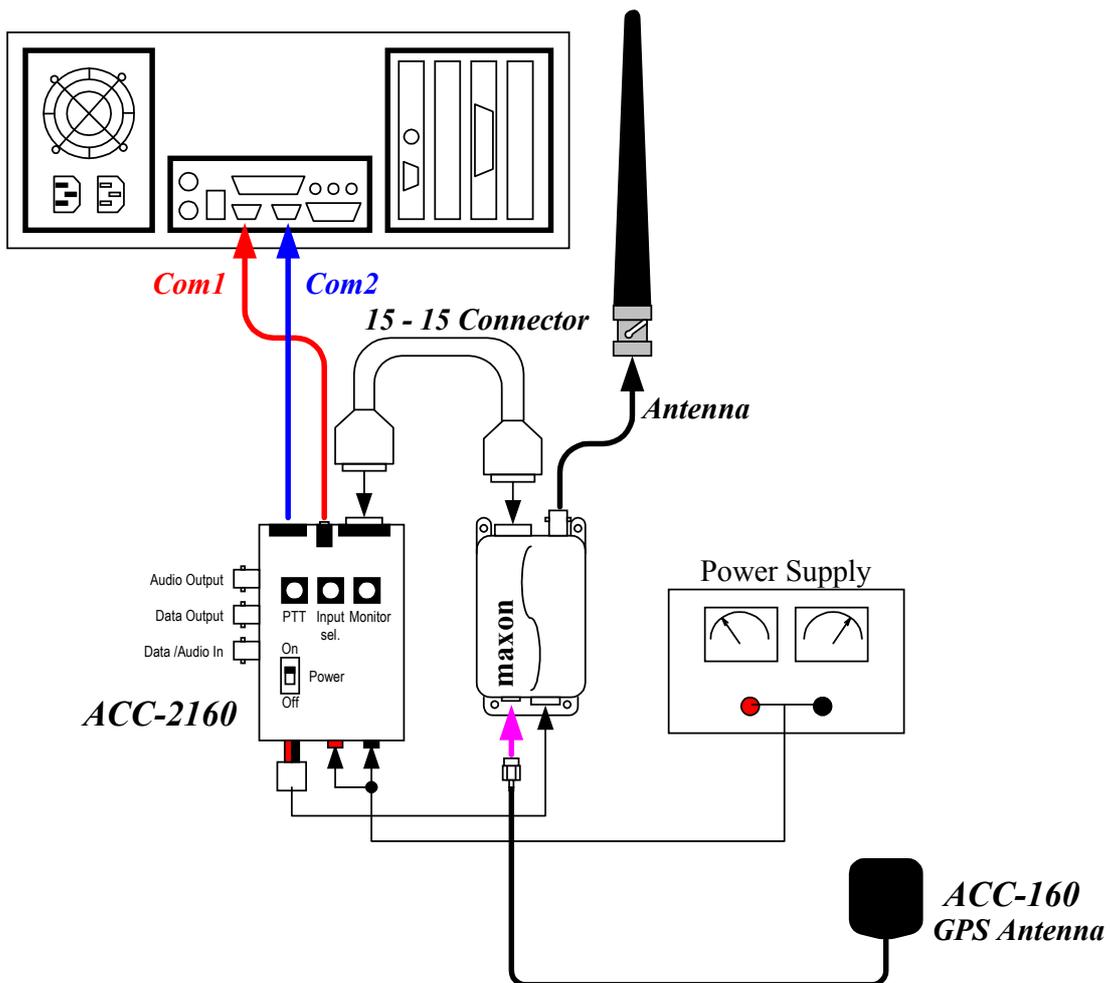


Figure 4.1. Test equipment setup for operation test of ACC-515

ACC-2160 has two RS-232 interface for communication with PC(Personal Computer). One is used for control and program of radio, which is connected to PC through 8-pin modular jack. The other is prepared for GPS to handle NMEA formatted data, which uses stereo jack to connect to PC (Refer to Fig 4.2.).

Caution : “GPS data in/out” port of ACC-2160 should be connected to **communication port1 (Com1)** of PC because GPS data test program, which called “SD-160 GPS test” program, support only COM1 port.

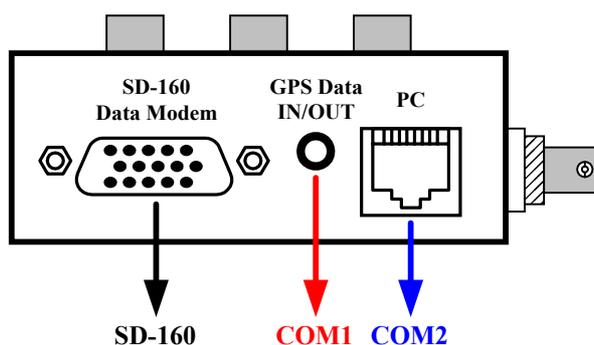


Figure 4.2. ACC-2160 Interface End View

Because ACC-515 is controlled by serial command, easily tested by programming software (ACC-916) which includes some of useful examples for serial command such as squelch & calibration sub-program. To monitor GPS data from ACC-515 and select its contents, MAXON provides “SD-160 GPS test” program. This program displays simultaneously received NMEA formatted GPS data and simple position data decoded from some of that. In addition, input of parameters for GPS is available, which is used for calculation of position data and decision of output format of GPS data. More detail information for parameters for GPS is explained in Appendix B.

4.2. Installing the software

- a. Find “SD-160 GPS test” program at software package for SD-160
- b. Click the Start Menu, the select Run... and type:
D:\WSetup.exe, enter your CD_ROM drive name instead of D:
- c. Close the information box by pressing Enter or clicking on the “OK” button.

- d. The program will then begin the installation process.

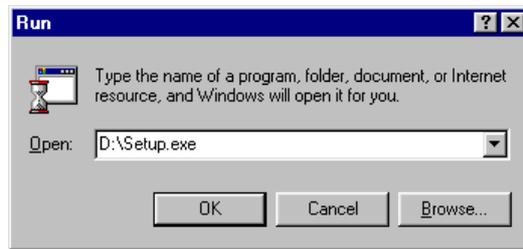


Figure 4.3. Run Setup Menu

- e. Exit all windows programs, then click NEXT.

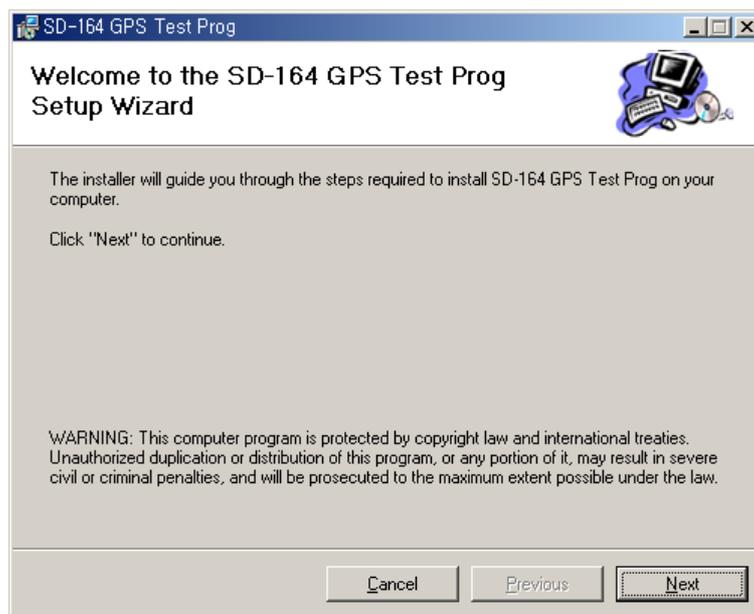


Figure 4.4. Setup Welcome Screen

- f. The “Select Installation Folder screen” will then be displayed. It is recommended that you accept the defaults suggested by the setup program. Click NEXT.

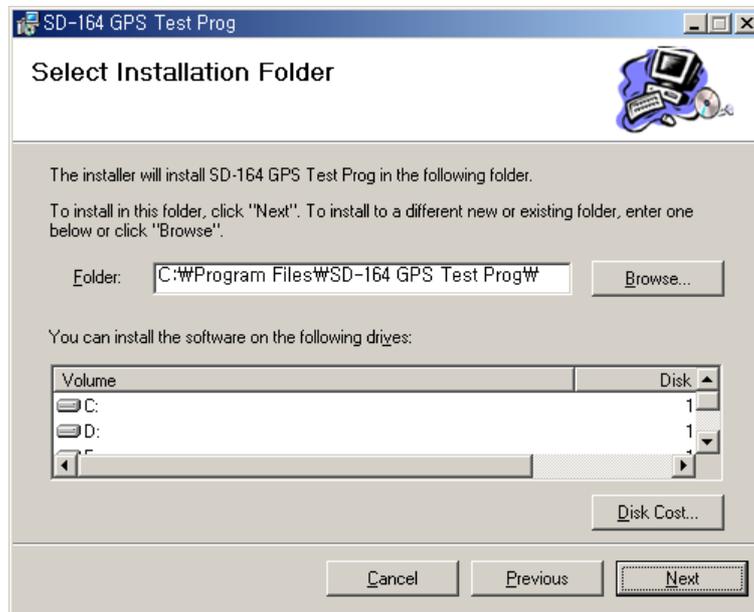


Figure 4.5. Select Installation Folder Screen

- g. The “Confirm Installation” screen will then be displayed. Click NEXT to begin the installation process.

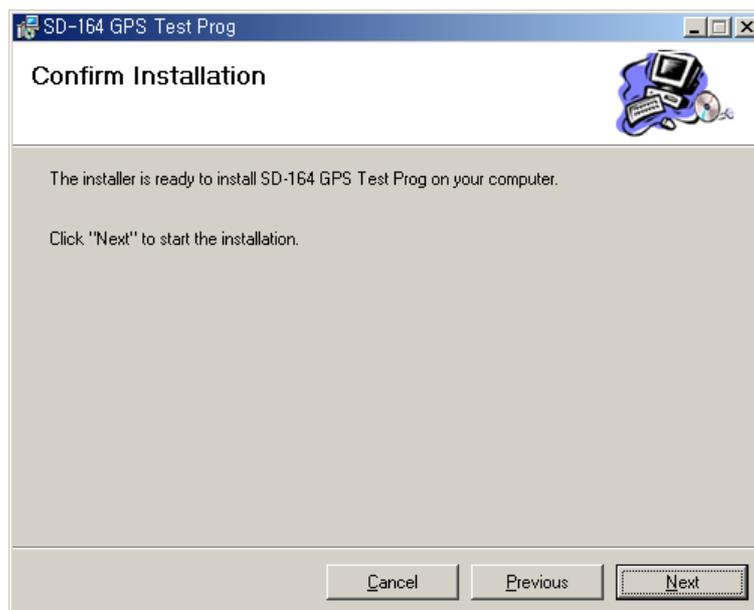


Figure 4.6. Confirm Installation Screen

- h. Wait a few seconds by the end of installing the files.

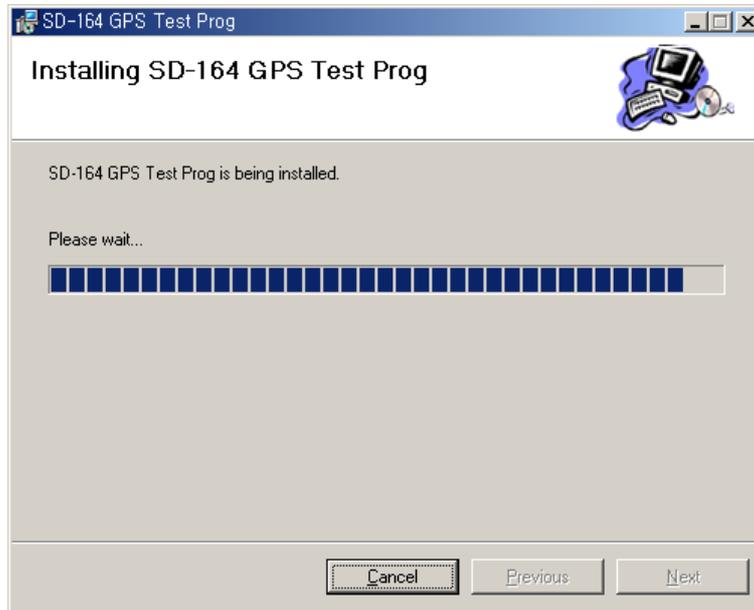


Figure 4.7. Installing the Files Screen

- i. Once Setup has finished installing the files and configuring your computer, the “Installation Complete” screen will then be displayed. Click “Close” to complete the installation and exit the setup program.

