GPS NMEA data on ER9X
(based on the ArduPilot solution)

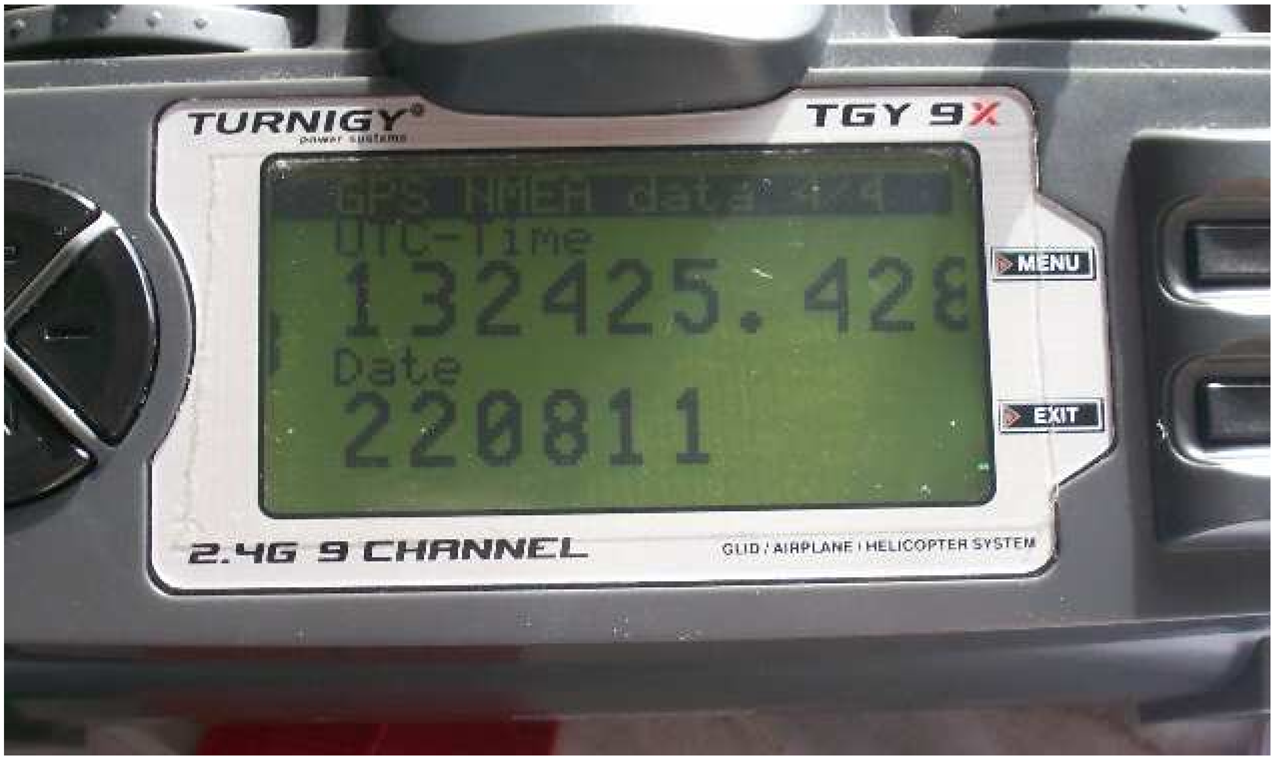
This is more or less a DIY project, as there is no premade hardware available. **Do it at your own risk.** You may use different GPS receivers or transceivers, as long, as the receiver, attached to the TGY 9X delivers pure NMEA datapackages via an UART serial interface at a baud rate of 4800 Bd. A different baud rate can be set in the nmea.cpp module, if required. (As the original software of ArduPilot uses a baud rate of 38400 Baud, I suppose, NMEA data will also work up to this baud rate.)

