INTERSOFT ELECTRONICS

Global Positioning System - GPS450

User Manual

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Global Positioning System - GPS450 User Manual	
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Conventions Used

Note: This icon to the left of bold italicized text denotes a note, which alerts you to important information.

Caution: This icon to the left of bold italicized text denotes a caution, which alerts you to the possibility of data loss or a system crash.

Warning: This icon to the left of bold italicized text denotes a warning, which alerts you to t he possibility of damage to you or your equipment.

Glossary of Terms

ACP	Azimuth Change Pulse
ASCII	American Standard Code for Information Interchange
ARP	Azimuth Reference Pulse
ATC	Air Traffic Control
ECEF position	Earth-Centered, Earth-Fixed (Cartesian coordinate system)
GPS	Global Positioning System
ICD	Interface Control Document
IE	Intersoft Electronics
Radar	Radio Detection And Ranging
RASS-R	Radar Analysis Support Systems – Real-time measurements
RASS-S	Radar Analysis Support Systems – Site measurements
SAC	System Area Code
SIC	System Identification Code
UTC	Coordinated Universal Time

1. Technical Manual GPS450

1.1. General Introduction

1.1.1. Introduction to GPS

A GPS receiver determines its geographic position by measuring the ranges (the distance between a satellite with known coordinates in space and the receiver's antenna) of several satellites and computing the geometric intersection of these ranges.

To measure a range, the receiver measures the time required for the GPS signal to travel from the satellite to the receiver antenna. The timing code generated by each satellite is compared to an identical code generated by the receiver.

GPS supports a wide variety of applications including navigation, surveying and time transfer. Receivers may be used in a standalone mode or integrated with other systems to enhance the overall system performance.

1.1.2. GPS450

The weatherproof, portable GPS receiver is automatically powered up after it is connected to the host computers serial port. Using a simple HMI the GPS450 data can be recorded and reviewed afterwards for analysis. The GPS450 data can also be interpolated to be used as a reference source for data analysis (RASS-R function).

Another important function of this GPS450 is the absolute time stamping of radar data recorded by one of the radar data recording tools. By using the GPS450 each incoming radar message (ASTERIX) can be absolutely time stamped with an accuracy of 50µs. This allows the analysis of the processing delay of the radar. The time stamping is required for typical RASS analysis.

1.2. Key Features

- Position determination
- UTC Time stamp
- Time mark 1 second pulse

1.3. Hardware Description

1.3.1. Block Diagram

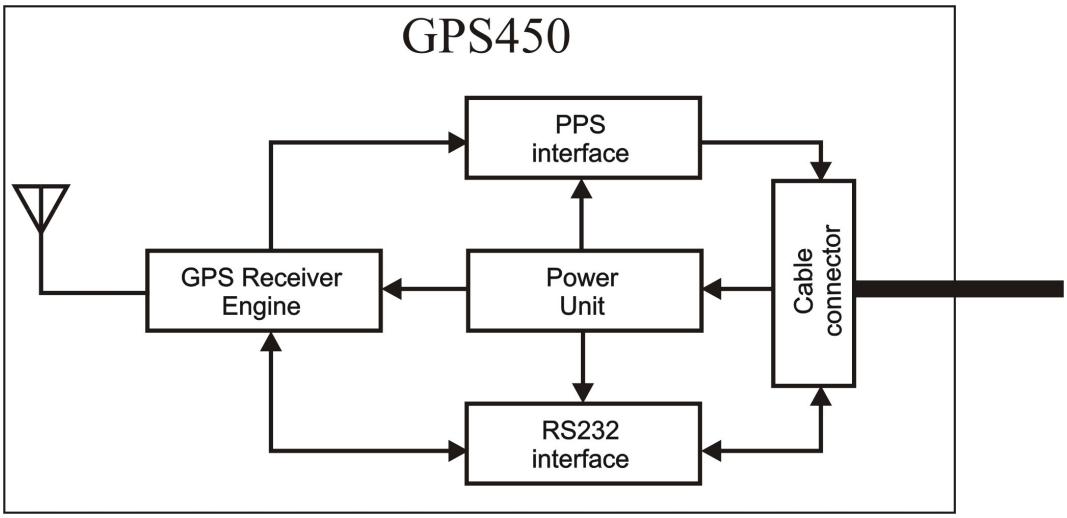


Figure 1: GPS450 Block diagram

1.3.2. Technical Specifications

- Input voltage: 9 to 15V
- 12 parallel-channel receiver engine
- Operation/storage temperature range: 0° C to +70° C
- The rising edge of each TMARK pulse is synchronized with the UTC one second epochs to within ±1 microsecond.
- Maximum extention cable length GPS450 is 50 meters, defined for a cable with following spec: 26AWG (0,12 Ohm/meter).