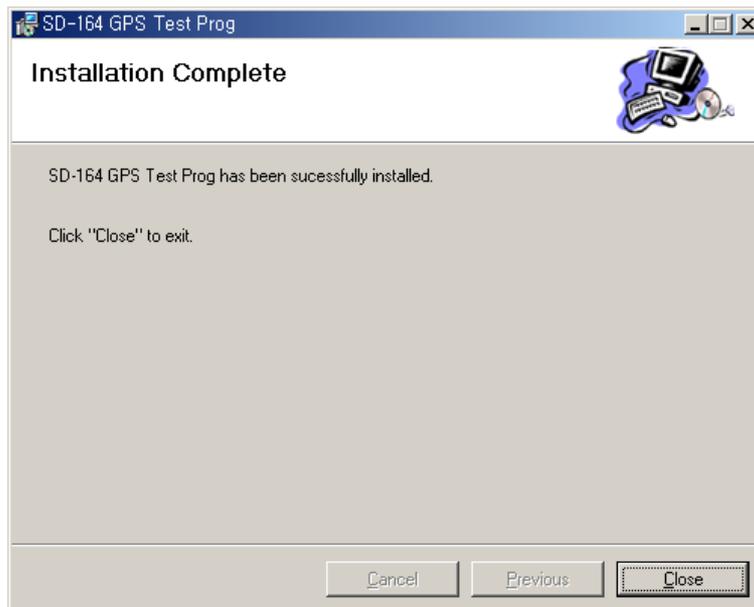


Figure 4.8. Installation Complete Screen

4.3. Getting Started

To start the “SD-160 GPS test” program

- a. Find “SD-160 GPS test” program icon on desktop screen.
- b. Double click that icon, and opening window will appear.

Cautions : “SD-160 GPS Test” program supports only **COM1** port.

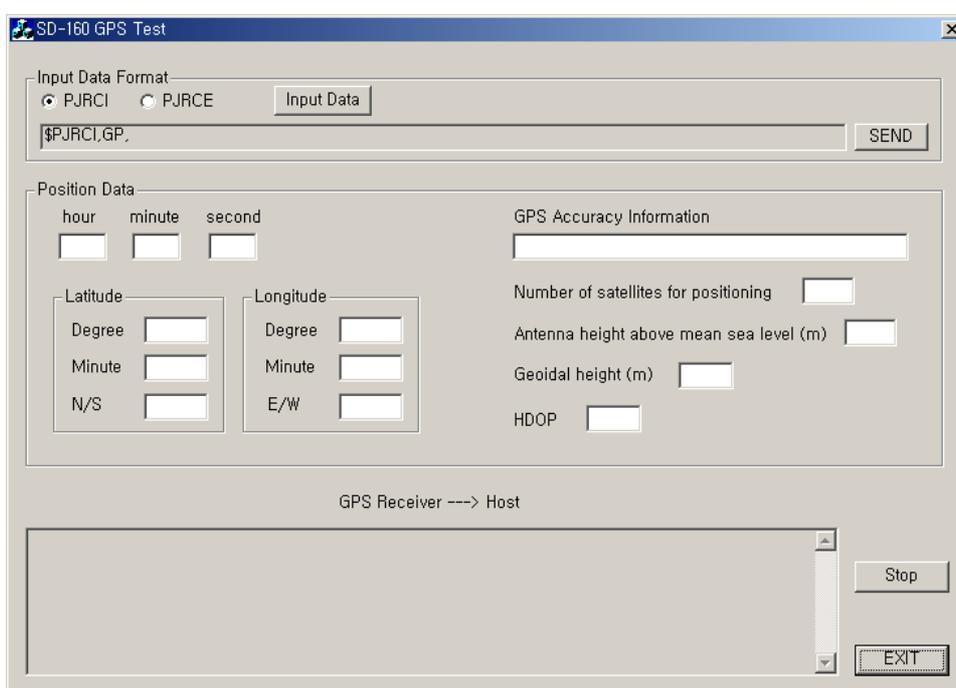


Figure 4.9. Opening Window

Brief explanation for “SD-160 GPS test” program

Opening window of “SD-160 GPS test” program consists of two group boxes and one display window (Refer to Fig 4.10.). In case of Input group box, user can set two sorts of options for basic operation of ACC-515. One is Initial Time & Position Set through PJRCI instruction and the other is Receiver Mode Set through PJRCE instruction. Detail parameters for each instruction will be displayed on Pop-up window if user clicks “input data” button after selecting instruction (Refer to Fig 4.11. and 4.12.). More detail

information for each parameter for PJRCE & PJRCI instruction is explained in Appendix B.

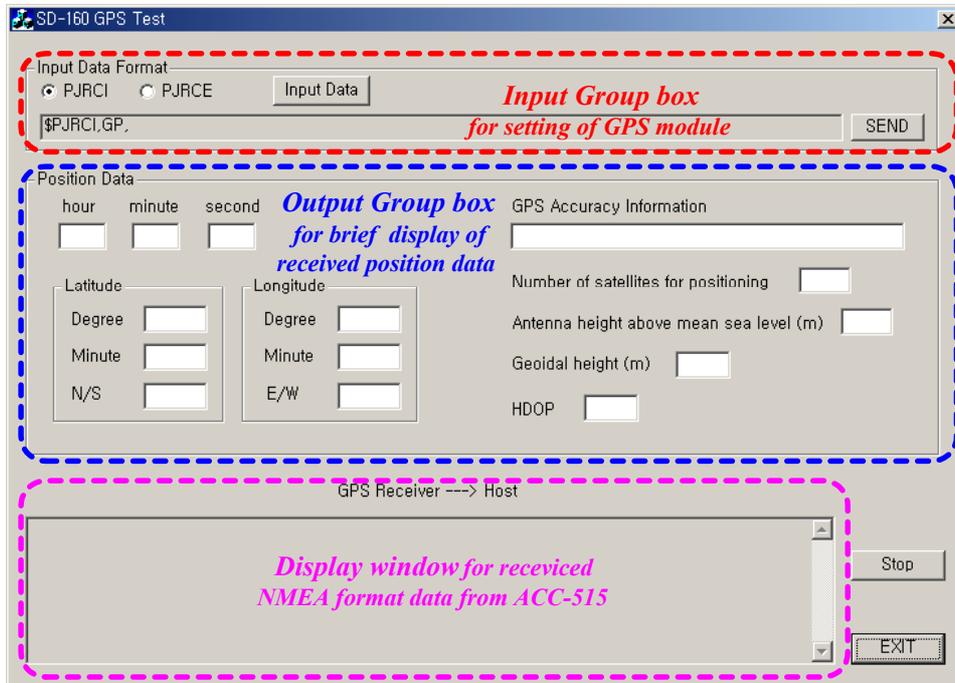


Figure 4.10. Composition of Opening Window

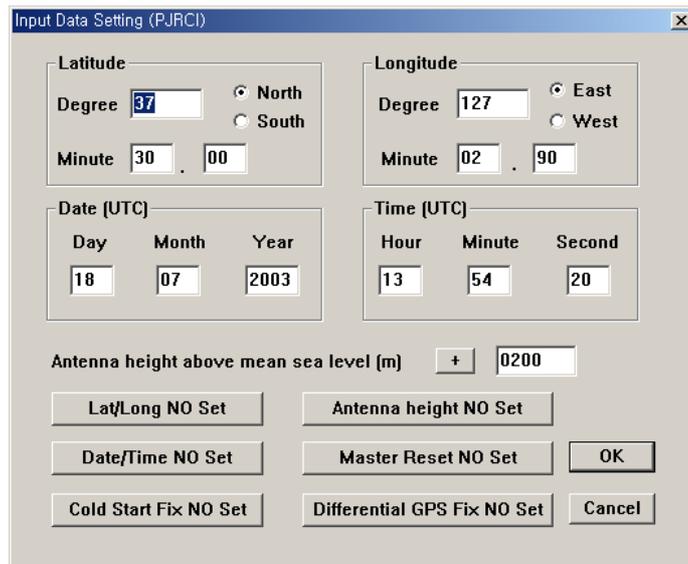


Figure 4.11. Pop-up window for PJRCI instruction

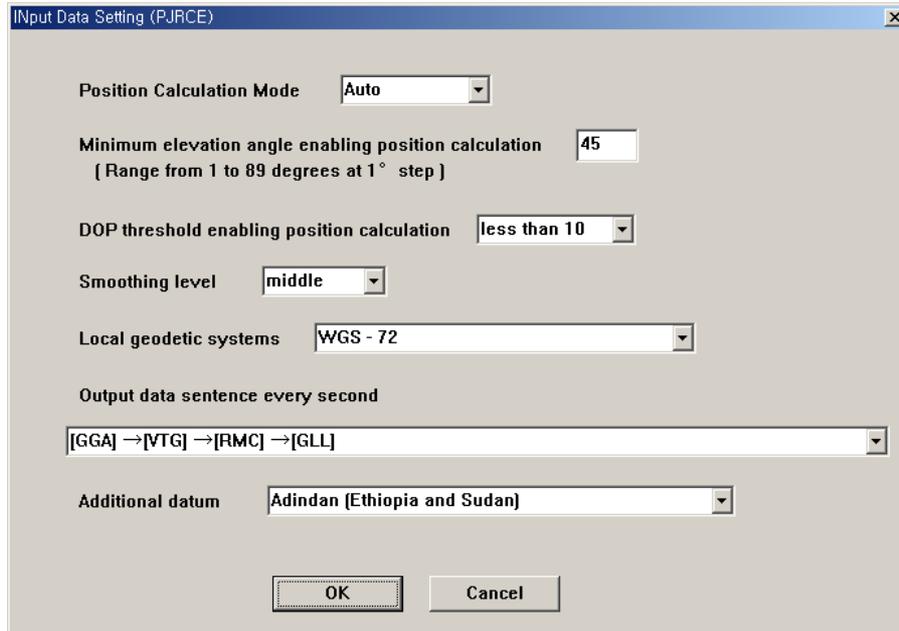


Figure 4.12. Pop-up Window for PJRCE instruction

If you click “OK” button on the Pop-up window after selection for each parameters, complete instruction will be displayed on Opening window. After that, click “SEND” button and then this instruction will be inputted to ACC-515 (Refer to Fig 4.13.).

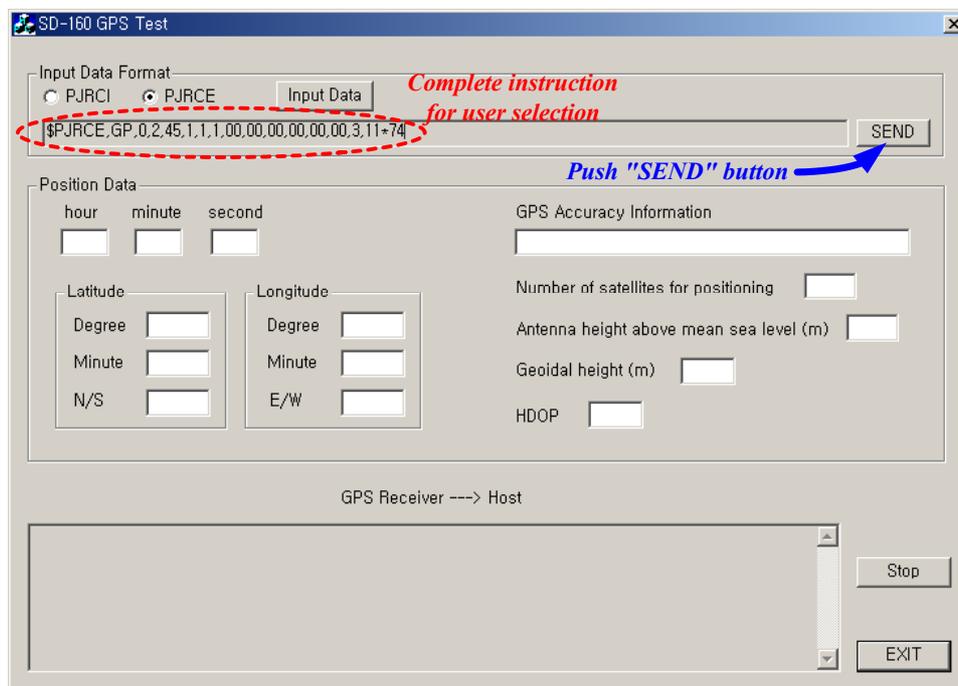


Figure 4.13. Display of full instruction for PJRCE

In case of output group box, simple position data, extracted from GGA data among GPS data, is displayed with several extra information. Especially, GPS Accuracy Information on the output group box notifies whether received data from ACC-515 is valid or not.

