GPS Synchroniser

Operating and Software instructions

Firmware versions 2v14 to 2v27 and 3v80

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This manual is provided as an aid to use of the GPS Synchroniser kit and its software.

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1 Introduction

The GPS Synchroniser is designed to measure the time at which events occur to near microsecond accuracy using a precision oscillator in conjunction with the GPS network.

The GPS Synchroniser operates automatically and autonomously. Each time it receives an external trigger signal, the date and time are recorded in a non-volatile memory, transmitted via the serial port and displayed on the unit.

The non-volatile memory has a capacity of 4095 records (8191 for software 2v20 and above) which is organised on a last in, last out basis.

The unit is triggered by a nominal 5 volt TTL level. The polarity (rising or falling edge) is programmable via the serial port.

The contents of the memory can be transferred to a PC using the serial port.

There is an internal test facility to check and adjust the precision clock.

1.1 Timing Considerations

The GPS Synchroniser records a single event in any second. The information is displayed and written to memory during the following second. The unit is ready to record the next event during the second afterwards. Thus the maximum repetitive recording rate is one event every two seconds.

2 External Connections

12 Volt Supply

PC Serial Connector

Antenna Connector

Input Trigger Connector

GPS Seconds LED
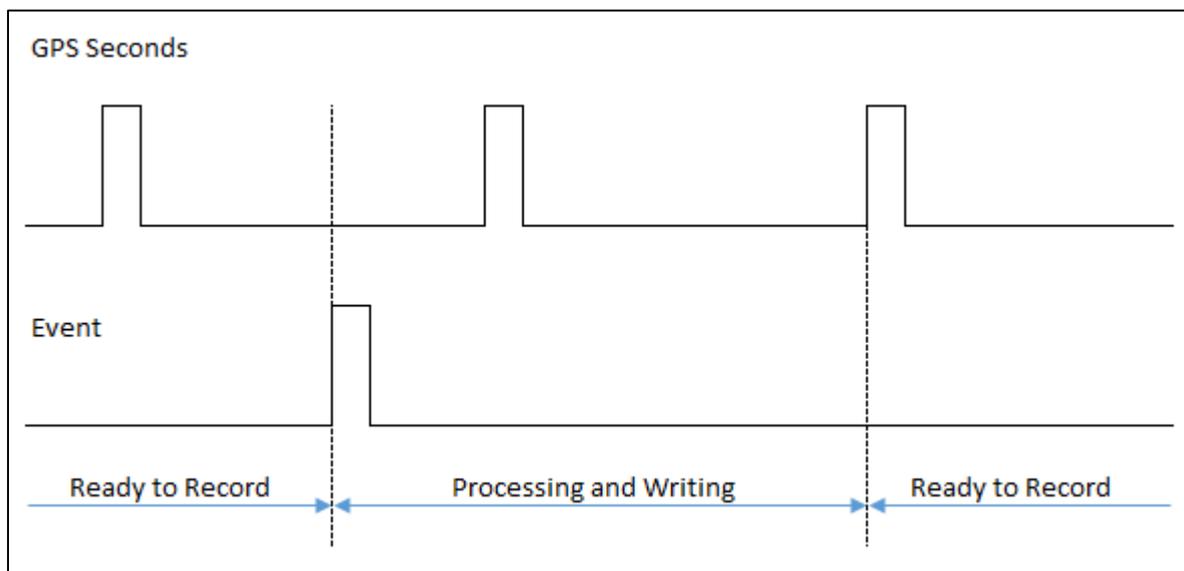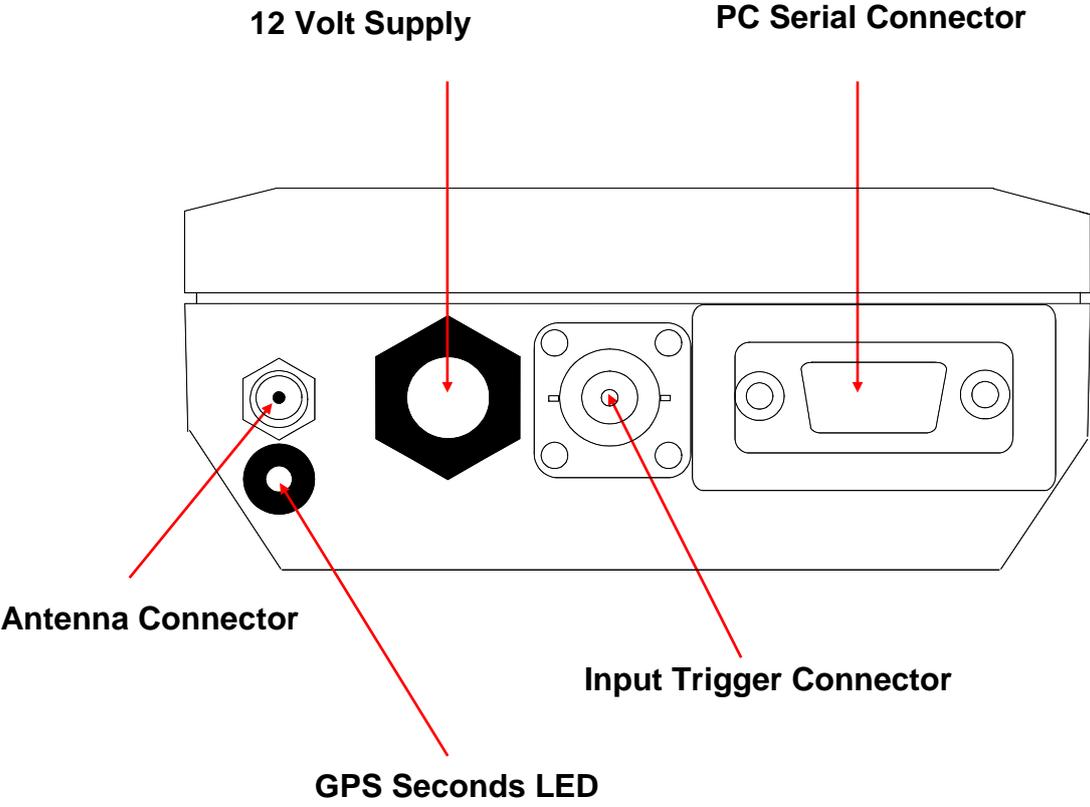
3 Operation

1.   Place the antenna in a suitable location and connect to the GPS Synchroniser. The base is magnetic and the arrow should point upwards.

2.   Connect the unit to a 12 Volt supply. The following display appears:

```
GPS SYNC 2v14 02
  Waiting for TB
```

This indicates that the unit is waiting for a trigger input. The LED on the end panel will flash once a second indicating that the GPS unit is functioning.

The figure on the upper right of the display indicates the number of satellites that the system is using for calculation; this is refreshed once a second. The system must use at least one satellite to produce a valid time.

If there is a problem with the antenna connection the number is replaced by a two-letter code:

     OC   The antenna current is too high (possible short circuit)
     UC   The antenna current is too low (possible open circuit)
     NV   The antenna status cannot be determined.

3.   Connect the trigger signal to the unit. When a trigger is received the following display appears:

Event time - microseconds

Trigger polarity

"U" - UTC Time
"G" - GPS Time

```
  45743 us        +
U 17:05:34 11 05
```

Event time - hours minutes and seconds

Available Satellites

Satellites used in time calculation

6
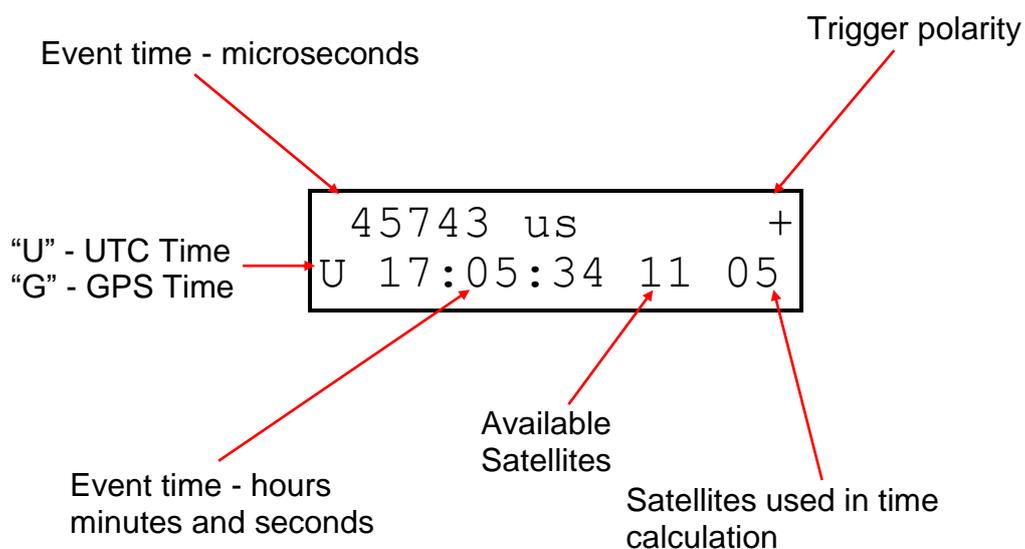
The data is also output from the serial port. It can be captured on a PC using GPSSerial 2 (software on the supplied CD) or a terminal utility such as "Hyperterminal".

