GPS-721U Series User Manual

V3.0.0, Feb. 2025

Support

GPS-721U-MRTU

GPS-721U-MRTU-UTA

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Edited by Sunny Chiu

Warranty

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Packing List

The shipping package includes the following items:

GPS-721U-MRTU

ANT-115-03-2

RS-232 Cable (CA-0910)

Plastic Rail

Software and Manual Download:

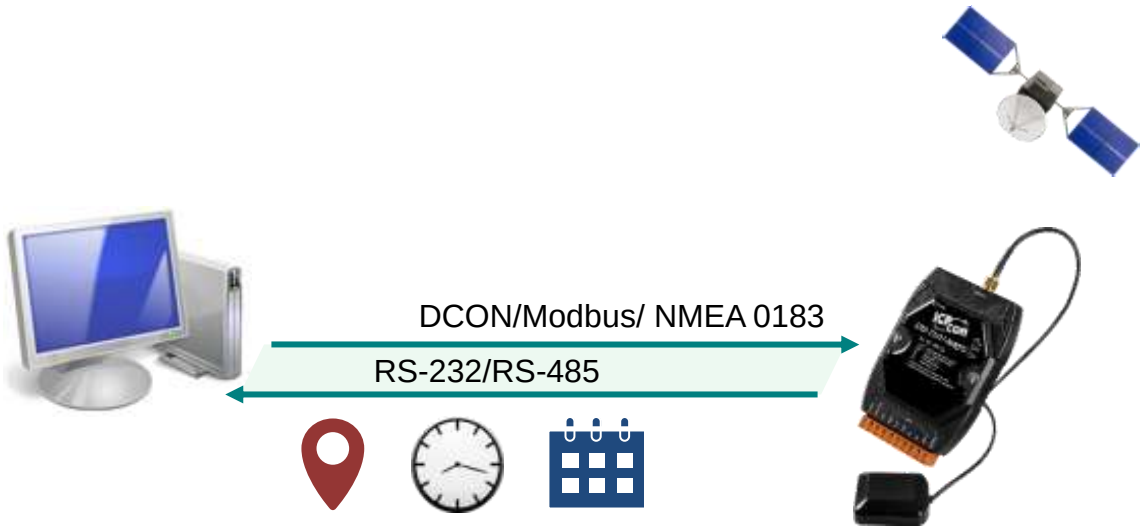
https://www.icpdas.com/en/download/index.php?model=GPS-721U-MRTU

1 Introduction

The GPS-721U-MRTU series GPS/GLONASS receiver module features high sensitivity, low power consumption and ultra small form factor with DCON, Modbus RTU and the NMEA 0183 protocols. This powerful item provides you with superior sensitivity and outstanding performance even in the harshest environment.

Users can read the GPS/GLONASS coordinates in Google Maps format from the GPS-721U-MRTU series module to display locations on Google Maps, as well as information including altitude, HDOP, geoid separation and the speed over the ground in knots. Through the commonly used RS-232 or RS-485 communication interface, the GPS-721U-MRTU series module can be easily integrated into most of automatic control systems, including automotive navigation, personal positioning and navigation and marine navigation.

In addition, the GPS-721U-MRTU series module comes with 1PPS output signal, which normally has a rising edge aligned with GNSS system time. It is useful in the accurate field such as time transfer or time measurement, as well as providing a low-cost option to discipline local clocks to maintain synchronization with UTC time.



Features

- Supports GPS/GLONASS
- Capable of SBAS (WAAS, EGNOS, MSAS)
- RS-485 supports NMEA v0183 v2.3, DCON or Modbus RTU protocol
- RS-232 supports NMEA v0183 v2.3, DCON or Modbus RTU protocol
- Built-in 1 channel DO, 1 channel PPS(1 pulse per second)
- 1 PPS: 100 ms pulse/s output for precise timekeeping and time measurement
- 10 ~ 30 VDC input with power reverse polarity protection
- Provides LED indicators for system, 1PPS, DO and available satellites number

GPS-721U-MRTU Series Comparison Table

	GPS-721U-MRTU	GPS-721U-MRTU-UTA
SBAS	WAAS, EGNOS, MSAS	
Protocol	DCON, Modbus RTU, NMEA	
Interface	RS-232/RS-485	
Max. Altitude	< 50,000 m	
Max. Velocity	< 500 m/s	
Position Accuracy	Autonomous: 2.5 m SBAS: 2.0 m	
Digital Output	1	
Standards	2014/30/EU 2014/53/EU 2014/35/EU	
Operating Temperature	-25 ~ +75°C	-40 ~ +75°C

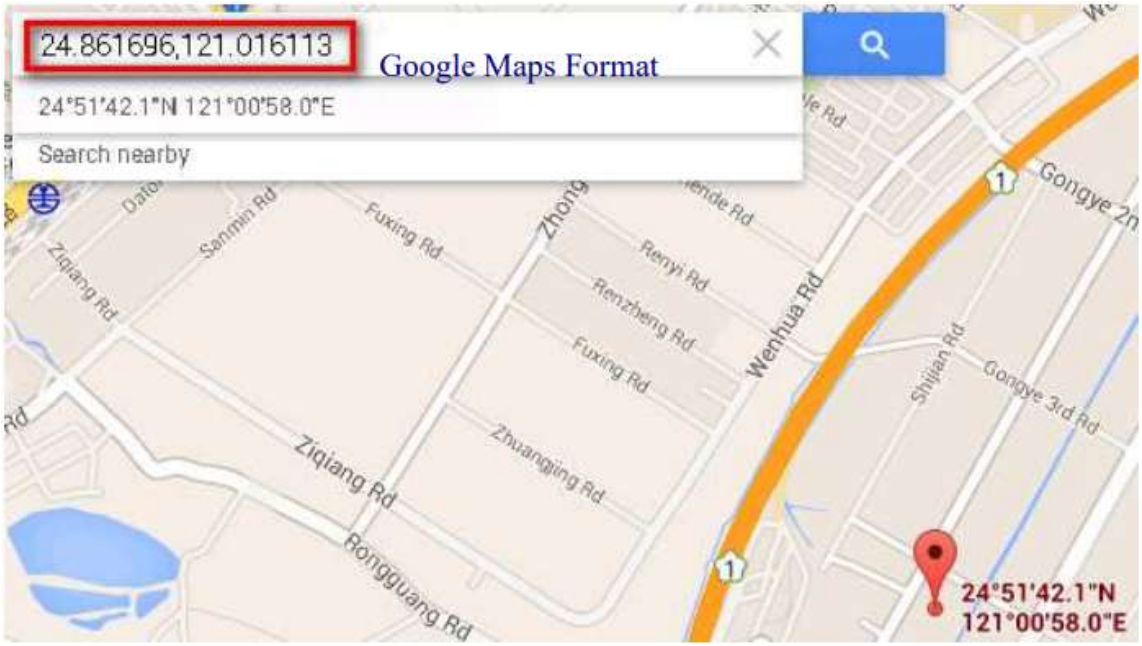
Transmitting NMEA-0183 sentences via RS-232 or RS-485

The GPS-721U-MRTU series module can transmit NMEA 0183 sentences to the host through the widely used RS-232 or RS-485 interface. The length of a NMEA 0183 sentence is longer, and multiple sentences will be transmitted continuously. Using baud rate 1200 ~ 4800 bps may lose some important information.

The GPS-721U-MRTU series modules transmit NMEA 0183 messages at a fixed speed of 9600 bps, which can effectively improve the transmission performance of the system and completely transmit the data to the host.

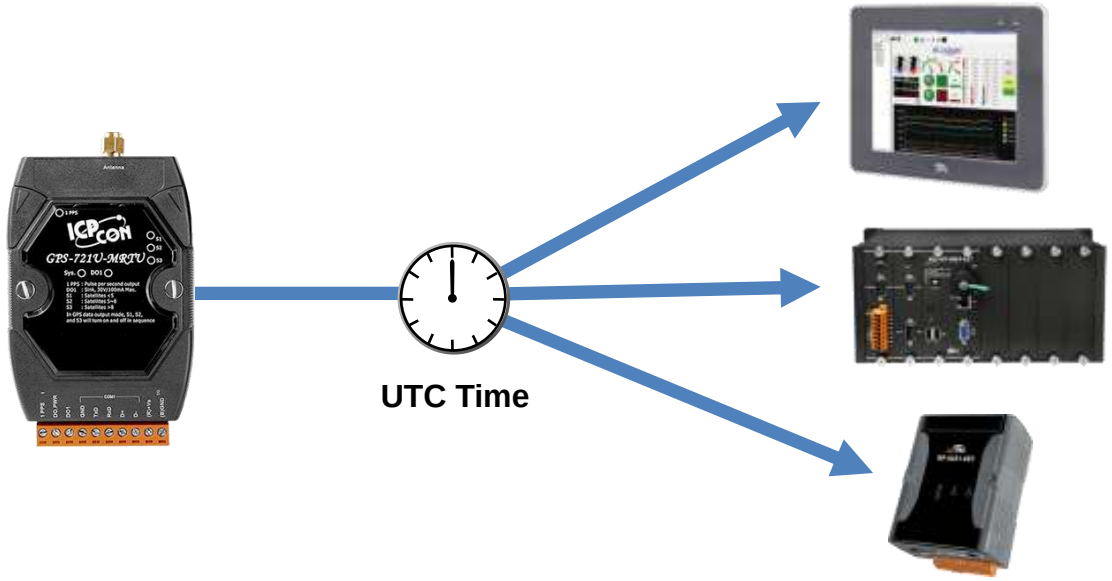
Automatically converting GPS NMEA data to Google Maps format

Both DCON and Modbus RTU protocols can be used to read the coordinates in Google Maps format to display the current location on Google Maps. Since the positional information is retrieved every second and the maps updated at the same frequency, you can achieve real-time location tracking integrated with Google Maps.



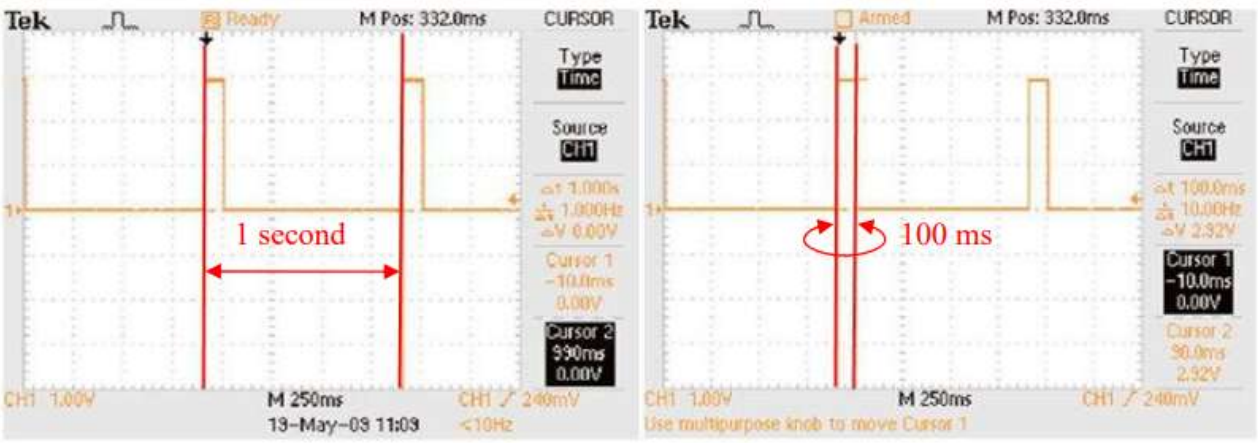
Accurate time transfer and synchronization

Time and frequency transfer is a scheme where multiple sites share a precise reference time or frequency. The GPS-721U-MRTU series can be an accurate time source for synchronization of your various devices or servers to work with the UTC time properly.



As well as the 1PPS signal that normally has a rising edge aligned with the GNSS_1PPS reference, is a "perfect" 1s interval signal. It can be applied to the accurate field such as time and frequency measurements, or ensure your measurements start at exactly the same time.

The 1PPS signal outputs 100ms active high pulse at 1Hz when effective GNSS signals are being received, as shown in the following figure.

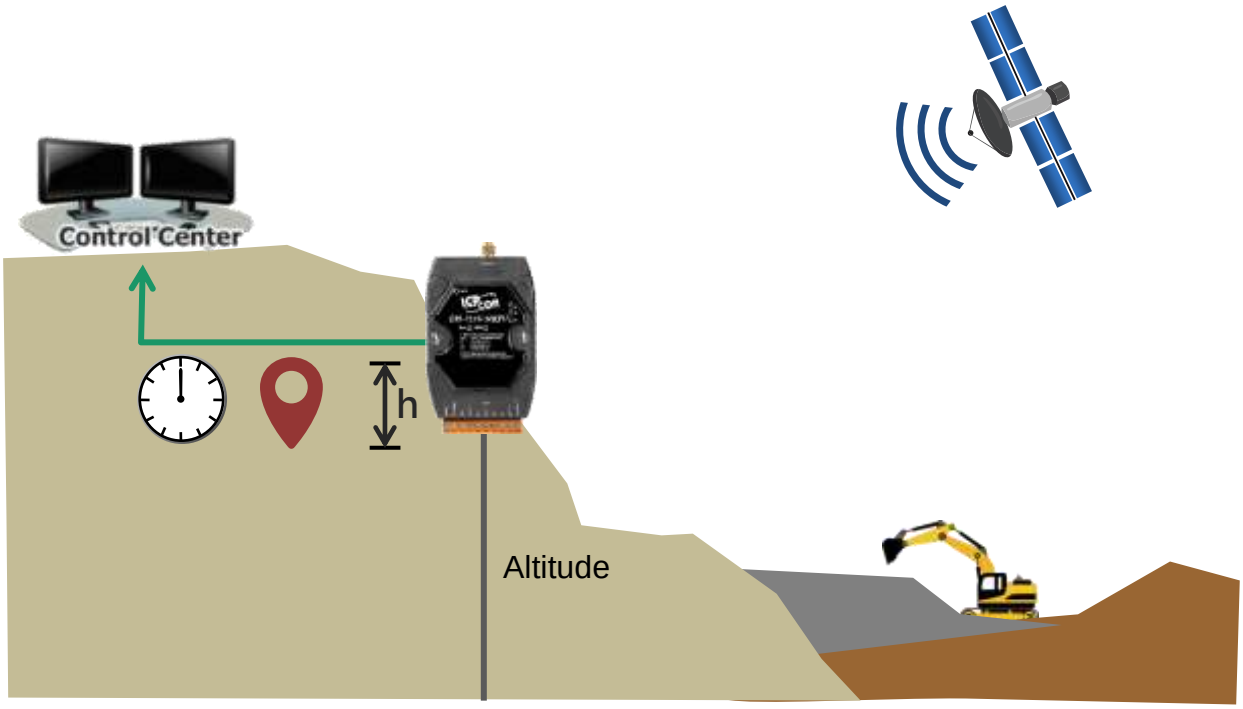


- **Easy to switch GPS/GLONASS satellite system**

  Depending on the signal strength of the installation location, users can switch to receive signals from GPS or GLONASS satellite system through easy-to-use software utility or configuration commands.

- **Providing information about altitude, geoid separation and knot speed**

  In addition to providing location and time information, the GPS-721U-MRTU provides more useful information including altitude, geoid separation and knot speed, allowing the GPS-721U-MRTU to be used in more applications such as slope monitoring, sounding balloons and ocean observations.



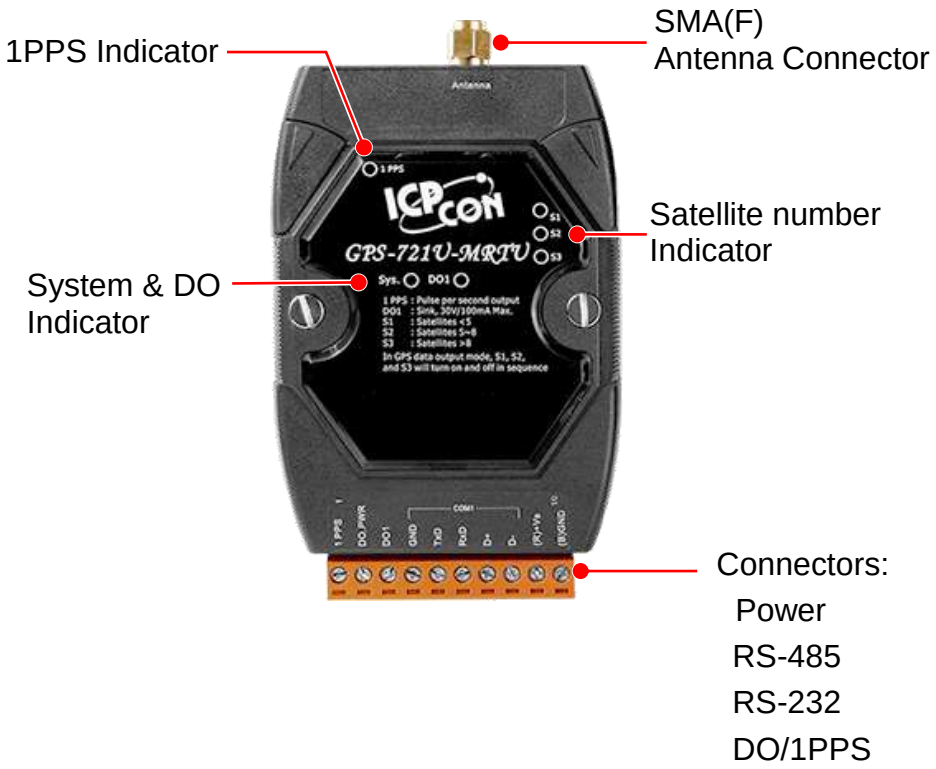
2. Hardware

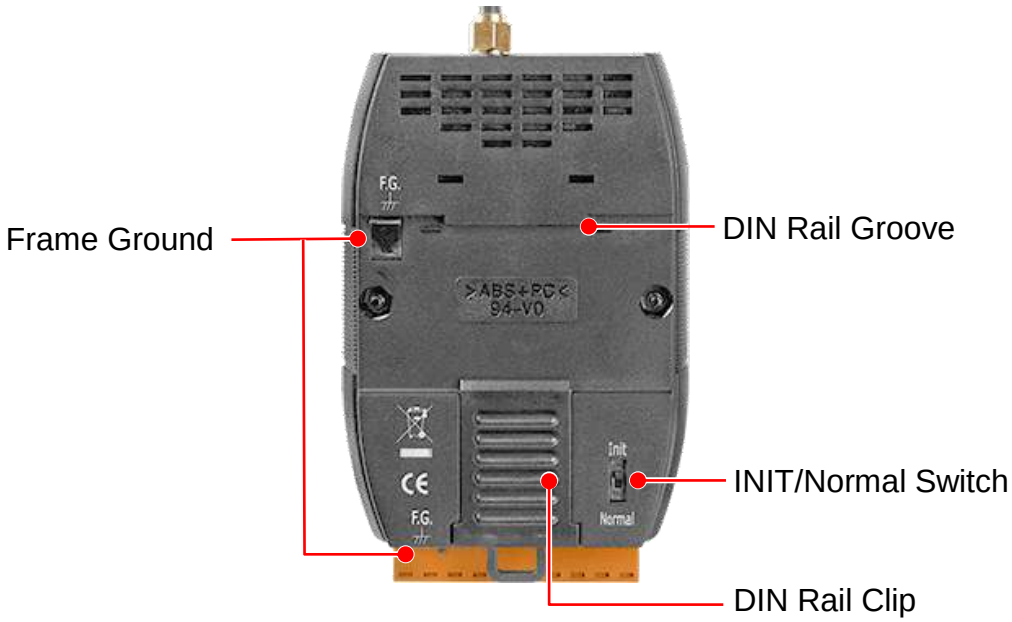
2.1. Specifications

Model	GPS-721U-MRTU	GPS-721U-MRTU-UTA
GPS/GLONASS		
Acquisition Time	Cold Start (Open Sky) = 29 s (typical)	
Chip	u-Blox solution	
Frequency	L1 1575.42 MHz, C/A code	
Max. Altitude	< 50,000 m	
Max. Velocity	< 500 m/s	
Position Accuracy	Autonomous: 2.5 m SBAS: 2.0 m	
Sensitivity	Tracking = Up to -161 dBm Cold start = Up to -148 dBm	
1 PPS	Pulse per second output (Default 100 ms pulse/sec)	
COM Ports		
Ports	1x RS-232, 1x RS-485	
Baud Rate	1200 ~ 115200 bps	
Data Format	N81, N82, E81, O81	
Protocol	RS-232: DCON, Modbus RTU or NMEA 0183 (9600 bps, N81 fixed) RS-485: DCON, Modbus RTU or NMEA 0183 (9600 bps, N81 fixed)	
LED Indicators		
Indicators	3 x GNSS 1 x 1 PPS 1 x Power/Communication 1 x DO	

Model	GPS-721U-MRTU	GPS-721U-MRTU-UTA
Digital Output		
Channels	1 (Sink)	
Type	Non-isolated Open Collector	
Load Voltage	+5 VDC ~ +30 VDC	
Load Current	100 mA	
Power		
Input Range	+10 VDC ~ +30 VDC (Non-regulated)	
Consumption	2.5 W	
Protection	Power reverse polarity protection	
Mechanical		
Casing	Plastic	
Dimensions(mm)	72 x 117 x 35 (W x L x D)	
Weight	200 g	
Environment		
Operating Temperature	-25°C ~ +75°C	-40°C ~ +75°C
Storage Temperature	-40°C ~ +80°C	
Humidity	5 ~ 95% RH, Non-condensing	

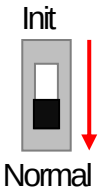
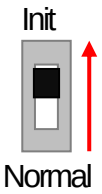
2.2. Appearance





INIT/Normal Switch

Putting the Init/Normal switch on the back of the GPS-721U-MRTU to the Init or Normal position, and then powering on the module can start up the module in different modes.

