



# All-in-one Tester for the Vehicle Diagnostics

In the engineering, test and verification of diagnostic and control functions, it is imperative to ensure that diagnostic communication works reliably. The standard procedure to date has been to use a number of tools whose functions overlap and whose different operating concepts are each tailored to suit the requirements of a limited circle of users. In practice, this both disturbs the working processes and jeopardizes the quality. It is far more efficient to use one single engineering tool that covers the entire spectrum of vehicle diagnostics and can be adapted flexibly to suit all kinds of tasks and user groups.

By Matthias Ziegel

Most of today's innovations are based on software developments. Vehicles are no exception. Software innovations improve vehicle performance and increase both the safety and sustainability of mobility. The number of ECUs and the associated networking are continually increasing in the process. In addition to control functions, diagnostic functions have also gradually become more and more significant. In today's engine ECUs, the diagnostic part already accounts for anything

up to 70 %. Although diagnostics was originally only intended for checking that legal emissions standards were being adhered to, today it plays an integral part in the entire value chain of vehicle manufacturers. In engineering, testing and validation, in manufacturing and ultimately in after-sales service.

This requires the ever-increasing exchange of diagnostic data both between different divisions of any particular

vehicle manufacturer as well as with ECU manufacturers, system suppliers, tool manufacturers and as part of co-operations between vehicle manufacturers. The ever-growing complexity of links can only be mastered, both technically and economically, by using non-proprietary technologies, such as for example Open Diagnostic Data Exchange (ODX) as a standardized data exchange format, and powerful tools.

**Using Several Different Tools Causes Problems**

Various manufacturers offer a large number of different tools for the development of diagnostic functions. Their subfunctions do, however, have a tendency to overlap, whether to a greater or lesser extent. Using various tools also means that users often have to get to grips with different operating concepts and data exchange formats. This often results in tool breaks that disturb working processes and jeopardize quality.

An added complication is that every tool is aimed at a specific user group. However, there can be considerable differences in the level of knowledge of the users as well as the requirements in terms of operation. For example, those responsible for entire systems or parts thereof, usually diagnostic experts, require full access to all functions. This is accompanied by a correspondingly complex user interface. Technical personnel, on the other hand, usually only require a limited access to functions when testing and verifying vehicle functions. In this area of working, it is more important, for example, that test sequences are as easy as possible to run and that a quick change of vehicle is supported.

**Requirements of an Engineering Tester for Vehicle Diagnostics**

The problems described above can be solved by using a universal engineering tester for the entire vehicle diagnostic chain. This tester should be based on international standards and should also completely cover all typical diagnostic tasks in engineering, testing and test preparation:

- Testing communication
- Analyzing data on bus
- Examining ODX data vs. ECU
- Reading/deleting error memory
- Programming flash memory
- Displaying measuring values
- Parameterizing ECUs
- Coding variants
- Executing ECU routines
- Testing OBD functions
- Creating/executing test sequences

The user interface of this kind of all-in-one engineering tester should be able to be adapted easily and flexibly both for a whole range of different test tasks and for the different user groups. In addition, the simple implementation of specific

extensions for individual vehicle manufacturers should be possible.

**Universal One-Tool Solution for Engineering, Testing and Test Preparation**

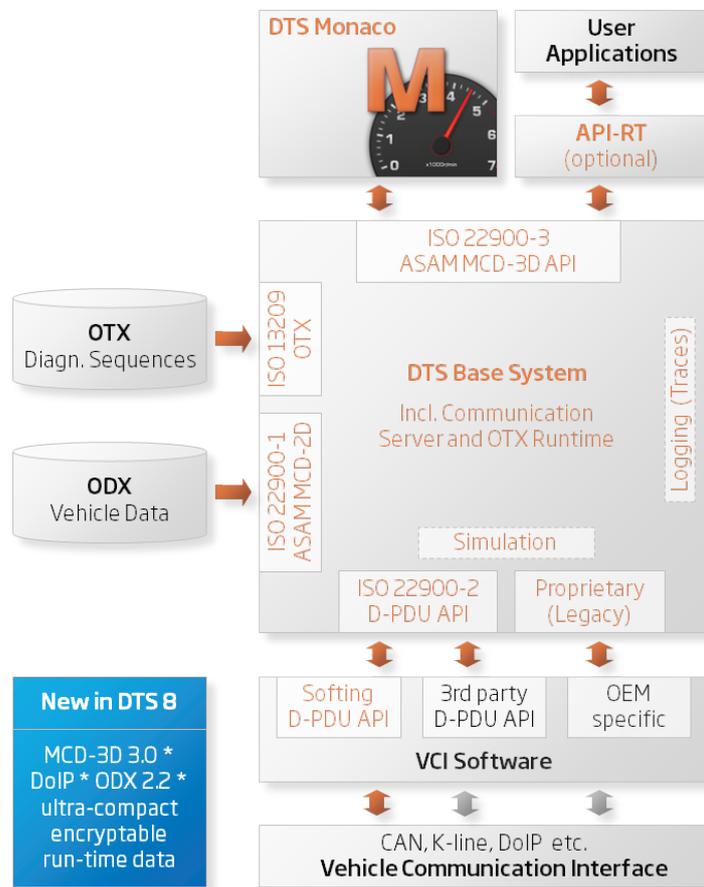
DTS Monaco by Softing [1] is a tool that fulfills all the above-mentioned requirements. The name “Monaco” stands for “Modular Analyzer for Vehicle Communication”. It implements all the latest international standards, such as:

