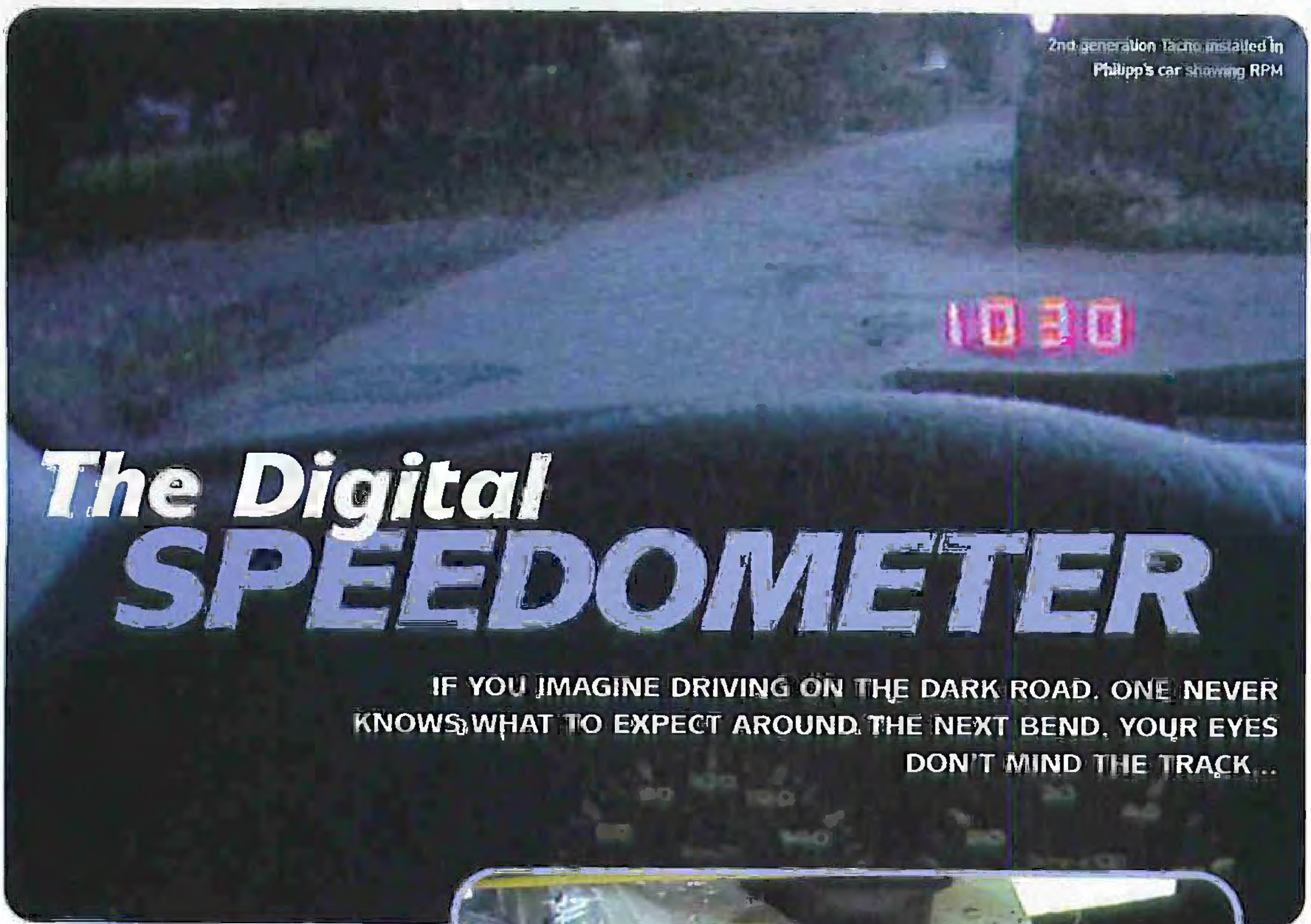


2nd generation Tacho installed in Philipp's car showing RPM

The Digital SPEEDOMETER

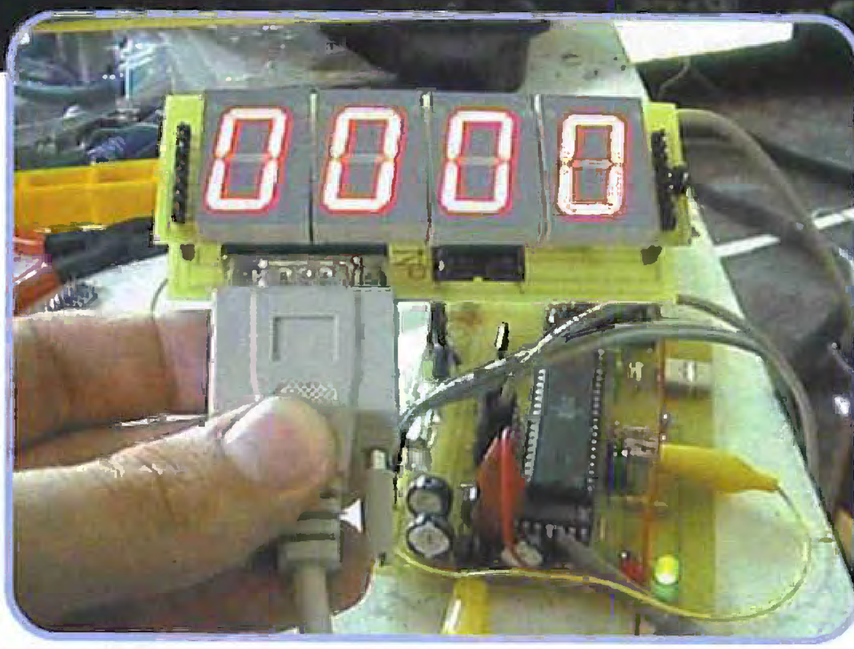
IF YOU IMAGINE DRIVING ON THE DARK ROAD. ONE NEVER KNOWS WHAT TO EXPECT AROUND THE NEXT BEND. YOUR EYES DON'T MIND THE TRACK...

The signpost shows 70 km/h and concentrating as much as one possibly can, one follows the flow of traffic. With time you lose a sense of speed. A glance at the speedometer costs quite a lot of time. The eyes adjust slowly from the change between the high lighted speedometer and the dark street.

However I have driven such a street and felt insecure in the darkness, where it was difficult to evaluate in terms of judging the speed on the basis of the dark landscape moving outside the car window. On one particular bend in the road, I have noticed, that I was driving too fast to safely get round the bend and my car became uncontrollable. I was quite lucky to manage to get round the bend. In effect I had followed the road paying as much attention as I could.