This hardware setup can also be used to feed a PDA (e.g. Palm m500 with SD memory card) to show calculated values (with reference to the starting position) and log all NMEA data for after flight analysis. (See pictures at the end of doc)
`See  http://www.rcgroups.com/forums/showpost.php?p=17604732&postcount=5272`

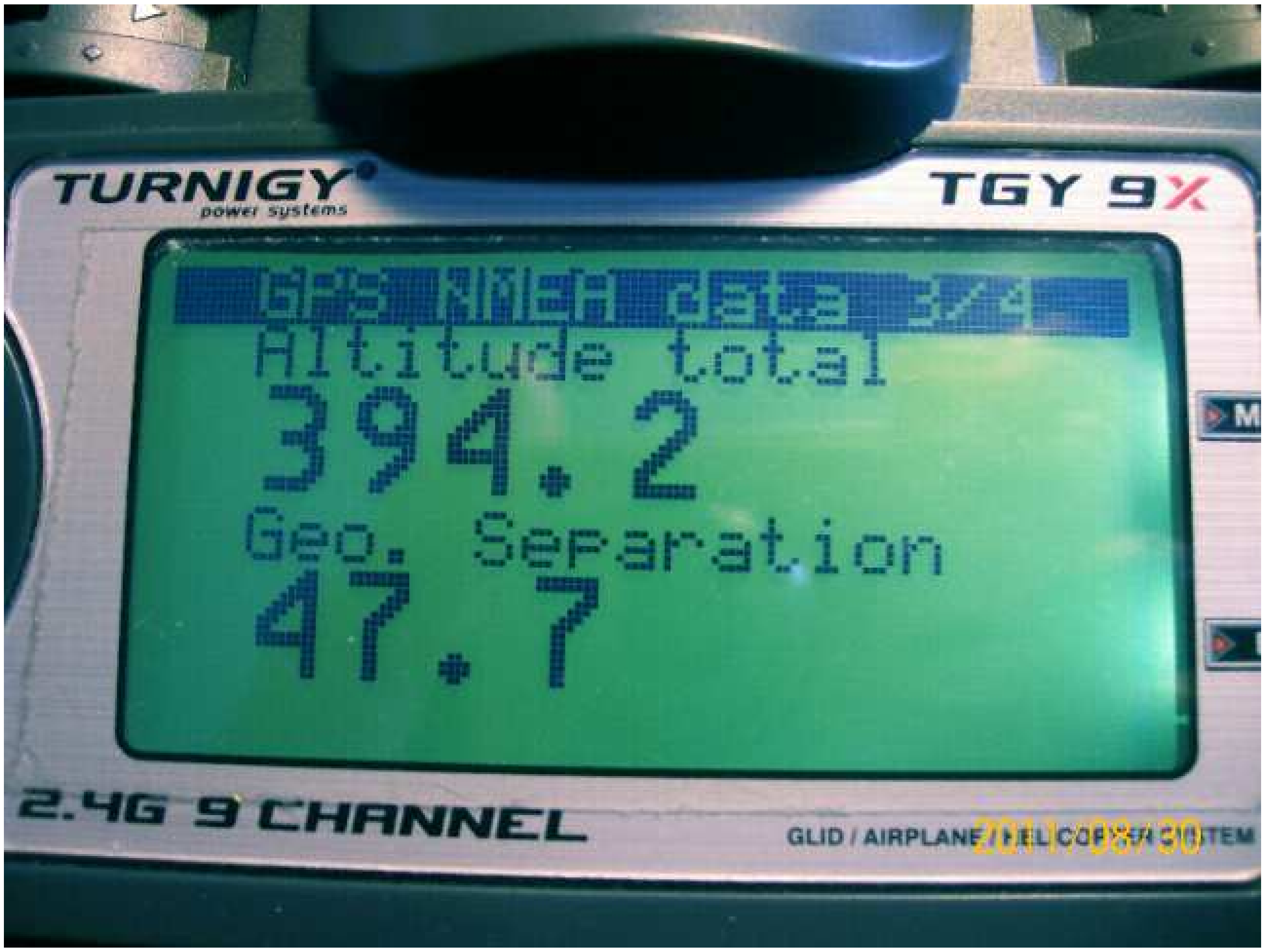
My implementation is based on a Holux GM-210 GPS mouse and two APC200 modules as RF-link.