In display window, all output data from ACC-515 are displayed on this window. ACC-515 has 11 different output data and one of 8 different combination of them is released every one second. Each combination is selected by “Output data sequence every second” parameter for PJRCE instruction (Refer to 4.12.). More detail information for combination is also explained in Appendix B.

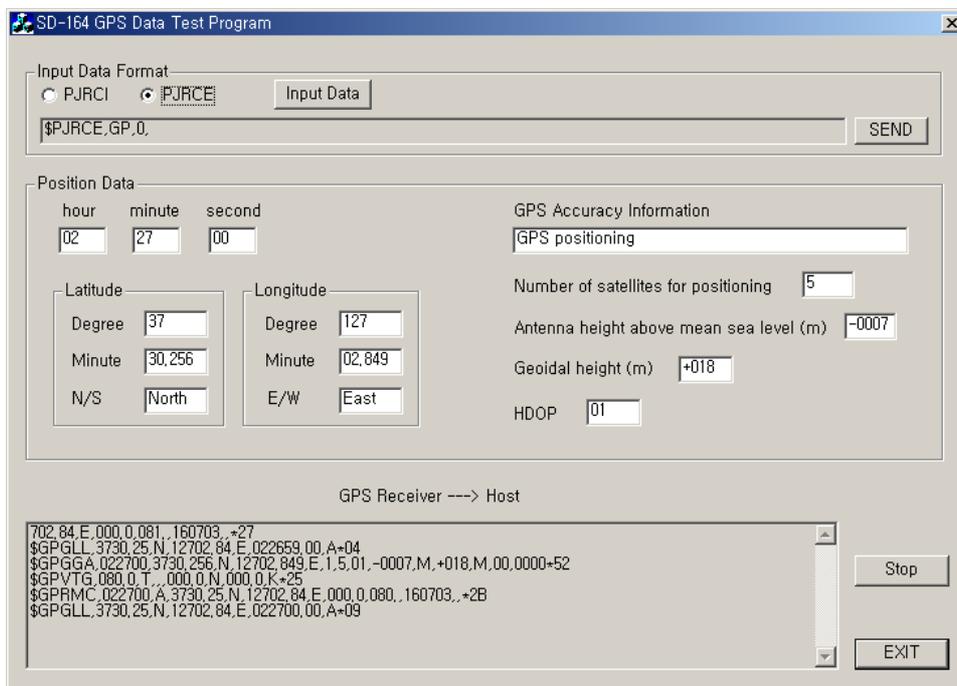


Figure 4.14. Display of Position data and NMEA formatted GPS output

5. Evaluating ACC-515 through application test

This chapter describes simple test procedure for ACC-515 by using ACC-916 and “SD-160 GPS test” program. Additionally, communication test through combination of ACC-513 or ACC-514 and ACC-515 will be explained. User can not only understand overall functions related to ACC-515, but evaluate its performance through these application tests.

5.1. Basic test for ACC-515

Simple test procedure for ACC-515

Make sure that hardware configuration is completed as shown in Fig 4.1 before starting operation test of ACC-515 and connection of communication ports. GPS in/out connector of ACC-2160 should be connected to COM1.

1. Execute “SD-160 GPS test” program.
2. Execute ACC-916 and then select Squelch & Calibration menu (Monitor icon) on the toolbar. Squelch & Calibration window will appear.

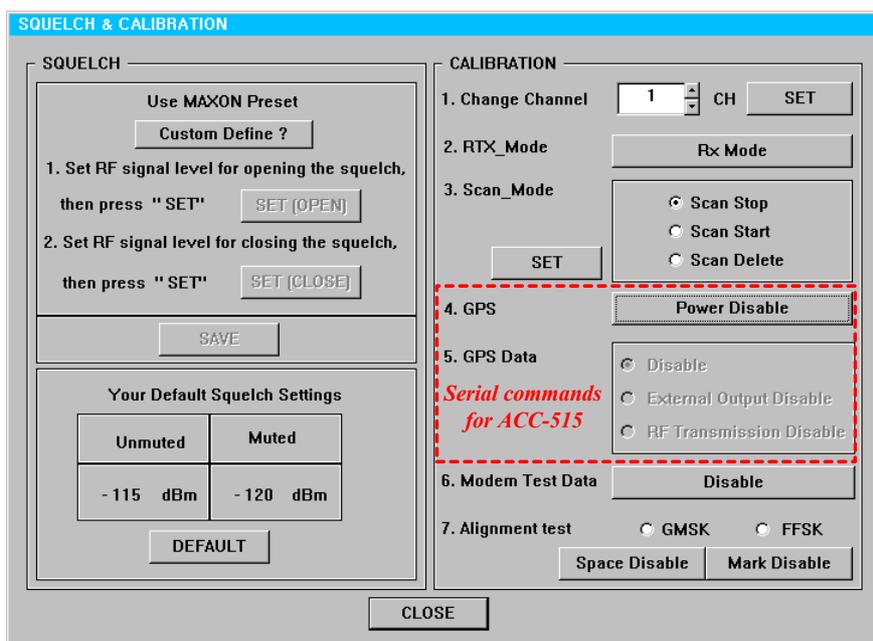


Figure 5.1. Control menu for ACC-515

In calibration group box, Item #4 and Item #5 controls ACC-515 through serial commands.

3. Click the “Power Disable” button of Item #4 and then identify “Power Enable” is displayed on the button. As SD-160 receives this command, power will be supplied to ACC-515.
4. Select “External Output Disable” menu among Item #5 and then identify whether “External Output Enable” is displayed. If SD-160 receives this command, received data from ACC-515 will be released through pin #15 of DB-15 connector.

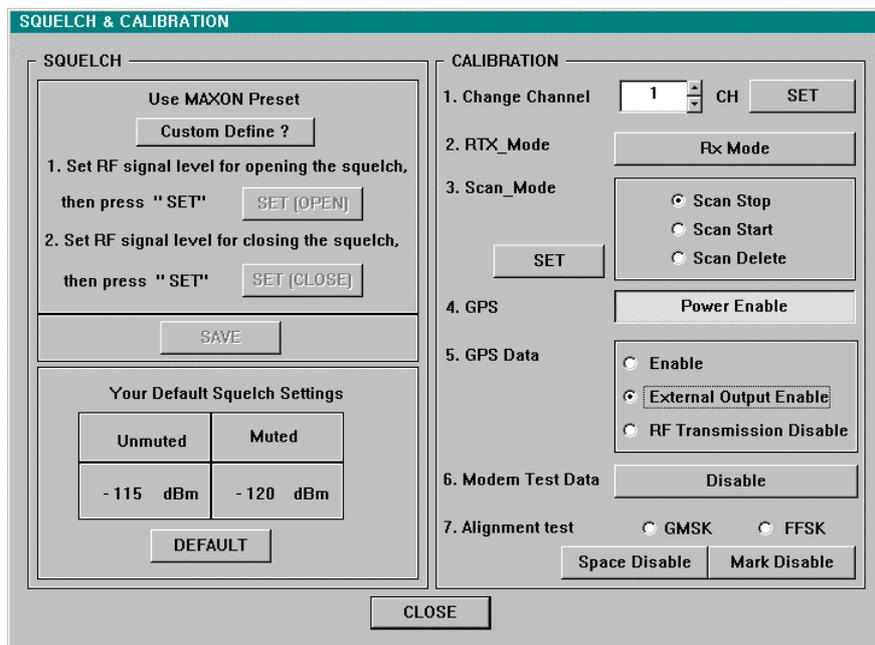


Figure 5.2. Enabled GPS Power and External Output

5. Identify “SD-160 GPS test” program is receiving GPS data from ACC-515.
6. Check the GPS Accuracy Information. If “No positioning or invalid data” is showed, that means current displayed position is not valid.
7. Wait for about 40 sec. because ACC-515 needs average 40 sec. for the cold start.

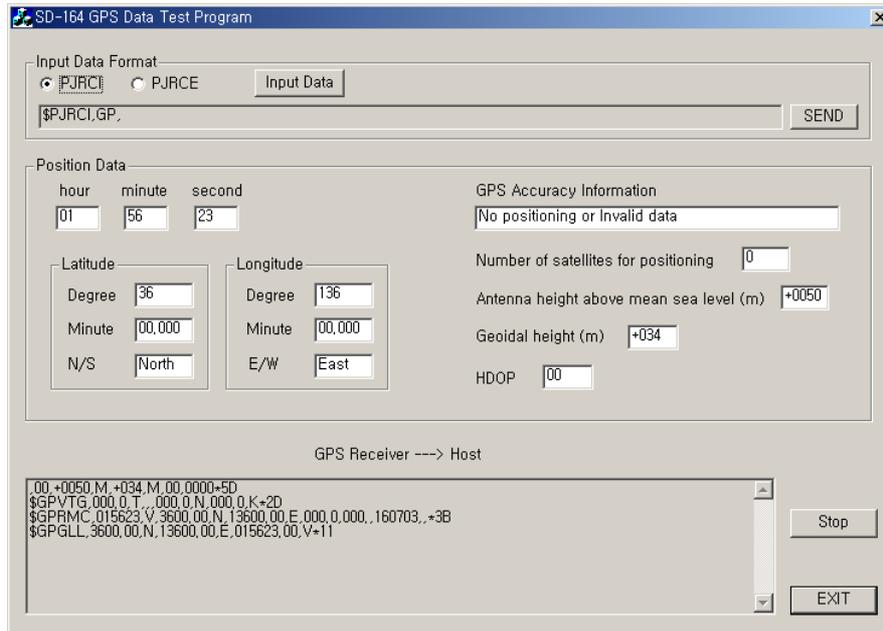


Figure 5.3. Received GPS data (No positioning)

8. After about 40 sec., check again the GPS Accuracy Information if “GPS positioning” is showed, that means current displayed position is available. If the status remains still “No positioning or ... ” over 1 min., check the surrounding environment of GPS Antenna which needs enough open space to see four satellites.

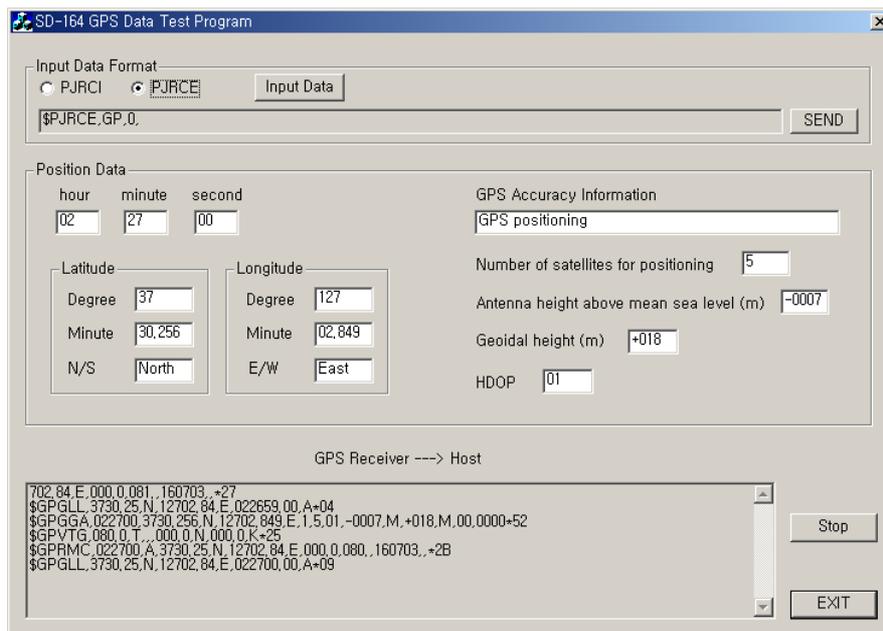


Figure 5.4. Received GPS data (GPS positioning)

As mentioned before, ACC-515 has 11 different output data which is selected by PJRCE instruction. To explain the more specified use of this instruction, GSA and GSV data will be taken in the following as an example. For your reference, GSA and GSV data contain specified information for visible satellites such as DOP(Dilution of Precision), PRN, elevation angle, direction angle and SNR.

9. Select PJRCE instruction on input group box and then click “input data” button. The pop-up window for set of detail parameters will appear.