The parameters should be set to:

> 9600 bits per second
> 8 data bits
> No parity
> 1 stop bit
> No flow control

The cable is not supplied with the unit. The wiring diagram is on page 30.

3.1 Data Format

Typical output data string via serial port:

012 289238 us + U 12:14:31 11 03 15/02/2005

012	Serial Number of the unit
289238 us	Event time – microseconds
U	Time is UTC (or 'G' for GPS – see page 12)
+	Trigger is on positive transition (or '-' for negative)
12:14:31	Event time hours, minutes and seconds.
11	Number of visible satellites
03	Number of satellites used for calculation
15/02/2005	Event date, day, month and year

4 Firmware Version 3v80

This version of the software adds two extra items of information to that provided by version 2vXX.

- The time stamp is also recorded in microseconds in GPS time. This is the elapsed time in microseconds since 00h00 on 6th January 1980. This information is not added to the real-time output string.
- The position in WGS 84 format. This is raw GPS information (not DGPS).

Typical output data string via serial port (real-time):

```
254  147080 us + U 10:12:35 08 02 28/08/2013 N 51d 26m 27.17s W
00d 20m 36.00s
```

The output data is a single line. The format is the same as version 2vXX on the previous page with the addition of coordinates in degrees, minutes and seconds.

Typical output data string via serial port (transferred data):

```
254 1061719971147080 us + U 10:12:35 08 02 28/08/2013 N 51d 26m
27.17s W 00d 20m 36.00s
```

The output data is a single line. The format is the same as the real-time version with the addition of the ten digits to the time stamp corresponding to GPS time.

It should be noted that the sixteen digits of the timestamp are always in microseconds in GPS time. The next part of the time section in HH:MM:SS DD/MM/YY format is in UTC time or GPS time as indicated by the 'U' or 'G' character in the output string. There is a difference between the two (17 seconds in May 2016) due to the addition of leap seconds to UTC time. This can be seen with the example data below showing the same event recorded on two different units. Unit 253 was set to GPS time and 254 to UTC time. The initial 16 digit values are the same but the HH:MM:DD format time on unit 253 is 16 seconds ahead of unit 254.

```
253 1061719973147009 us + G 10:12:53 08 03 28/08/2013 N 51d 26m
27.20s W 00d 20m 35.89s
254 1061719973147009 us + U 10:12:37 08 02 28/08/2013 N 51d 26m
27.17s W 00d 20m 36.00s
```

5   Using GPS Sync 1.1 Software
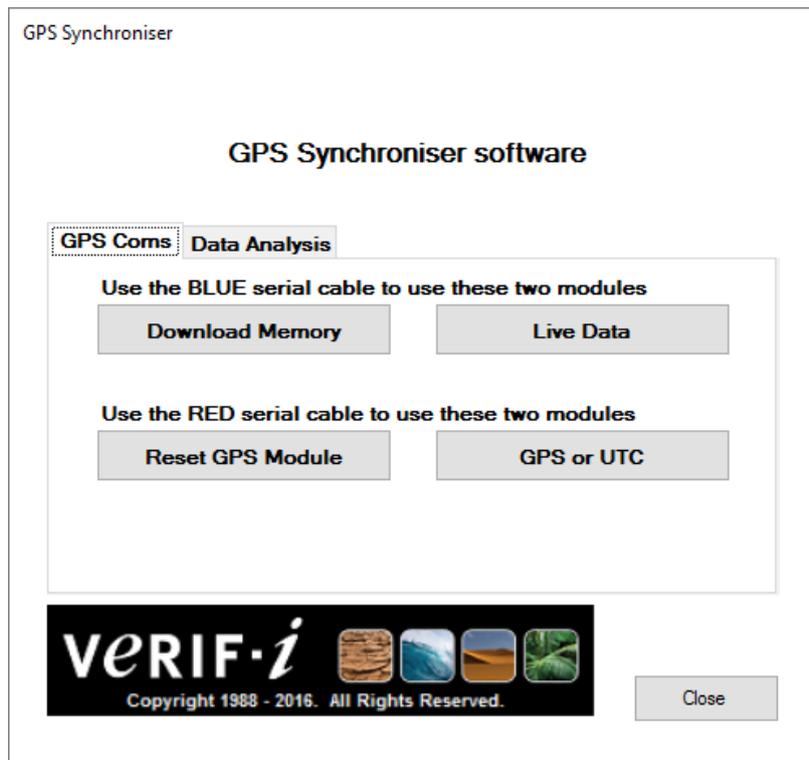
This software has been designed to work on the Microsoft's .NET framework which is built into all versions of Windows after Vista. It will also work on XP if service pack 1 is installed.

5.1 Download Memory

The Download Memory module is designed to allow the user to download all data currently stored on the GPS Synchroniser via the supplied blue cable. To avoid missing data the serial port should be set up and the GPS Synchroniser connected to the PC using the blue cable before power is applied to the GPS Synchroniser.

Note that data is not erased from the memory when it is read so data download can be repeated if necessary.
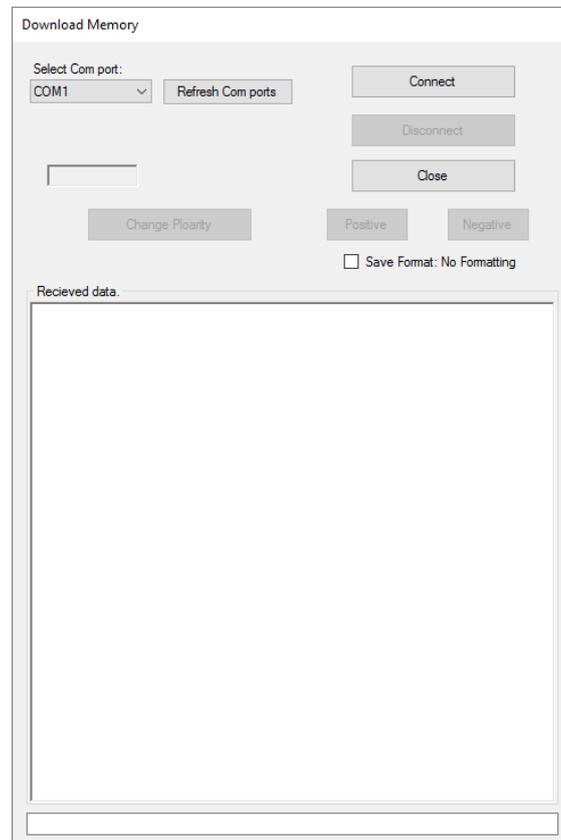
Before connecting power to the GPS Synchroniser select which serial port the GPS Synchroniser is connected to using the drop down list on the Select Com Port control. This list can be refreshed if the serial port is attached to the PC after the module has been started, e.g. if a USB to Serial converter is connected to the PC after the software has been launched.

Data downloaded from the GPS Synchroniser can be saved into a Tab Separated Value (TSV) text file. Alternately this data can be saved with no formatting. This is selected by checking the save format check box which will indicate the save format which is currently selected. When saved in TSV this allows data to be easily imported into spreadsheet programmes such as Microsoft Excel. An example of the TSV format is shown below:

GPS Serial:	11	No. Lines Read:	8199	Firmware type:	2				
Serial No.	microsecond value	us	Trigger Polarity	Timing Mode	Time		Sats. seen	Sats. used	Date
11	867318	us	+	U	11:30:28		12	6	11/11/2015
11	975701	us	+	U	11:30:30		12	6	11/11/2015

Once the serial port has been selected click the Connect button.

The software then prompts for the folder and file name in which to save the downloaded data. This file's location and name is displayed in the text box at the bottom of the window under the Received data text box.

