
A tachograph with Etrex, BASIC-Tiger® and SmartMedia®

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1. Introduction

We already know the Global Positioning System – in application note 057 we described an application that enabled us to file positions in the BASIC-Tigers® memory. Saving time, location and speed over a long period of time is a bit more complex. Like this you can reconstruct a journey in every detail afterwards. It even happens that, e.g. after an accident, it is extremely important to reconstruct the exact position, time and speed. In a plane we call it black box, in a car data is recorded in a so-called tachograph. Such tachographs have to be provided in many trucks and busses by law. In general speeds, driving and resting times are recorded. It is a mechanical combination of clock and tachometer on a paper disc, which serves for subsequently finding out about the driven speed at any time. There are no such laws for cars, motorcycles or even bikes, it can be attractive, however, to record this data somewhere. We will see that such a device is no problem for BASIC-Tiger® and a few external components, it even works much more precise and with much more data.

In application note 057 we learned a lot about GPS and the coupling of GPS receivers and BASIC-Tiger®. The introduced version of a logbook enabled us to save position data of many journeys in the flash of BASIC-Tigers® and to read it on the PC. Compression there means among others only to evaluate those position data which are important for the logbook. In addition only relevant position changes are recorded by a tricky procedure. If you would like to implement a real tachograph, you cannot be content with position data, we also need e.g. date, time and speed. If we wanted to save all data which the Garmin Etrex outputs in an economical text mode every second, this would still amount to more than 50 bytes. But this would mean that we would have more information than a standard tachograph would record. While the latter can only inform us about the driven speed during a certain period of time and the driver's breaks, a tachograph with GPS and BASIC-Tiger® would give us more information – and of course in more detail. The autonomous function (without a speedometer) is also interesting so that this tachograph would also work in every plane, balloon, boat or bike. So what information do we want to save every minute?

- The exact time (UTC)
- The exact geographical location worldwide with evaluation of the precision
- Information about altitude
- Values for the three speed components in east-west respectively north-south direction
- as well as climbing speed or rate of vertical descent

The rather exotic Etrex text mode (much more popular is the NMEA protocol) is an option because of the following reasons: Quantity of data is much smaller, it is structured more simply, every second a record is transmitted (the Etrex NMEA mode only transmits every two

seconds) and finally the baud rate can be set higher (9600 instead of 4800 bauds). Details of the Etrex data formats can be found in note 057.

We realize that such a system is able to do much more than a “simple” tachograph. But these abilities have their price – a bit more than 50 bytes a second mean 180,000 bytes an hour respectively 4,320,000 bytes a day. These are realistic numbers for a coach or a truck with a change of driver. It is not, however, for a BASIC-Tiger® even with the most “opulent” equipment – neither RAM nor Flash can record such an amount of data. Here the SmartMedia® adapter by Wilke Technology is the solution. It offers everything (hard- and software) which you expect from a bulk memory. All at once we have no less than 128 Mbytes at our disposal, space for a month of mere driving time! With a few connections between BASIC-Tiger® and the fully equipped adapter, all available device drivers for the SmartMedia® system as well as a software library are ready for work.

Let’s add something concerning the advantages of such a DIY system. Of course it is quite an effort. There are surely cheaper and more comfortable solutions, especially when looking for finished versions containing large memories for tracks and tours within a great supply of GPS devices. The advantage of our system – we can manipulate occurring data arbitrarily, save what we think is necessary, convert or format output or saved data, adapt our system to specific conditions, expand or couple it with other systems and much more. Everyone who wants to learn more about the interaction of the systems GPS, BASIC-Tiger® and SmartMedia®-Card this application note will offer interesting impulses.

2. Hardware

Let’s start with connecting the components GPS, BASIC-Tiger® and SmartMedia® adapter.