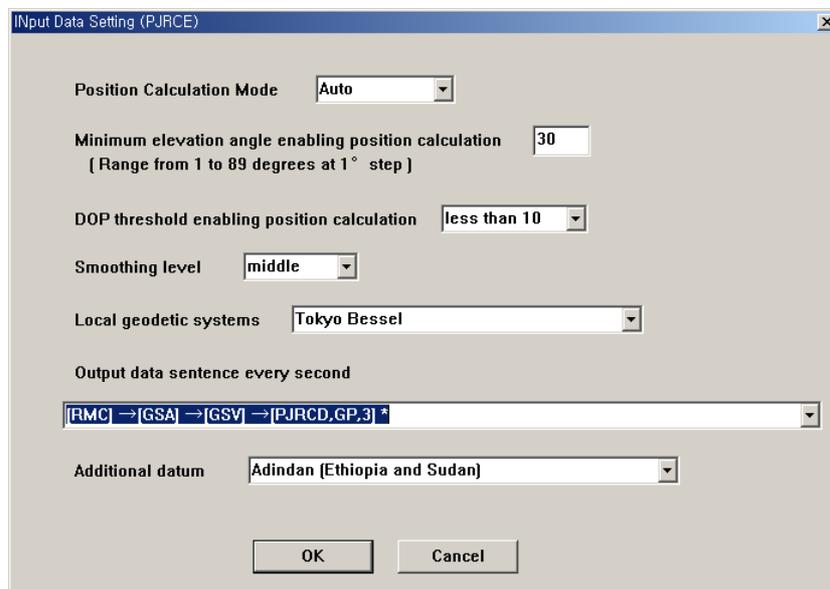


Figure 5.5. Inputted detail parameters for PJRCE instruction

10. Input each parameter referring to Fig 5.5. and Appendix B., and then click “OK” button. The pop-up window will disappear and full instruction for PJRCE will be displayed on input group box. Especially, you should select “[RMC]+ [GSA] + [GSV]+ [PJRCD,GP,3]” as a parameter of “Output data sentence every second”.
11. Verify that the current settings are correct and click “SEND” button to send full instruction.

Win_sats

Win_sats program can be used to check the output from a GPS receiver. It provides a map and reception information on the Satellites which can be viewed. Before use of this program, you should change output data of ACC-515 into “[RMC]+ [GSA]+ [GSV]+ [PJRCD,GP,3]” format (Refer to Fig 5.5).

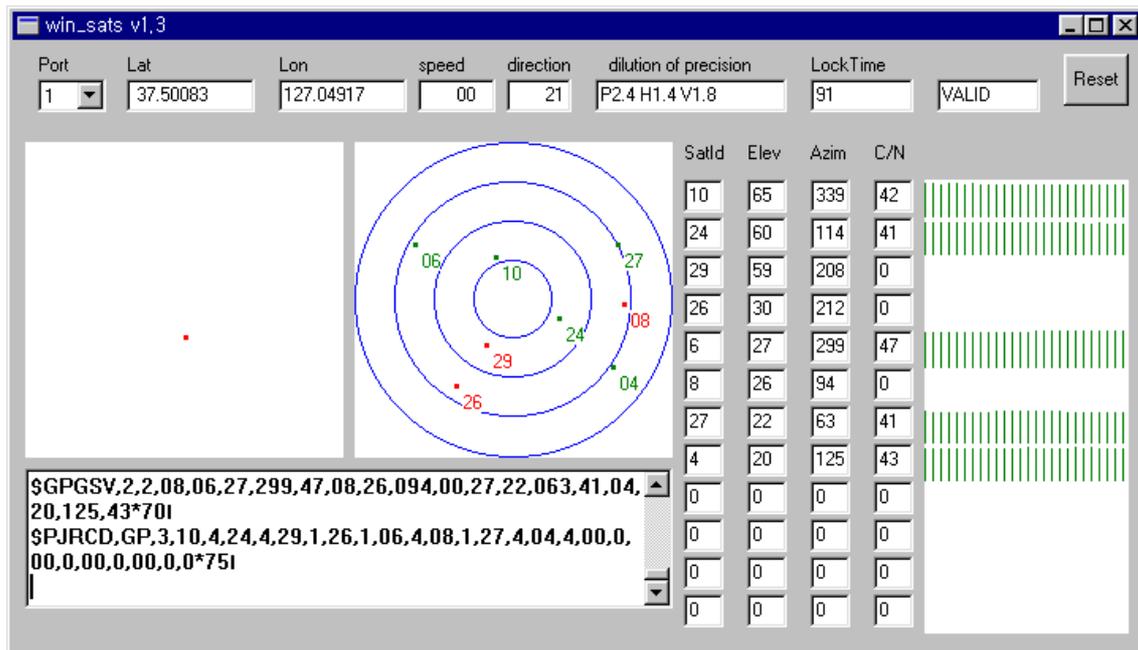


Figure 5.8. Win_sats Screen

The main part of the screen shows a trace as the vehicle moves around. The table in the middle shows the satellite position in Azimuth and Elevation plus the Carrier-to-Noise (C/N) value in decibels (dBs). Where the C/N is shown as 0(dB) this means that the satellite is not currently visible. The last known position is shown. The bar graph on the right-hand side shows the C/N in bar graph form. The window at bottom left shows the NMEA string from the receiver. In the above example, five satellites are currently visible.

For reference, this program is made by Maxon Europe Ltd for DM-200 data radio.

5.2. Test of GPS data transmission through ACC-513 or ACC-514

As introduced in chapter 3, by applying ACC-513 or ACC-514, GPS data from ACC-515 can be transmitted to other radio through RF communication. In other words, GPS data can be one of sources for point-to-point or point-to-multipoint RF data communication. In this case, various configurations for SD-160 are needed according to user application. For instance, if user constitutes vehicle-tracking system by SD-160, two kinds of configuration are required. One is transmitter which contains ACC-513 and ACC-515 and transmits received data from ACC-515 through ACC-513. The other is receiver which contains only ACC-513 and receives transmitted data. But, receiver should be connected to DTE (Data terminal equipment) to constitute host system which analyze received data and display then on the application software.

Consequently, this chapter explains two basic hardware configurations and their evaluation process to help user constitute their application.

5.2.1. Automatic GPS data transmission mode

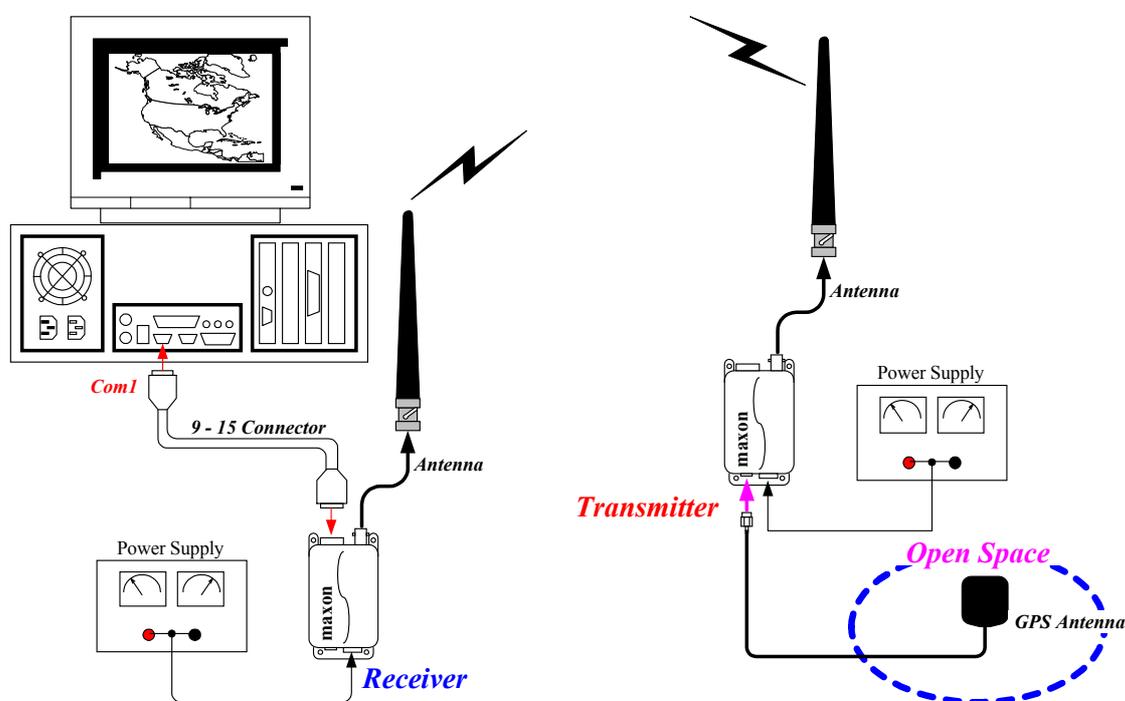


Figure 5.9. Constitution of hardware for Automatic GPS data transmission mode

This operation mode also requires two hardware configurations such as transmitter and receiver. You should install ACC-513 and ACC-515 to transmitter and only ACC-513 to receiver. After that, each radio should be programmed according to its use. Detail procedure for radio programming is as the following.

Programming procedure for transmitter

1. Read data from SD-160.
2. Select “System Option / GPS” Tap on the main window of ACC-916.
3. Check on GPS option box.
4. Input detail timing for Transmission cycle, Data transmission time and Data delay time. (Refer to section 3.1. and Fig 5.10.).

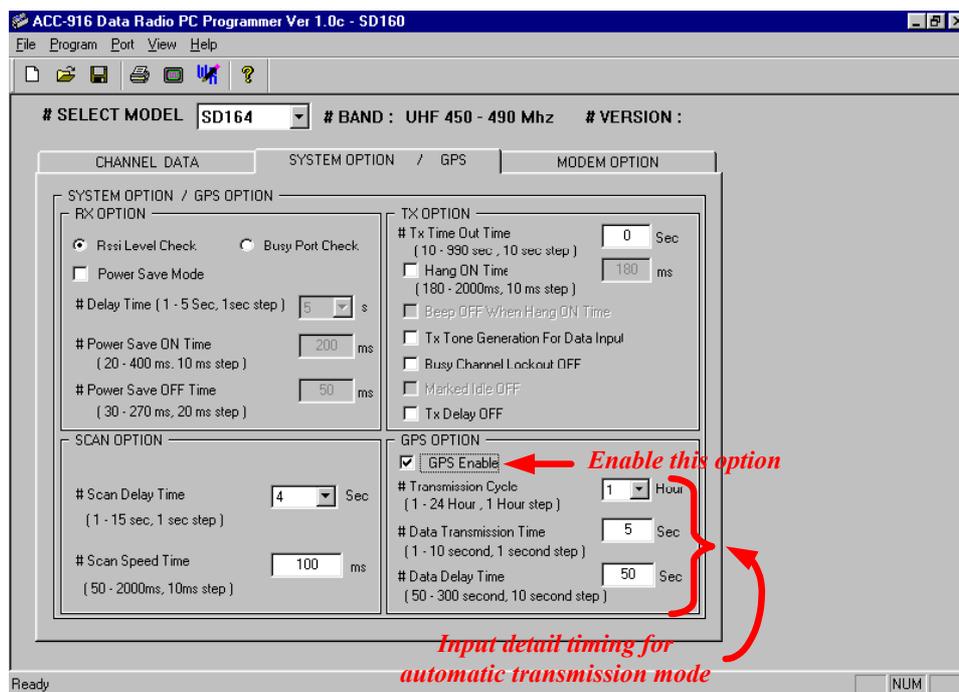


Figure 5.10. Editing GPS Option for Automatic GPS data transmission mode

5. Select “Modem Option” Tap on the main window.
6. Select GMSK if ACC-513 is installed, or select FFSK if ACC-514 is stalled.
7. Click “Modem disable” button and then identify whether “Modem enable” is displayed.