Normal mode (Default)	
	In Normal mode, the module will operate based on the user's settings. During normal operation of the module, the switch should be set to the Normal position.
Init mode	
	In Init mode, a connection can be established using the default settings. It can be used to reset the module's communication parameters ● Protocol: DCON ● Module Address: 00 ● Baud Rate: 9600bps ● Checksum: Disabled

In the case of applications using the DCON protocol, changing certain configuration parameters requires manual switching the Init/Normal switch to the INIT position. Then put the switch back to the Normal, and restart the device for the settings to take effect.

If the GPS-721U-MRTU is installed in a place where it is difficult to adjust the switch on the back of the device, the Soft INIT function can be used to remotely setting these parameters. Refer to Chapter 1.1 of DCON Command Set for GPS-721U-MRTU Series Module.

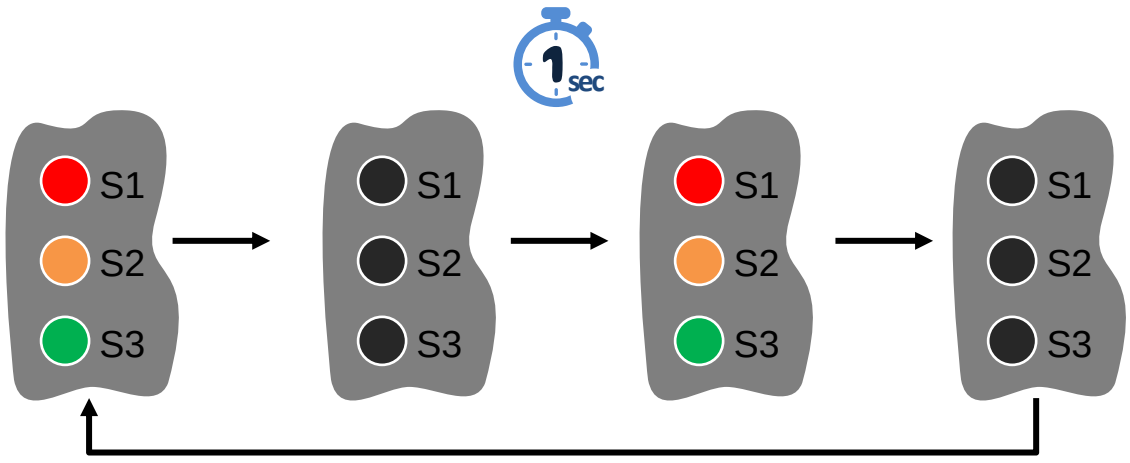
LED Indicators

LED	State	Description
Sys.	ON	The module is functioning correctly.
	OFF	There is an error with the module.
DO1	ON	The digital output status is on.
	OFF	The digital output status is off.
S1	ON	The number of signals received from GNSS satellites is less than 5.
	OFF	The module cannot receive any signals from satellites.
S2	ON	The number of signals received from GNSS satellites is 5 ~ 8.
	OFF	The number of signals received from GNSS satellites is less than 5.
S3	ON	The number of signals received from GNSS satellites is more than 8.
	OFF	The number of signals received from GNSS satellites is less than 8.
1PPS	ON	The 1PPS signal is active
	OFF	The 1PPS signal is inactive

In addition to displaying the number of GPS/GLONASS satellites in Normal mode, LED indicators S1 ~ S3 are also used to display the Init mode or NMEA transmission mode in which the module is running, allowing users to easily identify the module mode from its appearance.

Init mode: S1, S2 and S3 are off

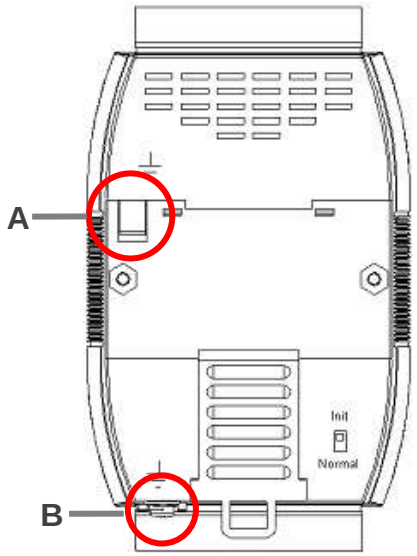
NMEA transmission mode: Transmitting NMEA sentences via RS-232 and RS-485
When the NMEA transmission mode is enabled, the LED S1 ~ S3 flash together, about twice in a second



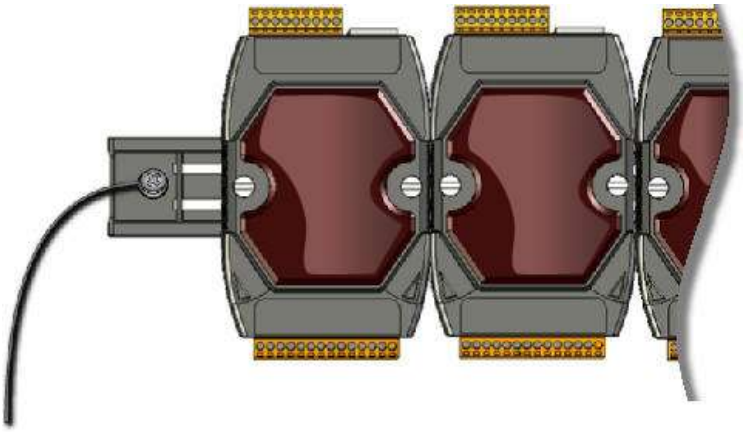
Note:
During NMEA transmission mode operation, the GPS-721U-MRTU will continue to transmit NMEA sentences through the RS-485 port. Therefore, communication between the host and other devices on the same RS-485 is not available.

Frame Ground

The GPS-721U-MRTU series module is designed with two frame ground contact points; they are placed on the back of the module as shown below. When mounted to a DIN rail, point A and the DIN rail are in contact. Thus, protection can be achieved by also connecting the DIN rail to earth ground.



Alternatively, connect the lower frame ground terminal (point B) to a wire and connect the wire to the earth ground to provide a better protection for the module.



Earth Ground

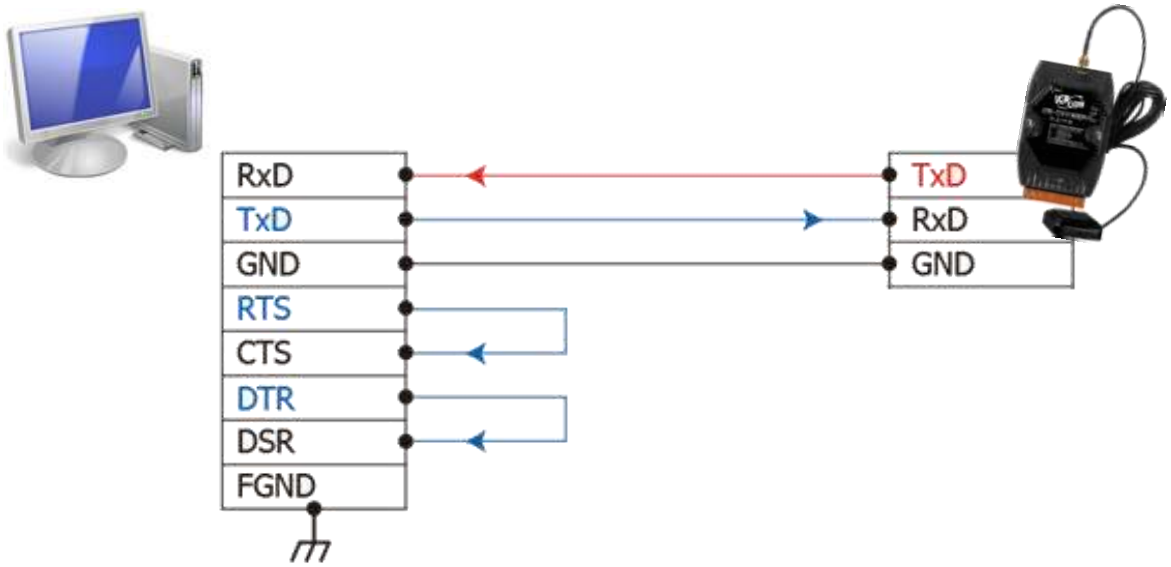
2.3. Pin Assignments

Terminal No.	Pin Assignment
01	1 PPS
02	DO.PWR
03	DO1
04	GND
05	TxD
06	RxD
07	D+
08	D-
09	(R)+Vs
10	(B)GND

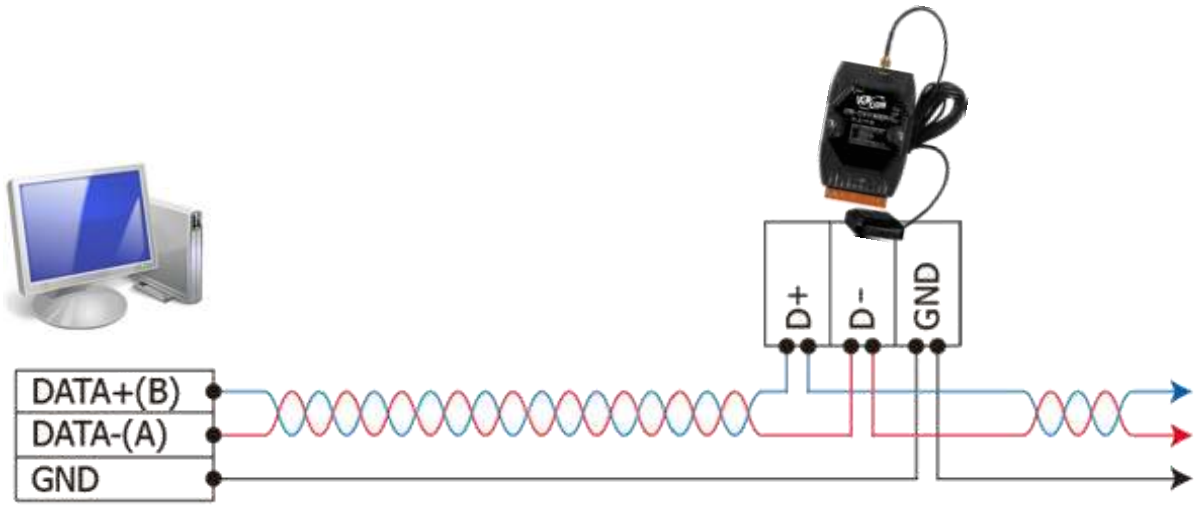
(R)+Vs/(B)GND	V+ and Ground Pins for Power Supply. (+10 ~ +30 VDC)
TxD/RxD/GND	RS-232 Wiring
D+/D-	RS-485 Wiring
DO.PWR	Power Input for DO1 and 1PPS.

2.4. Wiring Connection

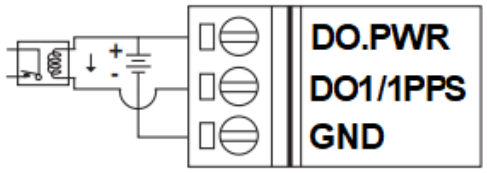
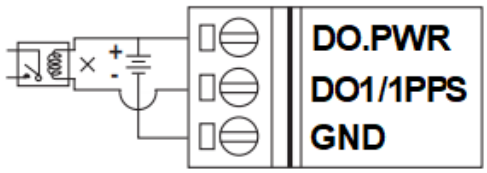
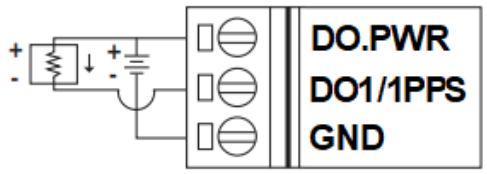
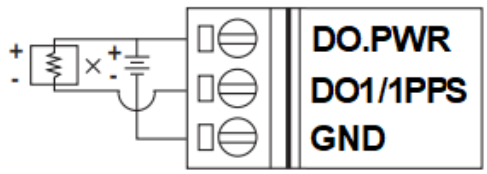
RS-232 Wiring



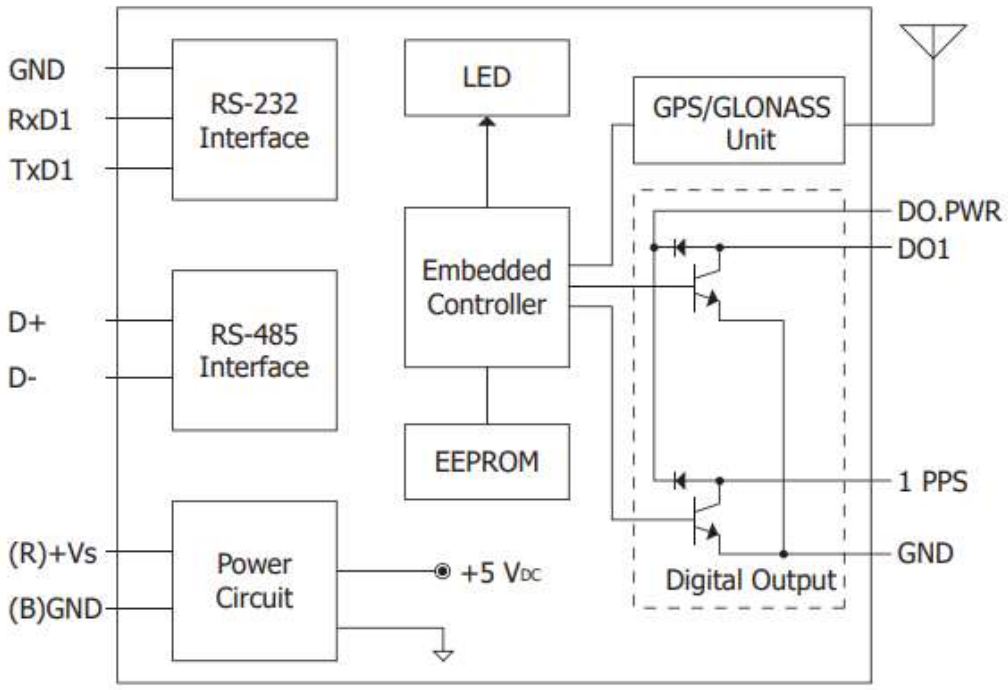
RS-485 Wiring



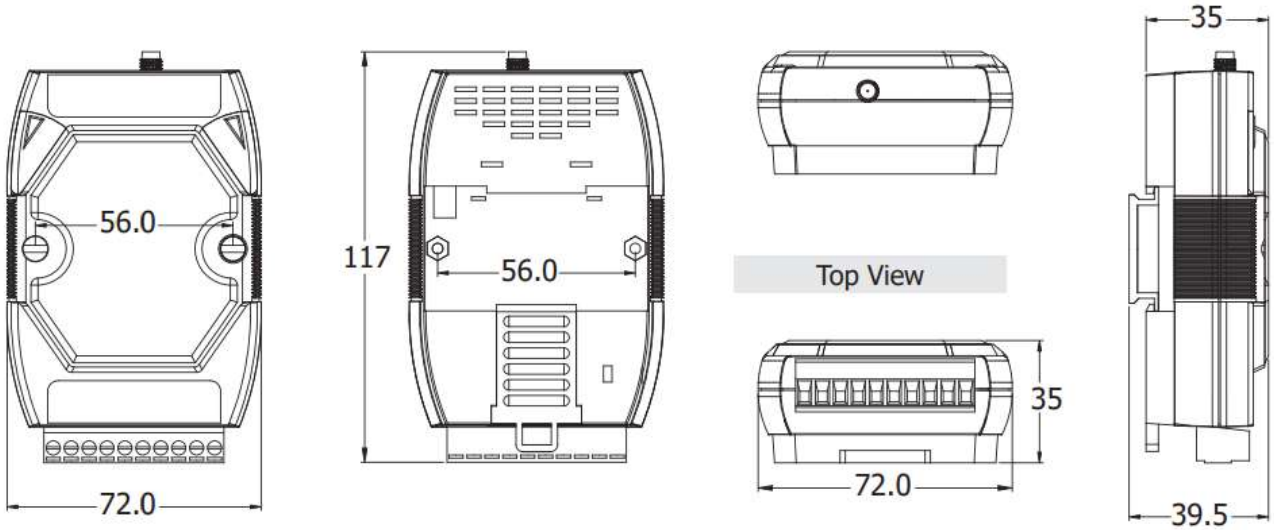
DO1/1PPS Wiring

Output Type	ON State (LED ON, Readback as 1)	OFF State (LED OFF, Readback as 0)
	Relay ON	Relay OFF
Drive Relay		
Resistance Load		

Internal I/O Structure



2.5. Dimensions

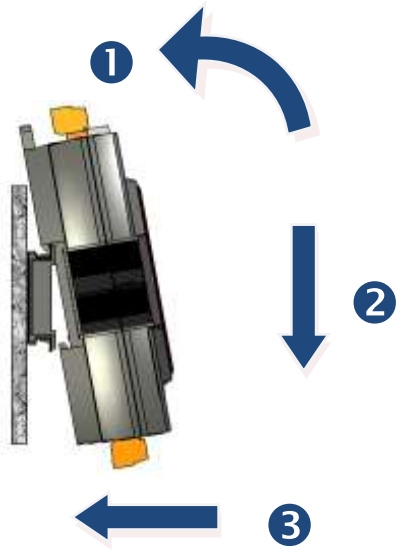
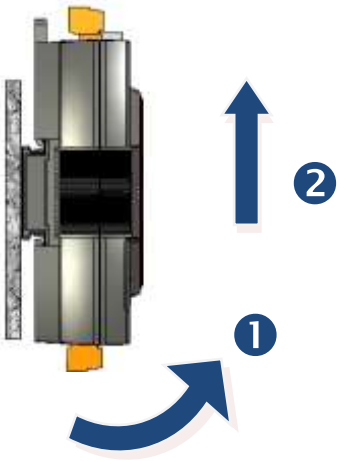


2.6. Mounting

The GPS-721U-MRTU series module can be mounted by attaching the rear of the chassis to a DIN-Rail, or be piggybacked to another module.