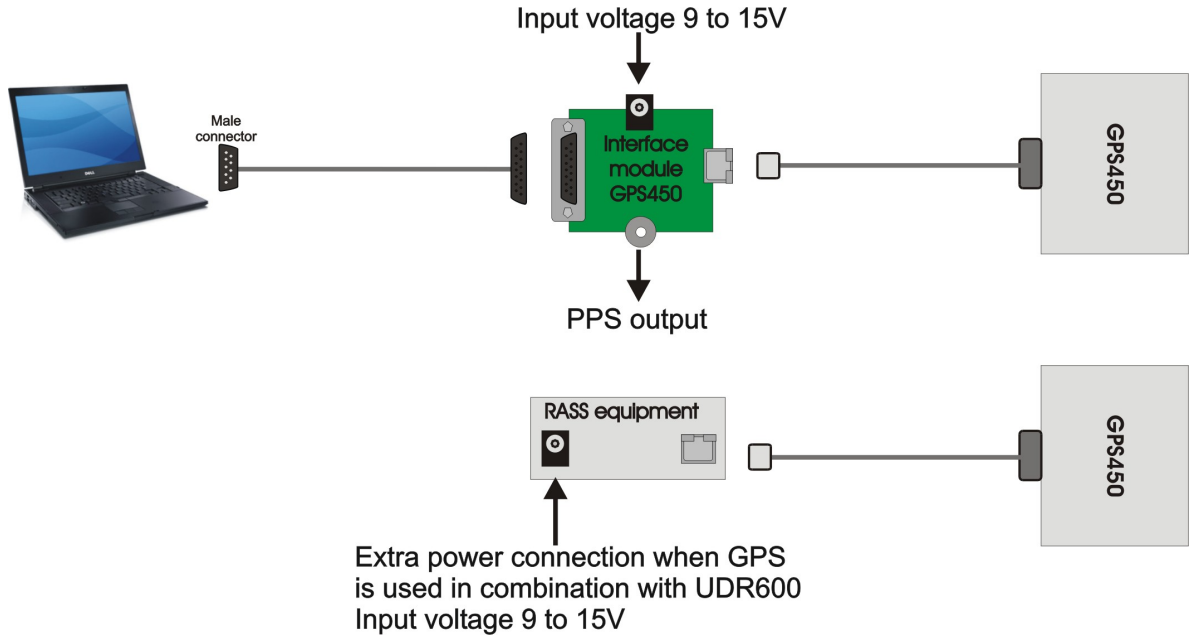


Figure 2: GPS450 connections to workstation or RASS-S equipment

2. Determine GPS Position

2.1. Getting Started

On first time usage of the system, make sure you have selected the correct type of GPS unit. This can be done in the ***RASS-S Set-up*** panel which can be called from the ***Change Settings*** button in the toolbox. Depending on the selected type, the corresponding driver will be loaded. For the Weatherproof GPS450 the type GPS450 has to be selected.

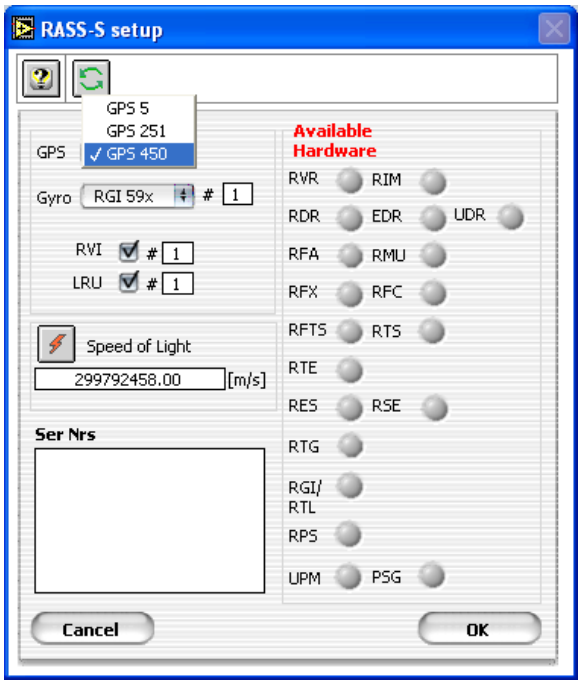


Figure 3: RASS-S Set-up panel – GPS450 type selection

The ***GPS Interface*** application can be loaded using the ***GPS*** button on the right-side of the RASS-S Toolbox (in the list the tool is called ***Determine GPS Position***).