Anyone who read the application note dealing with GPS (No. 057) knows that the Garmin Etrex has a simple RS232 interface. BASIC-Tiger® has two of those – hence the problem of transmitting data from Etrex to BASIC-Tiger® on the hardware side is solved, it takes place via SER0 in our example. This of course requires BASIC-Tiger® with an integrated RS232 interface or an external MAX232. Then we can chose between an original Etrex data cable for operating the PC, which does however not contain a free line for its external power supply. In addition an adapter (male to male with lines 2 and 3 crossed) would be required, because the Etrex data cable for the PC connection also has a female connector. Or we use a DIY construction with a special Garmin plug connector, where the Etrex power supply can take place via the BASIC-Tigers® VCC. You can order the Garmin plug connector at

<http://www.haid-services.de/pi1013036774.htm> (a bit of patience is needed when soldering!)

and the finished data cable at

<http://www.haid-services.de/pd-1149209411.htm>.

The external operating voltage supply of the Etrex is an important advantage when operating it permanently, as for example in a car. If the Etrex is connected via a 4-pin header or a specific 9-pin SUB-D connector (e.g. male), the SER0 can additionally use a 9-pin SUB D socket as usual. This version is shown in figure 1. Like this it is possible to simultaneously watch and evaluate the original serial data stream from Etrex to BASIC-Tiger® with another device. You should, however, only “listen” and never transmit during this actually illegal parallel operation! Note that contrary to the standard SER0 circuitry (Plug-and-Play-Lab) lines 2 and 3 are permuted.

We already dealt with coupling the SmartMedia® adapter to BASIC-Tiger® generally in note No. 044. The circuitry complies with the standard circuitry of the SmartMedia® adapter, the device driver, however, also allows different combinations so that you can adapt the system to different requirements.

To make our system show what is currently going on we add on the software side optional a display respectively an output via the second serial channel SER1. Especially the simultaneous display of several data such as location, time, amplitude and speed is a strength of the Tiger with its multi lined display and a weakness of standard GPS devices. You can leave out both, it will not change the function or way of recording of our tachograph. The display is connected like it is on the Plug-and-Play-Lab (standard configuration also for the LCD device driver provided). Data output at SER1 and SER0 is unproblematic (9600 bauds, text format) so that you can work with the same cable at the PC which you used for the usual loading of programs in the BASIC-Tiger® system. As we mentioned before you will get an extra service if you connect SER0 (normally taken by Etrex) additionally to a PC or another terminal (e.g. a Psion). Like this you can watch the Etrex original data, too. You can also feed other devices with GPS data via the 9-pin SUB-D socket at SER0. Since lines 2 and 3 are permuted you can use the cable for “listening in” which is also used to connect SER1 and PC.

Hence the circuit is almost completed. A LED on the SmartMedia® adapter displays the SmartMedia® system’s state (here: LED3, red). We know that such cards are never to be removed while recording, deleting or formatting, at least data loss would be a consequence! Every time a data transfer takes place the LED, which is a standard fitting on the SmartMedia® adapter, flashes. Here no more additional components, as for example a series resistance or a transistor, are required.

Finally power supply is added, which is a bit more complex here. It is our aim that the whole BASIC-Tiger® / SmartMedia® card system is initiated after switching on the Etrex and that it is put to hibernation again when switching off the Etrex (data should be saved on the SmartMedia® card beforehand).

Power supply for all components is the car’s on-board voltage (12 Vdc), which has to be fused properly in the supply cable. As usual a 7805 voltage regulator supplies the BASIC-Tiger® / SmartMedia® card system. At 12 V this regulator requires an adequate heat sink.

In addition we need 3 V for the external power supply of the Etrex. A LM317, which has to be adjusted with two additional resistors (in contrast to a fixed-voltage regulator), serves as a supplier. Also here an adequate heat sink is required. The schematic shows rough values that should be tried out accordingly.

In front of the 7805 and LM317 regulators there is a relay contact which can switch supply voltage on and off completely (no current consumption during driver's breaks!). In the lower part of the circuitry we find a part with a HEXFET transistor which controls the relay. This MOS transistor is always connected with its drain to the battery plus of the car and evaluates the serial signals of the Etrex at the gate. It is necessary that the Etrex always contains batteries, also because the Etrex saves important data in a SRAM which is cached by a GoldCap capacitor. This GoldCap again will be kept on voltage by the batteries when the Etrex is switched off. If you remove batteries for a longer period of time the Etrex will not work properly any more – then a complex master reset will be required!