Power should then be applied to the GPS Synchroniser to initiate the download.
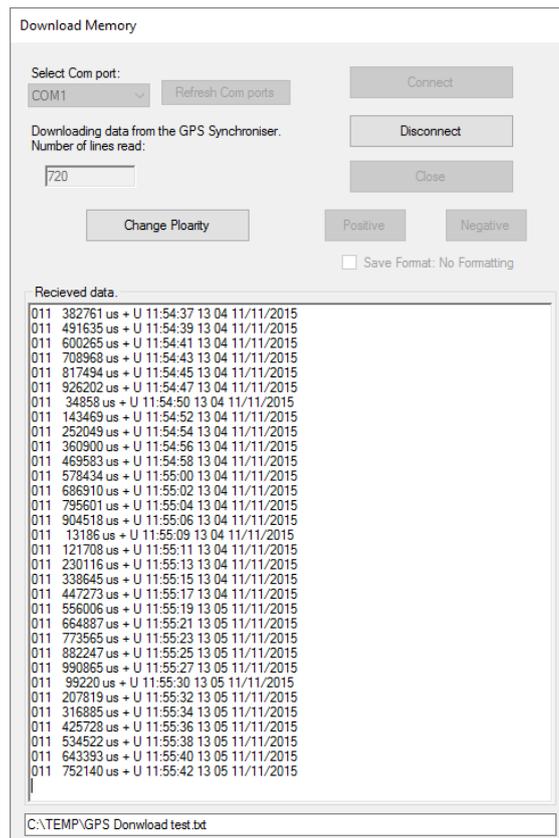
While the data is being transferred by the GPS Synchroniser the user will be able to see the incoming data as well as a line count to indicate the progress.

Data download can be cancelled at any time by clicking the Disconnect button which will close the serial port.

After data download is complete a timing test is continuously performed. While the timing test is in progress the trigger polarity of the GPS Synchroniser can be changed, see section 5.2 below.

If downloading data from more than one GPS Synchroniser, it is recommended that the software be closed and restarted. This will clear the received data table and the line count for the new unit.

5.2 Changing Trigger polarity

After data download is complete, as described in section 5.1 above, the trigger polarity of the GPS Synchroniser can be changed.

When the download is complete the GPS Synchroniser automatically performs a timing test. The timing test counts the number of microseconds counted by the GPS Synchroniser over two PPS seconds to give an indication of the accuracy of the GPS crystal (see section 9). This test repeats indefinitely until stopped by the operator.

While the timing test is in progress the polarity of the signal used to trigger the GPS Synchroniser can be changed by clicking the Change Polarity button. If the button was clicked while the data download was in progress the software will remember this and will start this procedure once the download is complete.
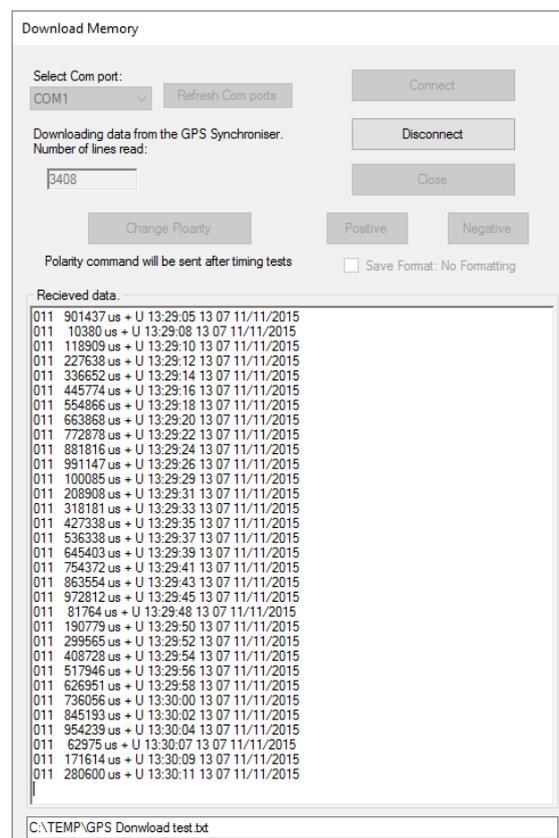
When the Change Polarity button is acknowledged by the software the Positive or Negative polarity buttons are enabled as appropriate to enable the polarity to be changed.

Download Memory

Select Com port:

[COM1 ▼]   [Refresh Com ports]   [Connect]

Downloading data from the GPS Synchroniser.
Number of lines read:

[8199]   [Disconnect]

                                              [Close]

[Change Ploarity]   [Positive]   [Negative]

Polarity ready to be changed.   ☐ Save Format: No Formatting

Recieved data.

```
011   921945 us + U 14:09:06 11 00 20/01/2016
011   893657 us + U 14:09:08 11 00 20/01/2016
011   481674 us + U 14:09:23 11 00 20/01/2016
011   863561 us + U 14:09:25 11 00 20/01/2016
011   188839 us - U 14:17:28 11 00 20/01/2016
011   710026 us - U 12:34:12 11 00 26/01/2016
011   564969 us - U 12:34:16 11 00 26/01/2016
011   280501 us - U 12:34:20 11 00 26/01/2016
011   115667 us - U 12:34:24 11 00 26/01/2016
011   154565 us - U 12:34:27 11 00 26/01/2016
011   530287 us - U 12:34:29 11 00 26/01/2016
011   147962 us - U 12:34:42 11 00 26/01/2016
011   443834 us - U 12:34:44 11 00 26/01/2016
011   826643 us - U 12:34:46 11 00 26/01/2016
011   101376 us - U 12:34:49 11 00 26/01/2016
011   260542 us - U 12:34:52 11 00 26/01/2016
011   450406 us - U 12:34:54 11 00 26/01/2016
011   847837 us - U 12:34:56 11 00 26/01/2016
011   912716 us - U 12:34:58 11 00 26/01/2016
011   943181 us - U 12:35:00 11 00 26/01/2016
011   848391 us - U 12:35:02 11 00 26/01/2016
011   355994 us - U 10:09:16 10 00 18/02/2016
011   829657 us - U 27:52:63 07 14 31/15/2025

2000000  00

POL > -

POL > - *
POL > - +
POL > +
```

[C:\TEMP\GPS Donwload test.txt]

In the above example the GPS Synchroniser polarity is currently positive, as shown in the bottom line of the display POL>+, so the Negative button is enabled to allow the polarity to be changed to negative if required.

After the polarity has been changed the GPS Synchroniser should be powered down and the blue cable removed before being used to record events.

5.3   Live Data

The Live Data module is designed to allow the user to monitor and record events recorded by the GPS Synchroniser as they are received. The user should construct a two wire serial cable, as described on page 30 of this manual, however the module will also work with the supplied blue cable if the GPS Synchroniser is powered up before the cable is attached (the download procedure automatically starts if a blue cable is detected when the system boots).
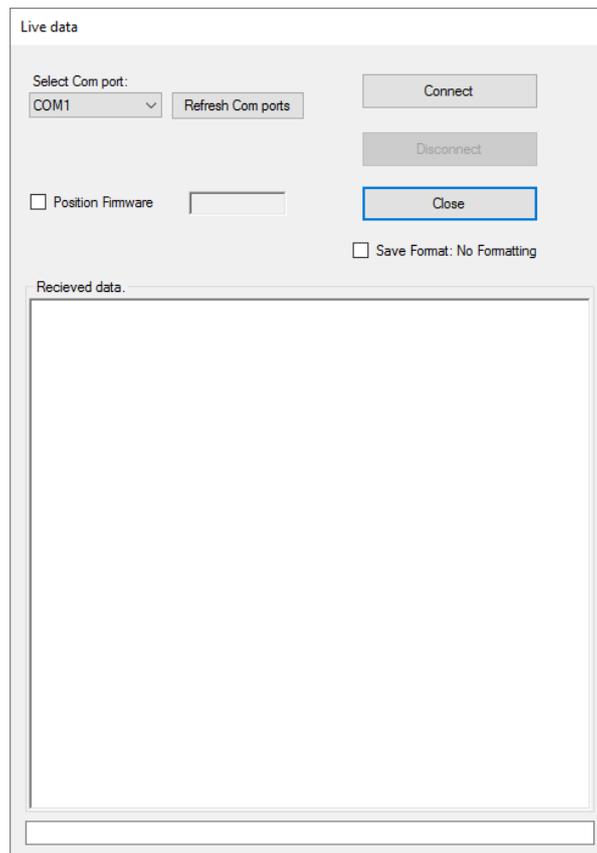
Live data

Select Com port:
COM1   Refresh Com ports   Connect

                                   Disconnect

☐ Position Firmware [   ] Close

                          ☐ Save Format: No Formatting

Recieved data.

The user should select which serial port the GPS Synchroniser is connected to using the drop down list on the Select Com Port control. This list can be refreshed if the serial port is attached to the PC after the module has been started e.g. if a USB to Serial converter is connected to the PC after the software has been launched.

Please note that if the GPS Synchroniser has the Positioning firmware, version 3.80, installed the Position Firmware box should be selected before the Connect button is clicked.

Data received from the GPS Synchroniser can be saved into a Tab Separated Value (TSV) text file. Alternately this data can be saved with no formatting. This is selected by checking the save format check box which will indicate the save format which is currently selected. When saved in TSV this allows data to be easily imported into spreadsheet programmes such as Microsoft Excel. An example of the TSV format is shown above.