With this modification, you can **display selected life GPS Data on the Tx display**. There is only a one way communication from the GPS transmitter to the Tx receiver.

According to my setup, the TX displays the following data:



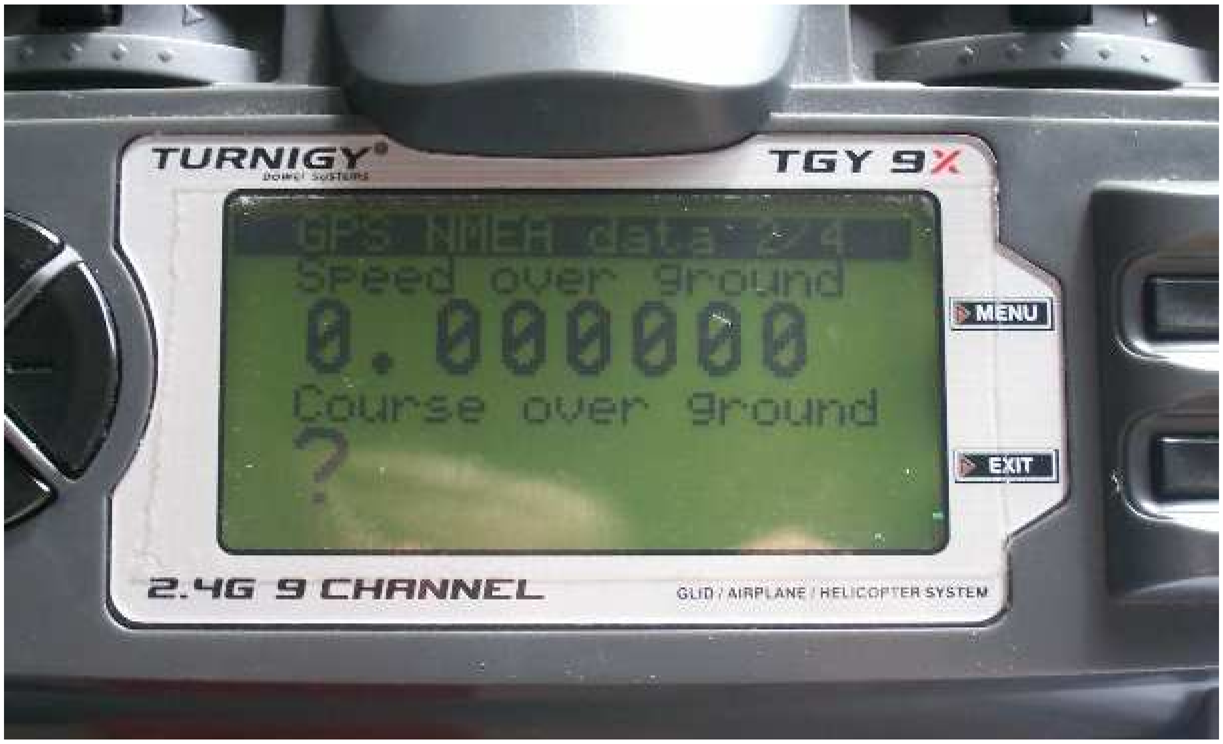
UTC-Time and Date



Altitude and Geoidal separation

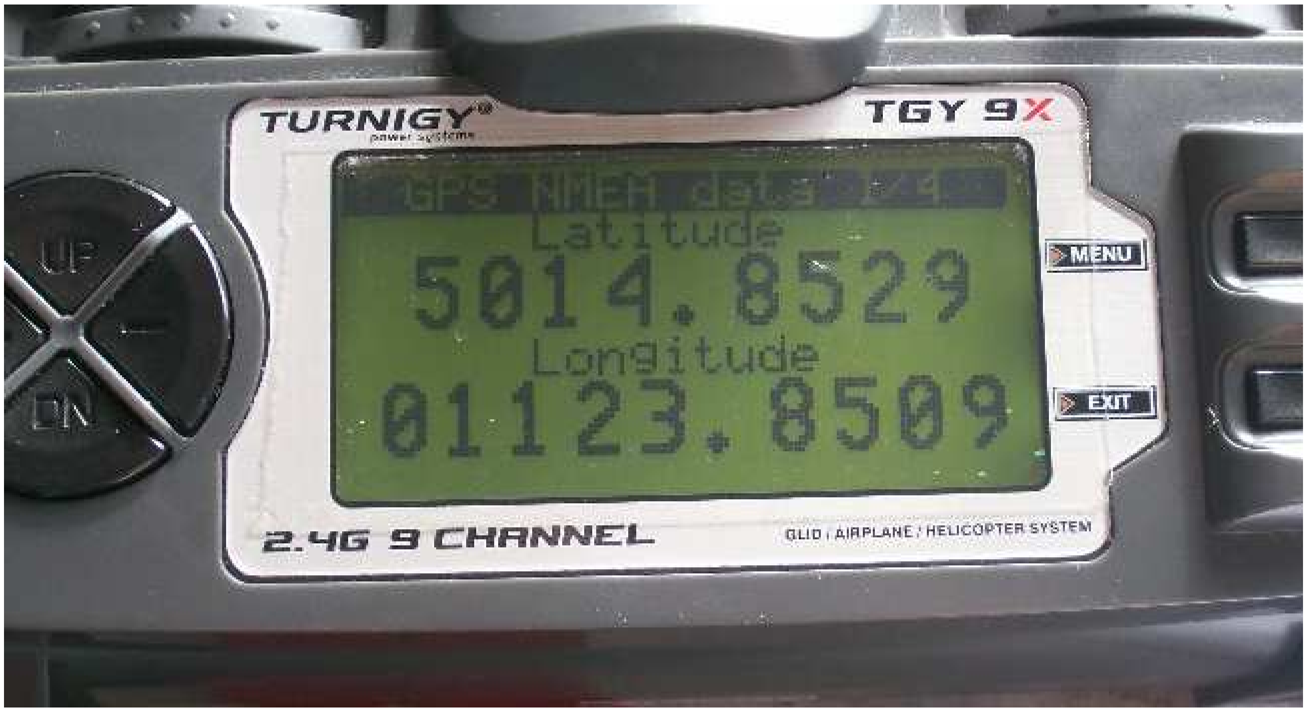
Note:
The altitude over sea level is to be calculated as:

Altitude minus geoidal separation



```
GPS NMEA data 2/4
Speed over ground
0.000000
Course over ground
?
```

Speed over Ground and Course over Ground



```
GPS NMEA data [illegible]
Latitude
5014.8529
Longitude
01123.8509
```

Latitude and Longitude

To use the NMEA build of ER9x you will need to make some modifications to the hardware in your radio. These modifications require soldering of small tracks on the radio circuit board. Be warned that it is possible to damage the board permanently if care is not taken.

You must have the programm to configure your GPS receiver (e.g. SIRFDemo.exe, depends on your GPS receiver) and the program to configure the APC200 modules (RF-Magic-42.exe from sureelectronics.net).
To attach the GPS mouse and the APC200 modules to the PC, you probably have to solder some temporary cables, that allow you to attach them to the COM port of your computer.
To configure the APC200 you temporarily need a level converter, as the APC200 can only be configured via the TTL UART.

You must apply the telemetrie mod to the TX to free up the input pin on the ATMega64 of the TX.

See for a description:

http://code.google.com/p/gruvin9x/wiki/FrskyInterfacing

Note: You only need to follow the rewire instructions. If you use the APC200 transceiver there is no need to build the interface with the level converter.

I have used the following items:

Holux GM-210

APC200

RS232 to TTL converter

Links are only given as an example.

A GPS mouse Holux GM-210 (e.g. http://www.ebay.de/itm/180653870348) combined with an APC200 (e.g. http://www.sureelectronics.net/goods.php?id=1053) transceiver module (431MHz - 478 MHz) as transmitter (to be attached to the plane) and another APC200 transceiver as ground receiver that feeds the GPS data signal into the ATMega64 of the TX.

