The creation of liquidTT

Jim Stuart (aka freegeek), chief cook at Race Diagnostics Ltd, wanted the functionality of VAG-COM—and a little more—but without the need for a laptop permanently in his car. Here he takes us through the development of his fabulous multifunction gauge and diagnostics tool, previewed in *AbsoluTTe* 15.

Above: Rear of the production prototype circuit board showing processor, power supply and interface electronics. Below: Front showing display and joystick control.

AUDI'S TT—an object of desire indeed. I wanted one for many years before finally being in a position to realise my dream in August 2004. When the time came it was bought almost on impulse, having spotted a tiny advert in the local paper for a low-mileage 225C in Denim blue. And after seeing it for only a few minutes on the forecourt I had to have it.

After three years of fabulous motoring, a remap, upgraded Haldex, R32 anti-roll bars and a lot of tinkering with VAG-COM, I started to think about how I could get the functionality of this great tool permanently within the car but without the need for a laptop computer.

It was about the same time that I bought a cool little MP3 player with a small LCD screen. It was then that I had that 'light bulb' moment. I thought that perhaps there would be a tool on the market that I could plug into the diagnostics port and mount somewhere on the dash.

First I started to investigate the handheld diagnostics tool market. It turned out that there were a lot of expensive high-end tools available, but nothing that suited what

I needed. There were also some low-end tools which could display standard OBDII diagnostic data. I bought one of these to try, only to find that it was pretty useless compared to VAG-COM. This is because Audi (actually all VAG cars) have their own 'secret' protocol for most of the interesting data which the cheap tools could not read.

Since there seemed to be nothing that met my needs, I would have to create a tool with the functionality of VAG-COM but display the data on a small LCD screen.

Given that I come from a marketing background, this was not going to be easy, but working for an electronics company, Freescale Semiconductors, plus a good knowledge of microprocessors, I felt that I had a fighting chance to pull it off.

This all kicked off on June last year, just before I was due to head off for a two-week beach holiday in France. I decided not to pack a bundle of paperbacks, but instead gathered all of the technical documentation I could find on OBDII diagnostics, one of Freescale's newest microprocessors and a copy of *C for Dummies*.

Initially I thought that it would take about
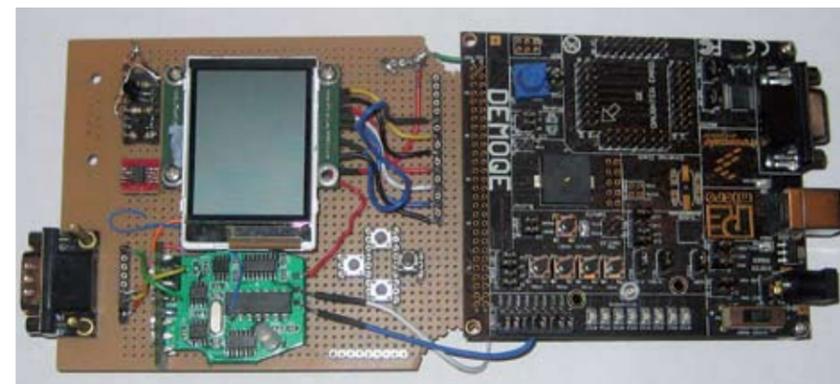
three to six months to design and build; this turned out to be roughly correct as I had a prototype running by about Christmas. But it has taken a substantial amount of time: about two hours of work virtually every day since June last year.

One of the biggest problems was finding out about the VAG protocol to let me read the interesting sensor values not available via OBDII. There was actually very, very little data about this on the web, but after a few pointers from Uwe Ross (the owner of Ross-Tech and creator of VAG-COM), I was able to understand the basics and get the unit up and running.

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From the start of the project I had a few things in mind: I wanted the displays to be graphical, rather than text-based, I wanted it to look as OEM as possible and, most importantly, I wanted to be able to display bhp and torque, neither of which are directly readable with VAG-COM but are easily calculated from MAF and engine revs.

A couple of other novel ideas I decided on early were to have a 0–60mph timer and a G-force display similar to the one shown during television coverage of F1 races.

Most of the other input for the functionality of the tool has come from

TT Forum members, who have been great at providing feedback over the last nine months.

I also needed a working name for the tool, and since the data is shown on a liquid crystal display, I went with the working title of liquidTT, and right now the name seems to have stuck, as I haven't been able to think of anything better.

