

# Cold-Test Bench

- **BMW Group simulates cold-test bench**
- **dSPACE Simulator used**
- **Optimizing cold-test routines**

The BMW Group has used a dSPACE Simulator to construct a virtual “cold-test bench”. This uses a real-time simulation model to check the testing and diagnostics routines used in the cold test. The dSPACE Simulator’s job is to help optimize the testing process and increase efficiency. As a result, the test cycle was reduced by 5%.

All individual engine components are tested meticulously before assembly. Yet after assembly, some engines fail to run completely smoothly. This can be caused by glitches in the assembly process, such as dirt or handling errors, or by awkward combinations of tolerances. To meet customers’ high expectations, a 100% end-of-line test is performed on all engines. Engines in large-scale production undergo cold testing, and racing and custom engines are hot-tested.

## Virtual Laboratory Test Bench

Cold tests are a firm fixture in the engine production process, so test procedures and processes are monitored continuously in the search for optimization potential. In cooperation with dSPACE, a virtual cold-test bench was constructed with hardware-in-the-loop (HIL) simulation technology to investigate and improve the testing and diagnostics routines used in the cold test.

The engine electronic control unit (ECU) and the host PC on the test bench are the only real components interacting with the Simulator.

The remaining test bench sensors, test bench drive, and combustion engine are provided by the simulation environment.

This allows both the processes and the test station software to be tried out and optimized before going into production. Appreciable savings in cost and time are the result.

## dSPACE Simulator

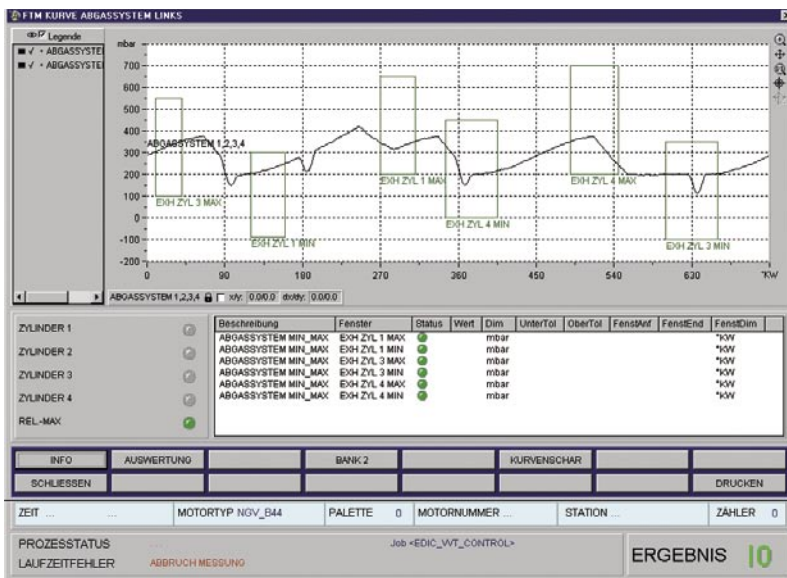
The real-time simulation model runs on two DS1005 PPC Boards in a multiprocessor system. These calculate the model of an unfired engine, which includes the internal friction and the effect of ambient air flowing through the engine. Two DS2211 HIL I/O Boards measure and simulate the necessary input and output signals.

The effect of the asynchronous machine on the engine in unfired operation is also simulated. The IP Carrier Board DS4501 is equipped with an INTERBUS module and provides direct access to the INTERBUS network used to send the rotational speed of the asynchronous machine to the measurement processor.

The actuators are simulated partly by substitute loads and partly by real loads.