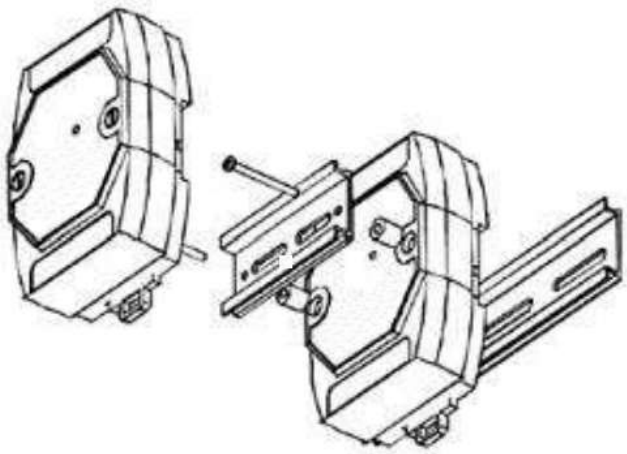
DIN-Rail Mounting

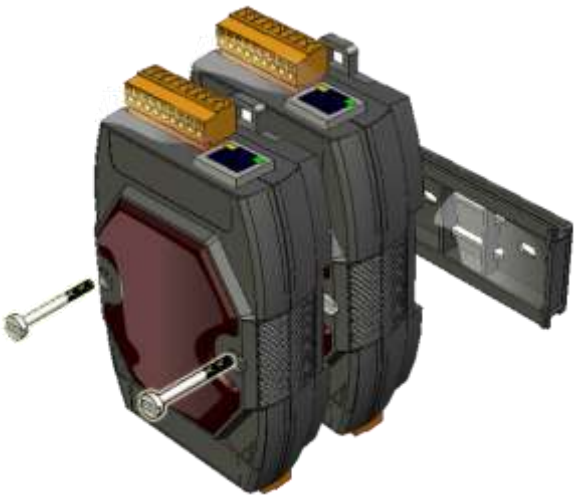
The GPS-721U-MRTU series module contains simple rail clips to enable it to be reliably mounted on a standard 35 mm DIN rail.

Mounting on a DIN-Rail	Dismounting from a DIN-Rail
	

Piggyback Mounting

With the piggyback holder, the GPS-721U-MRTU series module can be securely attached to another module for piggyback mounting in a compact space**.**

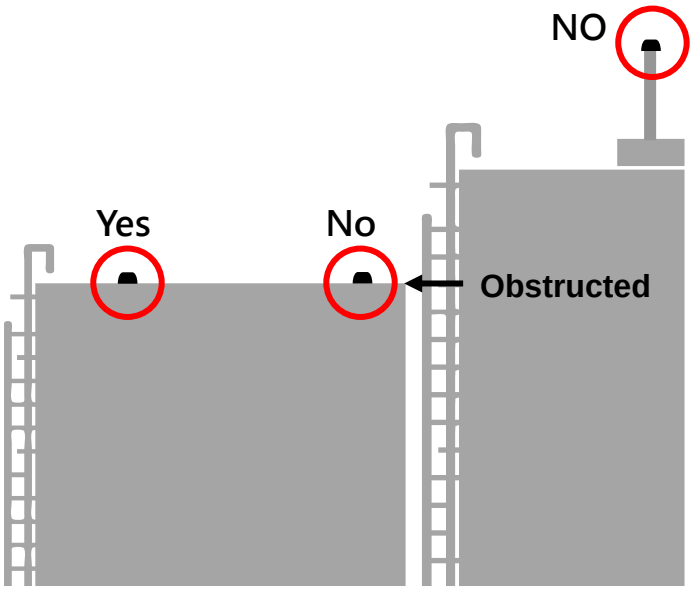




Antenna Installation

The antenna ANT-115-03-2 included with the GPS-721U-MRTU series module has a 5m signal cable, a strong magnetic base and IPX6 waterproof protection. The long cable allows bringing the antenna outside and mounting it with the included magnet, or double-sided tape.

When installing the antenna, try to choose an open location and avoid places surrounded by trees, houses and other large obstructions. If you have GNSS reception issues, try testing a few locations before choosing the final location to be sure the antenna is not impacted by other antennas. If using two or more GPS/GLONASS antennas, keep a distance of more than 2m. It is recommended to install the antennas in different locations to prevent simultaneous interference.



To avoid lightning, do not install the antenna at the highest point of its surrounding area, or consider installing a lightning arrester to protect the antenna.

3. Getting Started

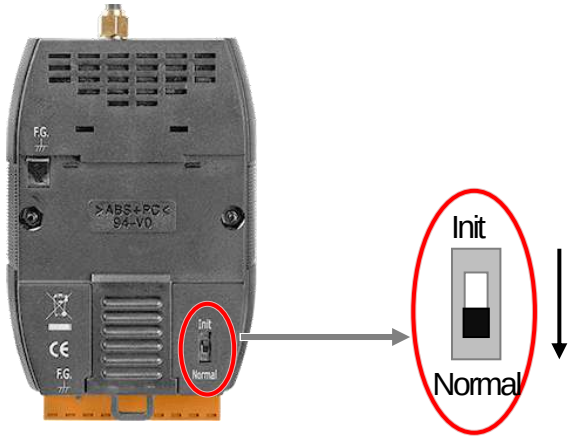
In this chapter, we will briefly explain steps for how to set up a new module. Before starting the configuration, download DCON Utility Pro from the following link and install the software on your computer.

https://www.icpdas.com/en/product/guide+Software+Utility_Driver+DCON__Utility__Pro

The default communication parameters of the GPS-721U-MRTU series module are shown in the table below.

Default Configuration	
Protocol	Modbus RTU
Address	1
Baud Rate	9600 bps
Data Format	N81
Checksum	Disabled

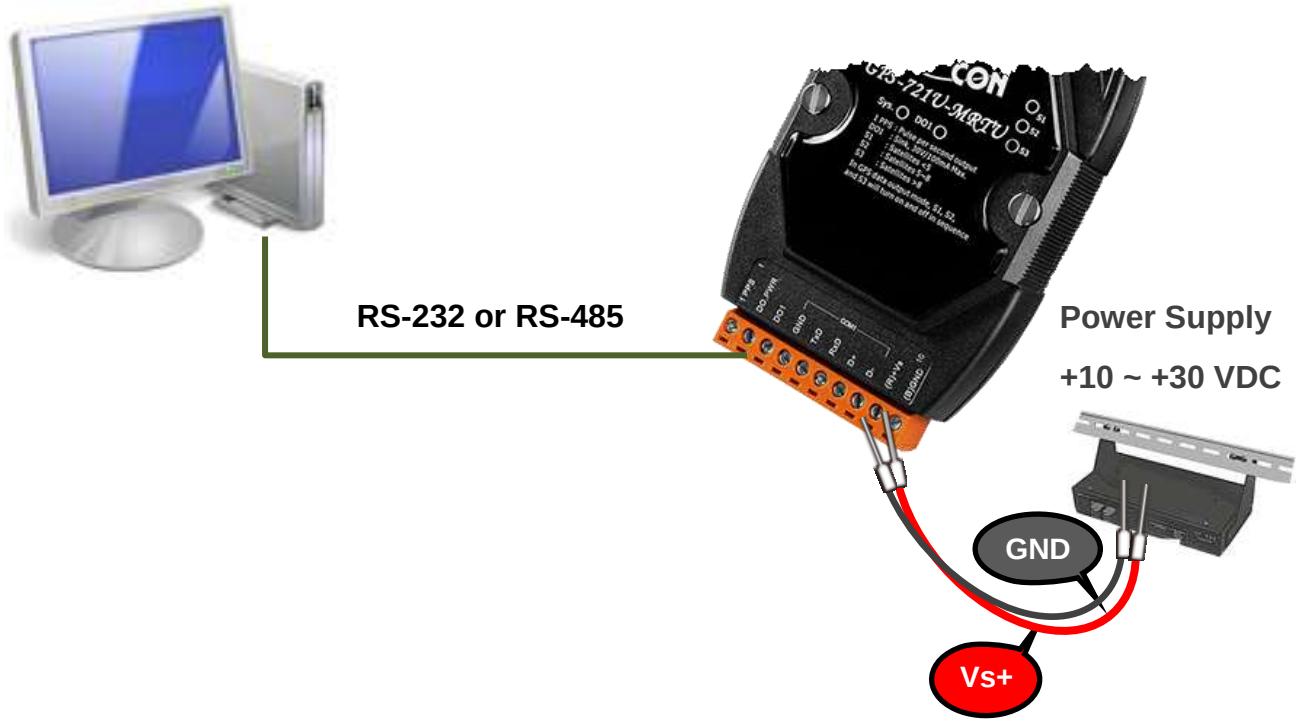
Before modifying the communication parameters of GPS-721U-MRTU series module, ensure that the Init/Normal switch is put in the **Normal** (down) position.



When modifying baud rate, checksum, or using ~AAMN or $AAPN commands to change transmission mode or protocol, the Init/Normal switch needs be set to the “Init” position. After completing the configuration, restore the switch to the “Normal” position, and then restart the module for the new settings to take effect.

3.1. Connecting the Power Supply and the Host PC

Refer to Section 2.4 for details to connect the PC and GPS-721U-MRTU series module with RS-232 or RS-485 interface, connect the power supply and turn it on.

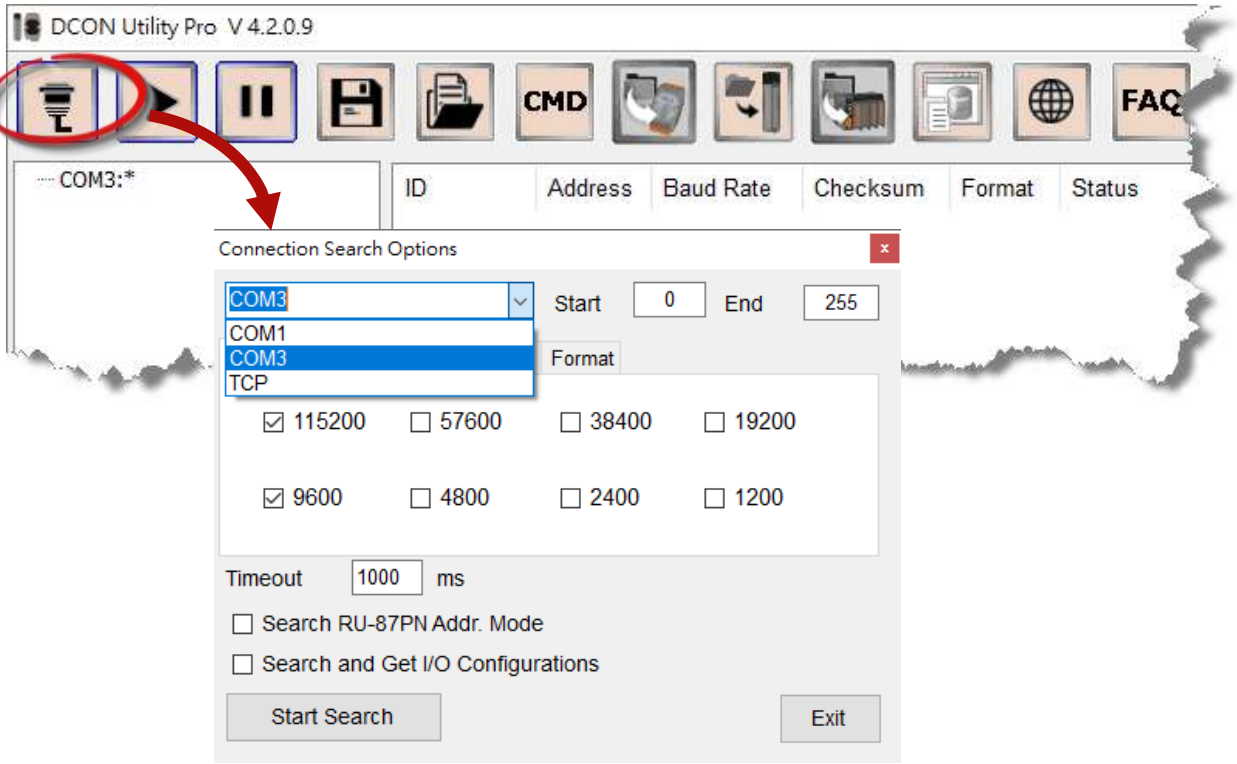


3.2. Configuring Communication Parameters

The latest version of DCON Utility Pro can be downloaded from the ICP DAS website.

https://www.icpdas.com/en/download/index.php?root=&kw=DCON%20Utility

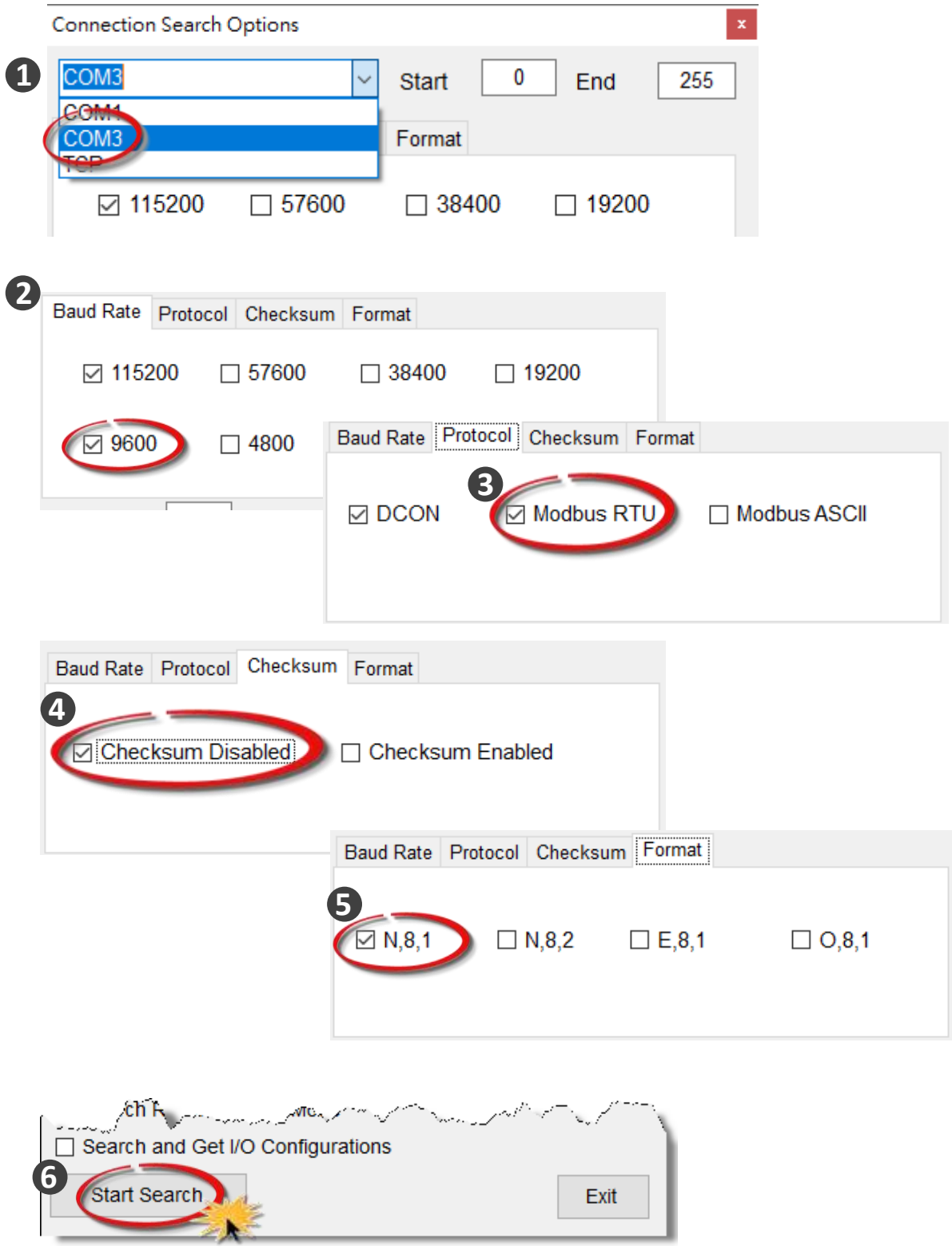
1. Launch the DCON_Utility_Pro.exe
2. Click the "**Search Servers**" icon to set the communication parameters for searching the GPS-721U-MRTU series module.



Note

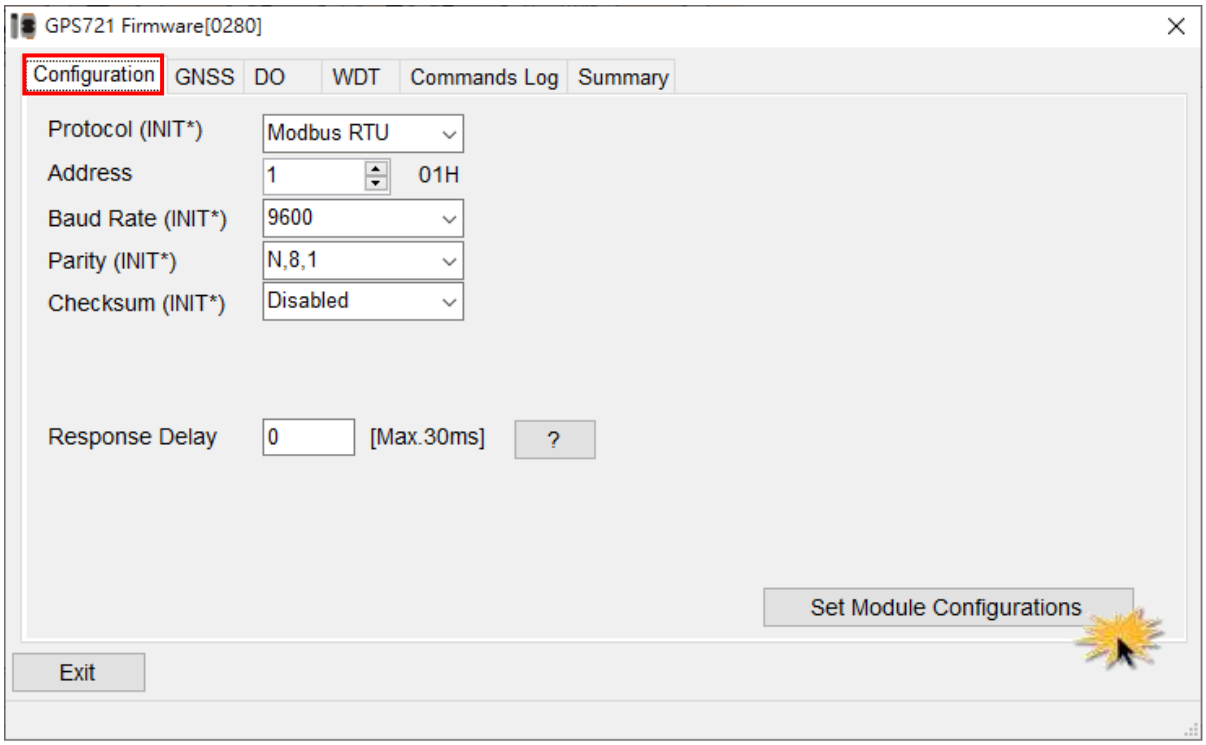
If there are multiple RS-485 modules waiting to be configured, it is recommended to connect one module at a time, set a unique address for each, and then connect all the modules to the RS-485 network.