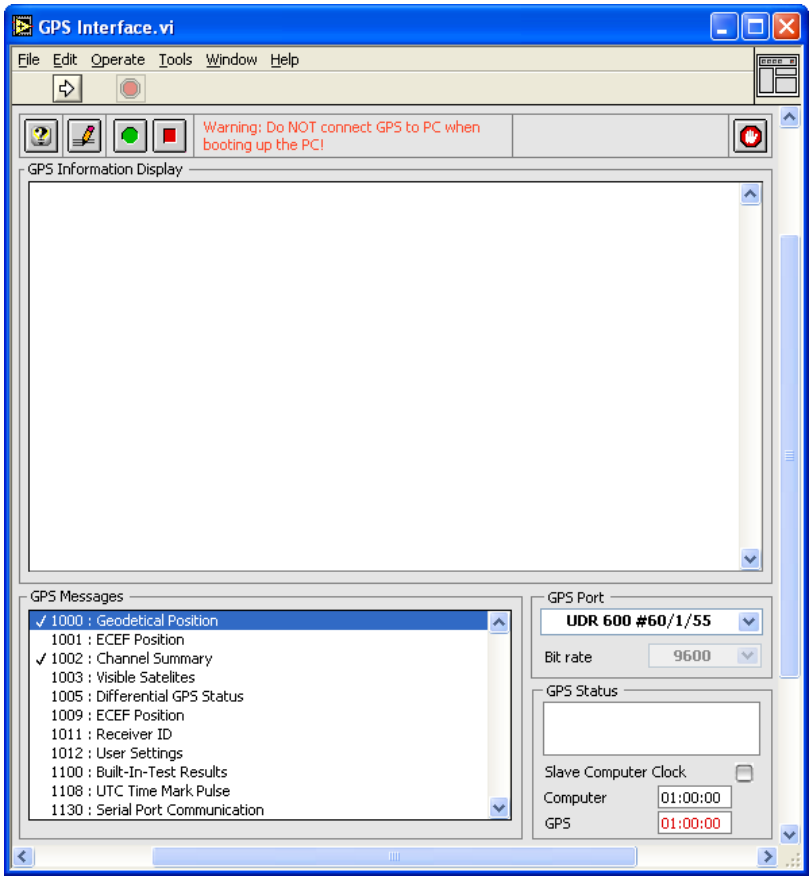


Figure 4: GPS Interface software (Determine GPS Position application)

Make the connections as shown in Annex 1: Connection Diagram.

2.2. Software

2.2.1. Selecting the COM Port

Upon starting the tool, the available COM Ports on the host computer will be listed in the ***GPS Port*** menu. Select the COM Port you connected the GPS450 to. Please note that you can also use the UDR600 as serial port interface for the GPS450.