A couple of months later I had an idea of using a shaver, to build a digital speedometer, which shows the reflex of the speed on the windscreen. However my lack of knowledge of digital technology and processors was an obstacle to implement the idea.

I had met by chance Philip, who had exactly the same idea. So we created a team and started to develop the basic concept. It was the beginning of the period, in which our e-mail accounts became full of building schemes.



1st generation Display Unit: two-layer (LEDs on top-, SAA1064 on bottom layer). Background: 1st-generation Main Unit in test mode

The basic idea was: simple and light to build and easy to use.

I started to become interested in embedded controllers. I saw in a German magazine a processor from Atmel, which had a well-developed library (assembler, emulator, debugger and all information for free downloading.

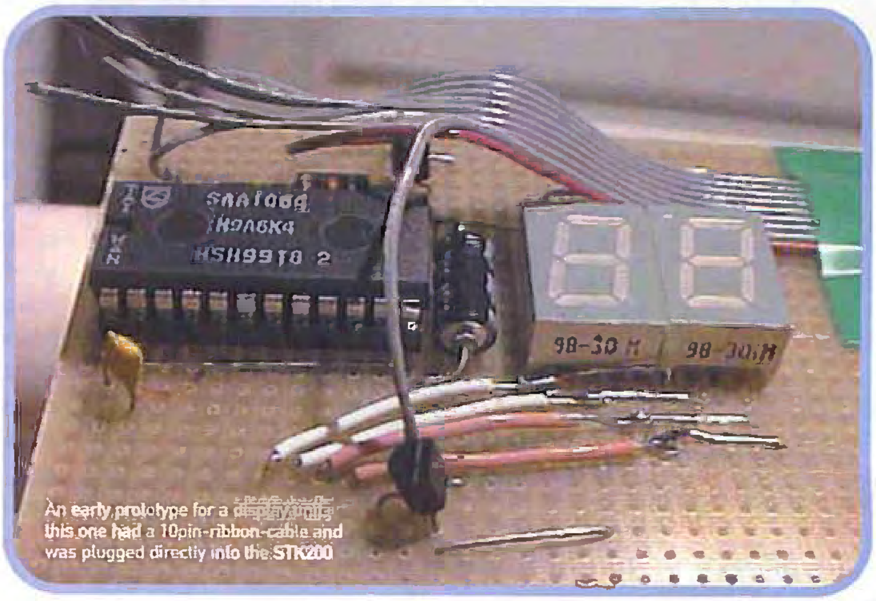
I was looking for an evaluation board. I bought a very good one from Kanda Systems in Great Britain, STK200.