- ISO 22901-1/ASAM MCD-2D (ODX)
- ISO 13209 (OTX) – Open Test Sequence Exchange
- ISO 22900-3/ASAM MCD-3D Application Programming Interface
- ISO 22900-2 (D-PDU API) via CAN, K-line and Ethernet
- ISO 14229 (UDS), ISO 15765, ISO 14230
- ISO 13400 (DoIP) - Diagnostics over Internet Protocol
- ISO 15031, SAE J1979 and SAE J2012 (all ODB)
- SAE J1939, WWH-ODB and others are currently under development

DTS Monaco is based on the homogeneous Base System of Softing’s Diagnostic Tool Set product family the core of which is a powerful communication server with standardized interfaces (Figure 1). It

receives, processes and sends diagnostic data. During data processing, the internal machine-readable representation is transformed into a symbolic representation that is readily understandable for the user. The ODX database can be accessed via the data interface of the Base System. The bus system interface enables the use of all kinds of bus protocols as well as DoIP over one or several interfaces of different manufacturers. Diagnostic functions can also be tested without an ECU thanks to an integrated “simulated” interface. Preconfigured templates are supplied for typical use scenarios such as communication tests, flash programming and on-board diagnostics (OBD). Universal authoring for OBD self-diagnosis as described in ISO 15031 or SAE J1979/SAE J2012 makes it possible to run OBD function tests immediately. Furthermore, the tool has a completely integrated OTX runtime for running complex test sequences in accordance with ISO 13209. An engineering environment for creating such OTX sequences can be started directly from DTS Monaco within the context of the project currently loaded.

In Demonstration mode, all functions can be tested, even without a license, using a detailed example including simulation.



**Figure 1. System overview of vehicle diagnostics with DTS 8 Monaco**

An extensive sample workspace based on completely documented sample authoring with three ECUs provides an overview of the available functions and, at the same time, is a practice-oriented template for creating your own workspaces.



**Figure 2. The start page of DTS Monaco offers simple and fast access to the functions most frequently required.**

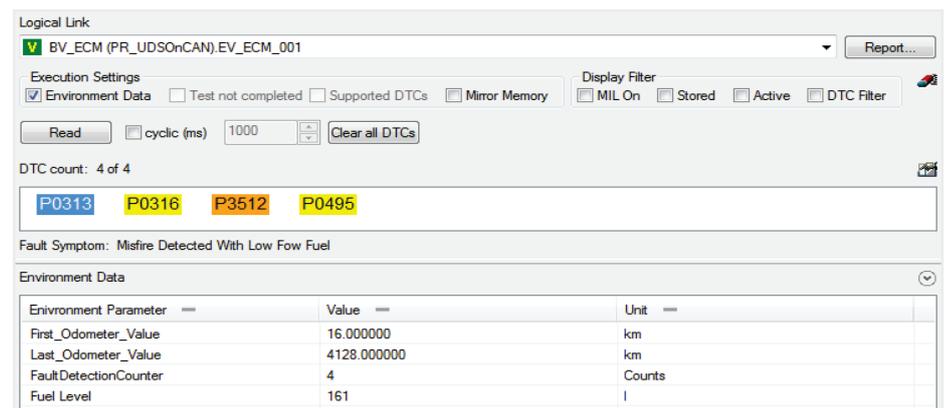
A clearly laid out start page (Figure 2) enables simple and fast access to the functions required most frequently when you start DTS Monaco. The actual DTS Monaco workspace is divided into two: one area with a fixed layout and one with layouts that you can toggle between using tabs. A status display below shows communication server messages. The various functions are realized using special, configurable interface elements. In Configuration mode, these “HMI Controls” can be arranged freely in the layouts and can be fully configured. Individual functions can be started automatically and communication established in advance if so required. In Execution mode, a saved workspace can be “started”, in other words enabled. Self-generated test sequences enable both simple and very complex function tests. This makes it possible to detect, and remedy, communication problems and function errors at an early stage. Communication data and test results can be documented in entirety in the process.