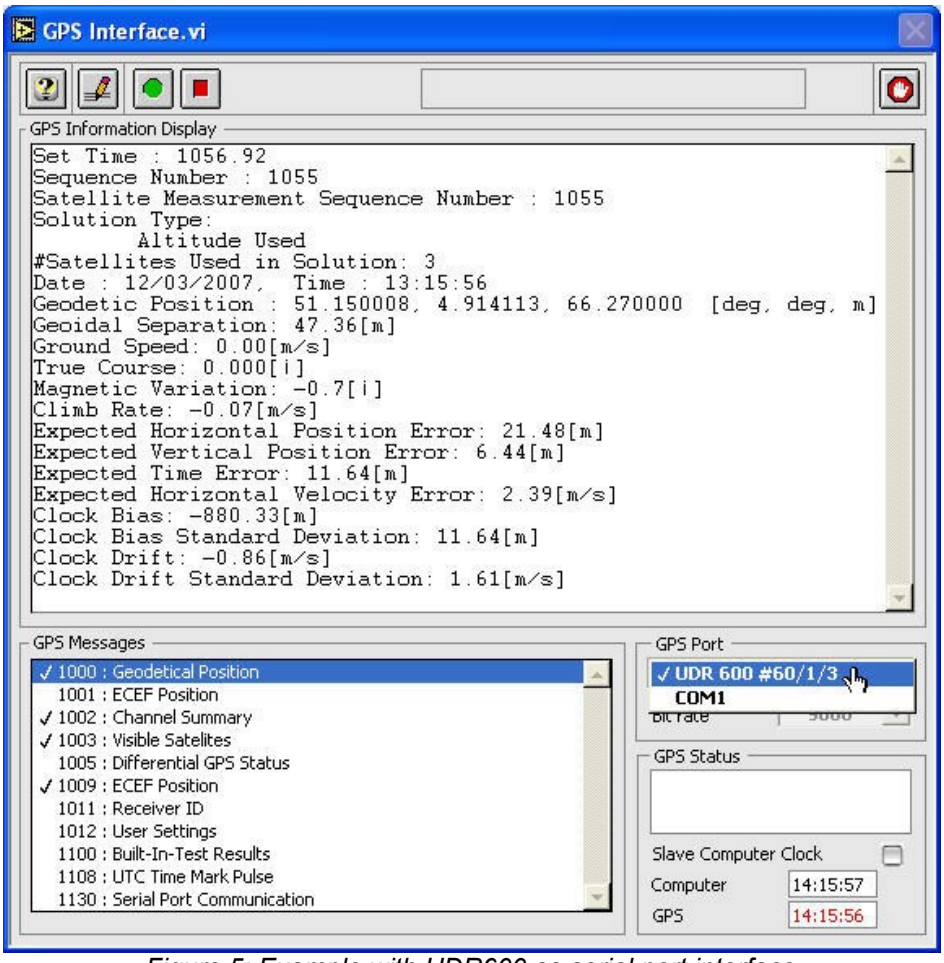


Figure 5: Example with UDR600 as serial port interface

2.2.2. Enable Messages/Logging

Open the ***Edit Messages*** window using the ***Edit Message List*** button in the software.

This window allows you to enable or disable any message coming from the GPS450. It also allows you to specify whether a specific message must be logged to disk or not. The logged files can later be used for differential GPS position determination. The GPS device operates by sending specific messages of data to the computer. Several types of messages exist:

- 1000 : Geodetical Position
- 1001 : ECEF Position
- 1002 : Channel Summary
- 1003 : Visible Satellites
- 1005 : Differential GPS Status
- 1009 : ECEF Position
- 1011 : Receiver ID
- 1012 : User Settings
- 1100 : Built-In-Test Results
- 1108 : UTC Time Mark Pulse
- 1130 : Serial Port Communication

Each message has its own specific contents. Example messages are listed in section 2.3. Example Messages.

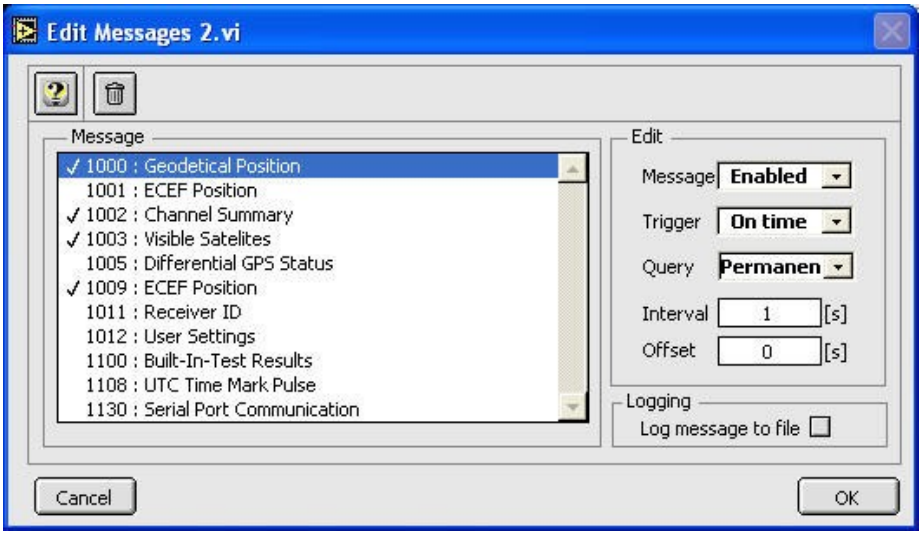


Figure 6: Edit Messages window

You can enable a message using the ***Message*** enable (Enabled/Disabled) feature in the ***Edit*** section. Messages can be send once or on a regular basis (once per second) by the GPS450. This can be selected by the ***Query*** (Permanent/One shot) and ***Trigger*** (On time/On update) menus. The period can be set per message (from once per second to higher interval times) using the ***Interval*** and ***Offset*** parameters.