Clicking the Connect button prompts the user to select the folder and file name in which to save the data. This file's location and name is displayed in the text box at the bottom of the window under the Received data text box.

Power should then be applied to the GPS Synchroniser and timing data is output each time an event is detected.

Live data

Select Com port:

COM1 Refresh Com ports Connect

Data received from the GPS Synchroniser.
Number of lines read:

10 ☐ Position Firmware Close

☐ Save Format: No Formatting

Recieved data.

```
011  381758 us + U 14:32:43 11 06 06/05/2016
011  405369 us + U 14:32:45 11 06 06/05/2016
011  640970 us + U 14:32:49 11 06 06/05/2016
011  517957 us + U 14:32:51 11 06 06/05/2016
011  395724 us + U 14:32:53 11 06 06/05/2016
011  281552 us + U 14:32:55 11 06 06/05/2016
011  906119 us + U 14:32:59 11 06 06/05/2016
011   87481 us + U 14:33:03 11 06 06/05/2016
011   45628 us + U 14:33:06 11 06 06/05/2016
011  363576 us + U 14:33:08 11 06 06/05/2016
```

C:\TEMP\GPS Live data test.txt

This shows that ten events were output to the PC. The events are also recorded into the internal memory of the GPS Synchroniser and can be downloaded as normal, as described in section 5.1.

5.4 Reset GPS Module

This module resets the parameters in the internal GPS module if they have been corrupted for any reason (e.g. the internal battery becomes discharged after a long period of storage). A symptom of parameter loss is an invalid time display such as "55:55:55" or displaying "OC" when an antenna is connected.

This module uses the red cable is used to communicate with the PC. The GPS Synchroniser should be powered up after the cable is connected.
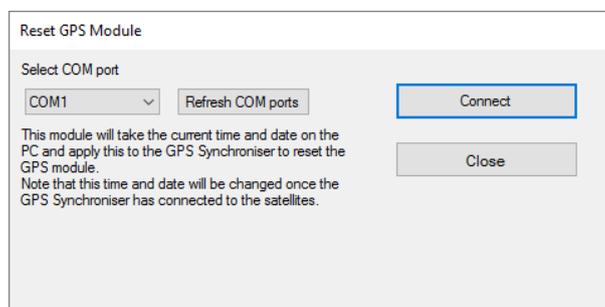
Reset GPS Module

Select COM port

COM1 Refresh COM ports Connect

This module will take the current time and date on the PC and apply this to the GPS Synchroniser to reset the GPS module.
Note that this time and date will be changed once the GPS Synchroniser has connected to the satellites.

Close

The user should select which serial port the GPS Synchroniser is connected to using the drop down list on the Select Com Port control. This list can be refreshed if the serial

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port is attached to the PC after the module has been started e.g. if a USB to Serial converter is connected to the PC after the software has been launched.

When the GPS Synchroniser has booted Clicking the Connect button resets the parameters in the GPS module.
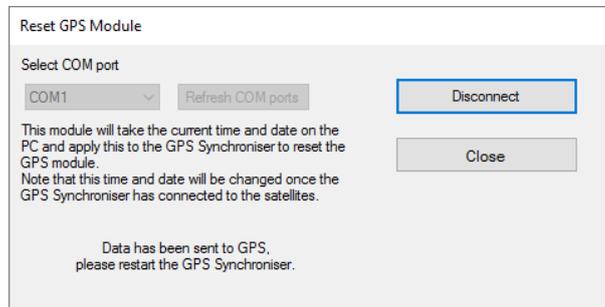
The GPS Synchroniser should be powered down and the red cable removed before being used to record events.

5.5 GPS to UTC

This module selects whether event times are recorded in GPS or UTC time.
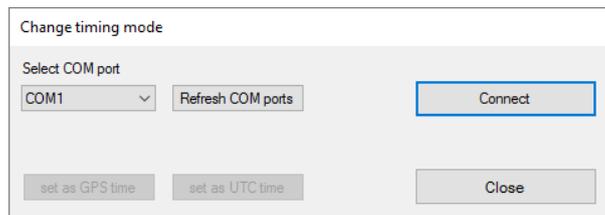
The red cable should be used to connect the GPS Synchroniser to the PC before the GPS Synchroniser is powered up.

Select which serial port the GPS Synchroniser is connected to using the drop down list on the Select Com Port control. This list can be refreshed if the serial port is attached to the PC after the module has been started, e.g. if a USB to Serial converter is connected to the PC after the software has been launched.

When the GPS Synchroniser has booted, clicking the Connect button interrogates the GPS Synchroniser to get the current timing mode.
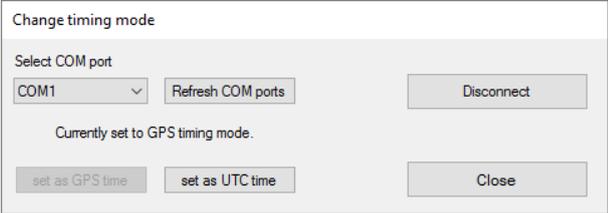
Currently GPS   Currently UTC
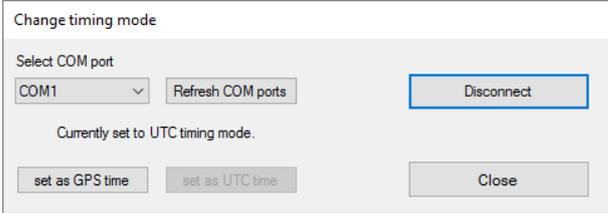
The above two images show how the software displays the current setting of the GPS timing mode of the connected GPS Synchroniser. Depending on which timing mode is currently being used the text below the COM port list will change accordingly. The appropriate button will then be enabled so that the user can change between modes.

6   Using GPSSerial2 Software

GPSSerial2 a terminal application supplied with the GPS Synchroniser. It will run on all versions of Windows from XP onward. It requires the .NET Framework to be installed on the PC, this is usually done by default on Windows Vista and Windows 7 installations.

6.1   Transferring Results to a PC Using GPSSerial2

1. Connect the cable with blue connectors between the PC serial port and the GPS Synchroniser.

2. Start GPSSerial2. If no serial port is found an error message is displayed and the programme exits.

3. Select the appropriate serial port and baud rate in the drop boxes at the top left. For a data transfer the baud rate should be 57600. If the serial port number is not known (for example if a USB converter is being used) the Device Manager may give useful information. Click on "Connect" to connect to the port.

4. Click on "Save" to select a filename and location for the transferred data. The extension "txt" is automatically added.

5. Connect the GPS Synchroniser to a 12 Volt supply. The following display appears:

```
GPS    SYNC    2v26
 Exporting Data
```

The display on the PC should show the data arriving. The complete transfer takes about 50 seconds (100 seconds for software 2v20 and above).

GPS Synchroniser Interface

COM1   Com Port   Disconnect

57600   Baud Rate

Polarity

Polarity   Positive   Negative   Exit

Received Data   Stop

```
088   193281 us + U 03:50:54 10 02 06/12/2011
088   193281 us + U 03:50:56 10 02 06/12/2011
088   193281 us + U 03:50:58 10 02 06/12/2011
088   193280 us + U 03:51:00 10 02 06/12/2011
088   193280 us + U 03:51:02 10 02 06/12/2011
088   193280 us + U 03:51:04 10 02 06/12/2011
088   193280 us + U 03:51:06 10 02 06/12/2011
088   193280 us + U 03:51:08 10 02 06/12/2011
088   193281 us + U 03:51:10 10 02 06/12/2011
088   193280 us + U 03:51:12 10 02 06/12/2011
088   193281 us + U 03:51:14 10 02 06/12/2011
088   193280 us + U 03:51:16 10 02 06/12/2011
088   193280 us + U 03:51:18 10 02 06/12/2011
088   193280 us + U 03:51:20 10 02 06/12/2011
088   193280 us + U 03:51:22 10 02 06/12/2011
088   193281 us + U 03:51:24 10 02 06/12/2011
088   193280 us + U 03:51:26 10 02 06/12/2011
088   193280 us + U 03:51:28 10 02 06/12/2011
088   193280 us + U 03:51:30 10 02 06/12/2011
088   193280 us + U 03:51:32 10 02 06/12/2011
088   193280 us + U 03:51:34 10 02 06/12/2011
088   193280 us + U 03:51:36 10 02
```

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6. When the transfer is complete a display similar to the following appears on the GPS Synchroniser, click on "Stop" to save the file:

```
   1999999
Timer Test
```

The Timer Test is an internal test during which the number of the microseconds from the internal precision clock is counted over a two second period from the GPS system. The test result is also output on the RS 232 port. Values from 1999998 to 2000002 are within specification. The precision clock can be adjusted if necessary (see page 11).

Software versions 2v22 and above will additionally display the number of satellites used for calculation in the upper right hand corner.