Non-operated, i.e. when no signals are emitted by the Etrex, the HEXFET transistor is locked and so the relay is without current. If the Etrex is switched on, positive impulses from its serial interface will reach the transistor gate, recharge the capacitor and interconnect the transistor when 2 V are reached. The relay picks up, both regulators will receive voltage and supply operating voltage for both systems. Like this also the Etrex is switched from operating with its internal batteries to external supply. The relay will hold for a couple of seconds, even if there are no impulses for a short period of time, due to the 10 M Ω resistor and the 2.2 μ F capacitor. If no serial impulses are coming for a longer period of time (Etrex is switched off), the software will notice this (variable "Timeout" is set to 1) and will quickly save the rest of data still existing in the BASIC-Tiger® on the SmartMedia® Card. The HEXFET transistor locks again after the given time, the relay is being released and the operating voltage is turned off. The meaning of this whole procedure is as follows. During normal operation entries on the SmartMedia® Card are supposed to be carried out regularly. The last part of the journey is problematic, if data are left in BASIC-Tiger® which have not been saved and transmitted to the SmartMedia® Card yet. This left-over data are supposed to be saved on the card immediately after switching off the Etrex at arrival. The transistor's voltage at the gate has to be kept on high as long as the saving procedure needs to be completed. Only after saving the relay is being released and the current from the vehicle's battery is switched off completely. Due to this trick we reduce the handling to switching the Etrex on and off, all other components are started and stopped automatically. Besides, this method is also suitable for different applications, in which BASIC-Tiger® is only supposed to consume current, if serial signals arrive. The time constant can be adapted individually by the resistor and the capacitor (here 10 M and 2.2 μ F).