### Uniform Operating Concept for all Diagnostic Tasks

Typical diagnostic tasks include the reading out of the error memory and flash programming. The uniform implementation in DTS Monaco, at least as far as the user is concerned, is illustrated here as an example.

Figure 3 shows the HMI Control for reading out and deleting the error memory of ECUs. This makes it possible for example to test whether a Diagnostic Trouble Code (DTC) was detected correctly under the corresponding conditions. The error memory can be read once or cyclically and, if required, together with the ECU environmental data. Users can choose between two views: All available details are shown in the Expert view. The Compact view, on the other hand, shows a simplified representation in which different states of the DTC are illustrated with different colors. The views can also be filtered according to different criteria, e.g. by saved or active DTC. If necessary, a report can be generated showing all DTC found.

Figure 4 shows the HMI Control for the flash programming of ECUs. This makes it possible to test flash jobs and ensure ECUs have specific software releases. The order of flash sessions and flash priorities can be configured.



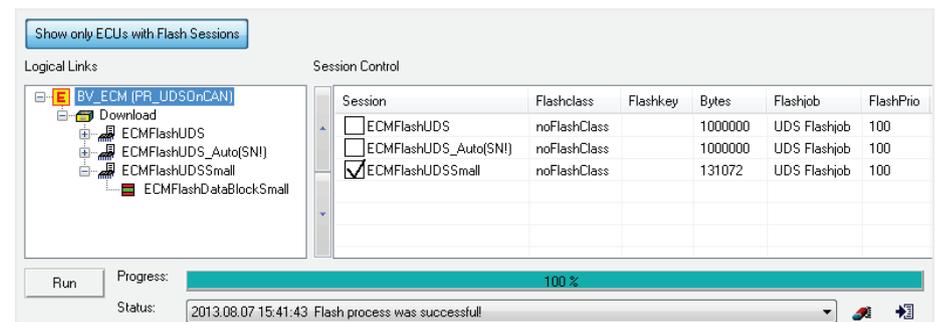
**Figure 3. HMI Control for reading out and deleting the error memory.**

As far as the user is concerned, the basic operating concept remains the same for these and all other diagnostic tasks: All HMI Controls in workspaces are configured in the same way within the provided framework and, in terms of higher-level functions, operated identically.

### Flexible Adaptation to Different Users' Requirements

One of the requirements, mentioned at the beginning of this article, of an engineering tester is that this kind of tool must be able to be adapted simply and flexibly to suit all kinds of user groups. Figure 5 shows how this is possible with DTS Monaco. The left of the picture shows a complex workspace with several HMI Controls that enables experts to carry out communication tests with full access to all diagnostic functions. In addition to the analysis of diagnostic communication, the data description can be tested. On the right-hand side of the workspace, diagnostic and basic services as well as jobs can be configured and run. It is possible to establish communication to one or more ECUs. The fact that services can be configured at PDU level makes parameterizations possible for which the ECU is not specified (worst-case tests). The results of any actions carried out are shown at the bottom

right in the workspace; users can adapt the display more or less to suit their purpose. Two bus traces are shown on the left. The top one enables the analysis of off- and onboard communication directly on the bus in hexadecimal representation. The bottom one shows