6.2 Changing Trigger Polarity Using GPSSerial2

1. Follow the procedure for transferring data on the previous page.

2. When the data transfer is complete click on "Polarity". After a few moments the GPS synchroniser will return the prompt "POL>" in the display:
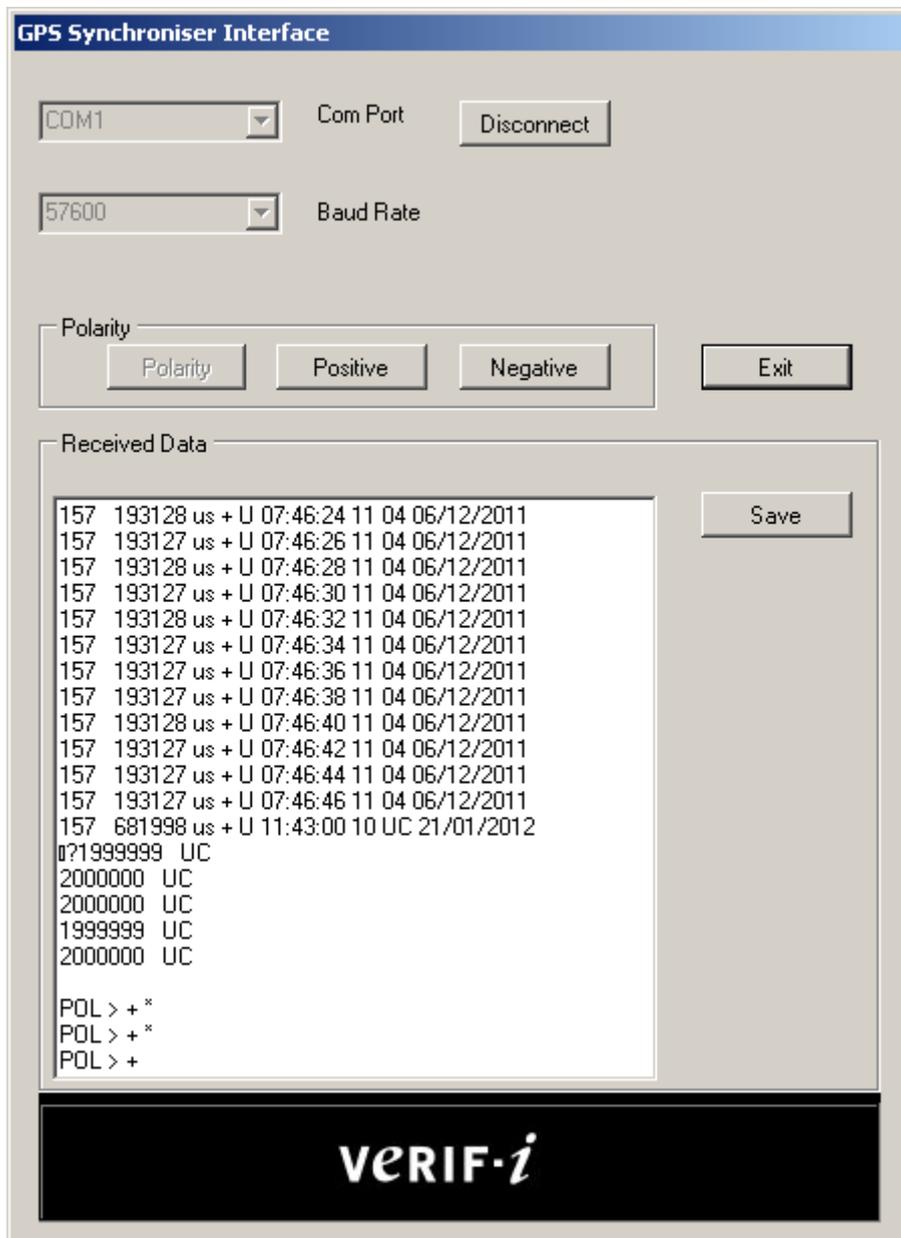
The '+' character is the current setting; in this case the unit will trigger on a positive edge.

To change the polarity, click on 'Positive' or 'Negative' as appropriate. The display will confirm the chosen configuration.
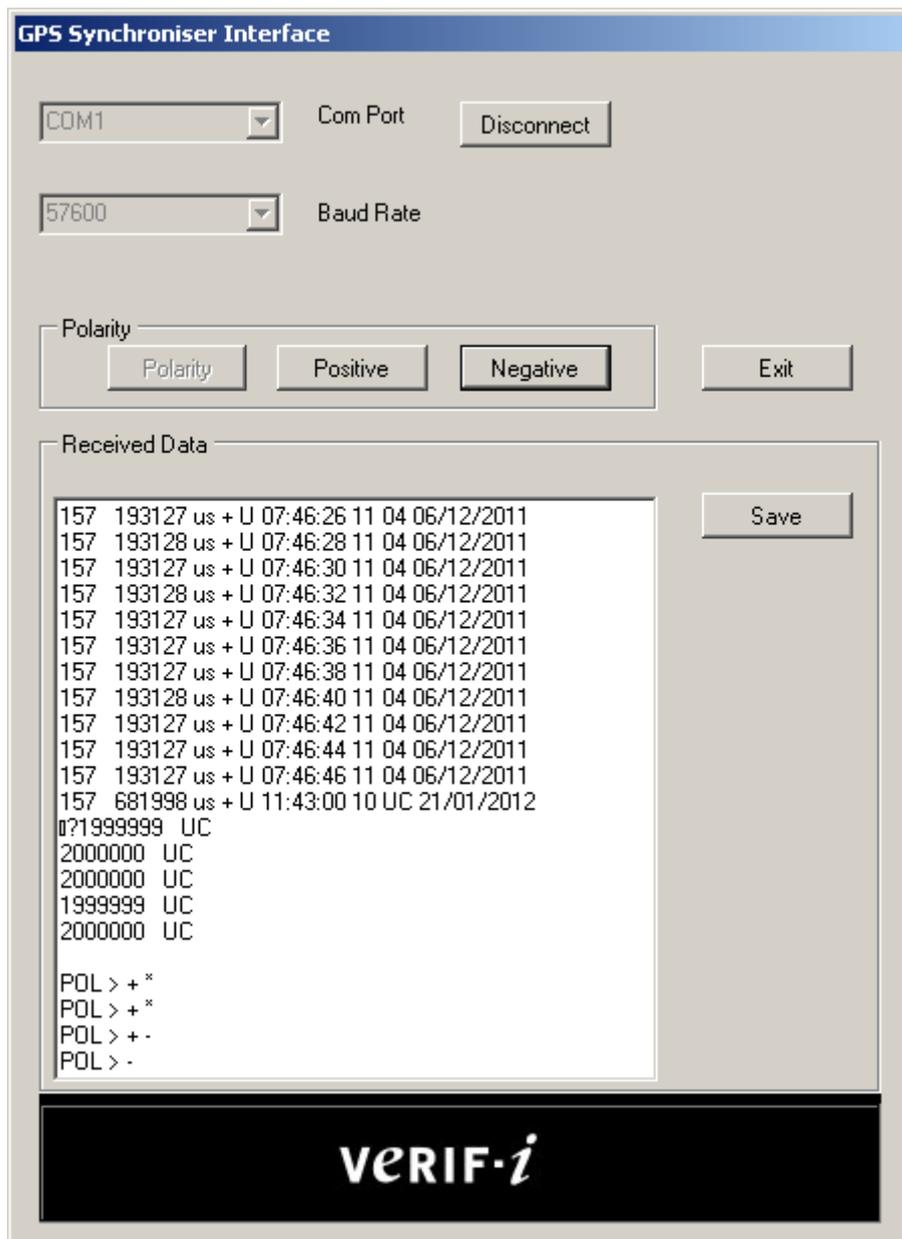
The GPS Synchroniser will need to be restarted after this process.

7 Using Terminal Software

7.1 Transferring Results to a PC Using Terminal Software

1. Connect the cable with blue connectors between the PC and the GPS Synchroniser.

2. Start a terminal utility such as "Hyperterminal" on the PC.

The parameters should be set to:

> 57600 bits per second
> 8 data bits.
> No parity
> 1 Stop bit
> No flow control

3. The "Capture Text" facility or equivalent can be used to save the transferred data in a file.

4. Connect the GPS Synchroniser to a 12 Volt supply. The following display appears:

```
GPS    SYNC    2v14
  Exporting Data
```

The terminal display on the PC should show the data arriving. The complete transfer takes about 50 seconds (100 seconds for software 2v20).

5. When the transfer is complete the following display appears:

```
   1999999
 Timer Test
```

This is an internal test during which the number of the microseconds from the internal precision clock is counted over a two second period from the GPS system. The test result is also output on the RS 232 port.