The STK200, supports several Atmel AVR devices including the AT 90s8515. It has, around the processor, all the devices, which are needed for development purposes such as:

- A 4MHz external clock circuit
- All port pins are connected to header pins around the edge of the board, which makes it easy to add circuits for different applications.

- Small rubber feet protect the circuit board in the creative atmosphere of development. All features of the board are well-labelled
- Connection for a Hitachi compatible LCD
- Contrast Potentiometer, which lets you adjust the contrast on the LCD (or windscreen!)
- A brown-out circuit with two voltage settings
- For PC's running windows, there is easy-to-use Beta software available
- RS232-Port using standard 9 pin D connector, for use in applications, for example to connect the board to a PC serial port, the AT90S8515 as EEPROM, RAM and Flash memory for code.

While searching for an application that gives more usage than a running-led-light (knight rider effect), I decided to build the digital-speedometer of the Porsche Boxer on my own.

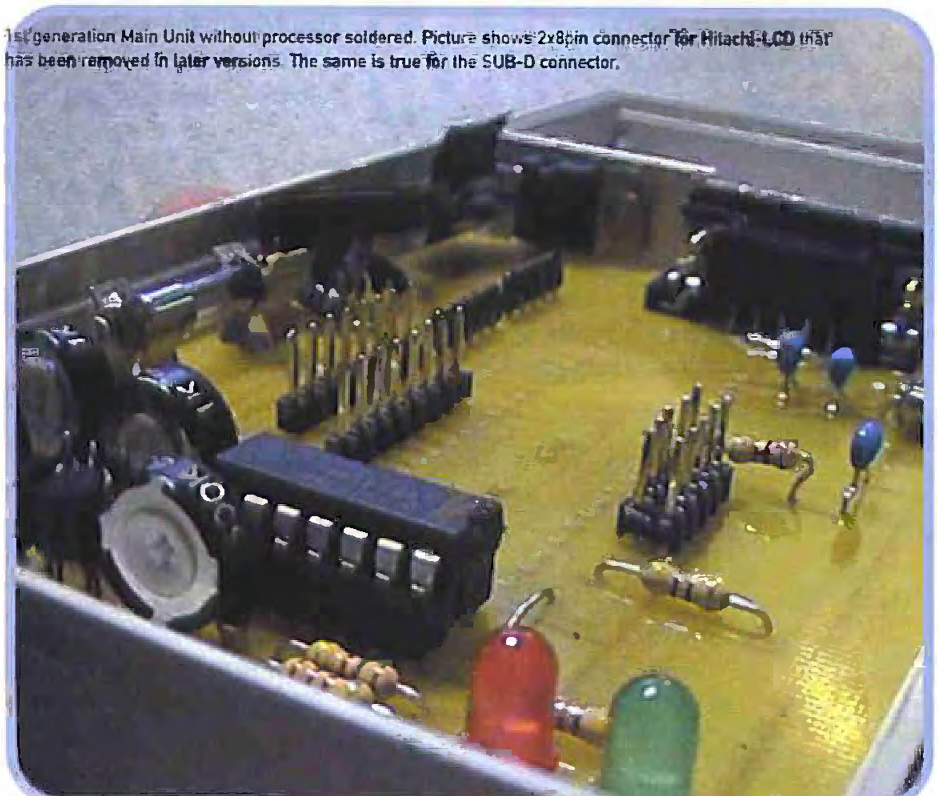

An early prototype for a display unit; this one had a 10pin-ribbon-cable and was plugged directly into the STK200

Philip filled the gap in terms of my lack of knowledge of microprocessor and programmers being a specialist in Electronics.

After we checked, with the help of the STK200, that our code was working, we had to concentrate on the development of the device to build it in into the car.

After some beta-versions, experiments to build a circuit board, we decided to build our own version of the circuit board, which would be tailored exactly to the needs of our digital-speedometer. We have excluded the parts of the circuit board, which were useless in running our code and could lower the board to one quarter of the size (50x80mm).

The step from a safe functioning hardware like STK200 to a self-developed board is normally enormous. As a beginner you confront all the problems, which are likely to appear in processor-controlled electronics, like the code running in the processor at 4 MHz, may produce 4 millions mistakes in a signal second! The creation of clock circuit (crystals) and providing the power may pose a problem. The problems do not seem so difficult, if you can use the STK200 to find the solution.