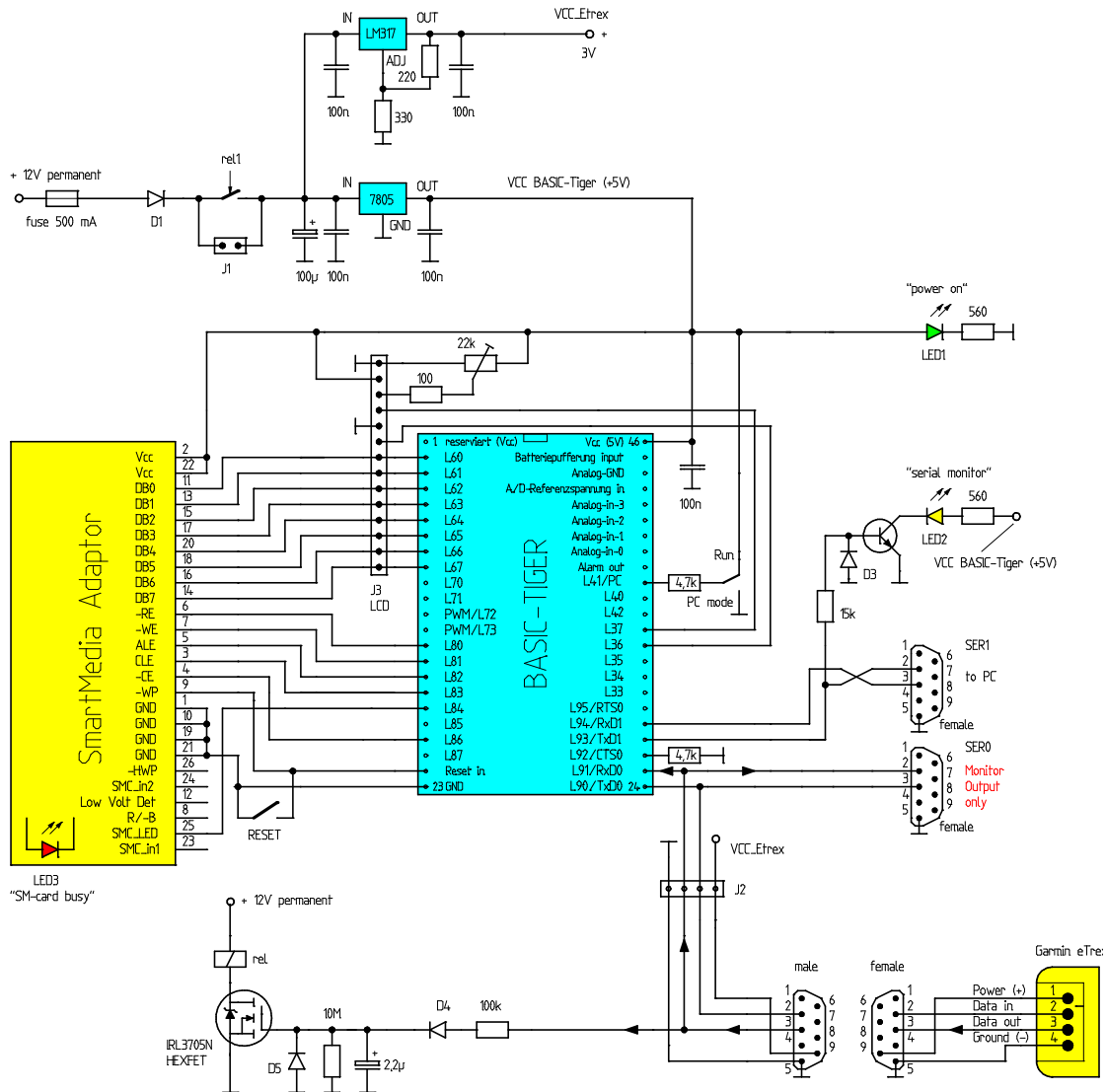


Fig. 1 GPS tachograph schematic (display and SER socket optional)

There are two extra LED on the SmartMedia[®] adaptor, in addition to LED3 which indicates access on the SmartMedia[®] Card. LED1 indicates that power supply is active (VCC for BASIC-Tiger[®] on) and LED2 signals that data is outputted via SER1, in order to control that every component works properly. D3 and D5 are used to eliminate the negative components of the RS232 interface for both transistors. Remember that the RS232 signal range can reach up to +/-18 V!

3. Software

Software needed for operating consists of two components. First of all we need a BASIC-Tiger[®] program that reads data coming from the Garmin Etrex via the serial interface,

processes it if needed and then saves it to the BASIC-Tigers[®] RAM first. We chose data storage in a string which is able to receive 32765 bytes “in one piece” as the most simple version. When such a string is “full” it is transferred as a data file to the SmartMedia[®] Card. In reality we will generate a new data file of about 17 kbytes every 5 minutes. A text file is probably the most convenient and universal way of evaluating data.

When data is stored as a text file on the SmartMedia[®] Card it has to be evaluated somehow, e.g. on the PC. Since we are speaking of text files which are easily readable, they can be read directly (Editor, Word etc.). A more elegant method is offered by Excel. Data is read in as a text and separated by separators. Converting time, position and speed data to different formats is no problem with Excel. The exercised Excel user can of course use all features of this spreadsheet program, such as charts, statistical functions etc. An independent PC evaluation software which makes clear and usable data (e.g. charts, graphics or even maps) from the raw material received from the SmartMedia[®] Card would be the top of our application. To read in data from the SmartMedia[®] Card of course a suitable card reader is required. Those are already integrated into modern PCs, otherwise you will have to provide and install an external card reader, e.g. for an USB or parallel connection. Like this the SmartMedia[®] card can be addressed like a normal drive, directories and files can be read via Windows, be saved elsewhere or deleted.

First let's take a look at BASIC-Tiger[®] program TACHO_01.TIG. With the Wilke Technology SM file system all preconditions seem to be given – it allows every data manipulation on a SmartMedia[®] Card from BASIC-Tiger[®] as we know it from the hard disk administration of a PC operating system. So it is possible to create or delete directories, to generate files, to manipulate, to read, to delete etc. The basic routines and information are also delivered with the free SmartMedia[®] adapter software package on the Internet.

Note!

During development some minor problems occurred with the SmartMedia[®] system software from Wilke Technology. For example the direction of the port 8 pins, which were actually not used by the SM system, had been defined, so that they were not freely available for the user (this is important for the LED at L84 in our example). To patch these problems the routines “fs_fat_i.inc” and “fs_smc_i.inc” were changed by Wilke Technology. If you lack the latest files, please download the new versions from the Internet!

