

# Golf GTI 53<sup>+1</sup> – The Driverless Car

- **VW Golf GTI drives itself**
- **Minimum lap times**
- **MicroAutoBox used for controlling**

The Golf GTI 53<sup>+1</sup> developed by VW can drive along a known road autonomously, with no driver. The aim is to test and verify control systems such as ABS and ESP in precisely reproducible test drives. A test track marked by traffic cones is measured by means of a laser scanner and a differential GPS (DPGS) navigation system, and the ideal line for achieving minimum lap times is computed. A MicroAutoBox from dSPACE controls the power steering, the accelerator pedal, and the brake booster automatically.

Electronic control units (ECUs) with electronic access to the engine, brakes, and chassis can intervene in the ongoing driving situation, for example, as assistants helping to avoid accidents. At VW, we converted a standard Golf GTI to enable it to drive round the defined track completely by itself, with minimum lap times along an ideal line. Our objective is to perform precisely reproducible test drives to test electronic control systems such as ABS, ESP, and EDTC (engine drag torque control). Incidentally, the test vehicle gets its name from Herbie, the self-driving Volkswagen Beetle who starred in several films and whose racing number is 53. The GTI 53<sup>+1</sup> is a worthy successor.

trip around the track, the GTI scans the area around it with the laser sensor as it crawls along from cone to cone. The DGPS navigation system measures its position with a precision of 2 cm. The MicroAutoBox runs the software for capturing the cone positions and controlling the autonomous drive. When the whole track has been captured, the GPS data is evaluated on a PC and the ideal line for minimum lap times is calculated.

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*"The MicroAutoBox lets us test changes to the models very fast."*

**Bernhard Müller-Bebler,**  
**Volkswagen AG**

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▼ *The laser scanner uses a reflected laser beam to capture the positions of the traffic cones.*

## **"Herbie" Finds His Way**

For the autonomous test drives, we added a DGPS navigation system and a laser scanner to the Golf GTI 53<sup>+1</sup>, and also installed an active brake booster. On its first

Calculation software from the University of Hamburg determines the ideal line to drive along, using a special optimization procedure to minimize the steering effort and distance step by step. We use the results from this





◀ The GTI 53+1 drives round the cones on the test track loop completely autonomously.

to produce the specifications for maximum driving speed and longitudinal acceleration. Our software determines the optimum braking points and the maximum cornering speed, selects the most appropriate steering wheel rotations, and marks the full acceleration sections.

**Full-Speed Cornering**

After just 30 minutes computation time, all the data is ready for controlling the electromechanical power steering, the electronic accelerator pedal, and the brake booster without any intervention by a human driver. Once the vehicle has set off, it travels round the track completely automatically. The MicroAutoBox continues to compute all the necessary signals and control the bus system. Thanks to the numerous I/O interfaces, it was no problem to integrate the MicroAutoBox into the development environment. We find it an extremely helpful tool for testing our models, which we developed with MATLAB®/Simulink®. The parameters on the current driving situation and the precise vehicle position are supplied by the DGPS platform. However, the test vehicle is simply a test system, not a driving robot. It cannot alter the course of the computed track, so it cannot swerve to avoid any obstacles that appear, even if they are detected by the laser sensor.

**Further Developments**

Our basic aim is to collect object measurement data, by means of aids such as the MicroAutoBox, as a basis for further evaluation and greater transparency. To achieve this, we will enhance the precision of traffic cone detection and also improve the electromechanical steering. Electronic linkages will continue to gain ground over mechanical

ones in the future. Our production vehicles have had electronic accelerator pedals for a long time now – to put it more precisely, since the introduction of turbocharged direct injection (TDI) – so they are connected to the vehicle electronics via an electrical cable. Our GTI 53+1 is a major contribution to further development of this technology.

*Carsten Spichalsky  
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▲ The MicroAutoBox was installed in the trunk of the test vehicle.

**Glossary**

**Engine drag torque control –**

If wheel slip occurs due to abrupt throttling, the throttle valve is opened, thereby increasing engine speed (in conjunction with ABS and ASR).

**DGPS navigation (differential global positioning system) –**

A method of enhancing the precision of GPS navigation by transmitting correction data.