GM-210 as well as APC200 work with 5 volt supply voltage and have UART input and output with TTL and RS232 level. This way, they can be connected easily with each other. To configure the APC200 you need an RS232 to TTL level converter (e.g. http://www.ebay.de/itm/190541492451)

GPS receivers usually output their data as records in NMEA format. This is pure ASCII data and is commonly used (see last pages).

There are many different NMEA records available that contain different information. But not all records are supported by every module.

Normally you can configure the module, which records and at what repetition rate these records are to be output from the GPS receiver.

I have configured the GM-210 to output $GPGGA and $GPRMC records once a second at 4800 Bd.

The APC200 modules that transmit at a selectable RF of 431 - 478 MHz and a maximum output of 10bdm are mid range modules (to my opinion). I verified a ground range of over 800 m with nearly (but not really) free line of sight.

The maximum range of the APC200 modules increases with lower over the air transmission speed.

Over the air transmission speed and UART serial input / output speed can be configured independently.

I have set up the RF transmission speed to 2400 Baud and the serial UART speed to 4800 Baud.
That means, that the GPS mouse has to send with 4800 Baud (the default speed of GM-210), the APC200 transmitter sends over the air at 2400 Baud, the APC200 receiver outputs with UART speed of 4800 Bd and the TX reads the data with 4800 Baud.

This is possible without data loss, because the APC200 has a buffer of 512 bytes and the selected NMEA records have a total of about 150 Bytes only, once per second.

The ER9x NMEA modification reads the data via UART, extracts the required fields and displays them (without any modifications) on four different screens.

You get the first screen pressing [long] the down button.
To step though the screens, you press [short] the up or down button
Pressing the exit button leaves the NMEA display.

Assembling and programming of the hardware

Warning !!

GPS modules tend to loose their configuration, when they are not used for a longer time (small backup battery). Therefore you should be prepared to have access to the connector of the GPS module and the appropriate programming cable to reprogram it at any time.

Don't throw away the programming cable.

The APC200 modules store the configuration in flash memory. They shouldn't loose their configuration. But configuring of the module is only possible via the TTL UART and requires a TTL / RS232 converter.

Step 1

Verify, that you have everything available

A PC that has a COM port (virtual COM ports via USB may not work reliable)
the (working) program to configure the GPS mouse
the (working) program to configure the APC200 transceivers

the GPS mouse
an RS232 to TTL level converter
two APC200 transceivers
The resistors for the telemetrie mod
one or two SUBD female connectors
some servo cables
plugs, that fit onto the APC200 connectors

Step 2:

Program the GPS mouse.

You need a program like SirfDemo.exe and a cable, that connects the RS232 signals from the mouse to the com port of your computer.

Configure the GPS mouse to send $GPGGA and $GPRMC records once every second at 4800 Baud

```
GM-210                                          SUBD female
-------------------------------------------------------------------------------------------
pin 2 green RS232 Tx    ---------------------         pin 3
pin 3 yellow RS232 Rx   ---------------------         pin 2
pin 5 white             ------------+--------         pin 5
                                    |--------         ground (servo cable)
pin 1 red               ----------------------        +5volt (servo cable)
```

Step 3:

Remove cover of GPS mouse

To save some weight on the GPS mouse, remove the housing. You have to, more or less, destroy the housing as upper and lower half are glued together and must be pried open with some force. There are no scews to be removed.

The housing of the GM-210

Step 4:

<u>Program the APC200 transceiver modules</u>

This is only possible via the TTL port of the module.

Therfore you must use a RS232 to TTL converter to connect the module to the COM port of your PC. Use the program Rf-Magic42.exe to configure the APC200 modules. It is important that the program is already running and the COM port is set, before the module is attached and powered on. (The program continuosly sends a 2 byte sequence over the Com port. Only if the module detects this data during power on, it switches into configuration mode.)

For the Series parameters, set the Series Rate to 4800 Baud, Parity disable and the RF TRx rate to 2400 Baud, RF Power to max.
Enable RFID and set an Index value.

Configure both modules identical.