**Figure 4. HMI Control for the flash programming of ECUs.**

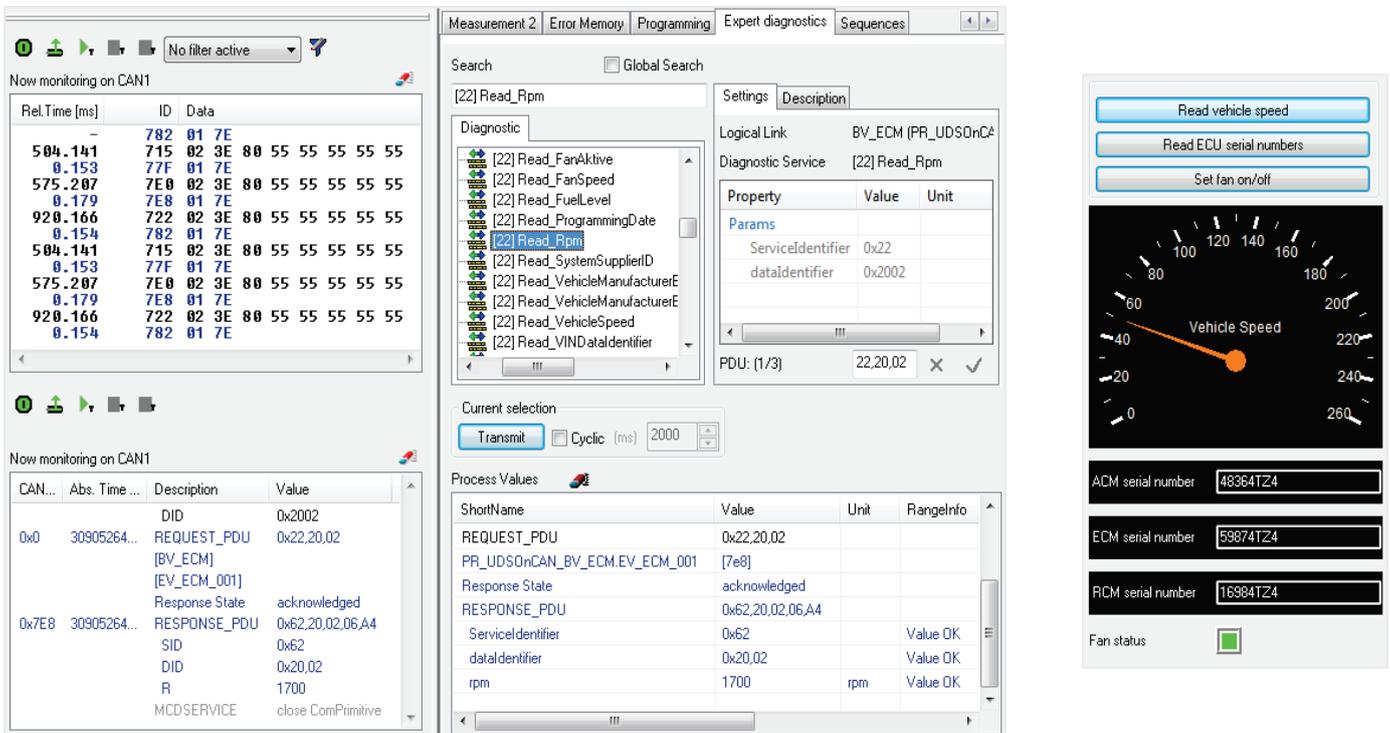


Figure 5. Direct comparison of workspaces: complex display for diagnostic experts (left) plus a simple start of test sequences using keys (right).

the diagnostic communication at application level in symbolic representation.

Furthermore, DTS Monaco makes it possible to initiate test sequences containing services, jobs or OTX sequences using keys. Based on this, the right-hand side of Figure 5 shows a sample workspace for another user group that in turn consists of several HMI Controls. No special diagnostic knowledge is required to operate this workspace, unlike the one on the left. The vehicle velocity and the serial numbers of three ECUs can be read out; the engine fan powered on and off. If so desired, the user can follow the establishing and terminating of communication and the changing of diagnostic sessions in the background.

### Reduced Cost of Procurement and Training, Fast Results

An all-in-one engineering tester also brings with it a number of additional advantages: Procurement costs are reduced as only one tool is required. Users only have to master one tool and consequently only be trained once in using it. Familiarization time with DTS Monaco is minimal thanks to the intuitive start page, Demonstration mode, pre-configured templates and universal

authoring for OBD self-diagnosis. And the problems of different data exchange formats and varying operating concepts when using several tools as well as the limited orientation to specific user groups described at the beginning of this article are also completely avoided by using a tool such as DTS Monaco.

### Literature

[1] Further information on DTS Monaco and a test version that can be downloaded here: [www.softing.com/dts8](http://www.softing.com/dts8)



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has worked as a product manager for Softing in Haar, Germany, since 2007. He first worked in the Industrial Automation Division on the diagnostics of industrial networks and played a major role in developing the Profibus tester 4. Since 2011, he has been in the Automotive Electronics Division where he is responsible for the Diagnostic Tool Set, a comprehensive total solution for vehicle diagnostics.