1st generation Main Unit without processor soldered. Picture shows 2x8pin connector for Hitachi-LCD that has been removed in later versions. The same is true for the SUB-D connector.

In March 2000, Philip visited me and we created the first character on the display.

After this first great success the development speeded up, and in April 2000 the first version of the speedometer appeared with a couple of small and easy to solve mistakes the speedometer was running in Philip's car.

The prototype of our speedometer was ready!

The next step was to make the device more sophisticated. The big problem was, how to connect the speedometer into a car. We were studying Alpine-Navigation systems, where we found connections for different cars by means of a speed-pulse. In the meantime we were able to build it into cars like AUDI A3, VW Polo 6N and Ford KA, due to the manufacturer's using the same system for the speed pulses.

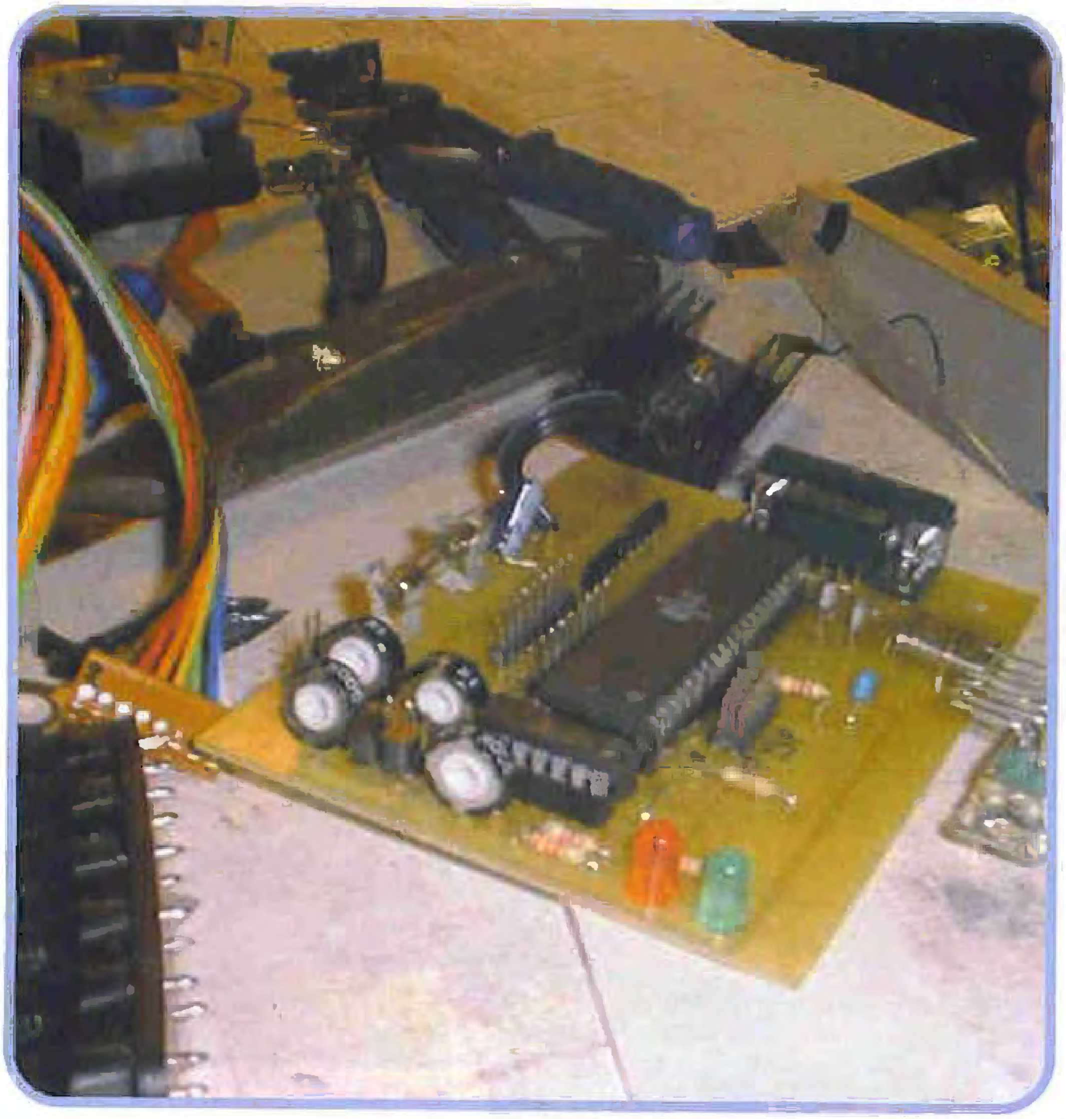
The technique

The signal for the speedometer can be provided in modern cars from the ignition control box, which has a hall-effect sensor which produces a square wave signal , or from the engine-control-unit.