3. Select the COM port number to which the GPS-721U-MRTU is connected, make sure that the checkboxes of baud rate 9600, protocol Modbus RTU, Checksum disabled and data format N,8,1 are checked, and then click the "**Start Search**" button.



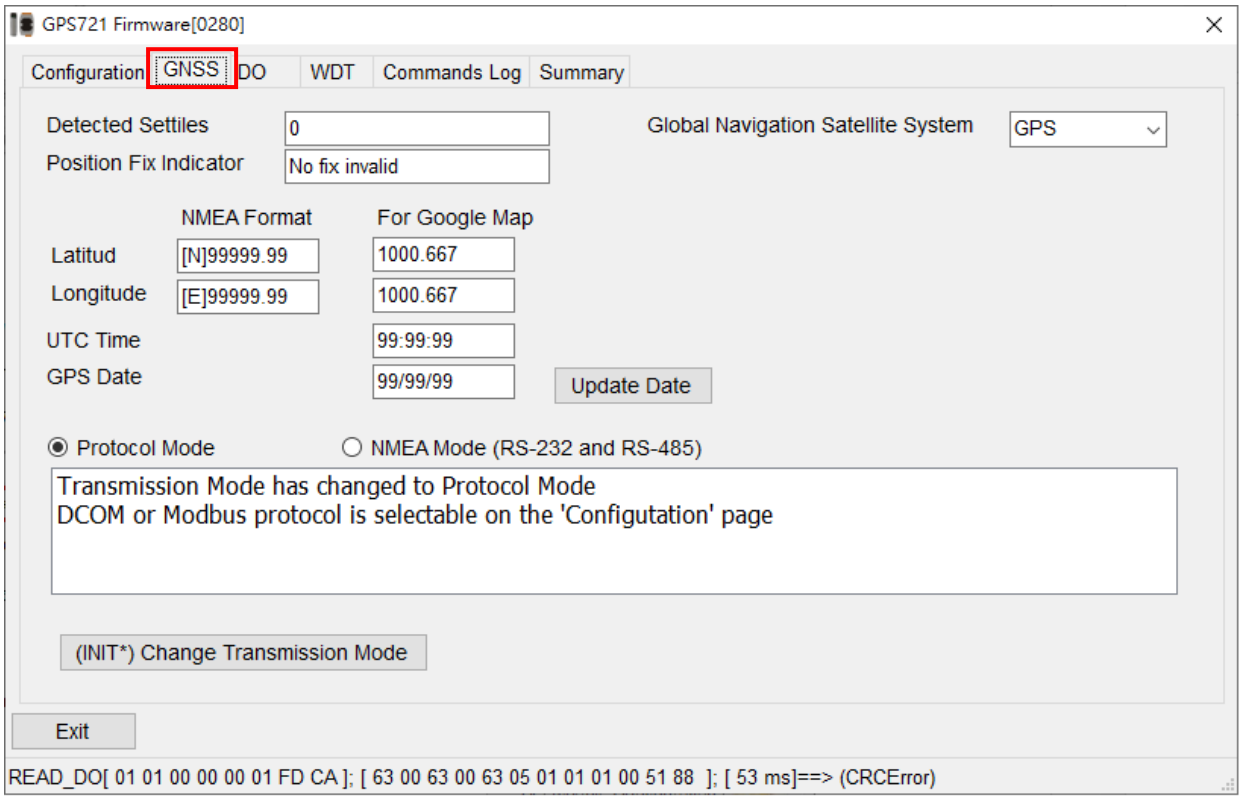
4. Click the module name shown in the search results field.

5. Modify communication parameters according to usage requirements and click the ***Set Module Configuration*** button to update the changes. Keep in mind to put the Init/Normal switch to the Init before modifying baud rate, checksum or protocol.



3.3. Getting GNSS Information

On the GNSS page, you can browse GNSS information such as coordinates, time and detected satellites. The transmission mode can be set on this page to receive NMEA sentences via RS-232 or RS-485 port (which is selectable with wiring).



Note:

1. If there are insufficient GNSS satellites in view, the data will be set to 9.
2. Remember to put the Init/Normal switch to the Init position before clicking the "***(INIT*) Change Transmission Mode***" button to update the mode.
3. If NMEA Mode (RS-232 and RS-485) is enabled, NMEA sentences will be continuously transmitted from the RS-485 port. Therefore, communication between the host and other devices on the same RS-485 is not available.
4. The NMEA 0183 messages are transmitted at a fixed speed of 9600 bps with a data format of N81. Configure the host to use the same settings to receive messages.

4. Configuration

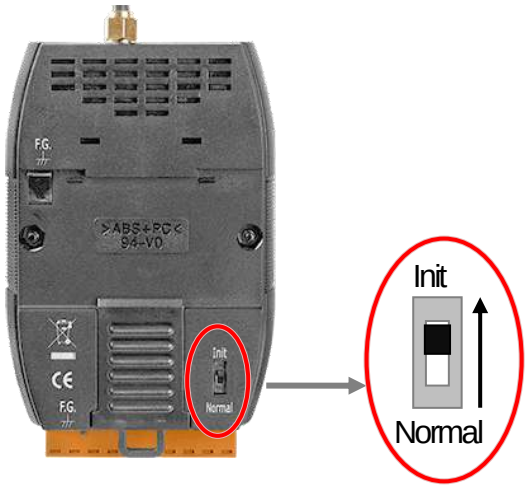
DCON Utility Pro is a toolkit for users to easy to search, configure and test remote I/O modules via RS-232 or RS-485 on Windows PC or ICP DAS PAC.

The latest version of DCON Utility Pro can be downloaded from our website at https://www.icpdas.com/en/download/index.php?root=&kw=DCON%20Utility

4.1. Init Mode

After setting the Init/Normal switch on the back of the GPS-721U-MRTU series module to the “Init” position and restarting the module, a connection can be established using the following module address and communication settings, allowing new parameters for the module to be set.

Init Mode Configuration	
Protocol	DCON
Address	0
Baud Rate	9600 bps
Data Format	N81
Checksum	Disabled



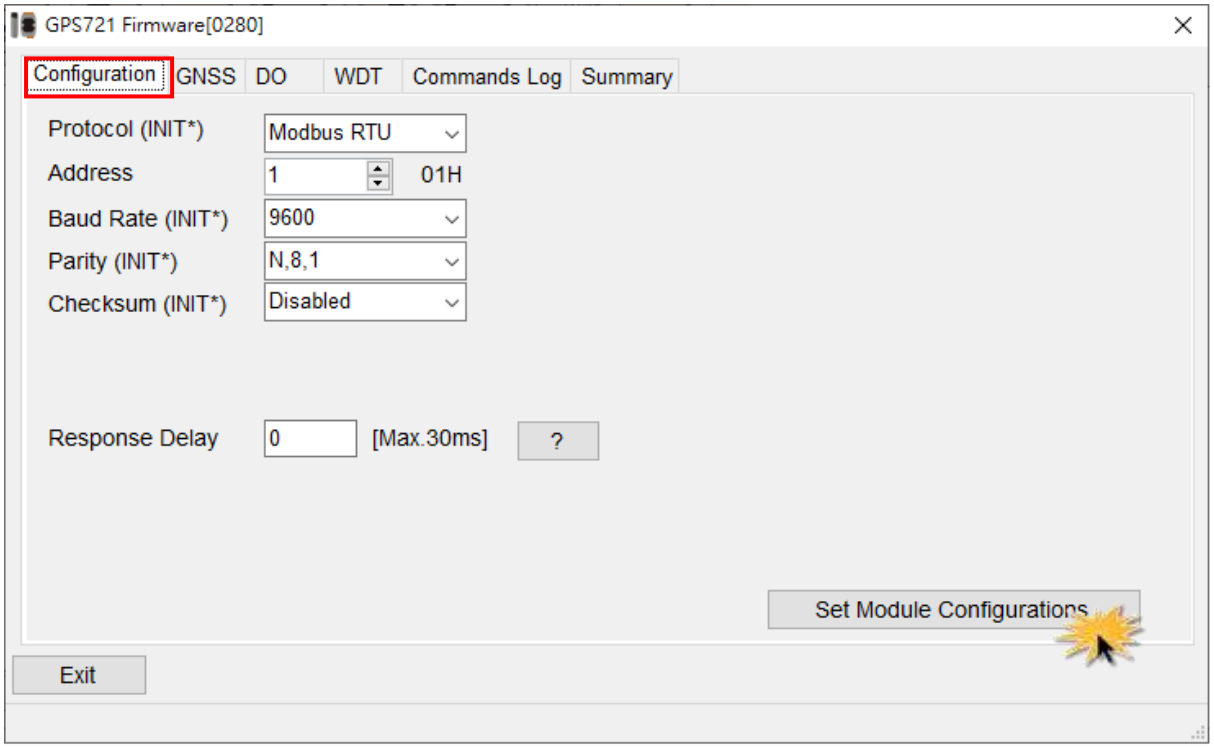
Normal mode is used for normal operation and parameter settings. However, when the communication parameters are lost and DCON Utility Pro cannot search the module, enabling the Init mode for module search and parameters settings is a quick and effective solution.

4.2 Communication

The default communication parameters of the GPS-721U-MRTU series module are listed as follows.

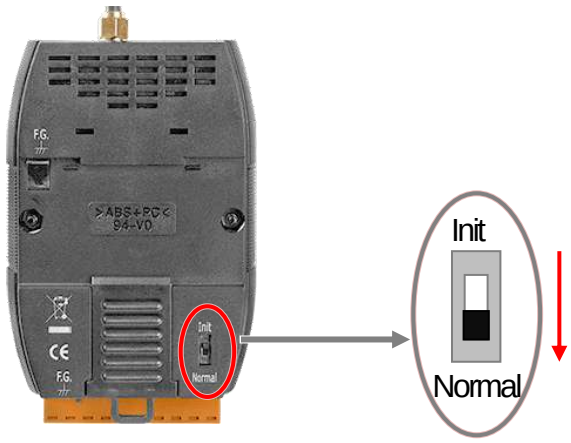
Default Configuration	
Protocol	Modbus RTU
Address	1
Baud Rate	9600 bps
Data Format	N81
Checksum	Disabled

1. Follow the instructions in Section 3.2 to search for the GPS-721U-MRTU module and click the module name to open the configuration window.



2. Modify the parameters on the Configuration page as required and click the "***Set Module Configuration***" button to update the parameters.

Before clicking “***Set Module Configuration***” to update baud rate and/or checksum, the Init/Normal switch needs be set to the “Init” position. After completing the configuration, restore the Init/Normal switch to the “Normal” position, and then restart the module for the new settings to take effect.



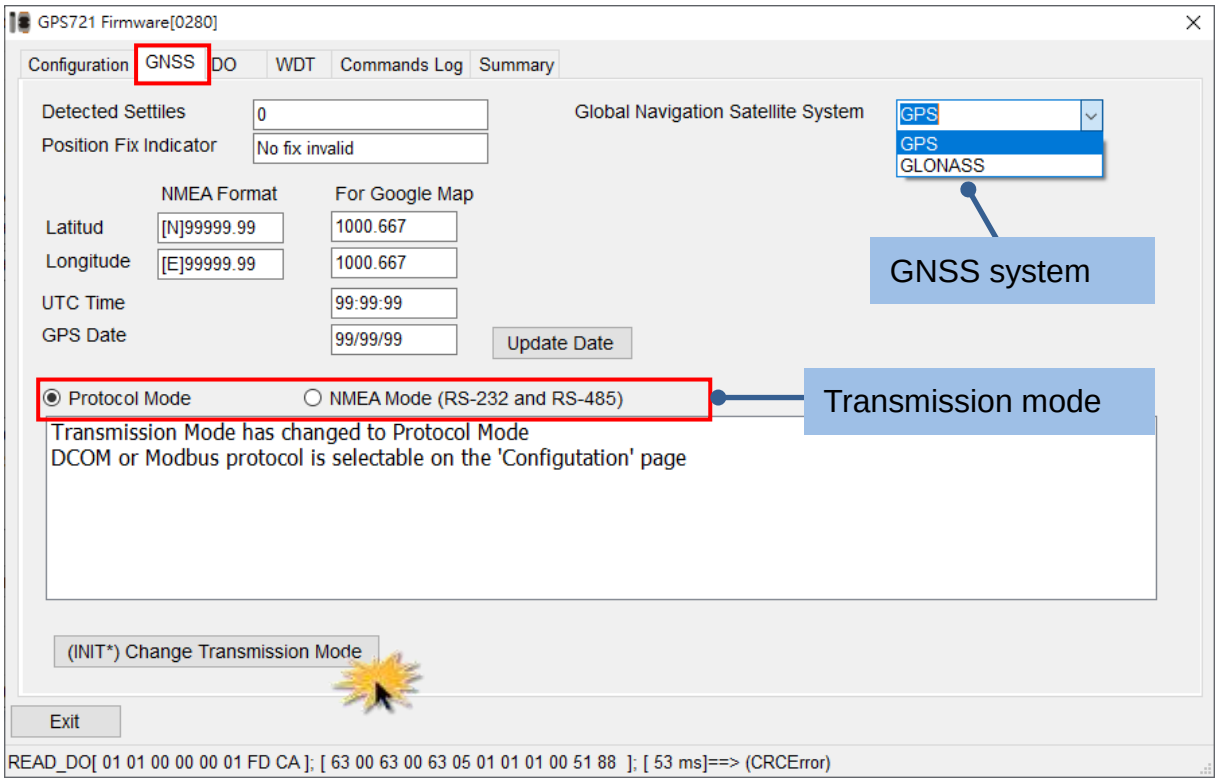
4.3 GNSS

The GNSS information including detected satellites, fix indicator, latitude, longitude, date and time are displayed on the GNSS page. The GPS-721U-MRTU series module provides the following two transmission modes for users to receive information.

Protocol Mode: Read the GNSS information with DCON or Modbus RTU protocol

NMEA Mode (RS-232 and RS-485): Continuously transmit NMEA sentences via RS-232 or RS-485 port (selectable with wiring).

You can change the transmission mode as required by selecting one from the three options and click the ***(INIT*) Change Transmission Mode*** button to update the change.

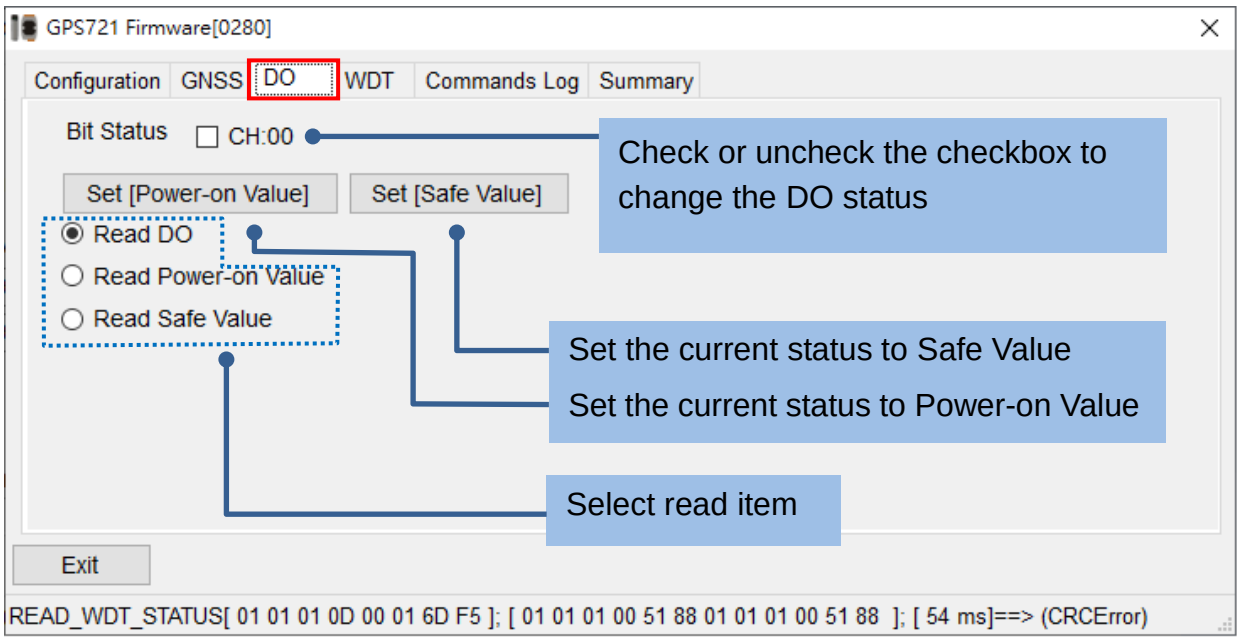


Note:

1. If there are insufficient satellites in view, the GNSS data will be set to 9.
2. Remember to put the Init/Normal switch to the Init position before clicking the "***(INIT*) Change Transmission Mode***" button to update the mode.
3. If NMEA Mode (RS-232 and RS-485) is enabled, NMEA sentences will be continuously transmitted from the RS-485 port. Therefore, communication between the host and other devices on the same RS-485 is not available.
4. The NMEA 0183 messages are transmitted at a fixed speed of 9600 bps with a data format of N81. Configure the host to use the same communication parameters to receive messages.

4.4 DO

The DO channel can be controlled with DCON or Modbus RTU command to turn on or turn off an equipment or alert device. The dual watchdog function allows user to set power on value and safe value for the DO. Every time the module is powered-on or restart, the power on value will be loaded to the DO channel. When the host watchdog is enabled and a timeout event occurs, the safe value will be loaded to the DO channel.