Each message can be marked individually for recording (logging) or not (***Log message to file*** selector). The logging itself can be switched on or off separately, but the user needs to enable the logging for a specific message. Typically, the message “1000 : Geodetical Position” is sufficient for a GPS position recording.

The ***Delete*** button disables all messages at once.

Click ***OK*** to leave the ***Edit Messages*** window and to return to the ***GPS Interface software***.

If you still don't see the GPS data flowing in, make sure you’ve selected the correct serial port and the proper ***Bit rate***. Most GPS450 sets are preset for 9600 Baud (default value).

Next, you can verify your position by selecting the “1000 : Geodetical Position” item in the GPS messages list as shown in figure 5 . You will see the time and position update once a second in the ***GPS Information Display***.

2.2.3. Performing a Recording

If the ***Log*** icon is visible, the data is marked to be logged to disk. The actual logging is activated using the ***Record*** button. When you click this button, the data is logged to a temporary file.

When you click the ***Stop*** button, a dialog will pop up to save the data to file. Enter a filename for the file and click ***OK***.

2.3. Example Messages

2.3.1. 1000 : Geodetical Position

```
Set Time : 1695070.18
Sequence Number : 24001
Satellite Measurement Sequence Number : 24001
#Satellites Used in Solution: 4
Date : 27/04/2000, Time : 07:36:15
Geodetic Position : 51.147664, 4.912762, 99.630000 [°, °, m]
Geoidal Separation: 47.36[m]
Ground Speed: 0.60[m/s]
True Course: 243.564[°]
Magnetic Variation: -1.4[°]
Climb Rate: -0.47[m/s]
Expected Horizontal Position Error: 16.33[m]
Expected Vertical Position Error: 12.37[m]
Expected Time Error: 10.84[m]
Expected Horizontal Velocity Error: 1.26[m/s]
Clock Bias: 13.72[m]
Clock Bias Standard Deviation: 10.84[m]
Clock Drift: 0.27[m/s]
Clock Drift Standard Deviation: 0.77[m/s]
```

2.3.2. 1001 : ECEF Position (Old type GPS)

```
Set Time: 1703629.19
Sequence Number : 32560
Satellite Measurement Sequence Number : 32560
ECEF Position (X Y Z) : 3994454.35, 343338.32, 4944088.50 [m, m, m]
Velocity (X Y Z): -0.14, -0.01, -0.17 [m/s, m/s, m/s]
```

2.3.3. 1002 : Channel Summary

```
Set Time: 1703549.19
Sequence Number : 32480
Measurement Sequence Number : 32480
GPS Week Number: 1059
PRN | C/No [dBHz] | Used | Ephemeris | Valid | DPGS
30    27                   x
01    26                   x
18    32                   x          x
25    45             x     x          x
19    26                   x
22    40             x     x          x
17    28                   x
23    33                   x          x
03    47             x     x          x
06    00                   x
10    00
00    00
```

2.3.4. 1003 : Visible Satelites

```
Set Time: 1703581.19
Sequence Number : 16275
Best Possible GDOP : 2.00
Best Possible PDOP : 1.80
Best Possible HDOP : 0.99
```

```
Best Possible VDOP : 1.50
Best Possible TDOP : 0.88
Number of Visible Satellites : 11
PRN  |  Azimuth [deg]  |  Elevation [deg]
 17        120.47        065.72
 22        293.12        053.89
 06        076.83        040.46
 25        212.06        026.41
 03        263.56        020.61
 10        035.61        014.94
 30        131.63        012.14
 23        142.19        005.72
 19        331.76        005.38
 18        329.65        002.91
 01        296.29        002.77
```

2.3.5. 1005 : Differential GPS Status

```
Set Time: 1703612.19
Sequence Number : 32543
Station Health : Ok, User enabled
Station ID : 0
Age of Last Correction : 999 [s]
# of Available Corrections : 11
Satellite Correction Information
PRN : 17, UDRE too high
PRN : 22, UDRE too high
PRN :  6, UDRE too high
PRN : 25, UDRE too high
PRN :  3, UDRE too high
PRN : 10, corrections not available, UDRE too high
PRN : 30, UDRE too high
PRN : 23, UDRE too high
PRN : 19, UDRE too high
PRN : 18, UDRE too high
PRN :  1, UDRE too high
```