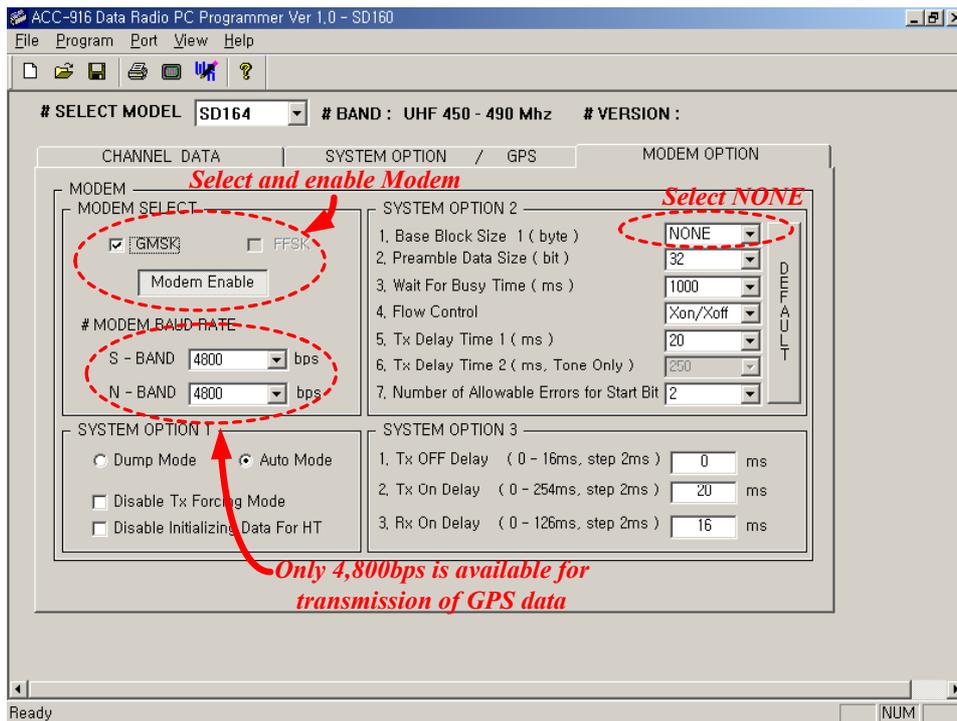


Figure 5.11. Editing Modem option for Automatic GPS data transmission mode

8. Select 4,800bps of modem baud rate.

Note : Only 4,800bps is available for transmission of GPS data.

If ACC-514 is installed, don't transmit GPS data in N-Band(narrow-band) because it's maximum baud rate is 2,400bps in N-Band.

9. Select Auto mode in group box of system option 1.
10. Select "None" of block size 1 in group box of system option 2.
11. Default value for remained options is recommended, but some of those can be changed according to user application.
12. Write data to SD-160.

Programming procedure for Receiver

1. Read data from SD-160.
2. Repeat step 5 ~ 11 of programming procedure for transmitter.
3. Write data to SD-160.

Test procedure for automatic GPS data transmission mode

1. Setup hardware like Fig 5.9.
2. Execute “SD-160 GPS test” program on the DTE (PC) which is connected with receiver through communication port 1 (COM1).
3. Supply power to receiver.
4. Supply power to transmitter and then check that measured Data delay time corresponds with programmed one. For reference, Data delay time can be measured by checking the period of time from the moment powered to SD160 to first transmission of GPS data. After first transmission, automatically ACC-515 enters power save mode for transmission cycle. More detail information is explained in section 3.1.
5. After assigned “Data delay time”, identify whether receiver and “SD-160 GPS test” program receive GPS data.
6. Verify position data on the “SD-160 GPS test” program.
7. After one transmission cycle, identify whether receiver and “SD-160 GPS test” program receive GPS data again.

5.2.2. Manual control mode

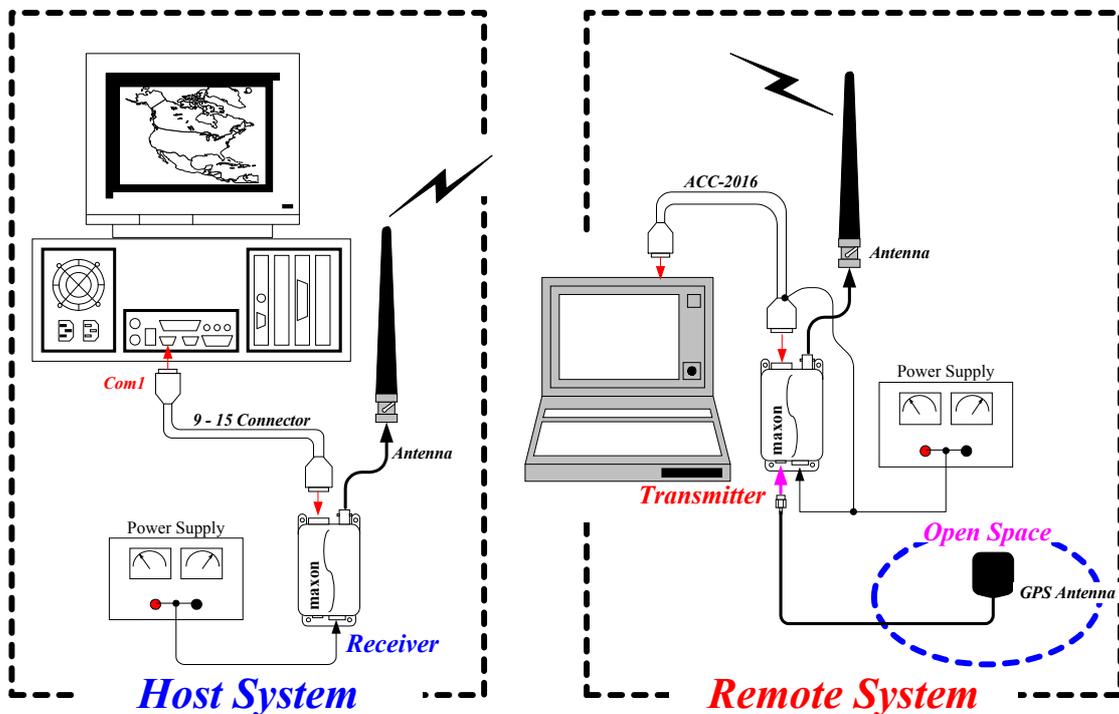


Figure 5.12. Constitution of hardware for Manual control mode

In case of Manual control mode, each SD-160 has similar hardware configuration to the Automatic GPS data transmission mode. You should install ACC-513 and ACC-515 to transmitter and only ACC-513 to receiver. After that, each radio should be programmed according to their use. Detail procedure for radio program is as the following.

Programming procedure for transmitter

1. Read data from SD-160.
2. Select “System Option / GPS” Tap on the main window of ACC-916.
3. Clear GPS option box.

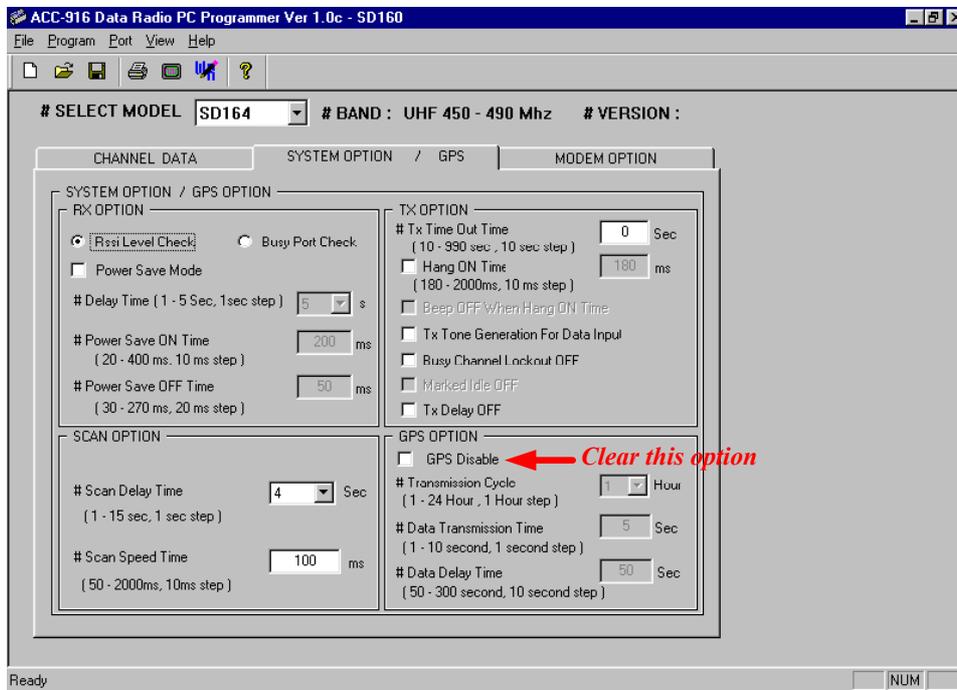


Figure 5.13. Editing GPS Option for Manual control mode

4. Select “Modem Option” Tap on the main window.
5. Select GMSK if ACC-513 is installed, or select FFSK if ACC-514 is installed.
6. Click “Modem disable” button and then identify whether “Modem enable” is displayed.

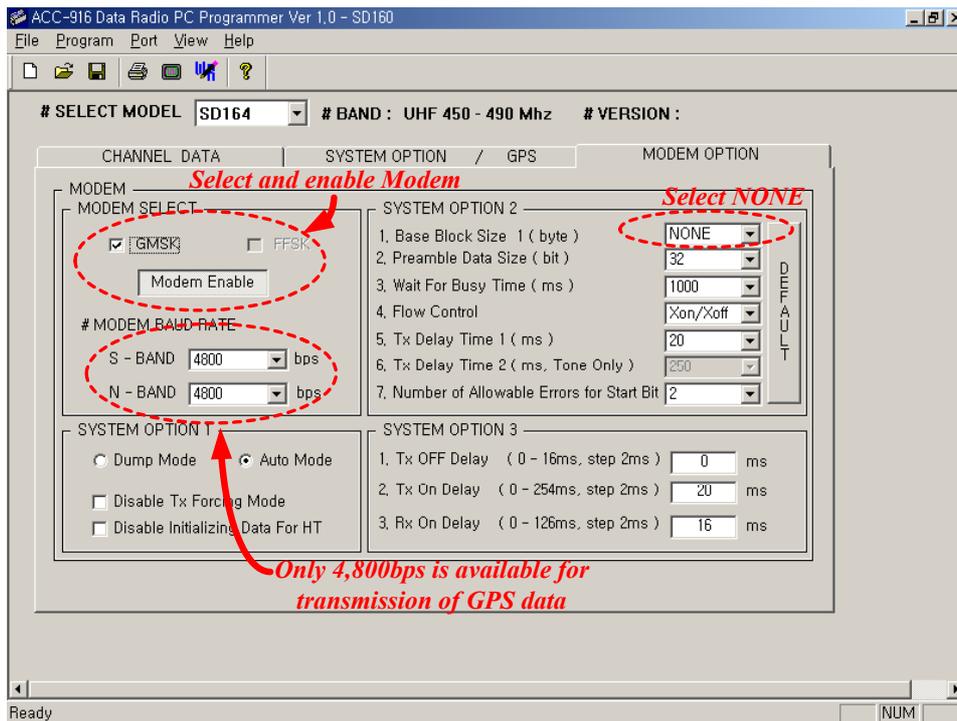


Figure 5.14. Editing Modem option for Manual control mode

7. Select 4,800bps of modem baud rate.

Note : Only 4,800bps is available for transmission of GPS data.

If ACC-514 is installed, don't transmit GPS data in N-Band(narrow-band) because it's maximum baud rate is 2,400bps in N-Band.

8. Select Auto mode in group box of system option 1.
9. Select "None" of block size 1 in group box of system option 2.
10. Default value for remained options is recommended, but some of those can be changed according to user application.
11. Write data to SD-160.

Programming procedure for Receiver

To program receiver, repeat same procedure with transmitter.

Test procedure for manual control mode

1. Setup hardware like Fig 5.12.
2. Execute “SD-160 GPS test” program on the DTE (PC) of host system. That’s connected with receiver through communication port 1 (COM1).
3. Supply power to receiver and wait reception of data.
4. Execute ACC-916 on the DTE of remote system. That’s connected with transmitter through communication port.
5. Supply power to transmitter and then run squelch & calibration sub-program.
6. Click “GPS Power Disable” button and then identify whether “GPS Power Enable” is displayed.
7. Click “RF Transmission Disable” menu in GPS data item and then identify “RF Transmission Enable” is displayed.
8. Check that transmitter starts transmission of GPS data.
9. Identify whether receiver and “SD-160 GPS test” program receive GPS data.
10. Verify position data on the “SD-160 GPS test” program and check how long time is required to receive valid position data.
11. Click “Enable” menu in GPS data item and then identify “Disable” is displayed.
12. Check that transmitter stops transmission of GPS data.