Values from 1999998 to 2000002 are within specification. The precision clock can be adjusted if necessary (see page 11).

Software version 2v22 will additionally display the number of satellites used for calculation in the upper right hand corner.

7.2 Changing Trigger Polarity using Terminal Software

1.   Follow the procedure for transferring data on the previous page.

2.   When the data transfer is complete type '∗' on the PC keyboard. The GPS Synchroniser will return the prompt:

    POL> +

The '+' character is the current setting; in this case the unit will trigger on a positive edge.

To change the polarity type '+' or '-' as appropriate.

Note

The GPS Synchroniser will only recognise the two characters '+' and '-'. Any other characters will be echoed to the terminal and the prompt will return, as in the following example:

    POL > + W
    POL > + R
    POL > + O
    POL > + N
    POL > + G
    POL > + -
    POL > -

In this case the sixth attempt was recognised and the polarity changed.

8 Specifications

Input:

Optically isolated to 1.5 kV

Input range 3.5 V to 12 V

Triggers on a positive or negative going transition, software selectable

Output:

RS232 - 9 pin D female with true RS232 levels

Accuracy:

± 5 microseconds for each event

Power Requirement:

9 V to 18 V DC 250 mA

Size:

100 x 250 x 45 millimetres

Weight:

430 grams

9 Adjusting the Precision Clock

1.   Remove the four screws holding the case together. The two upper screws are accessible after removing the small plastic panel on the back of the case.

2.   Put the GPS Synchroniser into test mode as described on page 8.
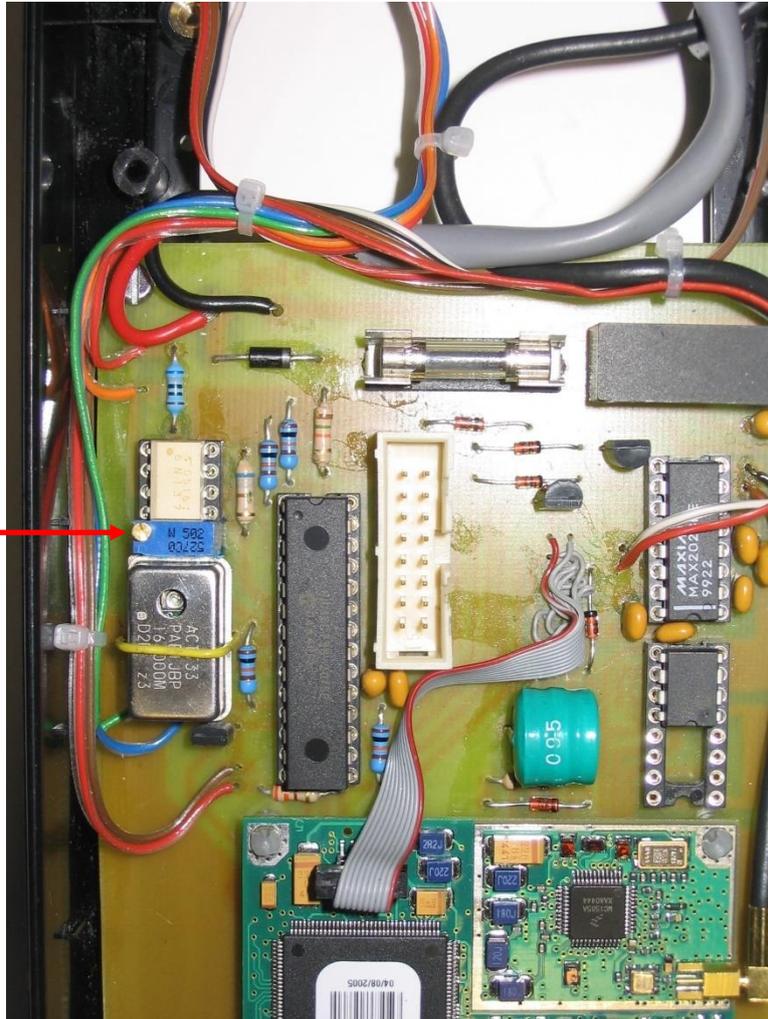
3.   Adjust the potentiometer (indicated) until the display reads 2000000. The display will typically vary by one or two counts. The front panel connector has been removed in the image above for clarity.

Note

1   The GPS Synchroniser displays the result of a count every two seconds. Sufficient time should be left between adjustments to allow the display to refresh.

2   The adjustment should only be made with the antenna connected and the unit capturing satellite data.

10 Setting GPS Receiver Parameters

Normally this should not need to be done. The GPS receiver has an internal battery powered memory for saving parameters. The parameters are reset if they are lost for any reason (eg battery failure) or it is required to change the time mode (UTC to GPS or vice-versa). A symptom of parameter loss is an invalid time display such as "55:55:55".

It is suggested that the following method is used for both cases.