2.3.6. 1009 : ECEF Position

```
Set Time: 1703629.19
Sequence Number : 32560
Satellite Measurement Sequence Number : 32560
ECEF Position (X Y Z) : 3994454.35, 343338.32, 4944088.50 [m, m, m]
Velocity (X Y Z): -0.14, -0.01, -0.17 [m/s, m/s, m/s]
```

2.3.7. 1011 : Receiver ID

```
Number of Channels : 12
     Software Version : 01.80
          Software Date : 11/26/97
               Options : 0003
1012 : User Settings
Set Time: 1703691.19
Sequence Number : 1
Operational Status
     Power Management : disabled
     Cold Start : enabled
     DGPS : enabled
     Held Altitude : enabled
```

```
        Ground Track Smoothing : enabled
        Position Pinning : enabled
        Active Antenna : disabled
    Cold Start Time-Out : 300 [s]
    DGPS Correction Time-Out : 45 [s]
    Elevation Mask : 9.97 [°]
    Selected Candidates : 11111111111111111111111111111111
    Altitude Not Used not required, DGPS not required
    Number of Satellites in Track : 0
    Minimum Expected Horizontal Error : 100.00 [m]
    Minimum Expected Vertical Error : 150.00 [m]
    Application Platform : default
```

2.3.8. 1100 : Built-In-Test Results

```
Not available to user
```

2.3.9. 1108 : UTC Time Mark Pulse

```
Set Time: 1703713.78
Sequence Number : 23881
UTC Time of Day : 10:00:20
GPS to UTC Time Offset : 12.999999998 [s]
Time Mark valid, UTC Sync.
```

2.3.10. 1130 : Serial Port Communication

```
Set Time: 1703744.19
SN : 1
Port 1 : 9600, 8, No, 1, [0, 0]
Port 2 : 9600, 8, No, 1, [0, 0]
```

2.4. Troubleshooting

Error 116 message pops up the minute you run the instrument
The computer has no serial ports. Please use a USB to serial port adapter (Keyspan) before starting the program. Make sure to correctly assign the serial ports. If you own a UDR600 you can use that as serial port interface for GPS recordings.

3. Review GPS Logfile

3.1. Getting Started

The RASS-S GPS viewing tool expects you to select a GPS recording and will then read and decode the file in order to plot the GPS coordinates translated to a new XY coordinate system. The tool can also read other GPS file data (such as ENATOR ASCII files, STNA ASCII files etc...) and copy the data into an S4 dataset.

This S4 file can then be read by the Inventory tool and be used as a reference input (e.g. for the Pd and accuracy tool) or can further be processed by the GPS Interpolation tool.