6. Appendix A.

PERFORMANCE SPECIFICATIONS

GPS RECEIVING UNIT

MODEL: CCA-453JZ

July.2, 2001

JRC *Japan Radio Co., Ltd.*

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1. COMPONENTS LIST

Item	Type	Qty	Remarks
Receiving Unit	CCA-453JZ	1	

2. RECEIVING UNIT SPECIFICATIONS

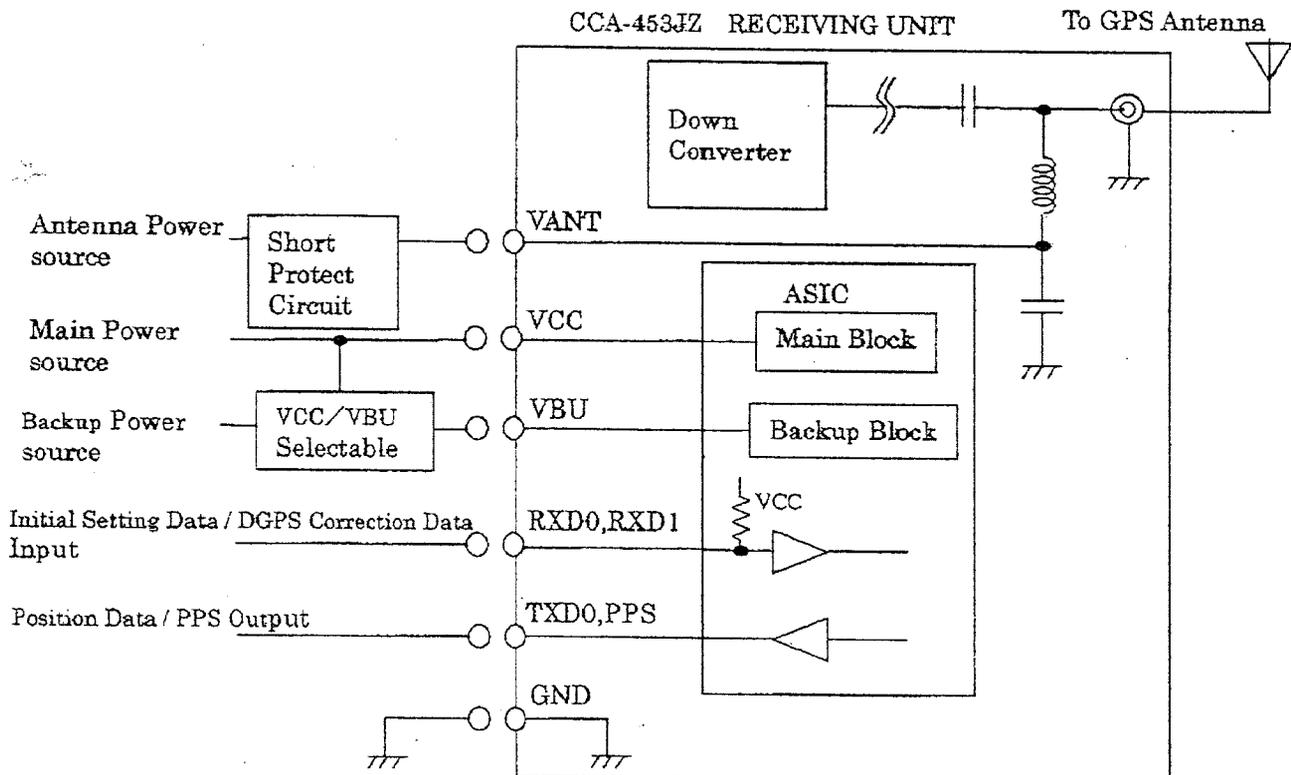
2.1 GENERAL

Receiving Method:	Multi-channel, (Receiving:15 channels, Special search:1 channel)
Receiving Frequency:	1575.42MHz (L1), C/A code
Sensitivity:	-130dBm (at NAY-3600G antenna receiving level)
Dynamic Range:	> 25dB
Fixing Method:	ALL IN VIEW
DATUM:	WGS-84 (default, 46 datums selectable)
Accuracy	
Alone	GPS System Accuracy
Position:	15m 2dRMS (SA off, HDOP \leq 1.5)
Speed:	0.04m/sec. RMS (SA off, HDOP \leq 1.5)
Course:	< 0.14° (SA off, speed = 60km/h, HDOP \leq 1.5)
DGPS	
Position:	7m 2dRMS (example)
1PPS Accuracy:	UTC \pm 1 μ sec.
Dynamic Capability	
Maximum Velocity:	300km/h
Maximum Acceleration:	2g's
Time To First Fix (no signal loss)	
HOT START:	8sec. typical
WARM START:	33sec. typical
COLD START:	40sec. typical
Re-acquisition Time:	3sec. (within 5 sec. block out)
DGPS Capability:	RTCM SC-104 version 2.1, 1200bps (Type 1,2,9) Option: DARC format available, 1200bps
WAAS Capability:	Under development
Position Fix Data Output Rate:	1sec.
Data I/O	
Interface:	CMOS level (3.3V)
Output:	TXD0 4800bps (Position Data Output)
Input:	RXD0 4800bps (Initial Setting Data Input) RXD1 1200bps (DGPS Correction Data Input)
Data Output Format:	NMEA0183 Revision 2.01S
Power Requirements	
Main Power:	Vcc: +3.3Vdc \pm 5%, 100mVp-p ripple (max.)
Consumption Current:	Icc: 125mA typical (except for antenna)
Backup Power (SRAM&RTC):	Vbu1: +2.2 to Vcc Vdc (Backup mode) Vbu2: +2.7 to Vcc Vdc (Operation mode)
Consumption Current:	Ibu1: 6 μ A typical (+3.3Vdc, 25°C) Ibu2: 500 μ A typical (+3.3Vdc, 25°C)
Input Power for Active Antenna:	Vant: +3.0 to +5.25Vdc
Consumption Current:	Iant: 5 to 30mA
Incorporated Battery:	No
Connectors	
RF Connector:	H.FL-R-SMT2(10) (Hirose) Mating connector: H.FL-LP-DFS111 (Hirose)
I/O Connector:	MA44-10PA-SH (Hirose), Mating connector: MA44-10D-2C

Size: 25mm × 39mm × 7mm
 Weight: 10g (approx.)
 Temperature
 Operating: -30 to +70°C
 Storage: -40 to +85°C

2.2 I/O CONNECTOR PIN FUNCTIONS

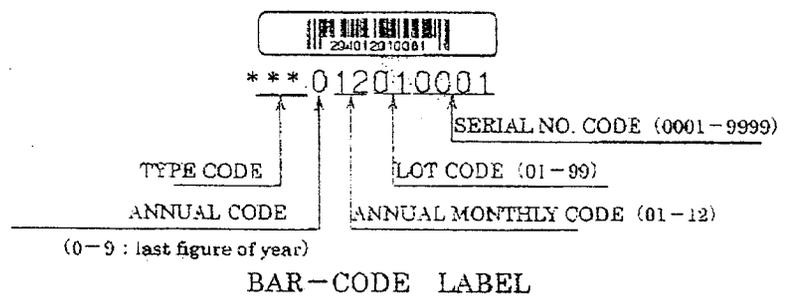
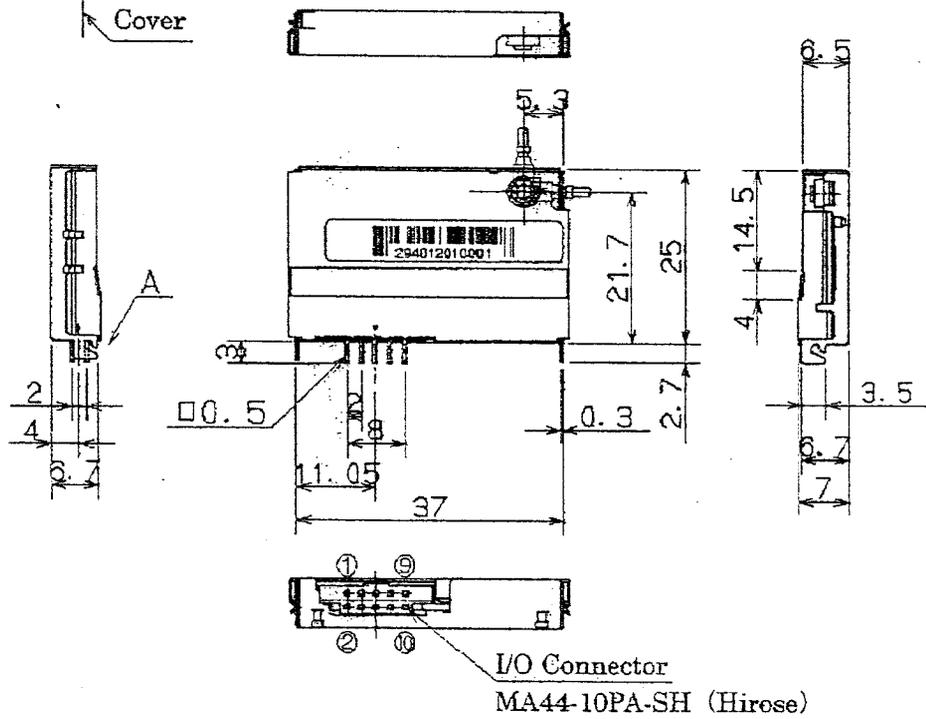
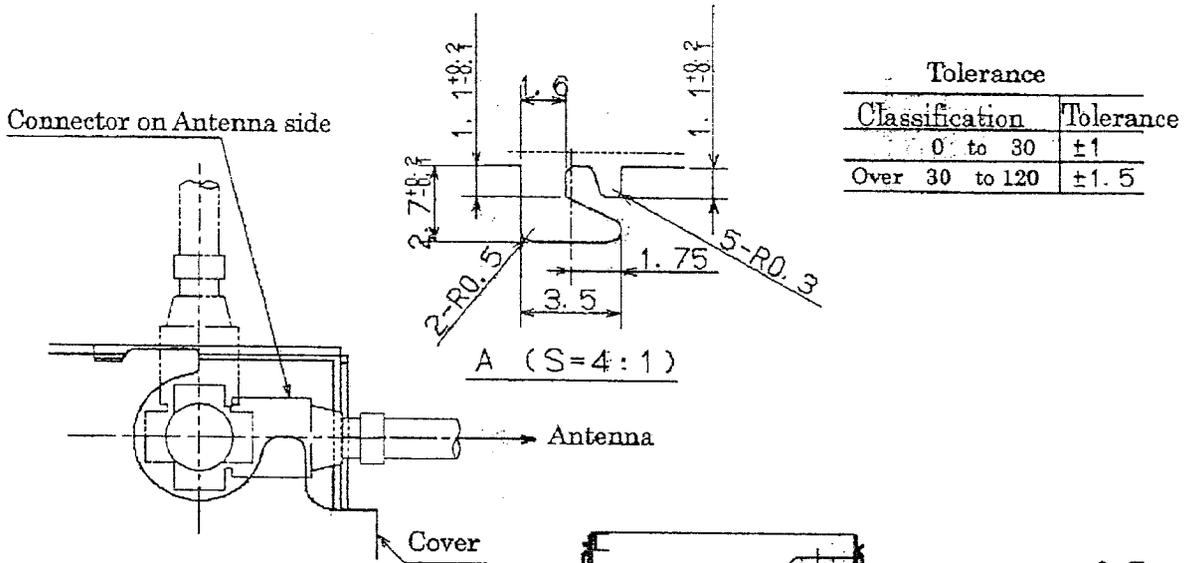
PIN No.	PIN NAME	DESCRIPTION	PARAMETER	TEST CONDITIONS	VALUE		UNIT
					MIN.	MAX.	
2	PPS	PPS Output	Output Level High (V_{OH})	$I_{OH} = -8mA$	$V_{CC} - 0.5$		V
			Output Level Low (V_{OL})	$I_{OL} = 8mA$		+0.4	
3	Vbu	Backup Power Input	Back up mode (V_{bu1})		+2.2	V_{CC}	Vdc
			Back up mode (I_{bu1})	$V_{bu} = +3.3V, 25^\circ C$	6(typ.)		
			Operation mode (V_{bu2})		+2.7	V_{CC}	Vdc
			Operation mode (I_{bu2})	$V_{bu} = +3.3V, 25^\circ C$	500(typ.)		
4	TXD0	Position Data Output	Output Level High (V_{OH})	$I_{OH} = -8mA$	$V_{CC} - 0.5$		V
			Output Level Low (V_{OL})	$I_{OL} = 8mA$		+0.4	
5	RXD0	Initial Setting Data Input	Input Level High (V_{IH})		$0.7V_{CC}$	$V_{CC} + 0.3$	V
			Input Level Low (V_{IL})		-0.3	$0.3V_{CC}$	
6	Vcc	Main Power Input	Supply Voltage (V_{CC})		+3.135	+3.465	Vdc
			Supply Current (I_{CC})	$V_{CC} = +3.3V$	125(typ.)		
7	Vant	Active Antenna Power Input	Supply Voltage (V_{ant})		+3.0	+5.25	Vdc
			Supply Current (I_{ant})		5	30	
8	RXD1	DGPS Correction Data Input	Input Level High (V_{IH})		$0.7V_{CC}$	$V_{CC} + 0.3$	V
			Input Level Low (V_{IL})		-0.3	$0.3V_{CC}$	
10	GND	Ground					