1.   Connect the GPS control cable (red connectors) between the PC and the GPS Synchroniser.

2.   Power up both units and start the WinOncore12 software.
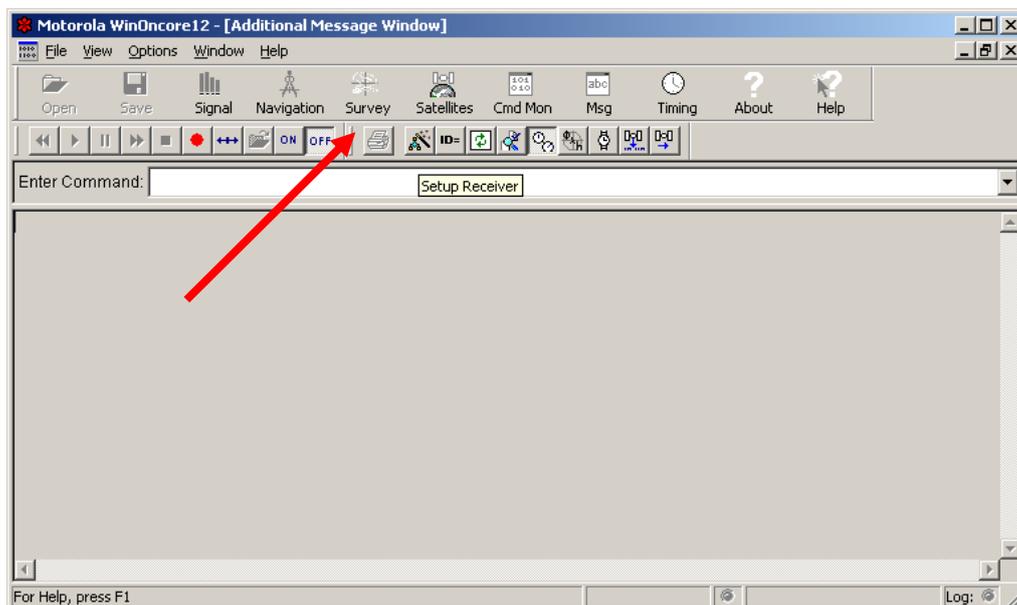
3.   Start the setup wizard from the button on the toolbar.
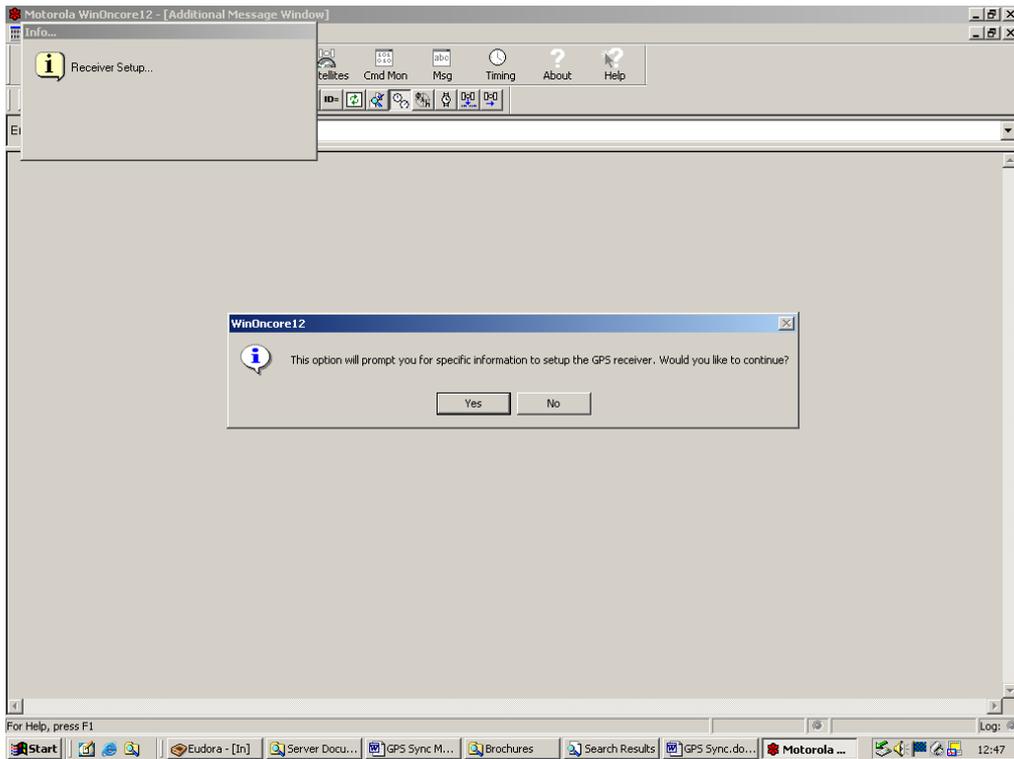
4. Click "Yes" to continue
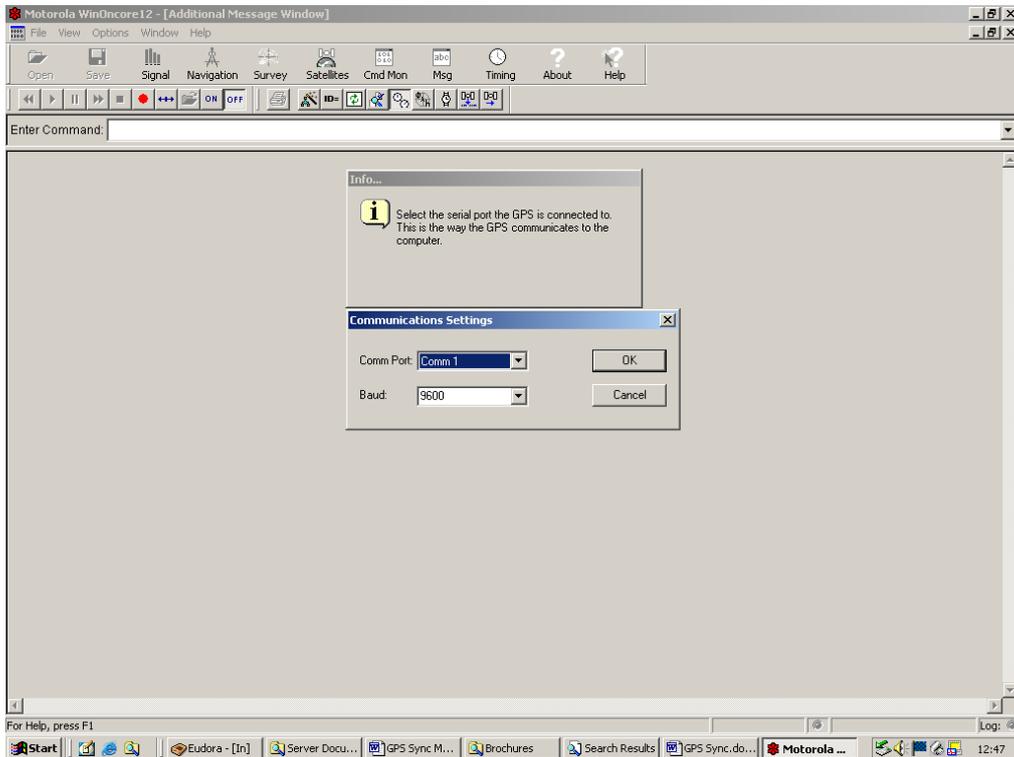
5. Check the serial port settings and click "OK"
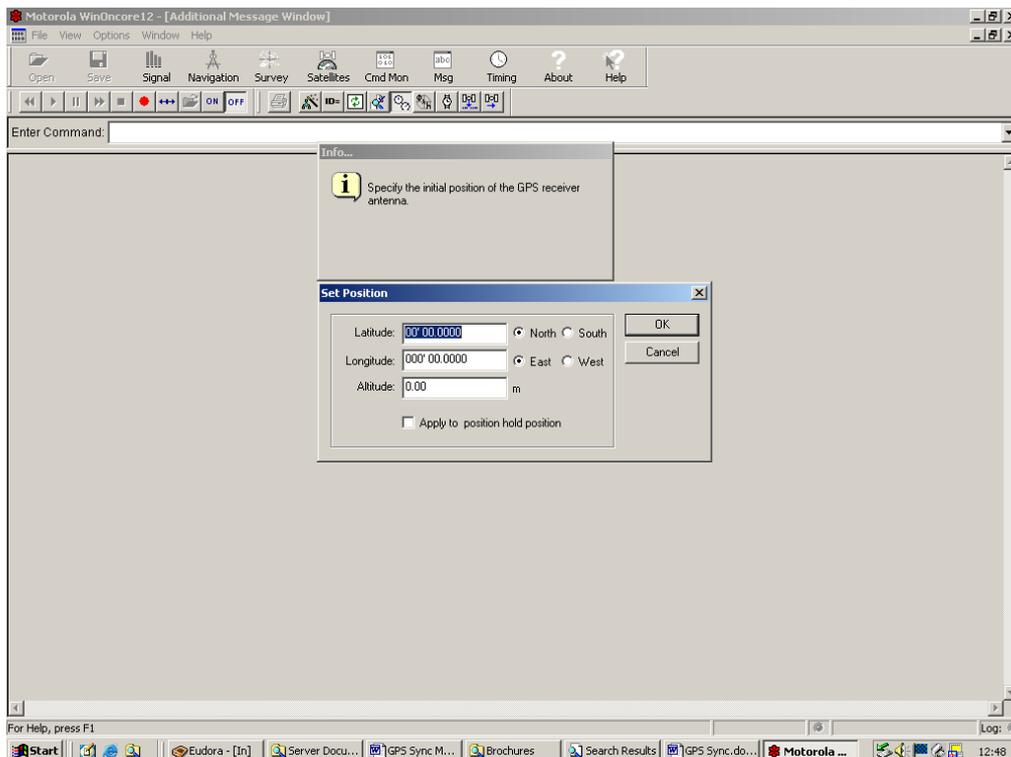
6. The position information is not important since it is not used. Click "OK" to continue.
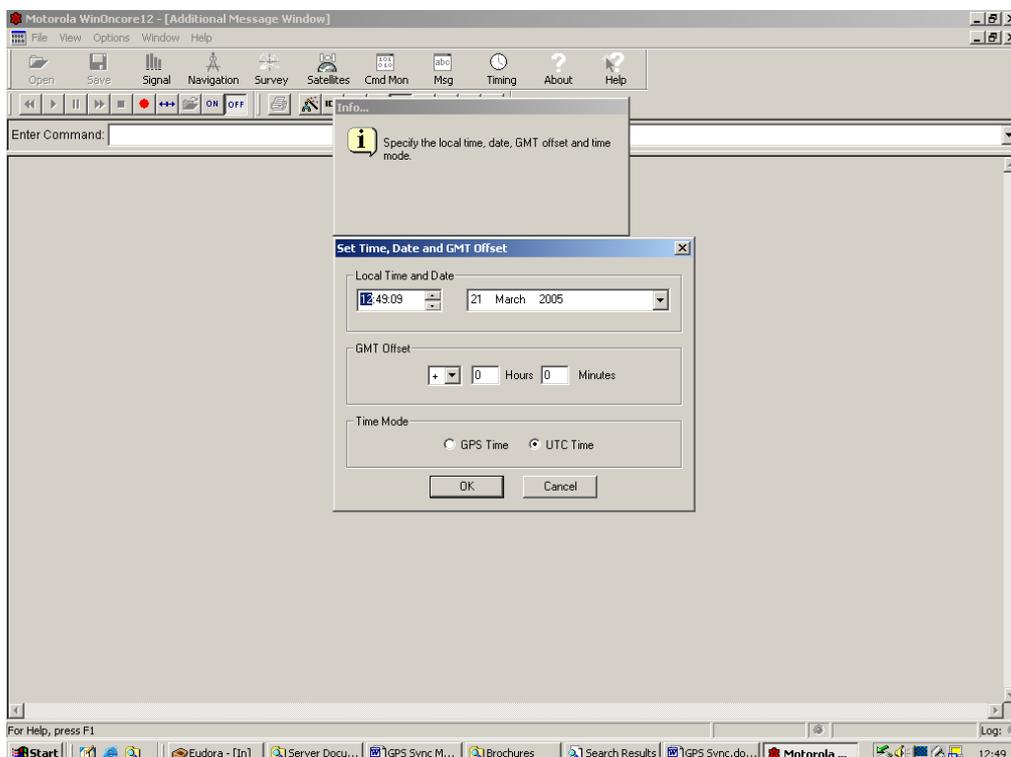
7. Choose GPS or UTC time mode (**important**). The date and time information is not important; the receiver will correct it as soon as it receives valid satellite data. Click "OK" to continue.
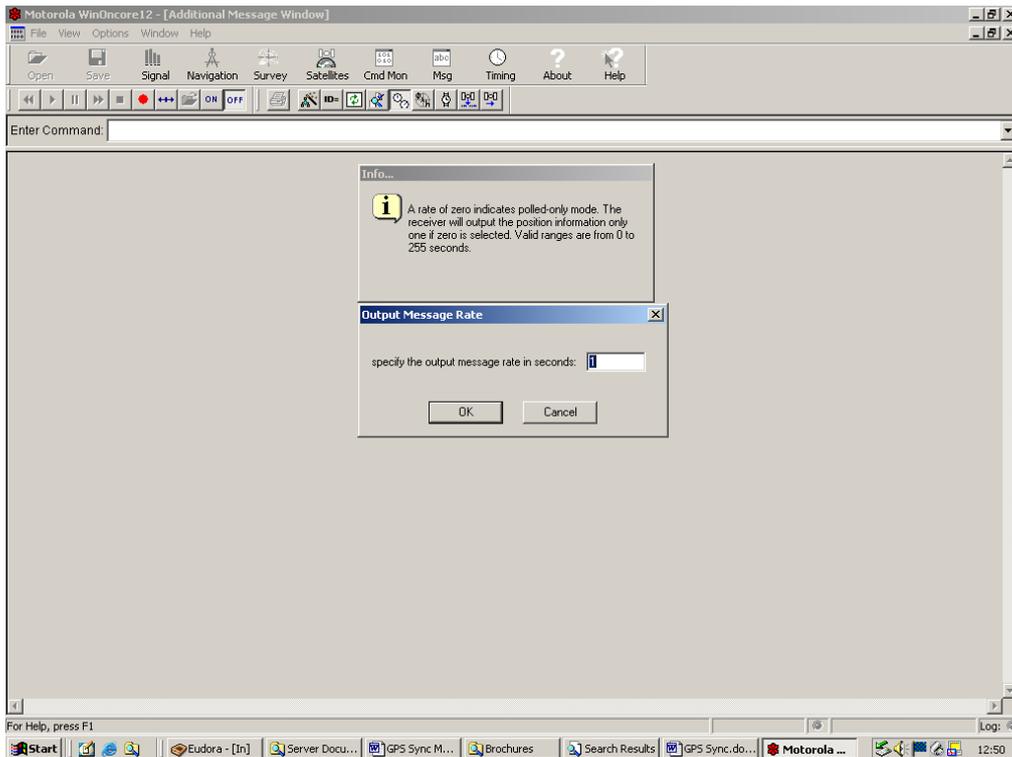
8. Set the output message rate to "1".