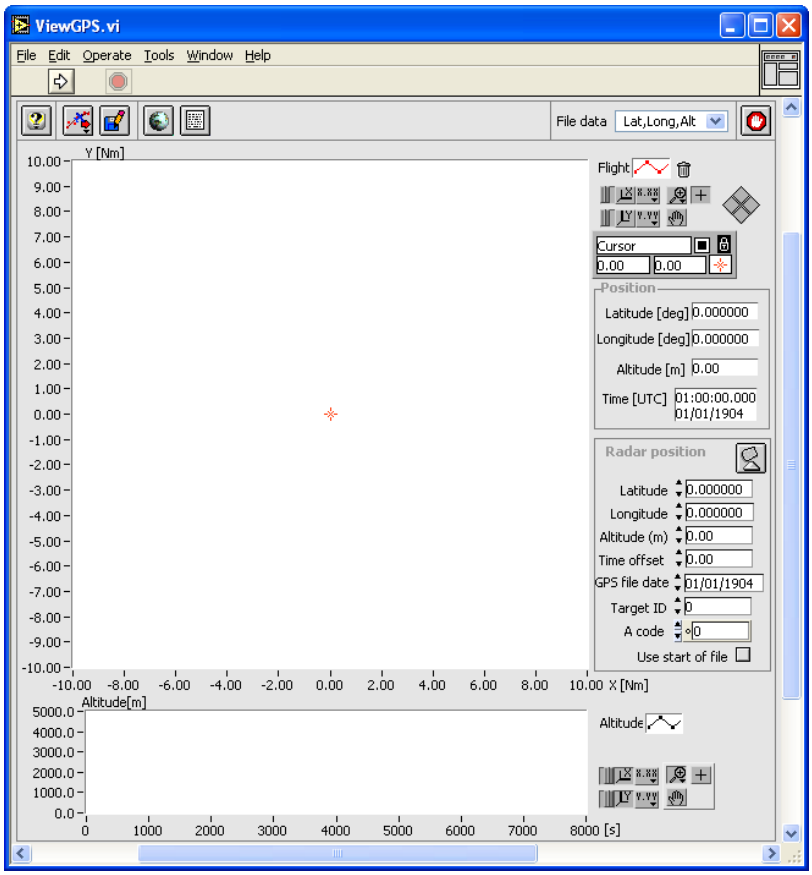


Figure 7: View GPS Software

The ***View GPS*** tool can be opened from the ***GPS*** 

button on the right-side of the RASS-S Toolbox (in the list the tool is called ***Review GPS Logfile***).

3.2. Software

3.2.1. Enter Radar Position (Reference)

Multiple methods are available for entering the reference position:

- Manually enter the position in the ***Radar position*** section of the software
- Load the Long-Lat position entered in the site file, by clicking the ***Site file***  button.
- Use the first point of the GPS data as the reference position (by clicking the ***Use start of file*** check box).
- Use a GPS recording containing a fixed position and average it to be used as reference position.

3.2.2. Load GPS Logfile

The GPS logfile should contain the test flight data. The positional data is then recalculated (coordinate translation) relative to the reference position. Load the GPS logfile using the ***Import***  drop-down list. The following input data formats are supported:

1. RASS-S GPS logfile
2. ENATOR ASCII data (.gas)
3. STNA format (.gps)
4. EADS1 data (.dat)
5. EADS2 data (.f08)
6. IE RFA GPS data (uplink)
7. NMEA-0183 format (.gps)
8. Flight Inspection format (.asc)
9. GPS Datalogger format (.csv)
10. Hellenic GPS data (.txt)
11. Cyrrus GPS data (.txt)

Select the data format of interest, select the logfile from the File Dialog that opens up and hit ***OK***.

The data is converted and displayed in an XY position relative to the given reference.

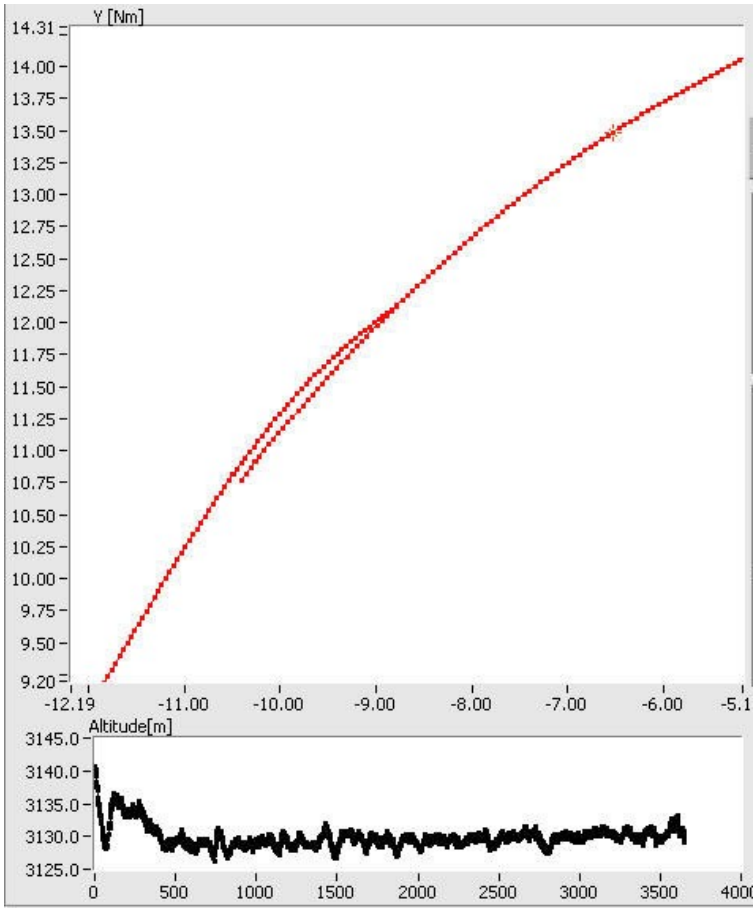


Figure 8: Converted GPS data in XY view relative to reference

3.2.3. Save S4 file

Use the ***Save*** button to save the data into an S4 format file that can be read by the same tools as used for viewing recorded data, i.e. the ***Inventory*** tool.