Note:

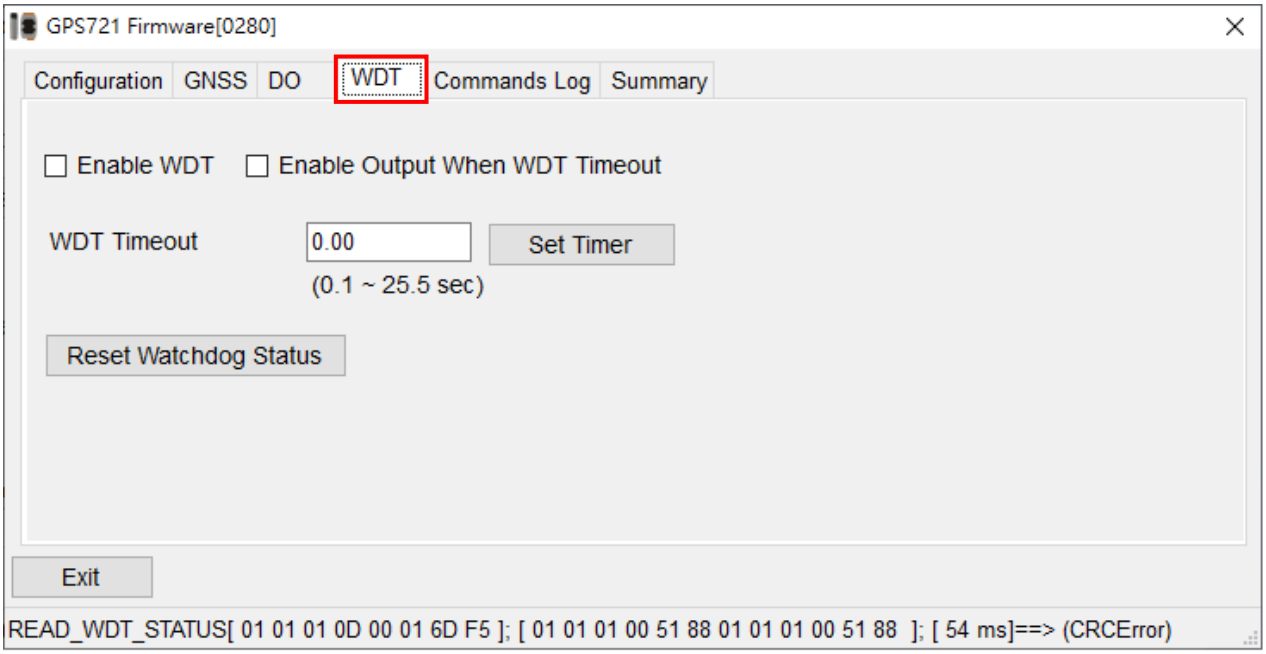
1. During the Host Watchdog timeout alarm period, the DO will stay in Safe value to prevent unintended operation, until the timeout event is cleared.
2. When Modbus RTU protocol is using, users can enable the function of controlling DO without clearing the timeout event if necessary. (Modbus register 00260)
3. When DCON protocol is used, the DO can be controlled again only after clearing the timeout event by using the command “~AA1”.

4.5 Host Watchdog

Host Watchdog is a software function designed to monitor the RS-485 communication status between the GPS-721U-MRTU series module and the host after being enabled. If the host PC does not send DCON command "~**" or Modbus command within the WDT Timeout period, the Host Watchdog will announce a timeout error and turn the DO to safe value to prevent unintended operation during the period of timeout event.

The Host Watchdog function can be tested by following the steps below:

1. Enter the timeout period in the relevant field and click the "***Set Timer***" button.
2. Check or uncheck the "**Enable Output When WDT Timeout**" checkbox to enable or disable the function of controlling DO again without clearing the timeout event.
3. Check the **Enable WDT** checkbox to enable the host watchdog.
4. Send Modbus commands within every time period set by WDT timeout to prevent timeout error.
5. Stop sending Modbus commands and allow Host Watchdog timeout to occur.
6. If the "**Enable Output When WDT Timeout**" checkbox is not checked, click the "***Reset Watchdog Status***" button to clear the timeout error.



5. Applications

If the GPS-721U-MRTU series module is unable to receive a GPS/GLONASS signal, check the position of the antenna. If the problem persists, try repositioning the GNSS antenna in an outdoor location.

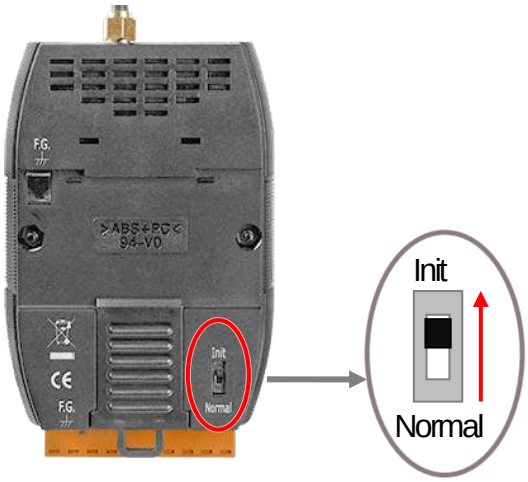
5.1. Receiving NMEA Sentences via RS-232 or RS-485

The "**NMEA mode (RS-232 and RS-485)**" of the GPS-721U-MRTU series module enables users to receive NMEA sentences through RS-232 or RS-485 interface. You can obtain coordinates, altitude, time and more informaiton at exactly one second interval.

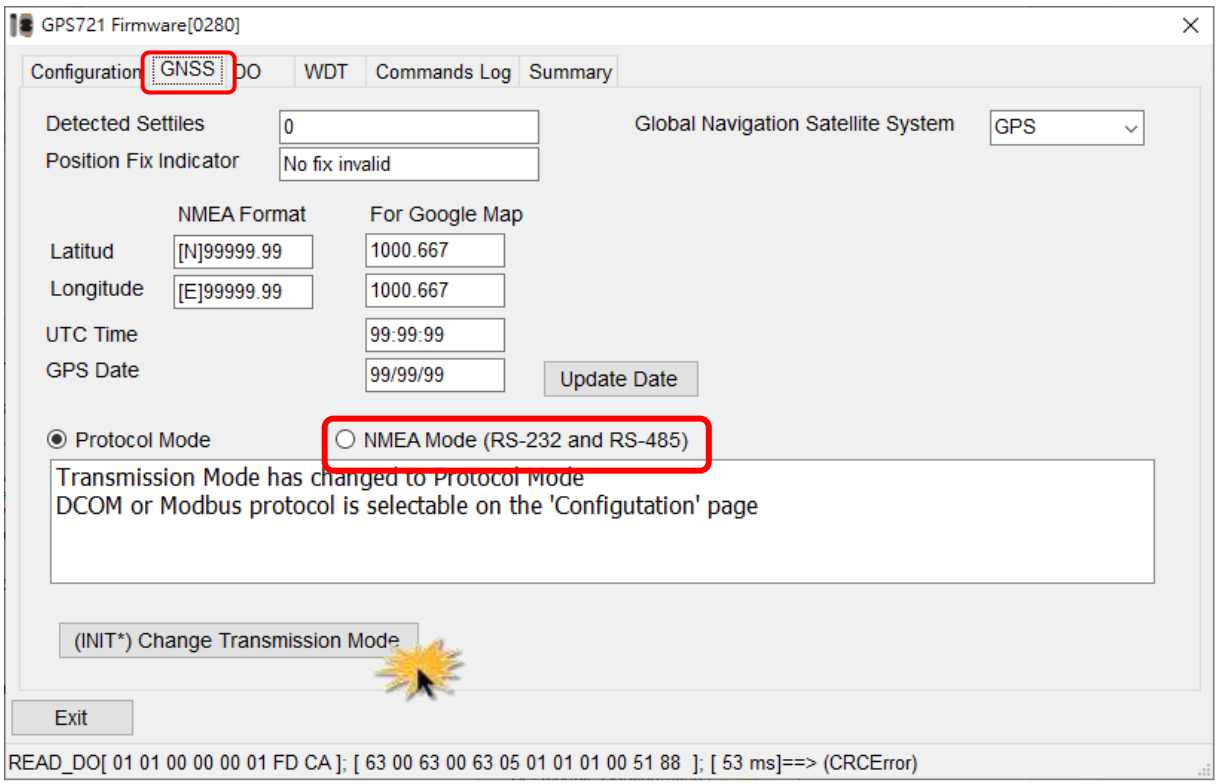
Note:

1. If there are insufficient satellites in view, the GNSS data will be set to 9.
2. Remember to put the Init/Normal switch to the Init position before clicking the "***(INIT*) Change Transmission Mode***" button to update the mode.
3. During NMEA transmission mode operation, NMEA sentences will be continuously transmitted from the RS-485 port. Therefore, communication between the host and other devices on the same RS-485 is not available.
4. The NMEA 0183 messages are transmitted at a fixed speed of 9600 bps with a data format of N81. Configure the host to use the same communication parameters to receive messages.

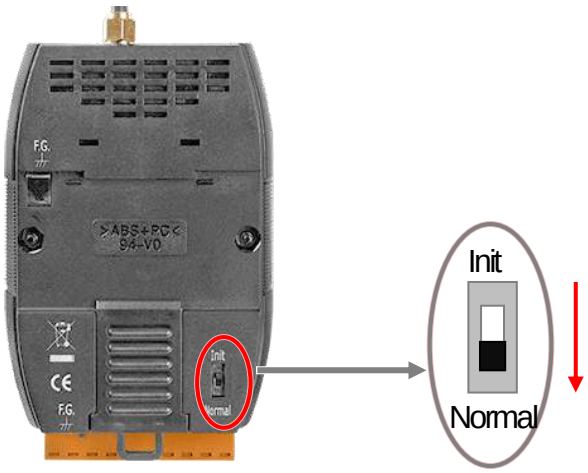
1. Refer to Section 3.1, connect the RS-232 or RS-485 port on the GPS-721U-MRTU series module to the computer, put the Init/Normal switch to the Init position, and turn on the power of the module.



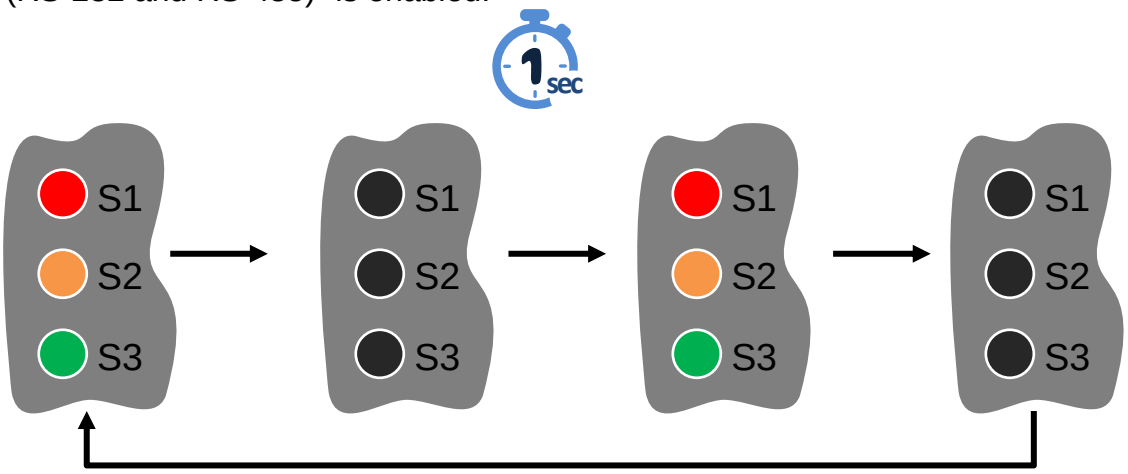
2. Launch DCON_Utility_Pro.exe, search the module, select the "**NMEA Mode (RS-232 and RS-485)**" and click the "*(INIT*) Change Transmission Mode*" button.



3. Put the Init/Normal switch to the Normal position, and then power cycle the module.



After the module starts again, the LED indicators S1, S2 and S3 will flash about twice a second in synchrony to indicate that the transmission mode of “NMEA Mode (RS-232 and RS-485)” is enabled.



4. Parse the required information from the received NMEA sentences

The GPS-721U-MRTU series module will transmit a subset of NMEA-0183 sentences as soon as it identifies satellites within its range. NMEA 0183 sentences are transmitted as ASCII characters, begin with $ and end with a carriage return and a line feed. Data fields follow comma (,) delimiters are variable in length. Null fields still follow comma (,) delimiters, but contain no information.

The GPS-721U-MRTU will transmit a subset of NMEA 0183 sentences in a fixed order every second. Take messages from GPS satellite system as an example, which contains:

$GPGGA: Time, position, and fix related data
$GPGSA: GPS DOP and active satellites
$GPGSV: GPS Satellites in view
$GPGLL: Position data: position fix, time of position fix, and status
$GPRMC: Recommended minimum specific GPS/Transit data
$GPVTG: Actual track made good and speed over ground

The first field is the message header, which consists of a 2-character talker ID and a 3-character sentence type. The talker ID “GP” indicates that it was transferred from a GPS receiver, and “GL” indicates that it was received from a GLONASS receiver.

The following is a piece of content extracted from the message returned by the GPS-721U-MRTU,

```
$GPGGA,053244.00,2451.70598,N,12100.99089,E,2,10,0.87,100.1,M,16.2,M,,0000*52
$GPGSA,A,3,02,07,21,17,08,14,27,16,30,09,,,1.30,0.87,0.96*05
$GPGSV,4,1,16,01,44,189,35,02,72,162,42,03,04,166,,04,05,189,17*79
$GPGSV,4,2,16,07,58,295,38,08,47,022,35,09,13,227,30,10,01,057,19*7F
$GPGSV,4,3,16,14,10,306,29,16,17,096,30,17,11,251,30,21,74,095,40*75
$GPGSV,4,4,16,27,17,048,33,30,28,314,36,40,13,259,32,50,60,166,37*74
$GPGLL,2451.70598,N,12100.99089,E,053244.00,A,D*6A
$GPRMC,053245.00,A,2451.70599,N,12100.99090,E,0.033,,290224,,,D*74
$GPVTG,,T,,M,0.033,N,0.061,K,D*21
```

The format and content of supported NMEA messages are described as follows:

GGA is the most commonly used NMEA message type; it contains information about location and time, such as latitude, longitude, altitude, and UTC time.

Format: $GPGGA,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11>,<12>,<13>,<14>*hh

Example: $GPGGA,085548.000,2237.8465,N,12018.4326,E,1,06,1.2,60.6,M,18.7,M,,0000*61

Field	Description	Format	Example
0	Message header	$GPGGA	$GPGGA
1	UTC time	hhmmss.sss	085548.000
2	Latitude	ddmm.mmmm	2237.8465
3	N/S indicator	N = North, S = South	N
4	Longitude	dddmm.mmmm	12018.4326
5	E/W indicator	E = East or W = West	E
6	GPS Quality indicator	Value Description 0 Fix not valid 1 GPS fix 2 Differential GPS fix 3 Not applicable 6 INS Dead reckoning	1
7	Satellites in used	Range from 00 through to 24+	06
8	HDOP	x.x	1.2
9	Orthometric height (MSL reference)	x.x	60.6
10	Unit of orthometric height	M (in meters)	M
11	Geoid separation	x.x	18.7
12	Unit of geoid separation	M (in meters)	M
13	Age of correction data	xx (in seconds)	
14	Differential base station ID	0000 - 1023	0000
15	Checksum	*hh	*61
16	Terminator	<CR><LF>	<CR><LF>

GSA message contains GNSS receiver operating mode, satellites and DOP values.

Format: $GPGSA,<1>,<2>,<3>,<3>,,,,,<3>,<3>,<3>,<4>,<5>,<6>*hh

Example: $GPGSA,A,3,02,07,21,17,08,14,27,16,30,09,,,1.30,0.87,0.96*05

Field	Description	Format	Example
0	Message header	$GPGSA	$GPGSA
1	Operation mode	M= Manual, forced to operate in 2D or 3D A = Automatically switching between 2D or 3D	A
2	Fix mode	1 = Fix not available 2 = 2D fix 3 = 3D fix	3
3	PRN number	01 to 32 for GPS 33 to 64 for SBAS 64+ for GLONASS	02,07,21,17,08,14, 27,16,30,09,,,
4	PDOP	0.5 to 99.9	1.30
5	HDOP	0.5 to 99.9	0.87
6	VDOP	0.5 to 99.9	0.96
7	Checksum	*hh	*05
8	Terminator	<CR><LF>	<CR><LF>

GSV message provides satellite information including the number of satellites in view, PRN numbers, elevation, azimuth and SNR value. Each message contains data for up to four satellites, fields 4 to 7 for one satellite will appear repeatedly. If there are more than four satellites in view, the remaining satellite data will appear in the next message.

If a satellite is visible but not tracked, the signal ID is unknown and is presented as 0.

Format: $GPGSV,<1>,<2>,<3>,<4>,<5>,<6>,<7>,….,<4>,<5>,<6>,<7>*hh
Example: $GPGSV,4,1,16,01,44,189,35,02,72,162,42,03,04,166,,04,05,189,17*79

Field	Description	Format	Example
0	Message header	$GPGSV	$GPGSV
1	Total number of GSV messages in this cycle	Ranged from 1 to 9	4
2	Number of this message	Ranged from 1 to <1>	1
3	Number of satellites in view		16
4	Satellite PRN number	GPS : 1 ~ 32 GLONASS = 65 to 96	01
5	Elevation	Units: degrees, 90 maximum	44
6	Azimuth	000 ~ 359.9 degrees with true North as 0 degrees	189
7	SNR (C/No)	00 ~ 99 dB null when not tracking	35
4,5,6,7	Second satellite	PRN number, elevation, azimuth, SNR,	02,72,162,43
4,5,6,7	Third satellite	PRN number, elevation, azimuth, SNR,	03,04,166
4,5,6,7	Fourth satellite	PRN number, elevation, azimuth, SNR,	04,05,189
8	Checksum	*hh	*79
9	Terminator	<CR><LF>	<CR><LF>

GLL message contains position data including position fix, time, and status

Format: $GPGLL,<1>,<2>,<3>,<4>,<5>,<6>,<7>*hh

Example: $GPGLL,2451.70598,N,12100.99089,E,053244.00,A,D*6A

Field	Description	Format	Example
0	Message header	$GPGLL	$GPGLL
1	Latitude	ddmm.mmmmm	2451.70598
2	North/South indicator	N = North, S = South	N
3	Longitude	dddmm.mmmmm	12100.99089
4	East/West indicator	E = East or W = West	E
5	UTC time	hhmmss.ss	053244.00
6	Data status	A= Data valid V= Data not valid	A
7	Positioning mode	A= Autonomous mode D= Differential mode E= Estimated (dead reckoning) mode N = Data not valid	D
8	Checksum	*hh	*6A
9	Terminator	<CR><LF>	<CR><LF>

RMC message is the Recommended Minimum Specific GNSS data, which contains the time, date, position, course and speed data.

Format: $GPRMC,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11>,<12>*hh
Example: $GPRMC,053245.00,A,2451.70599,N,12100.99090,E,0.033,,290224,,,D*74

Field	Description	Format	Example
0	Message header	$GPRMC	$GPRMC
1	UTC time	hhmmss.ss	053245.00
2	Position status	A= data valid, V= data invalid	A
3	Latitude	ddmm.mmmmm	2451.70599
4	N/S indicator	N = North, S = South	N
5	Longitude	dddmm.mmmmm	12100.99090
6	E/W indicator	E = East or W = West	E
7	Speed over ground	Unit: 0.1 knots or 0.1852 km/h	0.033
8	Course over ground	000 ~ 359.9 degrees with true North as 0 degrees,	
9	UTC date	DDMMYY	290224
10	Magnetic variation value	000.0 ~ 180.0 in degrees	
11	Magnetic Variation E/W Indicator	E = East or W = West	
12	Mode indicator	A= Autonomous mode D= Differential mode E= Estimated (dead reckoning) mode N= Data not valid	D
13	Checksum	*hh	*74
14	Terminator	<CR><LF>	<CR><LF>

VTG message contains course and speed information relative to the ground.