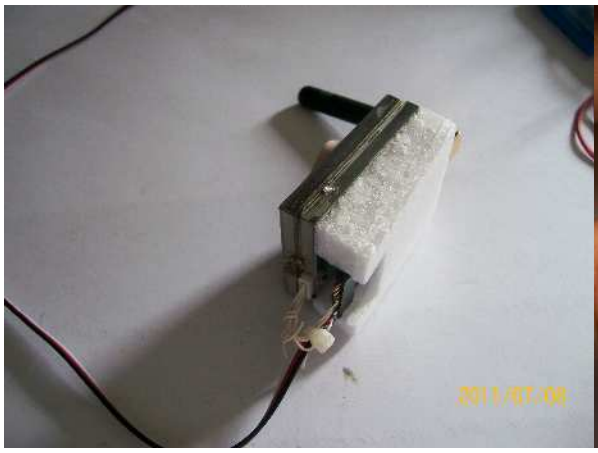
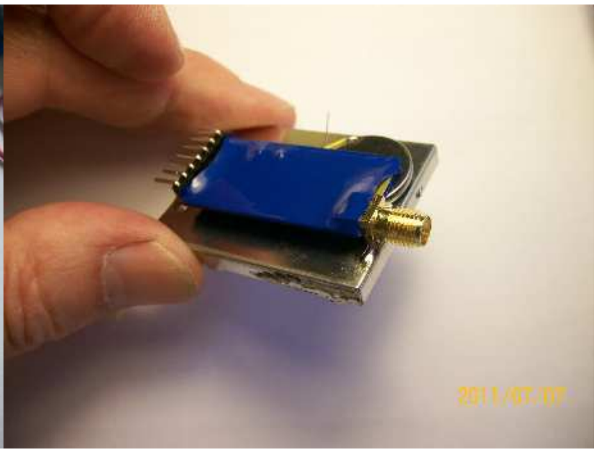
```
      APC200                      TTL/RS232  SubD female

TTL Rx  Pin 4    ----------------      Pin TTL TX
TTL Tx  Pin 5    ----------------      Pin TTL RX
+5 Volt  Pin 2   ---------+------      Pin +5 Volt
                          |____        +5 Volt Servo cable
0 Volt    Pin 1  ---------+-------     Pin 0 Volt
                          |_____       0 Volt Servo cable
```

Step 5:

Connect GPS mouse and transceiver

Cut the original mouse cable to still have enough length to connect the mouse with the APC200.
As power connector, use a servo cable and solder it to pins 1 (0 volt) and 2 (+5 volt) of the APC200 (watch polarity)

APC200 on back of GM-210

```
GM-210                                   APC200
-----------------------------------------------------------------------
pin 4 blue       ---------------------pin 5    TTL Tx
pin 6 black      ---------------------pin 4    TTL Rx
pin 1 red        -----------+-------- pin 2    + 5Volt
                            |_____  servo cable red +5 Volt

pin 5 white      -----------+-------  pin 1    ground
                            |_____  servo cable black 0 Volt
```

To power your GPS with transmitter, plug the servo cable into an unused servo position of the receiver or use a Y-cable splitter.

Check, that the LED of the GPS mouse lights up when powered on.

Step 6:

Modify the TX

Verify, that all the switches of the TX do work.

Apply the telemetrie mod to the TX to free up the input pin on the ATMega64 of the TX according to this description

http://code.google.com/p/gruvin9x/wiki/FrskyInterfacing

Note: You only need to follow the rewire instructions. No need to build the interface with the level converter as the APC200 has TTL output.

Verify, that two of the switches do no longer work e.g.with the diagnostic screens of ER9x.

Flash the TX with the NMEA version of ER9x

Verify, that all switches work correctly again.