The signal is cleaned up by a Schmitt-Trigger (which is placed in front of the processor) to be readable by the processor. The processor counts the pulses, because of several wheel-sizes we decided to integrate a kind of fine-tuning (calibration-system).

After installing the speedometer you have to drive a distance of 100 meters, during that distance the speedometer counts all pulses that were generated and this value is used for further calculations of the speed. By pressing a key this value will be written into the EEPROM of the AVR

For decoding I used two tables, which are placed in the program memory. The data is transferred from the Flash-ROM. The numbers are shown on the windscreen by using a mirror. In order to limit the use of I/O-connections, which are used by the display I have chosen a I2C-bus between the main unit and the display unit, which requires



Left: 1st generation Main Unit under heavy development

apart from the power connection just two additional connections. The display circuit uses the Philips SAA1064, which drives the LED's. The I2C bus supplies both data and power to the LED segments.

The present

At the moment, I have the second generation digital speedometer in my car, which in addition to speed, also shows revolutions per minute. The built-in tester lets me switch from the speedometer to the revolutions per minute display. The display is shown above the steering wheel on the windscreen, which allows you to keep your eyes on the road.

The software

The software is written in Assembler and is 2500 letters long. The software was tested both on the STK200 and on our own circuit board, by using the same debugger.

The future

We are planning the next generation of digital speedometer, which would use the PLCC-socket for the processor and become half the size of the current speedometer.

We are trying to write the program now in C language, as the tools for it are available in many variations, of course with the exception of professional IDEs.

Testing and programming for cars would be facilitated and speeded up.

We are working on the new display element, which can be connected like the previous one by I2C. Additionally we would like to use dot-matrix-displays, which would allow it to display further information like temperature, number of revolutions or the status of a connected mobile phone. It is possible to use the current main unit for new features.

If anybody still needs to ask what is the point in having a digital speedometer and don't see the obvious advantages, we have one more point to make: It looks very good!

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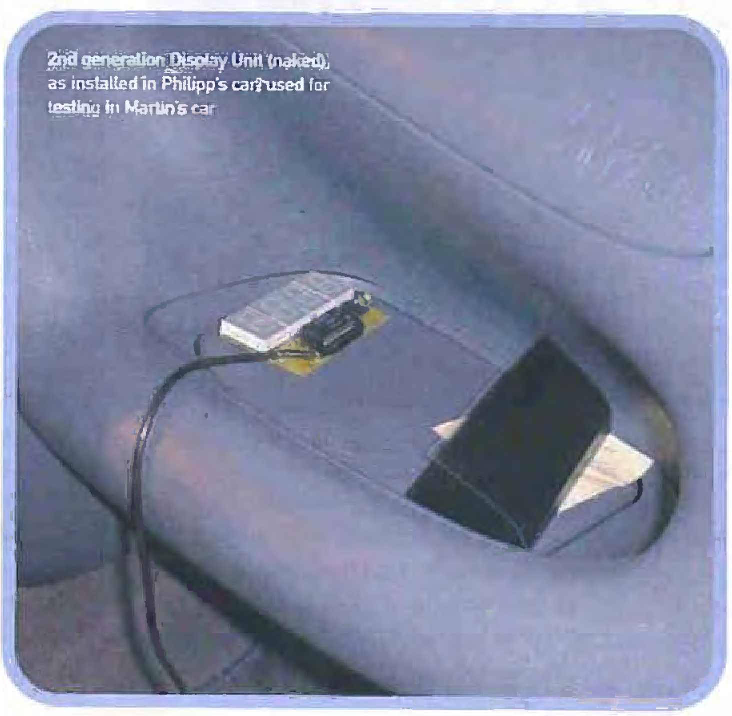
Technical Translation of material courtesy of Andy Walters, Hardware Engineer, Kanda Systems Ltd.



2nd generation Display Unit (naked), as installed in Philipp's car used for testing in Martin's car

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Why not send in your articles or ideas, we will publish any of your contributions and can translate from Russian, German, Polish and Japanese!