In our project we require definite and automatically generated directories with a unique and referring name for a complete file system. The same applies to every file and its name. Here the time offers to put our system in order – every Etrex record (text mode) begins with a very exact date (atomic time!). This information is given in the UTC format, i.e. independent from the location on earth. UTC is the Greenwich mean time (in England) without regarding summer time changes. Therefore in Germany we have to add 1 or 2 hours (summer time) to get local time (CET). But for our file system we can simply use UTC. With Etrex date and time are given in the American format, i.e. YYMMDD respectively HHMMSS. Like this you

can use the date transmitted by Etrex directly to create a new directory for every day. On 01 July 2003 this would be

Directory name 030701

In contrast to the usual German format DDMMYY this order has one great advantage – all alphabetical searching and assorting procedures by time are correct right away, because you can assort by year first, then by month and finally by day. The German format requires much more effort! Similarly we proceed with the file name. We simply use the current time which can only occur once in this file and append the ending “.txt”. You can use any different ending, but normally text files are a good choice in the first instance.

A file's name saved at 10:33:15 would be

File name 103315.txt

If a file is generated every 5 minutes the next file's name would be

103815.txt

etc.

Finally one more point concerning time. Like all file systems the Wilke Technology SM file system saves the creation date in addition to the directory and file names. With the SmartMedia® file system this takes place via the BASIC-Tigers® system time and therefore via the device driver RTC1.TDD. This driver sets itself to 0 after switching on the operating voltage and then counts the seconds passing by. With BASIC-Tiger® 0 means 01 January 1980, 0:00. As we know from earlier experiments with this internal clock, you have to set the seconds counter to current time in order to get real times. Here it is very simple, due to the Etrex transmitting UTC by nature. To provide a reasonable exact date and hour for the SM file system the following steps need to be taken:

- Installing RTC1.TDD device driver
- Inquiring the RTC state
- If the RTC is installed and set correctly, transmit the exact UTC using the subroutine “IDateDosToTig” which is hidden in an SM file system include file.

It makes no difference, if a RTC is build in or not, as on each power-on of the device the seconds counter is set to 0 and later to the exact date and time coming from the Etrex.

It is a drop of bitterness that when reading out sometimes the incorrect time is transmitted to the SM file system, although our internal clock is set to the correct time. Therefore date and time of a saved file are sometimes completely wrong – Wilke Technology has realized this problem and is working on a solution.

Such a text file which contains the Garmin Etrex data in text mode looks as follows (you find the data interpretation in application note no. 057):

Content:

```
@.....  
@030906102216N5113682E01104879G005+00160E0121N0175U0060  
@030906102217N5113692E01104890G005+00160E0126N0181U0060  
@030906102218N5113702E01104901G005+00161E0128N0185U0060  
@030906102219N5113712E01104912G005+00161E0129N0189U0059  
@030906102220N5113723E01104923G005+00162E0134N0196U0059  
@....
```

This system with its self-generated directory and file names is ingeniously simple and can be used for further evaluations without much effort. In addition there will never be the same name twice!

You would like to know where you have been on 6 September 2003 at 10:22 a.m.? Simply search for the directory for this date (030906), chose the right time and you will obtain all data on location, speed, altitude etc.! Always keep in mind that all exact dates and times are stated as UTC times and UTC dates! To convert these data to your local time you will have to add or subtract hours according to your time zone. Additionally you will have to consider summer time.

Of course you can also evaluate the data automatically on your PC.

4. Operation in practice

You constructed the circuitry and loaded the software, you do not need to plug the SmartMedia[®] Card into the adapter yet. When connecting the circuitry to +12 V (possibly a PSU in the first instance!), there should be no current flow at first.

Next you should prepare the Etrex. Switch it on, and set under SETUP; INTERFACE the mode TEXT OUTPUT and the BAUDRATE to 9600 baud. Now plug the Etrex to the 4-pin header (mind the correct pin order) or to your 9-pin SUB-D special plug.

Now check if this switches on the voltage supply VCC (LED1 should flash). If you connected a display you can read the messages "install RTC", "test RTC" and "wait for GPS". Besides, if you put a jumper on J1, you will be able to switch on the VCC permanently for experiments, no matter if the Etrex sends or not, or if there even is one at all.