Getting it to a production-worthy state has taken a further three months or so, with additional feedback coming from John H and Chip-iTT, who both spent a few weeks playing with the prototype.

I have used a small family-owned German electronics design and manufacturing house to help me take

Early standalone prototype, left, and processor development board for PC-based software development kit, right.

With the circuit board mounted in a modified air vent, installation is straightforward. The cable is threaded down to the OBDII diagnostics port for semi-permanent connection.

my prototype from a hand-wired board to a reliable novel circular PCB which fits perfectly into the air vent in the car. I tried positioning the display in a few places within the car but finalised on the air vent as it felt like the safest option to me. It won't be everyone's preferred option, but it is also available as a kit so the more adventurous can try alternative mounting positions.

Oh . . . next, how would I go about selling them? I needed to create a limited company, get a website, create an e-commerce shop on the site—just another massively time-consuming task to someone with no experience in any of the above.

Eventually it was achieved after spending a couple of hours brainstorming on a company name and website which did not already exist. Finally we (that is me and my ever-so-patient and wonderful partner Kim) agreed on Race Diagnostics Ltd, www.racediagnostics.com. We were amazed that the name was unused worldwide!

So that is the story so far. By the time this goes to press, I hope the website and online store will be up and running and I'll be taking a well-earned rest. Well it would be if it wasn't for the fact that there are still other features to be added. Since the electronics behind the display use flash memory for the program, I plan to offer an upgrade service to users when I implement new features. This way everyone will be able to stay up to date.

■ *Note from Editor:* As an electronics engineer myself, I am amazed at Jim's efforts. This is no trivial achievement,
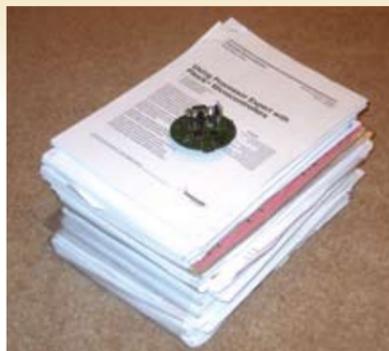
Bedtime and holiday reading—yes, there's quite a lot packed into the Liquid device!

but the result of a great amount of diligence and personal drive covering many disciplines. You'd wipe the floor on Dragon's Den, Jim. Hats off to you!

OK, what does liquidTT do . . ?

Gauge and graph data

The following data can be presented in one of two ways, either in a conventional gauge format or in a scrolling graph.

- Engine crankshaft bhp
- Engine crankshaft torque
- Turbo boost pressure
- Turbo command pressure
- Mass airflow
- Air–fuel ratio (Lambda)
- Air intake temperature
- Exhaust temperature
- Coolant temperature

- N75 position
- Engine misfire

The main menu allows navigation to each of the main functions.
- Gauge data
- Graph data
- G-force
- Speed timing
- Faults and adaptations
- Rear view
- Set-up

A miniature joystick is used to navigate around the various menus.

Gauge data

In addition to displaying the data reading on the gauge sweep, the actual value is displayed below the gauge.

The display also indicates the maximum value that is achieved during that session, displayed in the top right of the screen.

Graph data

In addition to displaying the data reading on the graph, the actual value is displayed to the right of the gauge. The display also indicates the

maximum value that is achieved during that session. This is displayed below the realtime value.

There is also a screen-freeze option which will hold the data on the screen so that it can be analysed later, as well as a dual display option to display both boost and command pressure.

- **G-force:** In this feature, the realtime G-force is displayed in terms of acceleration, deceleration and lateral right and left cornering forces. The G-force is represented by bar graphs for each of the above and the maximum achieved force is recorded for each

session. The maximum force that can be measured in each direction is 1.5g.
- **Speed timing:** The feature will allow you to measure the time it takes to reach one of two preset speeds, either 60 or 100mph. While there are also options for measuring braking times, these should be ignored as they cannot be measured accurately using the TT's diagnostic system.

Faults

Engine management fault codes can be read with this feature. Simply select DTC from the sub-menu, then after

a couple of seconds either the fault codes will be displayed or a message indicating that no faults were found will be displayed. Faults can also be cleared.

Big turbo select

In order to work successfully with heavily modified cars generating more than 300bhp and 300ft.lb of torque, this feature allows the user to select an alternative range for the power and torque gauge and graph.

The ranges are changed from a maximum of 300 to 500 for both bhp and torque.