Format: $GPVTG,<1>,T,<2>,M,<3>,N,<4>,K,<5>*hh

Example: $GPVTG,,T,,M,0.033,N,0.061,K,D*21

Field	Description	Format	Example
0	Message header	$GPVTG	$GPVTG
1	Course over ground (degrees true)	000 to 359 in degrees	
2	Course over ground (degrees magnetic)	000 to 359 in degrees	
3	Speed over ground	Unit: knot	0.033
4	Speed over ground	Unit: km/h	0.061
5	Mode indicator	A= Autonomous mode D= Differential mode E= Estimated (dead reckoning) mode N= Data not valid	D
15	Checksum	*hh	*21
16	Terminator	<CR><LF>	<CR><LF>

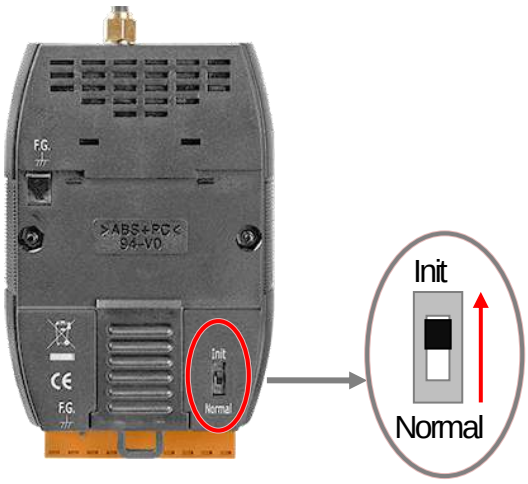
5.2. Reading Coordinates in Google Maps Format

The built-in data conversion function of the GPS-721U-MRTU series module can automatically convert NMEA data to a numeric format suitable for Google Maps. Users can obtain geographical coordinates in Google Maps format (including longitude and latitude) by sending easy-to-use DCON or Modbus commands to display the location on the map.

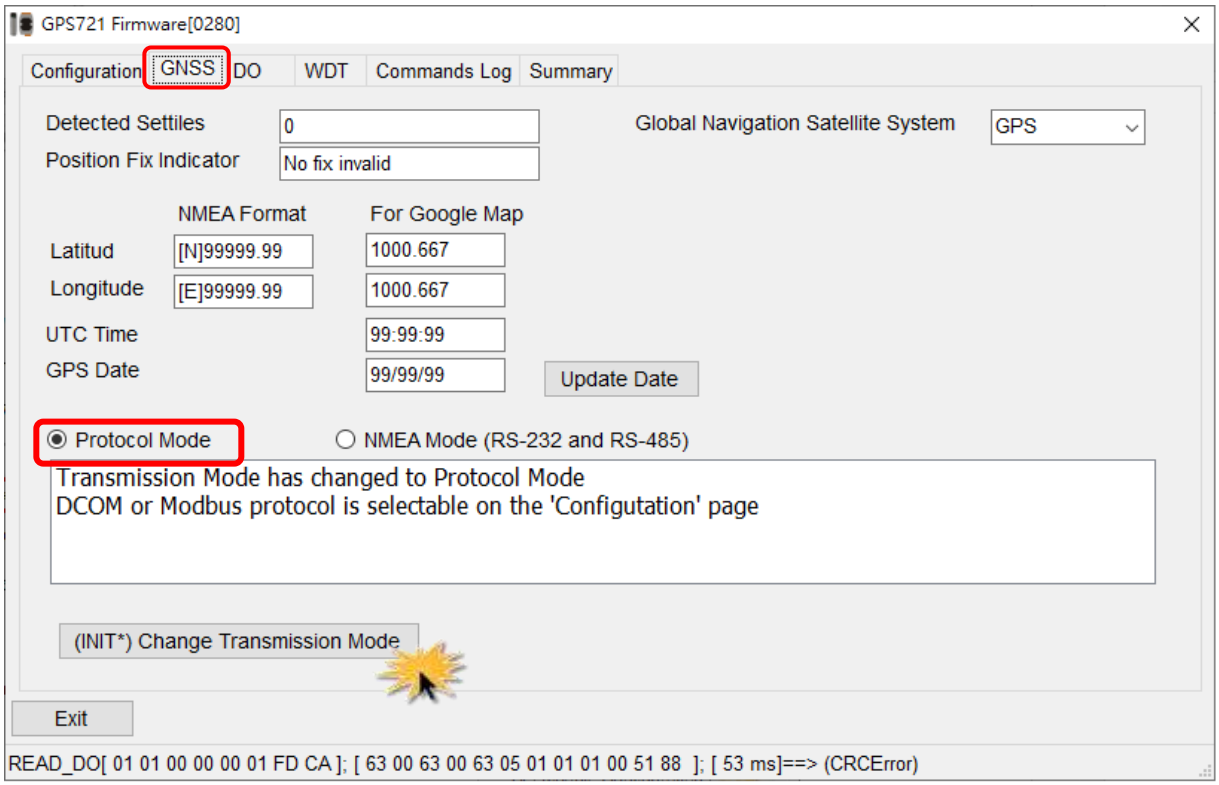
When Protocol Mode is enabled, the communication between host PC and GPS modules is available with either RS-232 or RS-485 interface.

5.2.1. Using Modbus RTU Protocol

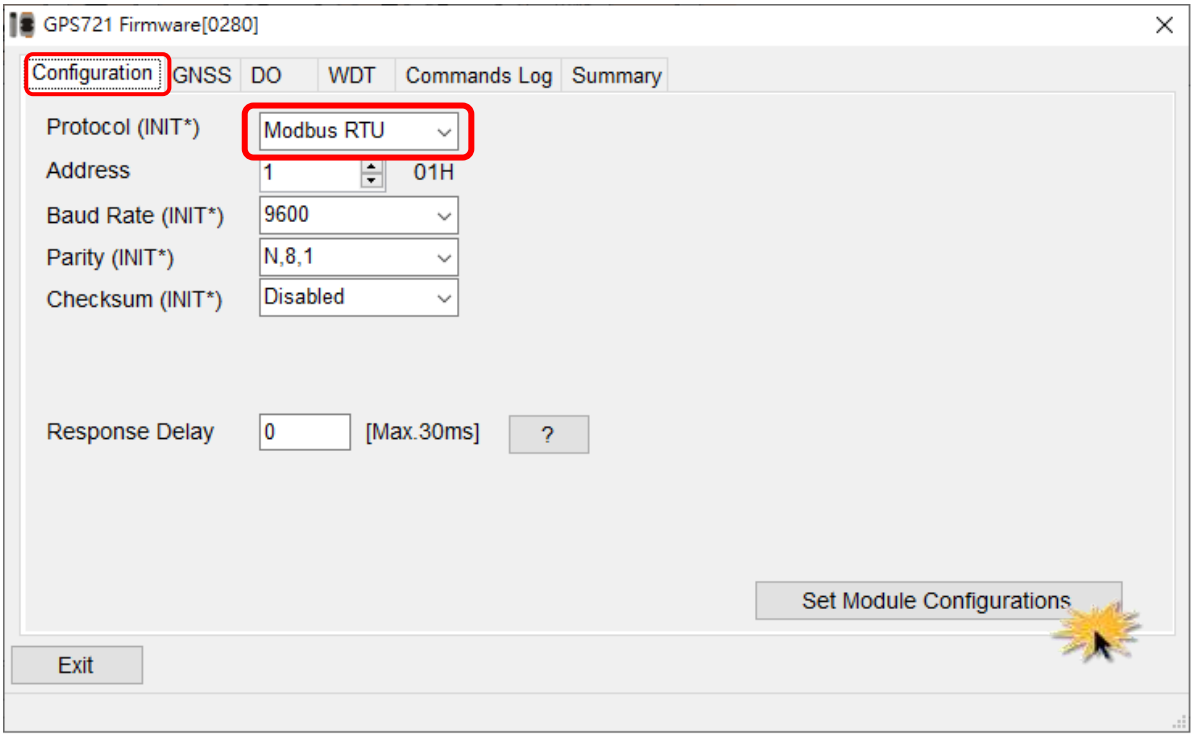
1. Put the Init/Normal switch to the Init position, and turn on the power of the GPS module.



2. Launch DCON_Utility_Pro.exe, search the GPS module, select the “Protocol Mode” and on the GNSS page and click the “***(INIT*) Change Transmission Mode***” button.



3. Select the “Modbus RTU” item in the Protocol (INIT*) menu on the Configuration page, make sure that the correct options have been selected for other parameters, and click the “***Set Module Configuration***” button.



4. Put the Init/Normal switch to the Normal position, and then power cycle the module.

5. Read the required data from the relevant register address

Address	Description
40017 ~ 40018	Reads latitude in decimal degrees format (Google Maps format) +/-dd.dddddd, + = north, - = south
40019 ~ 40020	Reads longitude in decimal degrees format (Google Maps format) +/-ddd.dddddd, + = east, - = west

The values of longitude and latitude in two consecutive registers each are in 32-bit IEEE floating point format, the first register is bits 15 - 0 of the 32 bit number, and the second register contains bits 31-16 of the 32 bit number. A value of 99999.99 is returned if there are insufficient GPS satellites in view.

If 32-bit floating point format is not supported on the control host (such as a PLC), an option of reading the relevant values in integer from the following addresses and then converting them to coordinates in Google Maps format.

Reading coordinates for Google Maps in decimal degrees format

Address	Description
40021	Reads the integer part of latitude in decimal degrees format (Google Maps format) (integer type) Value , +/-dd, + = north, - = south
40022	Reads the fractional part of latitude in decimal degrees format (Google Maps format) (integer type) Value/10000, +/-dddd, + = north, - = south
40023	Reads the integer part of longitude in decimal degrees format (Google Maps format) (integer type) Value, +/-ddd, + = east, - = west
40024	Reads the fractional part of longitude in decimal degrees format (Google Maps format) (integer type) Value/10000, +/-dddd, + = east, - = west

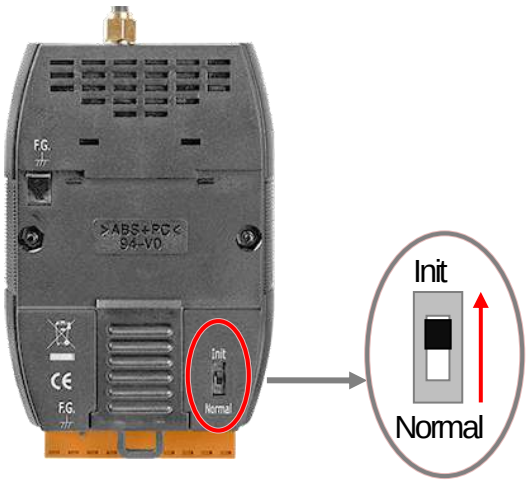
The GPS module also provides coordinates in DMM format for displaying locations on Google Maps.

Reading coordinates for Google Maps in DMM format

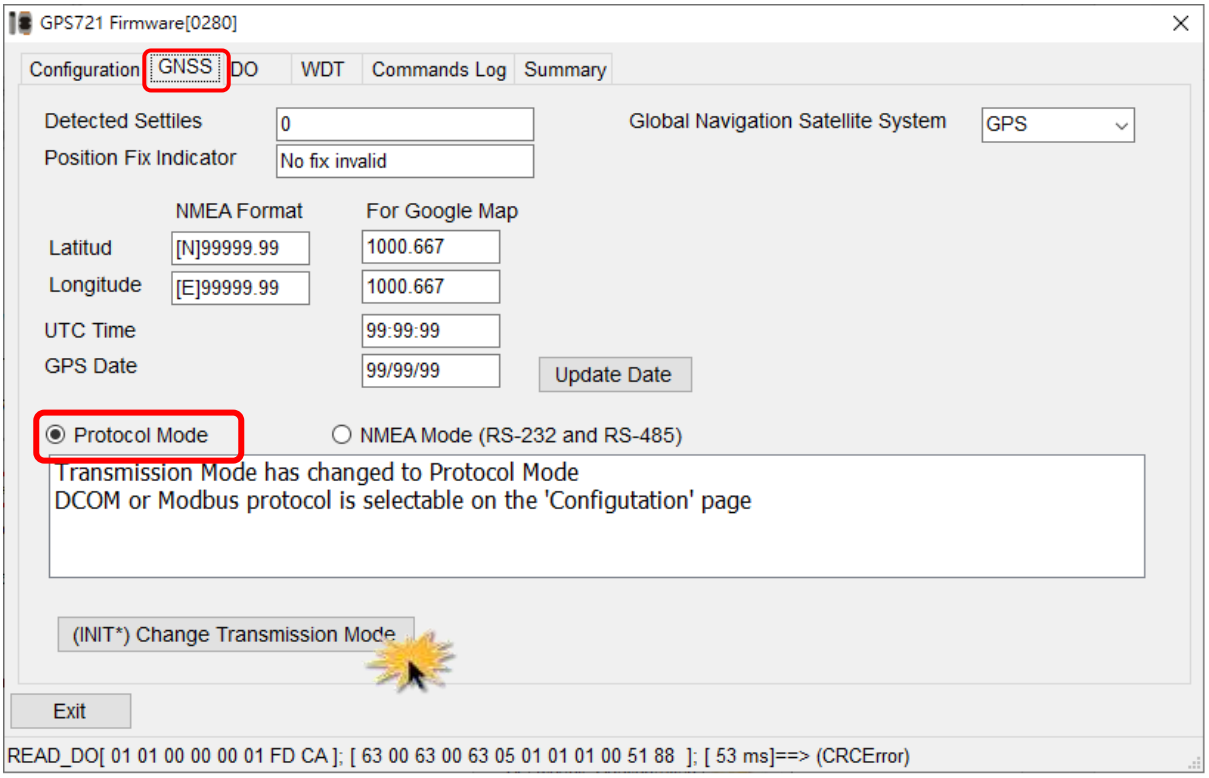
Address	Description
40033	Reads degrees of latitude (Google Maps format) (integer type)
40034 ~ 40035	Reads minutes of latitude (Google Maps format) (float type)
40036	Reads the direction of latitude for use in Google Maps. 0 = north; -1 = south
40037	Reads degrees of longitude (Google Maps format) (integer type)
40038 ~ 40039	Reads minutes of longitude (Google Maps format) (float type)
40040	Reads the direction of longitude for use in Google Maps. 0 = east; -1 = west

5.2.2. Using DCON Protocol

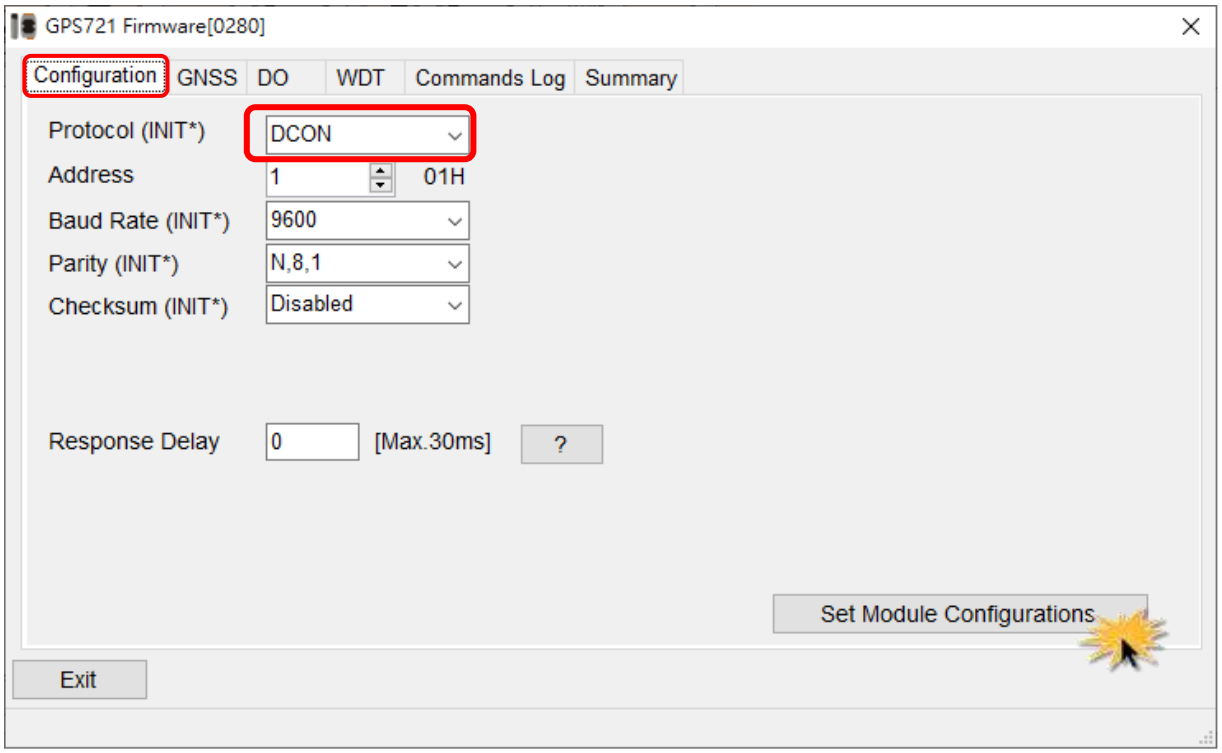
1. Put the Init/Normal switch to the Init position, and turn on the power of the GPS module.



2. Launch DCON_Utility_Pro.exe, search the GPS module, select the “Protocol Mode” on the GNSS page and click the “***(INIT*) Change Transmission Mode***” button.



3. Select the “DCON” option in the Protocol (INIT*) menu on the Configuration page, make sure that the correct options have been selected for other parameters, and click the “***Set Module Configuration***” button.



4. Put the Init/Normal switch to the Normal position, and then power cycle the module.

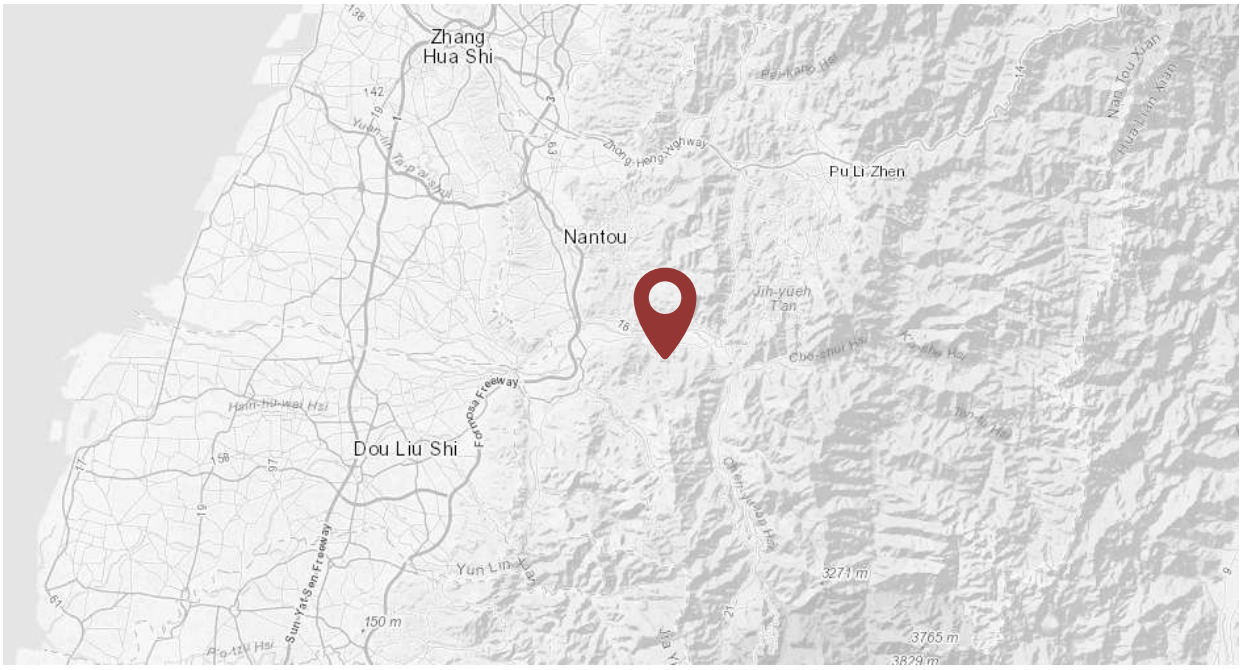
5. Send #AA5 command to read the latitude and longitude in Google Maps format.