That verifies, that the telemetrie mod has been done correctly

Press down [long] to enter the telemetrie display
Press up or down [short] to step through the screens
All the fields should show a big questionmark
Press exit to leave the telemetrie screens

Step 7:

Connect the APC200 module to the TX

APC200		TGY 9X
TTL Tx Pin 5	---------------------	via resistor of 1K to Pin 2 of ATMega
+5Volt Pin 2	---------------------	+5 Volt
Ground Pin 1	---------------------	Ground

Step 8:

Verify operation

Power on the GPS-transmitter and the TX
Select the telemetrie screens (push down [long])
Most of the fields will be similar to 0000.000
UTC-Time and Date will be the first fields to display real values.
When the GPS mouse gets a satellite fix, all the fields (except course over ground) will show meaningful values.
Course over ground requires, that the receiver is being moved.

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-------------------some GPS background---

NMEA Records:
=============

The length of the individual fields may vary (even be empty), but all Fields are always there and are separated by colon.
$GPGGA data is valid when field 6 <> "0" (Null)
$GPRMC data is valid when field 2 <> "V"
UTC-Date and UTC-Time are available some time before the GPS gets a satellite fix

Sample data with position not fixed:
============================

```
$GPGGA,130607.704,5014.8588,N,01123.8331,E,0,01,0.0,0.0,M,47.7,M,0.0,0000*73
$GPRMC,130607.704,V,5014.8588,N,01123.8331,E,0.00,,110211,,*0D
```

Sample data with position fixed:
========================

```
$GPGGA,130415.711,5014.8480,N,01123.9166,E,1,08,1.0,387.2,M,47.7,M,0.0,0000*79
$GPRMC,130415.711,A,5014.8480,N,01123.9166,E,2.59,312.81,110211,,*0E
```

$GPGGA - Global Positioning System Fix Data, Time, Position and fix related data for a GPS receiver.

```
                1         2   3  4      5 6 7  8  9  10 11 12 13  14  15
                |         |   |  |      | | |  |  |   |  |  |  |   |   |
 $GPGGA,hhmmss.ss,llll.ll,a,yyyyy.yy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh<CR><LF>
```

Field Number:
  1) Universal Time Coordinated (UTC)
  2) Latitude
  3) N or S (North or South)
  4) Longitude
  5) E or W (East or West)
  6) GPS Quality Indicator,
     0 - fix not available,
     1 - GPS fix,
     2 - Differential GPS fix
  7) Number of satellites in view, 00 - 12
  8) Horizontal Dilution of precision
  9) Antenna Altitude above/below mean-sea-level (geoid)
 10) Units of antenna altitude, meters
 11) Geoidal separation, the difference between the WGS-84 earth
     ellipsoid and mean-sea-level (geoid), "-" means mean-sea-level
     below ellipsoid
 12) Units of geoidal separation, meters
 13) Age of differential GPS data, time in seconds since last SC104
      type 1 or 9 update, null field when DGPS is not used
 14) Differential reference station ID, 0000-1023
 15) Checksum

$GPRMC - Recommended Minimum Navigation Information

```
            1    2 3       4 5        6 7   8   9    10  11 12
            |    | |       | |        | |   |   |    |   |  |
$GPRMC,hhmmss.ss,A,llll.ll,a,yyyyy.yy,a,x.x,x.x,xxxx,x.x,a*hh<CR><LF>
```

Field Number:
1) UTC Time
2) Status, V = Navigation receiver warning
3) Latitude
4) N or S
5) Longitude
6) E or W
7) Speed over ground, knots
8) Track made good, degrees true. = = Course over ground (COG)
9) Date, ddmmyy
10) Magnetic Variation, degrees
11) E or W
12) Checksum

Checksum calculation
====================

my_d is that part of the NMEA record that is between "$" and "*"