At least UTC time in format 12:32:49 should appear on the display, if things are going right, no matter if the Etrex is receiving satellite signals or not. Like this you can experiment

indoors, too. With the Etrex running now also LED2 will flash once a second, which means that now also BASIC-Tiger® is transmitting modified GPS data.

In your car this system should work plugged to the cigarette lighter, if it is connected directly to the battery plus pole, otherwise you will need an extra cable (most car radios are connected directly to the battery plus pole!). Also keep in mind the right polarity and fuse! Our diode D1 helps to avoid major damage, but when using the wrong polarity this won't work at all. On the active Etrex you can see right at the bottom of the display in MENU mode, if it is supplied by its own battery (battery symbol) or by the car's supply system (plug symbol).

Things get really exciting, when you put the connected Etrex on the dashboard and drive off. On the display (if connected) of your BASIC-Tiger® you can read off speed and altitude right below date and time, an example for the Etrex data converted by BASIC-Tiger®. If you wish to, you can make different data to appear here later...

!!! Despite all this excitement – always mind road safety !!!

Every 5 minutes the SmartMedia® adapter's LED will flash for a couple of seconds, a sign for data about to be written on it. If you also connected a beeper with its components to L42 according to the Plug-and-Play-Lab, a SmartMedia® access is signalled acoustically. If such a procedure is just finished, i.e. the LED just went out, you can safely plug or unplug a SmartMedia® Card (the right way!).

Now things get serious... When a few recording procedures are finished, you can remove the SmartMedia® Card immediately after access has ended. The system may continue operating at the same time. Now you absolutely need a PC with a card reader for SmartMedia® Cards. Check the explorer, if your system "left" something on the card. You should find a new directory named with the current date as well as some files named with the times. You can read and evaluate those text files with Word or the Notepad. If so, our device already fulfilled its main task. Further options, as e.g. LC display, original Etrex data on SER0 and modified data on SER1 are only extras which are also delivered without much effort.

For optimal results the Etrex should not be covered when active to ensure precise reception. This is mostly given on dashboards. We recommend installing the Etrex under the plastic or glass sunroof. Sometimes antennas printed onto the windows or sun protection films of conductive material jam the reception enormously. The GPS usually does not work at all in subterranean garages, tunnels and even under trees with dense foliage.

Please remember switching on Etrex before every journey with the tachograph. You need to press the I/O key, otherwise it does not start off and the whole system does not work... Queries at Garmin respectively other GPS specialists to find out a possibility to start the Etrex automatically remained without result.

Our system is now finished and had its first test drive. What can you do with such a new generation tachograph, what have we learned from designing it? Let's start with possible applications:

In your own vehicle – and that is what the system was designed for – you have a complete recording of every journey with a lot of interesting data: Date, time, location, speed, altitude, roads taken, breaks made etc. Keep in mind that maybe other people used your car, e.g. on test drives from the garage. Also with family members such questions could arise, but this is tangent to the grey area of data protection... Data become even more interesting if your vehicle was used unauthorised and is found somewhere later. Police and insurance companies might be quite interested in details of this jaunt! In a case of an accident, important data can be reconstructed, which would be of interest for police and insurance companies, too. Also data would become important when you are accused of speeding, but you cannot explain this accusation to yourself. This system could not serve as evidence in a lawsuit, but it would be helpful nevertheless...

The benefit of this system is even more obvious when using it for commercial purposes. Just think of haulage contractors, taxi enterprises and even private investigators, who will have evidence where their vehicles were under way on a specific date...

The usage is in no way limited to cars. It can offer important services to two-seaters, balloons, trains or ships as a reasonable and self-sufficient tachograph. With the according adoptions the system is also usable for cycling, hiking or even in research, e.g. on a drifting floe, on animals or in a weather balloon.

Epilogue

The author is aware of the fact that Etrex is actually a device for hiking or cycling, the adoption to our tachograph project must remain abortive. In addition it is too precious and too expensive for such tasks. It will pay off however, if you already have an Etrex and if you are looking for further applications. So-called GPS mouses, which do not need any batteries, any display and any presettings are more elegant for permanent solutions. They can start off immediately after plugging them to an external supply voltage. We will learn about such a reasonable solution in our next application note.