➢ **Example:**

Command	**Response**
#015	>24.861750 N,121.016200 E
Reads the latitude and longitude in Google Maps format from module with address 01 Returns the that the latitude is 24.861750 N (degrees), and the longitude is 121.016200 E (degrees)	

5.3. Reading Coordinates in NMEA-0183 Format

The easy-to-use Modbus RTU and DCON communication protocols can be easily integrated the GPS-721U-MRTU series modules into various navigation and positioning systems. When Protocol Mode is enabled, the communication between host PC and GPS modules is available with either RS-232 or RS-485 interface.



5.3.1. Using Modbus RTU protocol

1. Refer to step 1 to step 4 in Section 5.2.1 to configure the GPS-721U-MRTU series module to use Modbus RTU protocol.

2. Read the required data from the relevant register address

Address	Description
40001 ~ 40002	Reads latitude in degrees and minutes format (NMEA 0183 format) Value/100, +/-ddmm.mmmm, + = north, - = south * A value of 99999.99 is returned if fewer than 3 satellites are available
40003 ~ 40004	Reads longitude in degrees and minutes format (NMEA 0183 format) Value/100, +/-dddmm.mmmm, + = east, - = west * A value of 99999.99 is returned if fewer than 3 satellites are available.

The values of latitude and longitude in two consecutive registers each are in 32-bit IEEE floating point format, the first register is bits 15 - 0 of the 32 bit number, and the second register contains bits 31-16 of the 32 bit number. A value of 99999.99 is returned if there are insufficient GPS/GLONASS satellites in view.

If 32-bit floating point format is not supported on the control host (such as a PLC), an option of reading the relevant values in integer from the following addresses and then converting them to coordinates in NMEA 0183 format.

Reading coordinates in decimal degrees format in NMEA 0183 format

Address	Description
40013	Reads degrees and the integer part of the minutes of latitude (NMEA 0183 format) (integer type) +/-ddmm, + = north, - = south ***** A value of 9999 is returned if fewer than 3 satellites are available

Address	Description
40014	Reads degrees and the integer part of the minutes of longitude (NMEA 0183 format) (integer type) +/-dddmm, + = east, - = west ***** If fewer than 3 satellites are available, the returned value of firmware 2.00 is 9999, while the returned value of firmware 2.10 or later is 0x9999.
40015	Reads the fractional part of the minutes of latitude (NMEA 0183 format) (integer type) Value/10000, +/-mmmm, + = north, - = south
40016	Reads the fractional part of the minutes of longitude (NMEA 0183 format) (integer type) Value/10000, +/-mmmm, + = east, - = west

5.3.2. Using DCON protocol

1. Refer to step 1 to step 4 in Section 5.2.2 to configure the GPS-721U-MRTU series module to use DCON protocol.

2. Send #AA or #AA2 command to read the latitude and longitude in NMEA 0183 format.

➢ **Example:**

Command	Response
#01	!01035035.00,2451.7056,N,12100.9803,E,1,9
Reads the UTC time, latitude, longitude, mode and number of satellites in view for a module Returns the following information The UTC Time: 035035.000 Latitude, Longitude: 2451.7056, N,12100.9903, E Position Fix Indicator: 1 (GPS SPS Mode, fix valid) Satellites in view: 9	

Command	Response
#012	!012451.7057,N,12100.9904,E
Reads the latitude and longitude of module with address 01 Returns the latitude and longitude information is 2451.7057, N,12100.9904, E	

5.4. Time Transfer and Synchronization

Precise timing is fundamental to an accurate GNSS location, a nanosecond accurate time signal can be calculated from the highly accurate clock of a GNSS receiver as a reference time source to distribute to arbitrary number of users and synchronize clocks over large distances. Three options are provided on the GPS-721U-MRTU for users to read GNSS time according to the requirements in their applications.

5.4.1. Parsing Time from NMEA Sentences

1. Refer to steps in Section 5.1 to enable the NMEA Mode of the GPS-721U-MRTU series module to transmit NMEA sentences via RS-232 or RS-485.
2. Parse time information from $GPGGA messages.

5.4.2. Reading Time with Modbus RTU Protocol

1. Refer to step 1 to step 4 in Section 5.2.1 to configure the GPS-721U-MRTU series module to use Modbus RTU protocol.

2. Read the required data from the relevant register address

Address	Description
40008	Reads the Hour part of the UTC time * A value of 99 is returned if fewer than 3 satellites are available.
40009	Reads the Minute part of the UTC time * A value of 99 is returned if fewer than 3 satellites are available.
40010	Reads the Second part of the UTC time * A value of 99 is returned if fewer than 3 satellites are available.

5.4.3. Reading Time with DCON Protocol

1. Refer to step 1 to step 4 in Section 5.2.2 to configure the GPS-721U-MRTU series module to use DCON protocol.

2. Send #AA1 command to read the GNSS time.

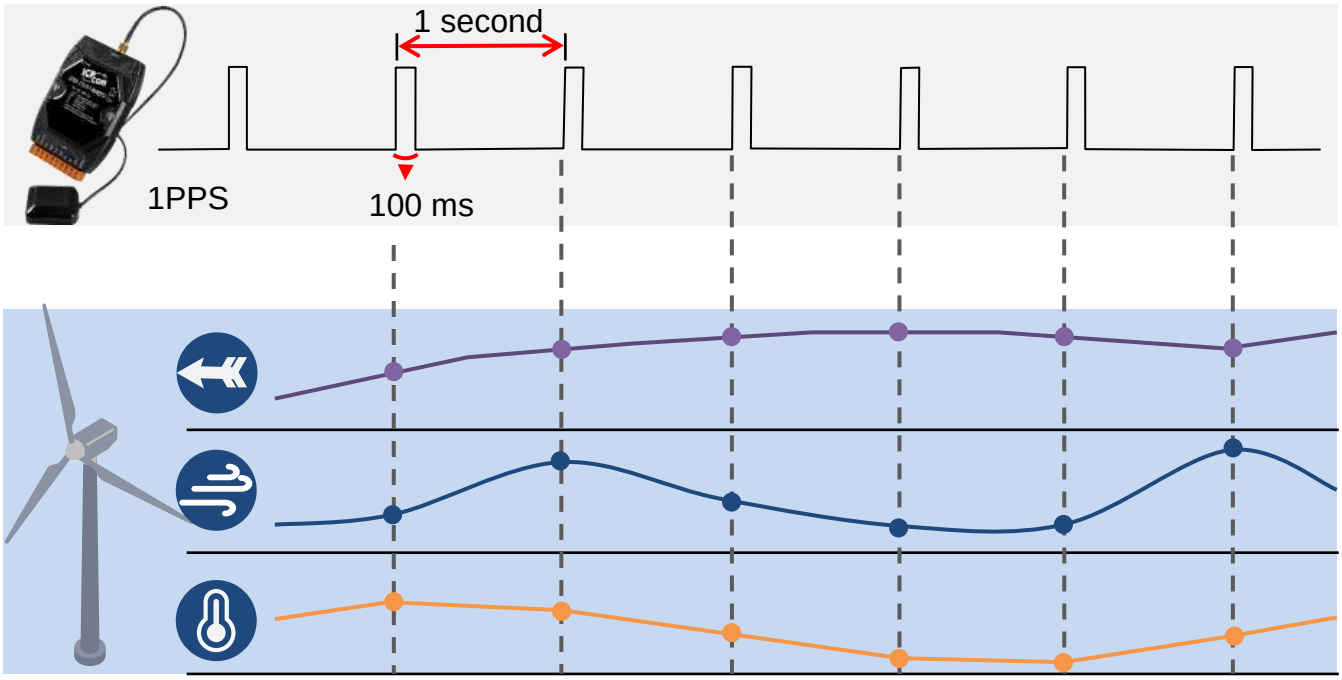
➢ **Example:**

Command	Response
#011	!01999999.999
Reads the UTC time of module with address 01 Returns the command is valid. The response shows the UTC time is invalid.	

5.5. 1 PPS

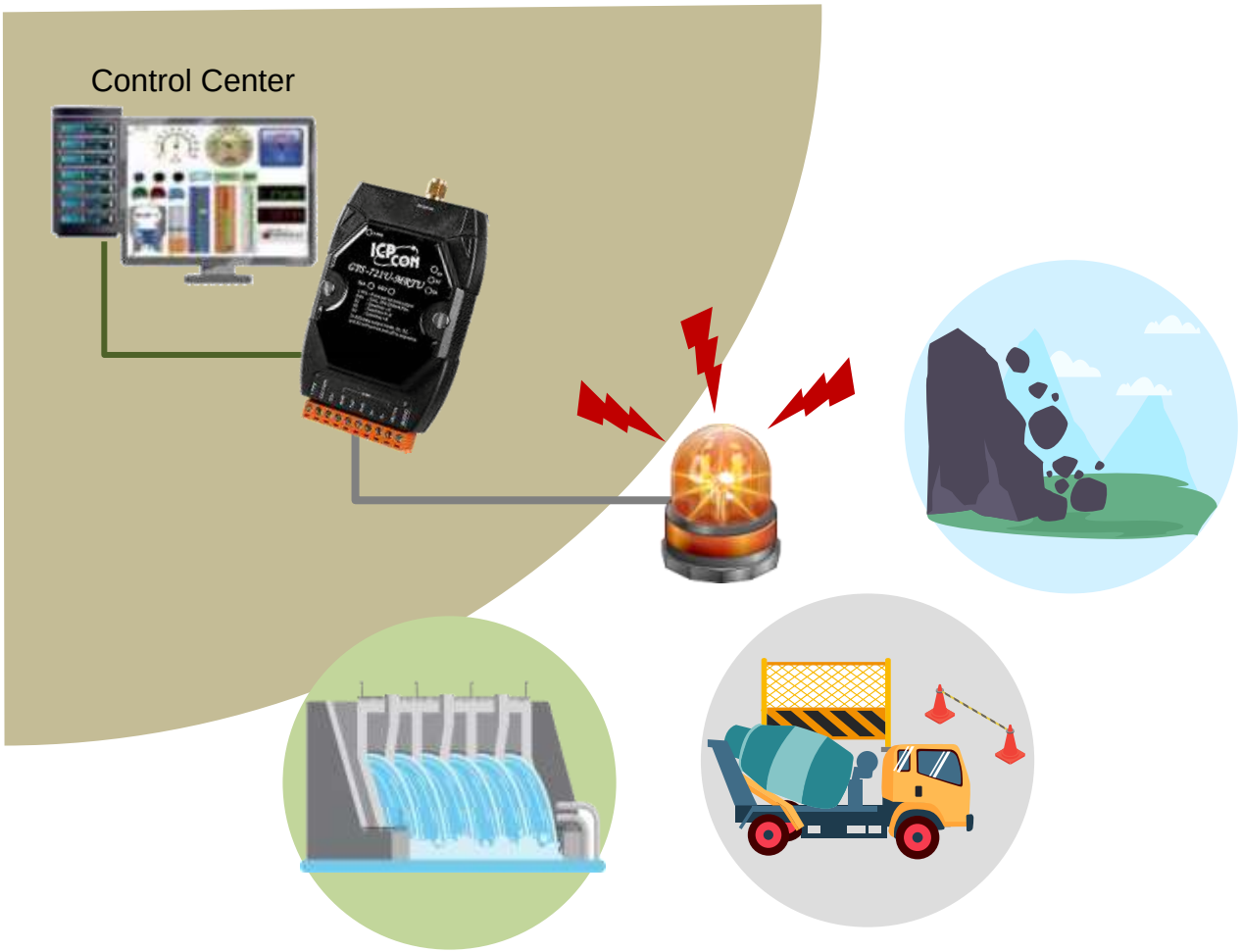
In addition to providing information such as coordinates, altitude and time, the GPS-721U-MRTU series module has a 1PPS output signal. The 1PPS signal has a sharply rising edge aligning to the UTC second, and is commonly used for precise timing, frequency measurement and synchronization data acquisition.

Taking wind power plant applications as an example, the 1PPS signal can provide a trigger signal for wind turbines to record wind direction, wind speed, and temperature every second. It can also be applied to simultaneously record the real-time power, rotor speed, and all related quantities of multiple wind turbines.



5.6. Changing DO Status

The DO on the GPS-721U-MRTU series module can be used to turn on the alarm when an emergency event occurs in the system, such as a vehicle enters a controlled area, a reservoir releases water, or a slope collapse or landslide occurs.



5.6.1. Using Modbus RTU protocol

1. Refer to step 1 to step 4 in Section 5.2.1 to configure the GPS-721U-MRTU series module to use Modbus RTU protocol.

2. Configure the DO value of on/off status if needed (00266).
   Write the corresponding DO value to control its status.

Address	Description
00001 10001	Sets/reads the status of the DO channel.
00161 10161	Sets/reads the power-on value of the DO channel.
00266	Sets/reads the configuration for DO value of on/off status 0: DO value 1 indicates on, while value 0 indicates off (default) 1: DO value 0 indicates on, while value 1 indicates off

5.6.2. Using DCON protocol

1. Refer to step 1 to step 4 in Section 5.2.2 to configure the GPS-721U-MRTU series module to use DCON protocol.

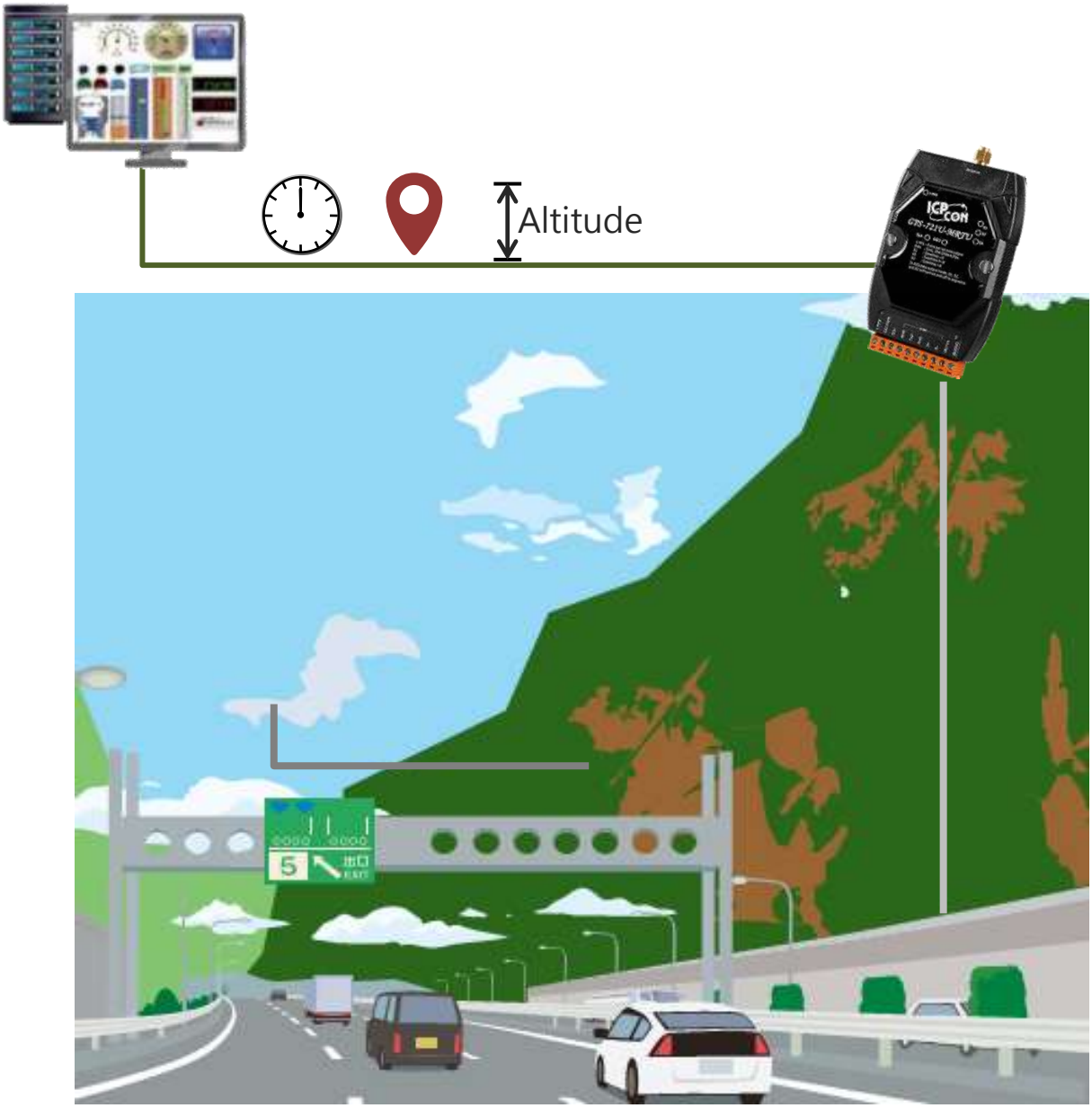
2. Send DO commands to control the status.

➢ **Example:**

Command	Response
@011	>
Sets DO1 of the module with address 01 to on. Returns the command is valid, DO is turned on.	
@010	>
Sets DO1 of the module with address 01 to off. Returns the command is valid, DO is turned off.	

5.7. Reading Altitude

Due to the ability of providing accurate time, coordinate and altitude at anytime and anywhere, the GPS-721U-MRTU series module can be applied in various areas in science and engineering, including terrain mapping, geodynamic research, structure deformation monitoring, air navigation positioning and atmospheric research.



5.7.1. Parsing Altitude from NMEA Sentences

1. Refer to steps in Section 5.1 to enable the NMEA Mode of the GPS-721U-MRTU series module to transmit NMEA sentences via RS-232 or RS-485.
2. Parse MSL altitude from $GPGGA sentences

5.7.2. Reading Altitude with Modbus RTU Protocol

1. Refer to step 1 to step 4 in Section 5.2.1 to configure the GPS-721U-MRTU series module to use Modbus RTU protocol.

2. Read the required data from the relevant register address

Address	Description
40067 ~ 40068	Reads the GNSS altitude in meters (float type) * A value of 99 is returned if fewer than 3 satellites are available.

The value of altitude in two consecutive registers each are in 32-bit IEEE floating point format, the first register is bits 15 - 0 of the 32 bit number, and the second register contains bits 31-16 of the 32 bit number.