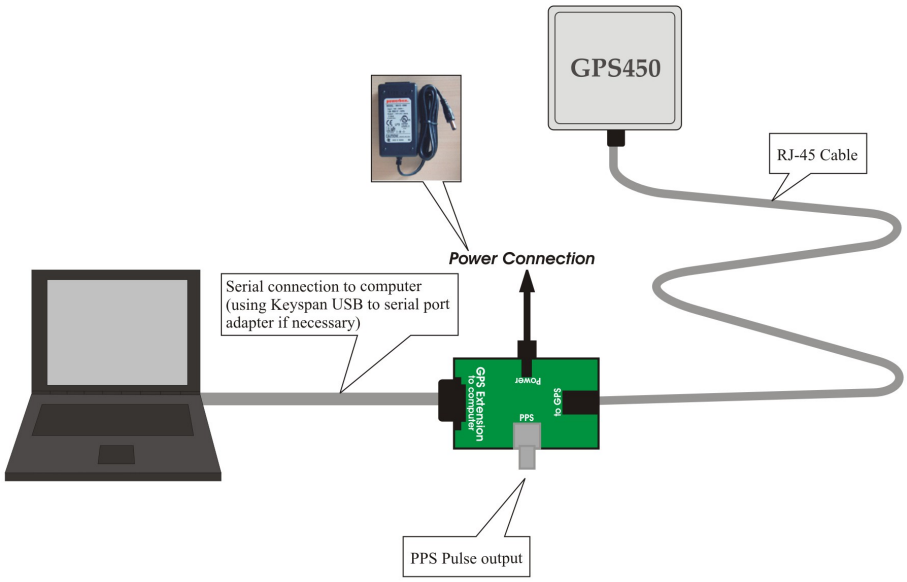
4. Using GPS450 for UTC Timestamping

The use of the GPS450 for UTC Timestamping of RASS-S data recordings is described in the corresponding data recorder manuals (UDR600 or RDR679 user manual).

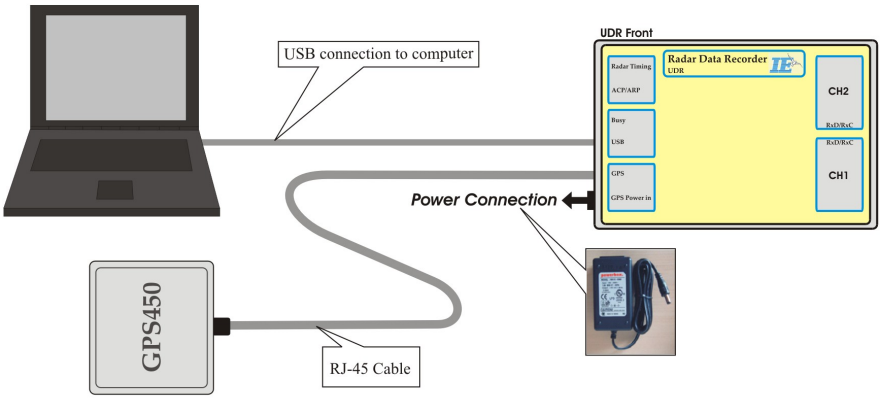
5. ANNEXES

5.1. Annex 1: Connection Diagram

Option 1: Connect GPS450 to computer through GPS Extension module



Option 2: Connect GPS450 to computer through UDR600



Set-up Guidelines:

- Place the GPS on a flat surface in the open air with the engraved side straight up.
- Try to avoid enclosed spaces: surrounding houses and trees might screen off satellite reception.

Figure 9: GPS450 Set-up

5.2. Annex 2: Configuration List

Check	Qty	Description/Item List
		Weatherproof GPS
O	1	Weatherproof GPS450
O	1	External Power Supply
O	1	Mains power cable (country specific)
		GPS Accessories - P475
O	1	GPS Pulse per Second Connection module
O	1	BNC(m) to BNC(m) RG581 - 1m black
O	1	Sub DB25(m) to Sub DB9(f) - 1.8m
O	1	CAT5 STP patch cord RJ45-RJ45 - 5m
O	1	CAT5 STP patch cord RJ45-RJ45 - 15m
O	2	RJ45 (8p) Extension connector
		Keyspan
O	1	Keyspan - USB Serial adaptor
O	1	USB cable A to B - 1m