All the bytes are XORed

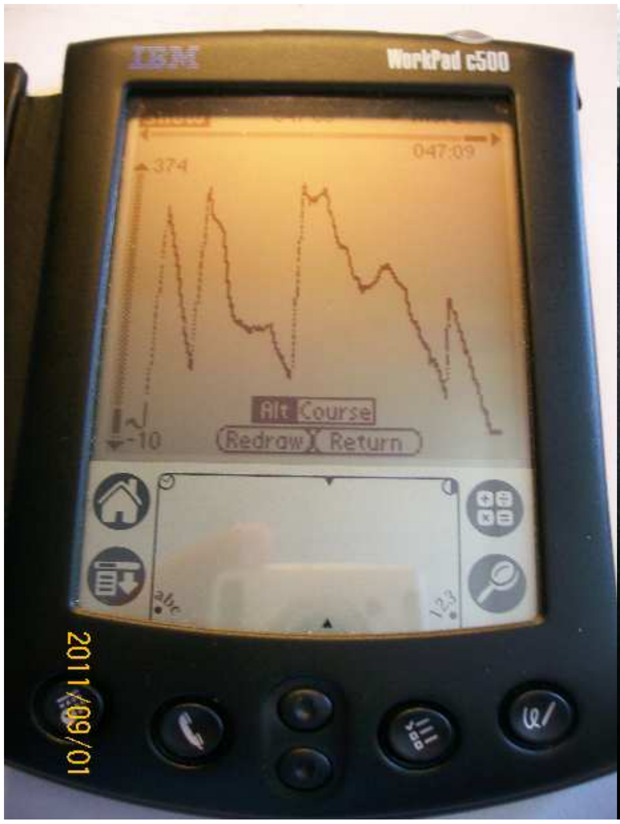
How I calculate the checksum in HB++

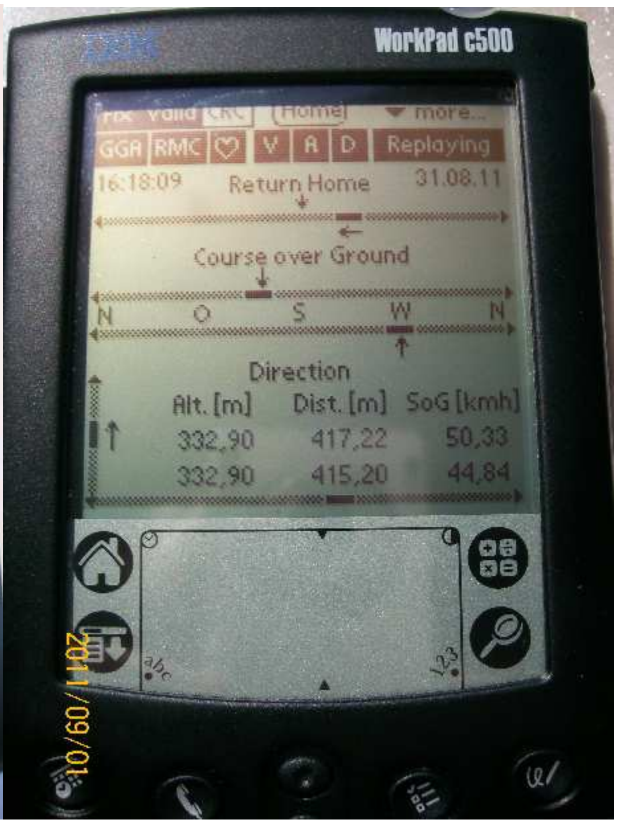
```
for n=1 to len(my_d)
        myhi=mid(my_d,n,1)
        cs=cs xor asc(myhi)
next

CheckSum= right("0" & hex(cs),2)    'to get a 2 character string
```

==

Using a PDA instead of the TGY 9x to display GPS data





Altitude curve of a 47 minute flight 		Snapshot of a flight (replaying a logged flight)

Altitude curve:
Altitude shows maximum altitude of 374 m over starting point and some areas with up lift.

Replay:
Below the dark fields to the left and right, you have the UTC time and date

All the values shown on the replay screen are available as live data during receiving and recording of the data.

The horizontal scrollbars from top to bottom show:
The direction and amount to steer (slightly left), to get the plane home (return home)

The course over ground, that is, what direction is the plane flying (South-south-east)

The direction that the plane has, relative to the starting point (West)

The air distance relative to the starting point (415 m, on scale that has been set to 700 m)

The left vertical scrollbar shows the altitude and the direction of lift (up, down, no lift. 332.90 m, on scale that has been set to 600 m)

The three fields for Altitude, Distance and Speed over ground, in the upper row show the max values and in the lower row the actual values.