5.7.3. Reading Altitude with DCON Protocol

1. Refer to step 1 to step 4 in Section 5.2.2 to configure the GPS-721U-MRTU series module to use DCON protocol.

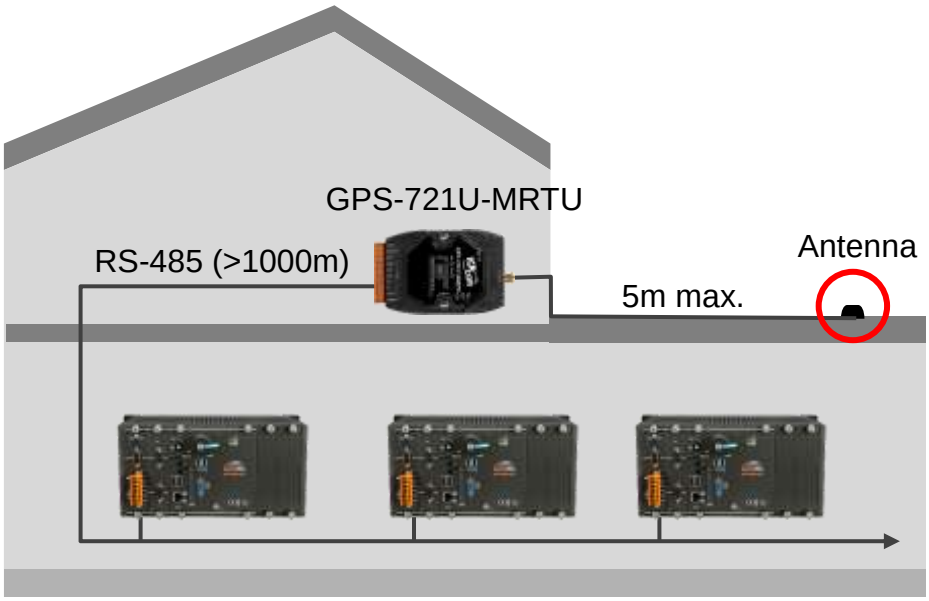
2. Send #AA7 command to read altitude in meters.

➢ **Example:**

Command	Response
#017	!000
Reads altitude of module with address 01 Returns the command is valid. The response shows altitude is invalid.	

5.8. Long-distance communication

The antenna ANT-115-03-2 provided with the GPS-721U-MRTU series module has a 5m signal cable, a strong magnetic base and IPX6 waterproof protection. It can be easily installed on metal surfaces in just a matter of seconds. With the RS-485 communication interface, the transmission distance of GNSS data can be increased to more than 1 km.



Appendix A: Modbus Address Table

The Modbus protocol was originally developed for Modicon controllers by Modicon Inc. It's a standard, truly open, and the most widely used network communication protocol in the industrial automation field. SCADA and HMI software can easily integrate serial devices via Modbus protocol.

Visit the website https://www.modbus.org for more information about Modbus.

The following Modbus RTU functions are supported on the GPS-721U-MRTU series module:

Function Code	Bit	Description		Reference Address
01 (0x01)	1	Read coils	Read DO	0xxxx
02 (0x02)	1	Read discrete inputs	Read DI	1xxxx
03 (0x03)	16	Read holding registers	Read AO	4xxxx
04 (0x04)	16	Read input registers	Read AI	3xxxx
05 (0x05)	1	Write single coil	Write a DO	0xxxx
06 (0x06)	1	Write single register	Write an AO	4xxxx
15 (0x0F)	1	Write multiple coils	Write multiple DOs	0xxxx
16 (0x10)	16	Write multiple registers	Write multiple AOs	4xxxx

If the function or addresses are not supported, the module responds error as below.

00	Address	1 Byte	1 to 247
01	Function Code	1 Byte	Function Code + 0x80
02	Exception Code	1 Byte	01

Note: If a CRC mismatch occurs, the module will not respond.

GPS-721U-MRTU Modbus Address Mappings (Base 1)

Address	Description	R/W
00001 10001	Sets/reads the status of the DO channel.	R/W
00129 10129	Sets/reads the safe value of the DO channel.	R/W
00161 10161	Sets/reads the power-on value of the DO channel.	R/W
00257 10257	Sets/reads the protocol for transmission mode 0 0: DCON, 1: Modbus RTU	R/W
00260 10260	Sets/reads the clear mode of host watchdog timeout when using Modbus RTU protocol 0: Clears the host watchdog timeout status by sending the clear command. The output channel cannot be changed until the host watchdog timeout status is cleared. 1: Clears the host watchdog timeout status by sending an AO or DO command. The AO or DO channel status will be changed at the same time.	R/W
00261 10261	Enables/disables the Host Watchdog. 0: Disable 1: Enable	R/W
00266	Sets/reads the configuration for DO value of on/off status 0: DO value 1 indicates on, while value 0 indicates off 1: DO value 0 indicates on, while value 1 indicates off	R/W
00270 10270	Reads the Host Watchdog timeout status. Writes 1 to clear the timeout status.	R/W

Address	Description	R/W
10273	Reads the reset status. It can be used to identify if the module has been restarted since the last read operation. 0. This is **NOT** the first time to read the reset status since the module was last powered on. 1. This is the first command to read the reset status since the module was last powered on.	R

Address	Description	R/W
40001 ~ 40002	Reads latitude (NMEA 0183 format) in degrees and minutes (DMM, float type) Value, +/-ddmm.mmmm, + = north, - = south ***** A value of 99999.99 is returned if fewer than 3 satellites are available	R
40003 ~ 40004	Reads longitude (NMEA 0183 format) in degrees and minutes (DMM, float type) Value, +/-dddmm.mmmm, + = east, - = west ***** A value of 99999.99 is returned if fewer than 3 satellites are available.	R
40005	Reads the Year component of the date ***** A value of 99 is returned if fewer than 3 satellites are available.	R
40006	Reads the Month component of the date ***** A value of 99 is returned if fewer than 3 satellites are available.	R
40007	Reads the Day component of the date ***** A value of 99 is returned if fewer than 3 satellites are available.	R
40008	Reads the Hour part of the UTC time * A value of 99 is returned if fewer than 3 satellites are available.	R

Address	Description	R/W
40009	Reads the Minute part of the UTC time * A value of 99 is returned if fewer than 3 satellites are available.	R
40010	Reads the Second part of the UTC time * A value of 99 is returned if fewer than 3 satellites are available.	R
40011	Reads the GPS data quality. 0 = Invalid 1 = GPS fix 2 = DGPS fix	R
40012	Reads the number of satellites currently in view.	R
40013	Reads latitude (NMEA 0183 format), the degrees and the integer part of the minutes (DMM, integer type) Value, +/-ddmm, + = north, - = south ***** A value of 9999 is returned if fewer than 3 satellites are available	R
40014	Reads longitude (NMEA 0183 format), the degrees and the integer part of the minutes (DMM, integer type) Value, +/-dddmm, + = east, - = west ***** If fewer than 3 satellites are available, the returned value of firmware 2.00 is 9999, while the returned value of firmware 2.10 or later is 0x9999.	R
40015	Reads latitude (NMEA 0183 format), the fractional part of the minutes (DMM, integer type) Value/10000, +/-mmmm, + = north, - = south	R
40016	Reads longitude (NMEA 0183 format), the fractional part of the minutes (DMM, integer type) Value/10000, +/-mmmm, + = east, - = west	R

Address	Description	R/W
40017 ~ 40018	Reads latitude in decimal degrees format (Google Maps format) (float type) Value/100, +/-dd.dddddd, + = north, - = south *A value of 99999.99 is returned if fewer than 3 satellites are available.	R
40019 ~ 40020	Reads longitude in decimal degrees format (Google Maps format) (float type) Value/100, +/-ddd.dddddd, + = east, - = west *A value of 99999.99 is returned if fewer than 3 satellites are available.	R
40021	Reads the integer part of latitude in decimal degrees format (Google Maps format) (integer type) Value , +/-dd, + = north, - = south	R
40022	Reads the fractional part of latitude in decimal degrees format (Google Maps format) (integer type) Value/10000, +/-dddd, + = north, - = south	R
40023	Reads the integer part of longitude in decimal degrees format (Google Maps format) (integer type) Value, +/-ddd, + = east, - = west	R
40024	Reads the fractional part of longitude in decimal degrees format (Google Maps format) (integer type) Value/10000, +/-dddd, + = east, - = west	R
40033	Reads degrees of latitude (Google Maps format, DMM) (integer type)	R
40034 ~ 40035	Reads minutes of latitude (Google Maps format, DMM) (float type)	R

Address	Description	R/W
40036	Reads the direction of latitude for use in Google Maps. (DMM) 0 = north; -1 = south	R
40037	Reads degrees of longitude (Google Maps format, DMM) (integer type)	R
40038 ~ 40039	Reads minutes of longitude (Google Maps format, DMM) (float type)	R
40040	Reads the direction of longitude for use in Google Maps. (DMM) 0 = east; -1 = west	R
40043	Reads the speed over ground in 1/10 knot steps or 0.1852km/h. (integer type)	R
40065 ~ 40066	Reads the HDOP (horizontal dilution of precision) value (float type)	R
40067 ~ 40068	Reads the GPS altitude in meters (float type)	R
40069 ~ 40070	Reads the GPS HOG, geoid separation in meters (float type)	
40481 ~ 40482	Reads the firmware version	R
40483 ~ 40484	Reads the name of the module	R
30485 40485	Sets/reads the module address, ranging from 1 to 247	R

<table>
<tr><th>Address</th><th>Description</th><th>R/W</th></tr>
<tr><td>30485
40485</td><td>Sets/reads the module address, ranging from 1 to 247</td><td>R</td></tr>
<tr><td>40486</td><td>Sets/reads the baud rate and the data format
Bits 5:0 (Baud Rate)
Baud Rate, valid range from 0x03 to 0x0A
<table>
<tr><th>Code</th><th>Baud rate</th><th>Code</th><th>Baud rate</th></tr>
<tr><td>0x03</td><td>1200</td><td>0x07</td><td>19200</td></tr>
<tr><td>0x04</td><td>2400</td><td>0x08</td><td>38400</td></tr>
<tr><td>0x05</td><td>4800</td><td>0x09</td><td>57600</td></tr>
<tr><td>0x06</td><td>9600</td><td>0x0A</td><td>115200</td></tr>
</table>
Bits 7:6
00: no parity, 1 stop bit
01: no parity, 2 stop bits
10: even parity, 1 stop bit
11: odd parity, 1 stop bit</td><td>R/W</td></tr>
<tr><td>30489
40489</td><td>Sets/reads the host watchdog timeout value.
The valid range is 0 to 255, in intervals of 0.1 seconds.</td><td>R/W</td></tr>
<tr><td>40490</td><td>Sets/reads the transmission mode.
0: DCON or Modbus RTU protocol via RS-232 or RS-485
2: NMEA 0183 message via RS-232 and RS-485</td><td>R/W</td></tr>
<tr><td>40491</td><td>Sets/reads the GNSS system. (Only available in firmware v2.80 and later)
0: GPS,
1: GLONASS</td><td>R/W</td></tr>
<tr><td>30492
40492</td><td>Sets/reads the host watchdog timeout counter.
Writes 0 to clear.</td><td>R/W</td></tr>
<tr><td>312345</td><td>Write any value to inform all modules that the host is OK</td><td>W</td></tr>
</table>

Appendix B: DCON Protocol

The DCON protocol consists of commands sent by a PC host and responses transmitted by a remote I/O module. Each module has a unique ID number that is used for addressing purposes. The DCON commands start with a delimiter character, followed by a 2-character module ID (hexadecimal), the command characters, and end with a CR character.

DCON Format	Delimiter	Module ID	Command	[CHKSUM]	CR
Example	$	01	I	-	[CR]

Only the addressed module will execute the command and response the result. The format of a response string is similar to a command. It starts with a delimiter character, followed by a 2-character module address (hexadecimal), the requested data, and end with a CR character.

Response	Delimiter	Module ID	Data	[CHKSUM]	CR
Example	!	01	0	-	[CR]

Delimiter: defines the type of command or response. Commonly used characters including “~”, “$”, “@”, “%”, “!”, “?” and “>”.

Module ID: the RS-485 address of the I/O module.

Command/Response: varies depending on the definition of each command.

CHKSUM: a 2-character hexadecimal checksum code. If checksum is disabled, there is no need to add the CHKSUM.

CR: end of command character, carriage return (0x0D)

Checksum Calculation

The letters of checksum are limited to uppercase letters. Checksum is calculated with sum of the ASCII code of all the characters (except [CR]) in a command or response string, and then perform a masking operation on the sum with 0xFFh. It can be said to only take the last two characters.

Example

Command string: $012(CR):

1. Sum of strings = “$” + “0” + “1” + “2” = 24h + 30h + 31h + 32h = B7h
2. The checksum is B7h, that is, [CHKSUM] = “B7”
3. Command string with [CHKSUM] = $012B7(CR)

Response string: !01200600(CR)

1. Sum of the string = “!”+”0”+”1”+”2”+”0”+”0”+”6”+”0”+”0”

   = 21h+30h+31h+32h+30h+30h+36h+30h+30h = 1AAh
2. Therefore the checksum is AAh, and so CHKSUM = “AA”
3. The response string with the checksum = !01200600AA(CR)

Note:
All checksum characters should be in upper case.

Refer to “**DCON Command Set for GPS-721U-MRTU Series Module**” for more detailed instructions on the DCON command set.

DCON Command Sets

Command	Description
$AAF	Reads firmware version Response: !AANN.NN -> the firmware version is NN.NN
$AAI	Reads the status of the INIT/Normal switch Response: !AA0 -> the INIT/Normal switch is in INIT position !AA1 -> the INIT/Normal switch is in Normal position
$AAM	Reads module name !AAGPS721
$AAP	Reads Modbus RTU/DCON protocol for transmission mode 0 Response: !AASC S: The protocols supported by the module 0 -> DCON only 1 -> DCON and Modbus RTU protocols 3 -> DCON and Modbus RTU/ASCII protocols C: The protocol saved in EEPROM, which will be applied after restart 0: DCON 1: Modbus RTU 3: Modbus ASCII
$AAPN	Sets Modbus RTU/DCON protocol for transmission mode 0 N-> 0: DCON, 1: Modbus RTU, 3: Modbus ASCII
$AA2	Reads configuration
$AA5	Reads reset status !AA1: first after power on, !AA0: others

Command	Description
#AA	Reads UTC Time, latitude, longitude, and the other GPS information separated by commas. Response: **!AATTTTTT.TTT,LLLL.LLLL,C,NNNNN.NNNN,C,P,S** TTTTTT.TTT: the UTC Time (hhmmss.sss) LLLL.LLLL: Latitude (ddmm.mmmm) C: N or S (North or South) NNNNN.NNNN: Longitude (dddmm.mmmm) C: E or W (East or West) P: Position Fix Indicator 0=No fix, invalid 1=GPS SPS Mode, fix valid 2=Differential GPS,SPS Mode, fix valid 6=Estimated (Dead Reckoning) fix S: umber of the satellites in view with a range of 0 to 12 If there are insufficient GPS satellites in view, the GPS data will be set to 9
#AAN	Reads specified GPS information N= 1 for the UTC time (hhmmss.sss), 2 for latitude and longitude (DMM), 3 the number of satellites in view, 4 for date (DDMMYY), 5 for latitude and longitude in Google Maps format (DD), 6 for the HDOP (horizontal dilution of precision) value, 7 for altitude in meters, 8 for the HOG (geoid separation) in meters, 9 for the speed over ground in 1/10 knot steps or 0.1852 km/h If there are insufficient GPS satellites in view, the GPS data will be

	set to 9

<table>
<tr><th>Command</th><th>Description</th></tr>
<tr><td>%AANNTTCCFF</td><td>Sets configuration
AA : current address,
NN: new address,
TT : Fixed at 40,
CC: new baud rate
Bits 5:0
Baud rate, 0x03 ~ 0x0A
<table>
<tr><th>Code</th><th>Baud rate</th><th>Code</th><th>Baud rate</th></tr>
<tr><td>0x03</td><td>1200</td><td>0x07</td><td>19200</td></tr>
<tr><td>0x04</td><td>2400</td><td>0x08</td><td>38400</td></tr>
<tr><td>0x05</td><td>4800</td><td>0x09</td><td>57600</td></tr>
<tr><td>0x06</td><td>9600</td><td>0x0A</td><td>115200</td></tr>
</table>
Bits 7:6
00: no parity, 1 stop bit
01: no parity, 2 stop bits
10: even parity, 1 stop bit
11: odd parity, 1 stop bit
FF: data format
Bit 6
0: checksum disabled, 1: checksum enabled
Response:
!AA -> the setting is successful</td></tr>
<tr><td>~AAD</td><td>Reads the definition of DO value
Response:
!AANN -> NN & 02 = 00:
DO value 1 indicates on, DO value 0 indicates off
!AANN -> NN & 02 = 02:
DO value 0 indicates on, DO value 1 indicates off</td></tr>
<tr><td>~AADVV</td><td>Sets the definition of DO value
VV = 00:
DO value 1 indicates on, DO value 0 indicates off
VV= 02:
DO value 0 indicates on, DO value 1 indicates off</td></tr>
</table>

Command	Description
@AA	Reads DO status Response: !OOII: OO = 01 -> the value of DO is 1 OO = 00 -> the value of DO is 0 Refer to ~00D command to read the definition of DO value.
@AA(data)	Sets DO status (data): 0 -> set the DO status to 0 1-> set the DO status to 1 Refer to ~00D command to read the definition of DO value.
~AAG	Reads the satellite system Response: !AAS: nn = 00 -> GPS nn = 01 -> GLONASS (Only available in firmware v2.80 and later)
~AAGnn	Sets the satellite system nn: 00 -> set the satellite system to GPS 01-> set the satellite system to GLONASS (Only available in firmware v2.80 and later)
~AAI	Enables the “Soft INIT” function to allow the module to temporarily be in INIT mode. Use “~AATnn” command to set the duration of the “Soft INIT” mode
~AATnn	Sets the Soft INIT duration nn: A 2-digit hexadecimal value that specifies the Soft INIT duration. The maximum time is 60 seconds. For example, nn = 10 to set the duration to 16 seconds

Command	Description
~AAM	Reads the transmission mode Response: !AASC S: transmission modes supported by the module 0: DCON 3: DCON\Modbus RTU\NMEA C: the current transmission mode in use. 0: DCON or Modbus 2: Sending NMEA messages via both RS-232 and RS-485
~AAMN	Sets the transmission mode N: The transmission mode. 0: DCON or Modbus 2: Sending NMEA messages via both RS-232 and RS-485
~AAO(Name)	Sets the module name (Name) The new name for the module (up to 6 characters)
~AARD	Reads the response delay time Response: !AA(Data) (Data): a 2-digit hexadecimal value to represent the response delay time in a range of 0 to 30 ms
~AARDVV	Sets the response delay time VV: a 2-digit hexadecimal value to represent the response delay time in a range of 0 to 30 ms
~**	Clears host watchdog timeout counter
~AA0	Reads host watchdog status
~AA1	Clears host watchdog timeout status
~AA2	Reads host watchdog enable/disable status and timeout value
~AA3ETT	Enables/disables host watchdog and set timeout value E-> 0: disable host watchdog, 1: enable host watchdog TT: host watchdog timeout in 0.1s in hex format
~AA4	Reads DO power on and safe value

Revision History

Revision	Date	Description
3.0.0	2025/ 02	Added commands for setting/reading the satellite system and applications.