Note : This is an important parameter.

Click "OK" to continue.
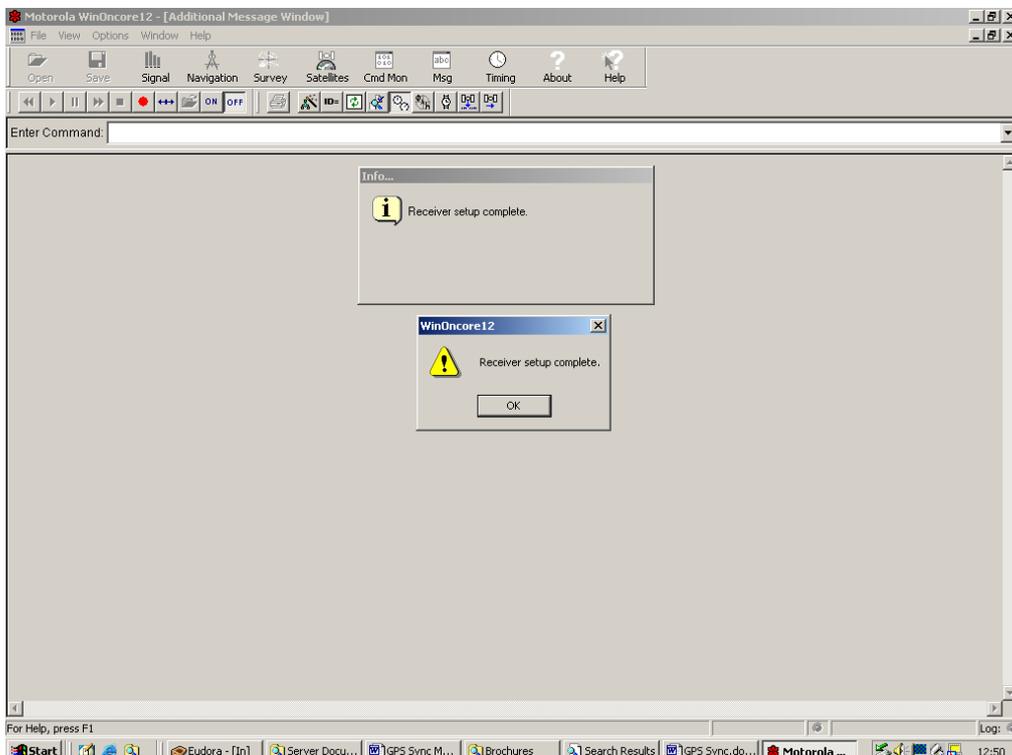
9. Click "OK" to finish..

11 Cable Diagrams

GPS Control Cable

GPS Synchroniser   PC Serial Port

1	————————————	2
8	————————————	3
5	————————————	5

9 Way D - Male   9 Way D - Female

Cable length: 1.5 m
Hood colour: Red

Data Transfer Cable

GPS Synchroniser   PC Serial Port

2	————————————	2
3	————————————	3
9	—————┐	4
5	—————┴————————	5

9 Way D - Male   9 Way D - Female
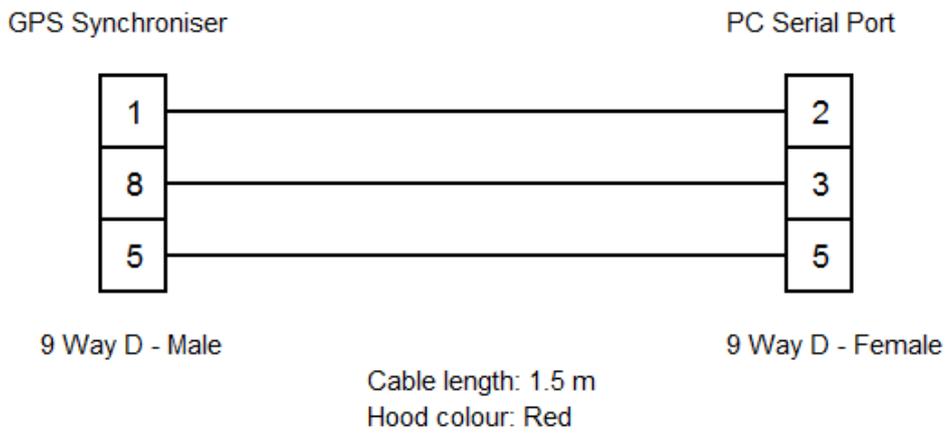
Cable length: 1.5 m
Hood colour: Blue
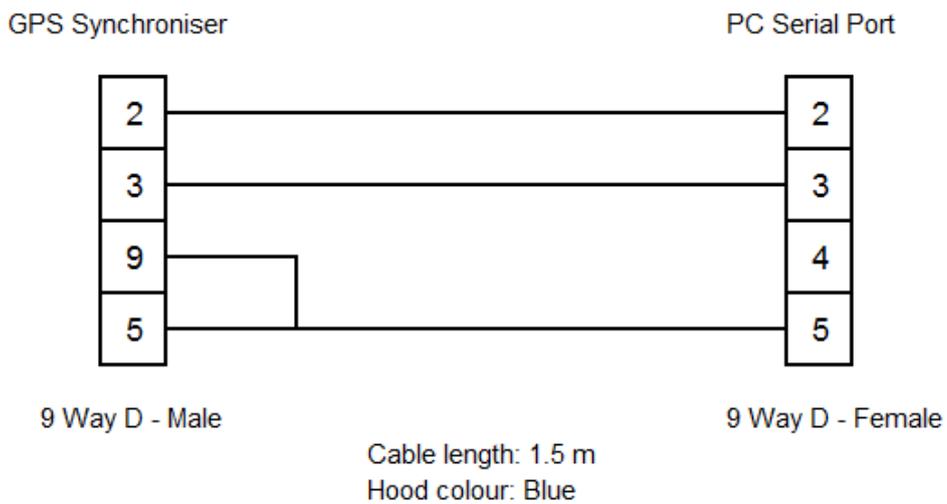
Real Time Download (not supplied)

GPS Synchroniser   PC Serial Port

| 2 |————————————| 2 |
| 5 |————————————| 5 |

9 Way D - Male   9 Way D - Female

Cable length: 1.5 m
Hood colour: Grey