2.3 RF CONNECTOR

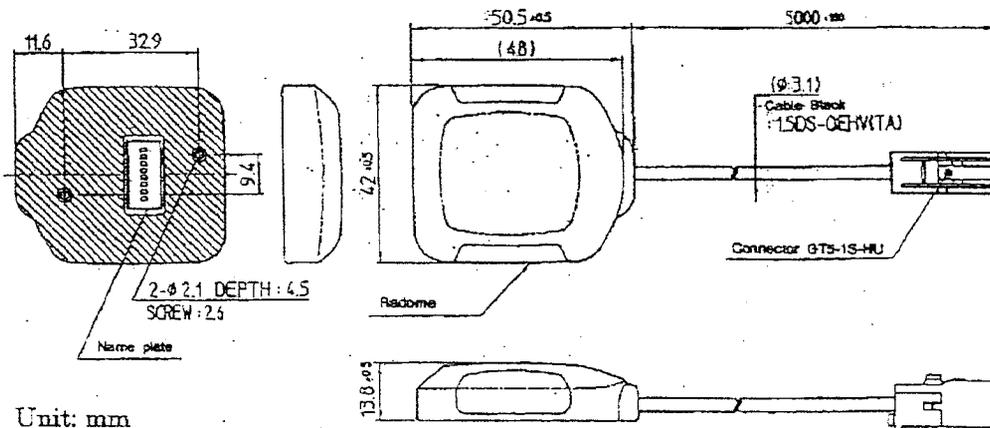
NAME	PARAMETER		VALUE		UNIT	REMARKS
			MIN	MAX		
RF CON- NECTOR	AC	Nominal Impedance	50		Ω	@f=1575.42±1MHz
		VSWR		2.2		

2.4 OUTLINE DRAWINGS



3 RECOMMENDED ANTENNA

Recommended Antenna:	NAY-3600G
Type:	Active
Overall Performance (Antenna+LNA+Cable)	
Gain:	> 22dBi (at elevation 10°)
Output Impedance:	50 Ω
VSWR:	2.0:1
Supply voltage:	+4 to +5Vdc
Current consumption:	< 30mA
RF Connector:	GT5-1S-HU (Hirose)
Antenna Part	
Gain Coverage:	> -5dBi (elevation ≥ 10°) > +2dBi (at zenith)
Polarization:	RHCP
Axial Ratio:	< 4.0dB (at zenith)
Low Noise Amplifier (LNA) Part	
Power Gain:	> 28dB (not including cable loss)
Noise Figure:	< 2.1dB
Bandwidth:	> 2MHz
Out of Band Rejection:	> 20dB (at 1575.42MHz±50MHz)
Cable:	1.5D Coax. Cable , 5m long

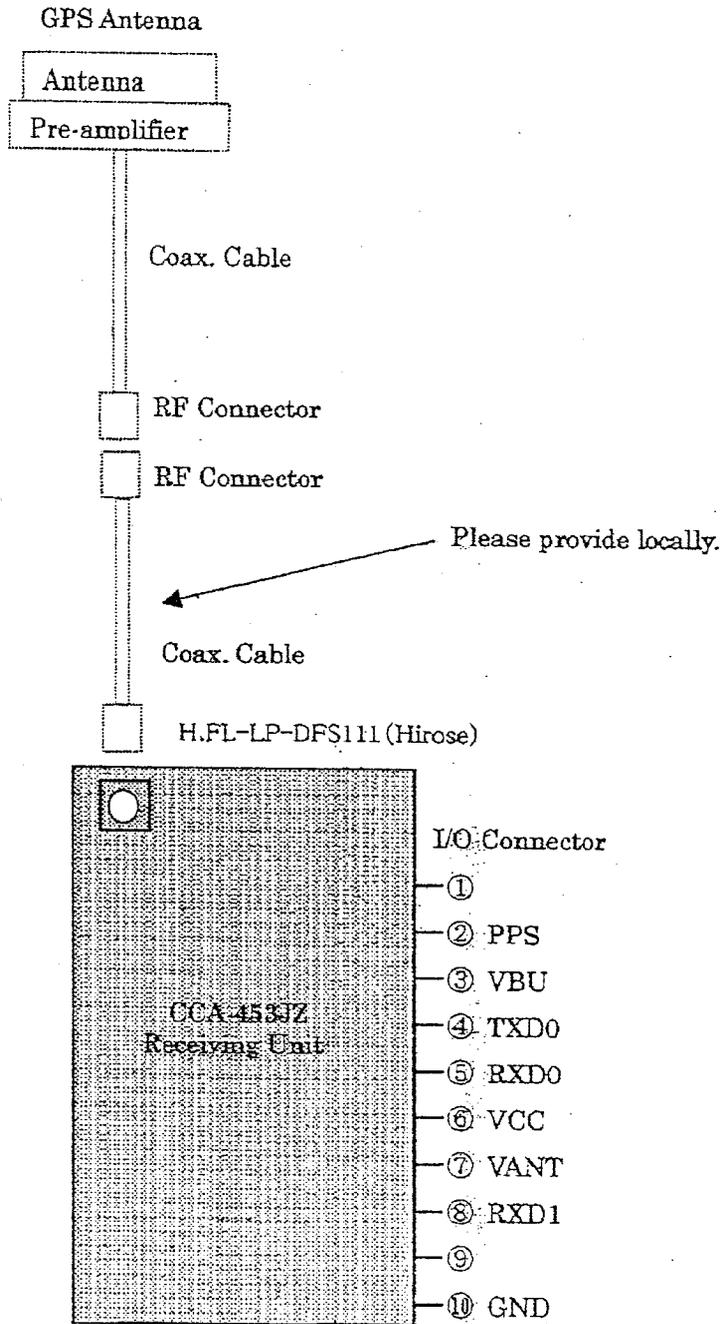


Unit: mm

Tolerance
(unless otherwise specified) ±0.3

NAY-3600G OUTLINE DRAWINGS

4 WIRING DIAGRAM



Pin # ① and ⑨ shall be left open.

7. Appendix B.

GPS RECEIVER

JRC STANDARD DATA INPUT/OUTPUT FORMAT

Revision 2.01

(IEC1162 NMEA0183 Version 2.10)

Oct.10,2001

Japan Radio Co., LTD.

Document Revision History

Date	Revision	Description
06/11/00	R2.01 (TS-01X539)	First Edition
10/11/01	R2.01 (TS-01X539A)	Added Sections 4.4, 4.7 and 4.9. 4.4 High Resolution GGA 4.7 High Resolution RMC 4.9 High Resolution GLL

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ADDENDUM 1. BYTES OF OUTPUT SENTENCE DATA	14

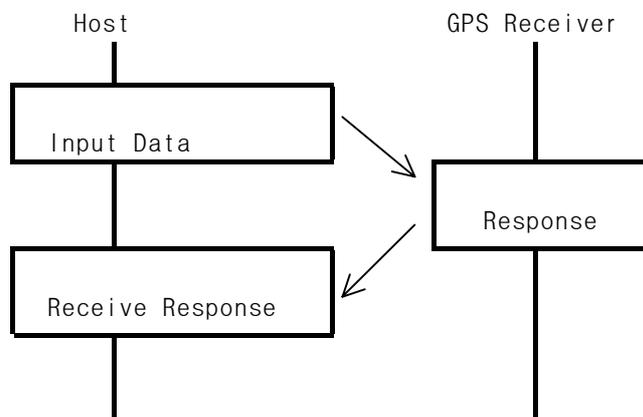
1. Data Transmission

- (1) Asynchronous Serial Data Transfer
- (2) Baud Rate: 4,800 bit/sec
- (3) Data Bit: 8 bit (D7=0) Non Parity
- (4) Stop Bit: 1 bit
- (5) LSB First Transmission

2. Data Protocol

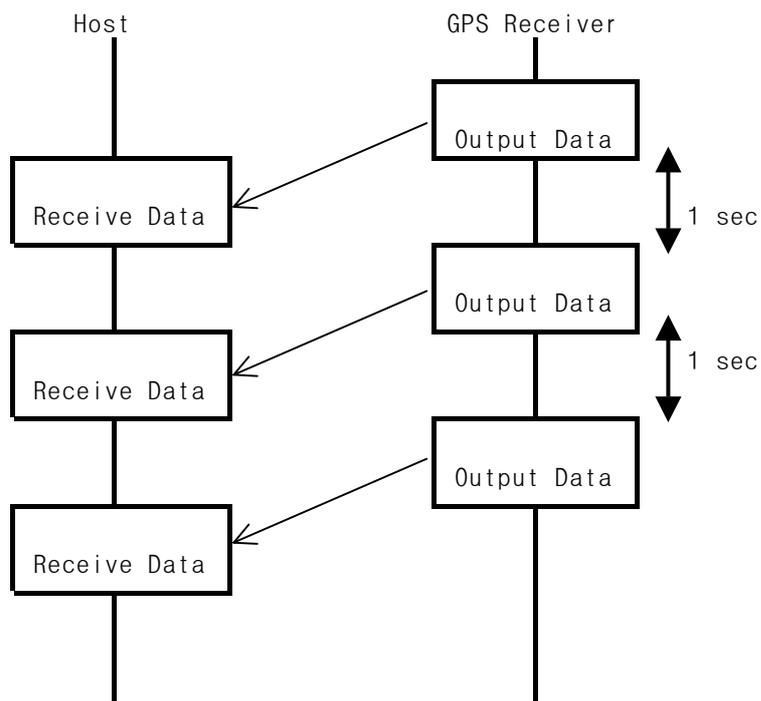
2.1 Protocol for Input Data

Protocol of data transmission from Host to GPS Receiver:



2.2 Protocol for Output Data

Protocol of data transmission from GPS Receiver to Host:



3. Input Data Format (Host → GPS Receiver)

3.1 PJRCI, GP - Initial Time & Position Set (71 byte)

```
$PJRCI,GP,1111.11,a,yyyyy.yy,a,uxxxx,hmmss,xx,xx,xxxx,A,A,A,A,A,A*hh<CR><LF>
```

1 2 3 4 5 6 7 8 9 101112131415

- 1,2: Latitude (Degree, Minute), N/S
- 3,4: Longitude (Degree, Minute), E/W
- 5: Antenna height above mean sea level (m), u: sign(+,-)
- 6: UTC (Hour, Minute, Second)
- 7: Day (UTC)
- 8: Month (UTC)
- 9: Year (UTC)
- 10: Flag of Lat/Long setting A=Set, V=No set
- 11: Flag of Antenna height setting A=Set, V=No set
- 12: Flag of Date/Time setting A=Set, V=No set
- 13: Flag of Master Reset A=Set, V=No set
- 14: Flag of Cold Start Fix A=Set, V=No set
- 15: Flag of Differential GPS fix A=Set, V=No set

Note 1: When this sentence is input, GPS receiver is initialized according to the items 10 to 15.

Note 2: Setting after power-on or master reset should be done after starting data output.

Note 3: Flag set is due to following priority. When high and low priority flags are set at once, just high priority flag is effective. When the same priority flags are set, all flags are effective.

		F l a g	
High ↑ Priority ↓ Low	1	<input type="checkbox"/> Master Reset	
	2	<input type="checkbox"/> Cold Start Fix	
	3	<input type="checkbox"/> Lat./Long. Setting <input type="checkbox"/> Antenna Height Setting <input type="checkbox"/> Date/Time Setting <input type="checkbox"/> Differential GPS Fix	

3.2 PJRCE, GP, 0 - Receiver Mode Set (50 byte)

```
$PJRCE,GP,0,x,xx,x,x,x,xx,xx,xx,xx,xx,x,xx*hh<CR><LF>
  1 2 3 4 5 6 7 8 9 10 11 12 13
```

- 1: Position Calculation Mode
 0 = 2 Dimension, 1 = 3 Dimension, 2 = AUTO
- 2: Minimum elevation angle enabling position calculation
 Range from 1 to 89 degrees at 1° step
- 3: DOP threshold enabling position calculation
 0 = less than 5, 1 = less than 10, 2 = less than 20
- 4: Smoothing level
 0 = strong, 1 = middle, 2 = weak
- 5: Local geodetic systems.
 Refer to table 1.
- 6-11: Not use : 00 fixed.
- 12: Output data sentence every second
 0 = [GGA]→[VTG]→[RMC]→[GLL]
 1 = [GGA]→[VTG]→[RMC]→[GLL]→[GSA]→[PJRCDC,GP,3]
 2 = [GSA]→[GSV]→[PJRCDC,GP,3]
 3 = [RMC]→[GSA]→[GSV]→[PJRCDC,GP,3] *
 4 = [High Resolution GGA]→[VTG]→[High Resolution RMC]→[High Resolution GLL]
 5 = [High Resolution GGA]→[VTG]→[High Resolution RMC]→[High Resolution GLL]
 →[GSA]→[PJRCDC,GP,3]
 6 = [High Resolution RMC]→[GSA]→[GSV]→[PJRCDC,GP,3] *
 9 = [PJRCDC,GP,4]
 *: There is the case where data is not output every second due to data length.
- 13: Additional datum Refer to table 2.

Table 1. No. of Datum

No.	Name
0	WGS-84
1	WGS-72
2	Tokyo Bessel
3	North American 1927 (America)
4	North American 1927 (Canada, Alaska)
5	European 1950 (Europe)
6	Australia Geodetic 1966 (Australia)
7	Ordnance Survey of Great Britain (England)
8	NAD-83
9	Other Datum specified by 13.

Note 1: Setting after power-on or master reset should be done after starting data output.

Table 2. No. of Additional Datum

No.	Name
11	Adindan (Ethiopia and Sudan)
12	ARC 1950 (Botswana)
13	Australian Geodetic 1984 (Australia)
14	Bermuda 1957 (Bermuda Islands)
15	Bogota Observatory (Colombia)
16	Campo Inchauspe (Argentina)
17	Chatham 1971 (Chatam Island)
18	Chua Astro (Paraguay)
19	Corrego Alegre (Brazil)
20	Djakarta (Vatavia) (Sumatra)
21	European 1979 (Europe)
22	Geodetic datum 1949 (New Zealand)
23	Guam 1963 (Guam)
24	Hayford 1910 (Finland)
25	Hjorsey 1955 (Iceland)
26	Indian (Indian and Nepal)
27	Ireland 1965 (Ireland)
28	Kertau 1948 (West Malaysia and Singapore)
29	L.C.5 Astro (Cayman Brac Island)
30	Liberia 1964 (Liberia)
31	Luzon (Philippines)
32	Merchich (Morocco)
33	Minna (Cameroon)
34	Nahrwan (Oman)
35	Naparima, BWI (Trinidad and Tobago)
36	Old Egyptian (Egypt)
37	Old Hawaiian (Hawaiian Islands)
38	Pico de las Nieves (Canary Islands)
39	Provisional South America 1956 (South America)
40	Provisional South Chilean 1963 (Southern Chile)
41	Puerto Rico (Puerto Rico and Virgin Islands)
42	Qornoq (South Greenland)
43	RT90 (Sweden)
44	Santa Braz (Sao Maguel, Santa Maria Islands)
45	South America 1969 (South America)
46	Southwest Base (Fail, Graciosa, Pico, Sao Jorge and Terceira Island)
47	Timbalai 1948 (Brunei and East Malaysia)

4. Output Data Format (GPS Receiver → Host)

4.1 PJRCI, GP - Initial Time & Position Set Response

Send back the same data which is input by Initial Time and Position Set.
Sentence itself is same as subclause 3.1.

4.2 PJRCE, GP, 0 - Receiver Mode Set Response

Send back the same data which is input by receiver mode set.
Sentence itself is same as subclause 3.2.

4.3 GGA - Position Data (71 byte)

```
$GPGGA,hhmmss,1111.111,a,yyyyy,yyy,a,x,x,xx,uxxxx,M,uxxx,M,xx,xxxx*hh<CR><LF>
```

1 2 3 4 5 6 7 8 9 10 11 12 13 14

- 1: UTC (Hour, Minute, Second)
- 2,3: Latitude (Degree, Minute), N/S (the datum specified by user)
- 4,5: Longitude(Degree, Minute), E/W (the datum specified by user)
- 6: GPS Accuracy information
 - 0: No positioning or invalid data,
 - 1: GPS positioning, 2: Differential GPS positioning
- 7: Number of satellites for positioning(up to 9 satellites data)
- 8: HDOP
- 9,10: Antenna height above mean sea level (m) (the datum specified by user)
- 11,12:Geoidal height (m)
- 13: DGPS data correction lapsed time (second), 00 when non DGPS positioning.
- 14: DGPS Reference Station No., 0000 when non DGPS positioning.

4.4 High Resolution GGA - Position Data (75 byte)

The same information of the above 4.3 GGA is given, but output resolution of Latitude and Longitude is expanded to 1/100000 from 1/1000.

However, position accuracy depends on its receiver specifications.

```
$GPGGA,hhmmss,1111.11111,a,yyyyy.yyyyy,a,x,x,xx,uxxxx,M,uxxx,M,xx,xxxx*hh<CR><LF>
      1      2      3 4      5 6 7 8 9      1011 1213 14
```

Contents of field is the same as the above 4.3.

**** Note ****

High resolution position accuracy depends on its receiver specifications.

Confirm Type and ROM version.

Type	ROM Ver .	position accuracy[min]
CCA-370HZ1	RD0.02	1/1000
CCA-390VZ	RD0.02	1/1000
CCA-391VZ	RD0.02	1/1000
CCA-450JK	RF9.05	1/1000
CCA-450JZ	RF9.04	1/1000
CCA-450JZ1	RF9.04	1/1000
CCA-450JZA	RG7.00	1/1000
CCA-453JZ	RF9.04	1/1000

4.5 VTG - Forward Direction and Ground Speed Data (37 byte)

Information of direction and speed.

```
$GPVTG,xxx.x,T,, ,xxx.x,N,xxx.x,K*hh<CR><LF>
      1  2  3    4 5    6
```

- 1,2: Forward Direction (degree)
- 3,4: Speed (knot)
- 5,6: Speed (km/h)

4.6 RMC - Minimum Specific Data (61 byte)

```
$GPRMC,hhmmss,f,ddmm,mm,a,dddmm.mm,a,xxx.x,xxx.,xxxxxx,*,*hh<CR><LF>
      1  2 3    4 5    6 7    8    9
```

- 1: UTC (Hour, Minute, Second)
- 2: Data status A: Valid, V: Invalid
- 3,4: Latitude (degree, minute), N/S (the datum specified by user)
- 5,6: Longitude(degree, minute), E/W (the datum specified by user)
- 7: Speed (knots)
- 8: Forward Direction (degree)
- 9: UTC day, month, year

4.7 High Resolution RMC - Minimum Specific Data (67 byte)

The same information of the above 4.6 RMC is given, but output resolution of Latitude and Longitude is expanded to 1/100000 from 1/100. However, position accuracy depends on its receiver specifications.

```
$GPRMC,hhmmss,f,1111.11111,a,yyyyy.yyyyy,a,xxx.x,xxx.,xxxxxx,*,*hh<CR><LF>
      1  2 3    4 5    6 7    8    9
```

Contents of field is the same as the above 4.6.

**** Note ****

High resolution position accuracy depends on its receiver specifications.
Confirm Type and ROM version.

Type	ROM Ver .	position accuracy[min]	Remarks
CCA-370HZ1	RD0.02	1/100	
CCA-390VZ	RD0.02	1/100	
CCA-391VZ	RD0.02	1/100	
CCA-450JK	RF9.05	1/10000	
CCA-450JZ	RF9.04	1/100	It will be renewed to RF9.05 in December, 2001.
CCA-450JZ1	RF9.04	1/100	It will be renewed to RF9.05 in December, 2001.
CCA-450JZA	RG7.00	1/100	
CCA-453JZ	RF9.04	1/100	It will be renewed to RF9.05 in December, 2001.

4.8 GLL - Geographic Time & Position Data (44 byte)

```
$GPGLL,ddmm.mm,a,dddmm.mm,a,hhmmss.ss,A*hh<CR><LF>
      1      2 3      4 5      6
```

- 1,2: Latitude (degree, minute), N/S
- 3,4: Longitude(degree, minute), E/W
- 5: UTC (hour, minute, second)
- 6: Status A=Valid V=Invalid

4.9 High Resolution GLL - Geographic Time & Position (50 byte)

The same information of the above 4.8 GLL is given, but output resolution of Latitude and Longitude is expanded to 1/100000 from 1/100. However, output resolution depends on its receiver specifications.

```
$GPGLL,1111.11111,a,yyyyy.yyyyy,a,hhmmss.ss,A*hh<CR><LF>
      1      2 3      4 5      6
```

Contents of field is the same as the above 4.8.

**** Note ****

High resolution position accuracy depends on its receiver specifications. Confirm Type and ROM version.

Type	ROM Ver .	Position accuracy[min]
CCA-370HZ1	RD0.02	1/100
CCA-390VZ	RD0.02	1/100
CCA-391VZ	RD0.02	1/100
CCA-450JK	RF9.05	1/100
CCA-450JZ	RF9.04	1/100
CCA-450JZ1	RF9.04	1/100
CCA-450JZA	RG7.00	1/100
CCA-453JZ	RF9.04	1/100

4.10 GSA - DOP and Visible Satellites Data (66 byte)

```
$GPGSA,a,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x,xx.x,xx.x,xx.x*hh<CR><LF>
      1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
```

- 1: Positioning mode M = Manual (2 or 3 dimension). A = AUTO
- 2: Positioning Calculation Mode
 - 1 = not positioning, 2 = 2 dimension, 3 = 3 dimension
- 3~14: Satellite PRN No. ("00" for no satellite in case of less than 12 satellites)
- 15: PDOP
- 16: HDOP
- 17: VDOP

4.11 GSV - Visible Satellites Data (70 byte)

Visible satellites data such as PRN, elevation angle, direction angle and SNR is available.

```
$GPGSV,x,x,xx,xx,xx,xxx,xx,xx,xx,xxx,xx,xx,xx,xxx,xx,xx,xx,xxx,xx*hh<CR><LF>
  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
```

- 1: Total of GSV message (1 ~ 3)
- 2: Serial number of GSV message (1 ~ 3)
- 3: Number of visible satellites
- 4: PRN No. of 1st satellite (01 ~ 32)
- 5: Elevation angle of 1st satellite (00 ~ 90 degree)
- 6: Direction angle of 1st satellite (000 ~ 359 degree)
- 7: SNR signal strength C/No of 1st satellite (00 ~ 99 dB)
- 8 ~ 11: Data of 2nd satellite (same order as 4 ~ 7)
- 12 ~ 15: Data of 3rd satellite (same order as 4 ~ 7)
- 16 ~ 19: Data of 4th satellite (same order as 4 ~ 7)

* "00" and "000" for no satellite in case of less than 4 satellites.

In case of more than 5 satellites, 2 sentences are employed and in case of more than 9 satellites, 3 sentences are employed.

ADDENDUM 1. Bytes of output sentence data

(1) The setup value of the output data designation and data length

Set Val	Output Sentence	Byte	Note
0	[GGA]+[VTG]+[RMC]+[GLL]	213	
1	[GGA]+[VTG]+[RMC]+[GLL]+[GSA]+[PJRCd,GP,3]	357	
2	[GSA]+[GSV]+[PJRCd,GP,3]	354	Max
3	[RMC]+[GSA]+[GSV]+[PJRCd,GP,3]	415	Max
4	[High Resolution GGA]+[VTG]+[High Resolution RMC]+[High Resolution GLL]	229	
5	[High Resolution GGA]+[VTG]+[High Resolution RMC]+[High Resolution GLL]+[GSA]+[PJRCd,GP,3]	373	
6	[High Resolution RMC]+[GSA]+[GSV]+[PJRCd,GP,3]	421	Max
9	[PJRCd,GP,4]	25	

(2) Each Sentence Data Length

Sentence	Byte
GGA	71
High Resolution GGA	75
VTG	37
RMC	61
High Resolution RMC	67
GLL	44
High Resolution GLL	50
GSA	66
GSV	70
PJRCd,GP,3	78
PJRCd,GP,4	25