## Optimizing the Test Process

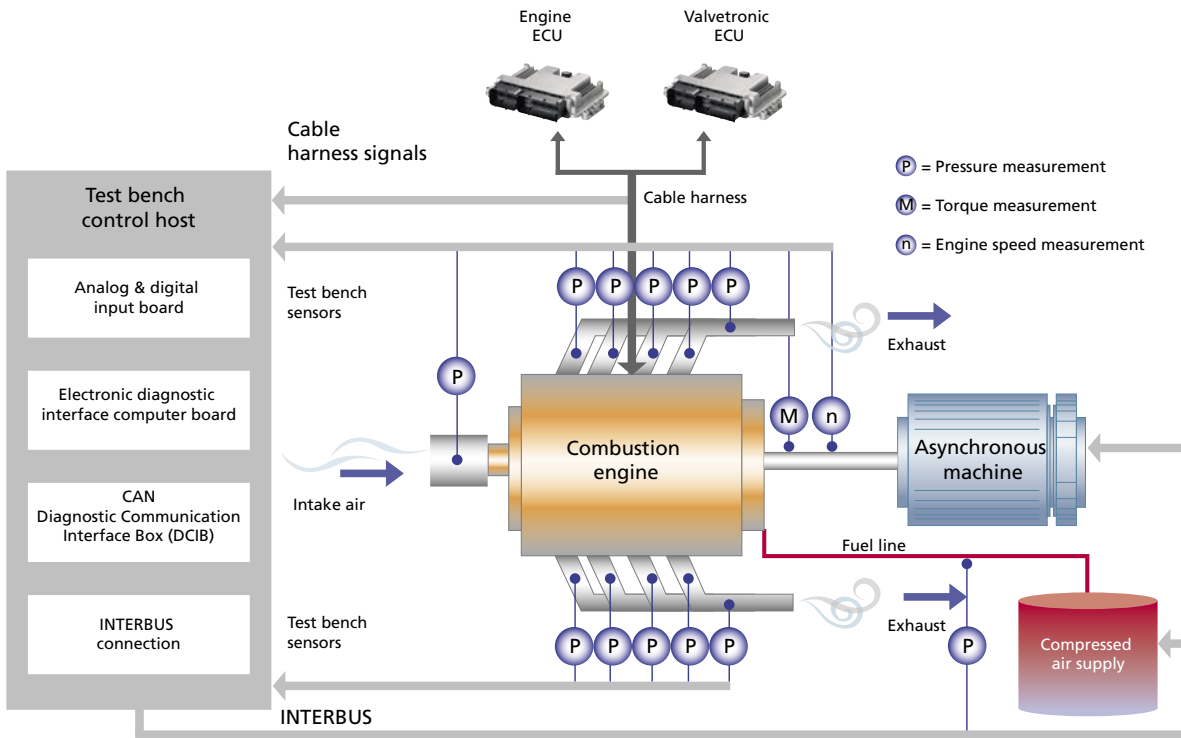
dSPACE Simulator is used not only to simulate the engine cold tests, but also to check the communication between the individual interfaces. The engine model



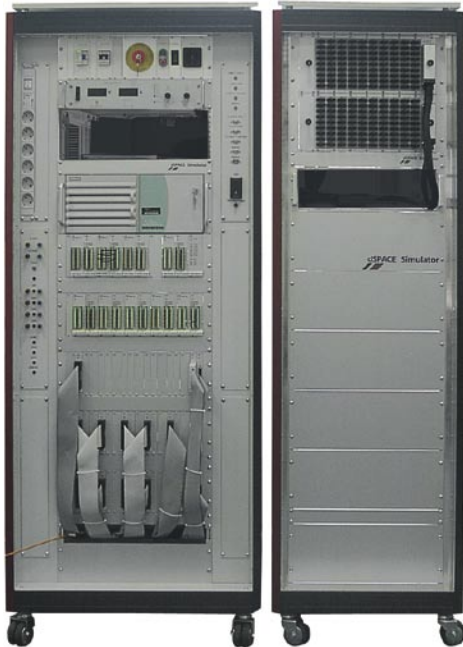
▲ *Virtual test cycle for engine checks.*

## Cold Tests on Engines

Cold-testing of every single engine is a major part of this quality assurance procedure. The unfired engines are pulled by an electrical asynchronous machine and tested for correct functioning at predefined engine speed profiles. The tests cover the engine assembly itself, the wiring harness, and the connected sensors and actuators. Compared with hot tests, in which the engine runs on fuel, cold tests cost a lot less in terms of ventilation, exhaust scavenging, cooling, fire prevention, and noise protection. A cold test takes only 20% of the time needed by a hot test. This boosts efficiency and cuts production costs.



▲ Schematic of the laboratory cold-test bench.



▲ dSPACE Simulator for the virtual cold-test bench.

is manipulated systematically to mimic assembly and component faults, so that the effectiveness of the cold test routines and the diagnostics in the ECU can be verified. Testing time was cut by 5% by improvements in efficiency. New interface boards and their drivers can also be tested easily. All these studies can be performed

under laboratory conditions and do not have to be done at the end of the assembly line during ongoing production.

Source:

AUTOREG 2006

„Hardware-in-the-Loop-Simulation zur Entwicklung und Verifikation von Prüfroutinen in Motorsteuergeräten für Bandendetests in der Motormontage“

## Glossary

### Valvetronic –

Variable valve timing system with continuously variable intake valve lift.

### Cold test –

Function test on engines without firing up.

### INTERBUS (process field bus) –

Standard for field bus communication.

### End-of-line test –

Function test on engines when they reach the end of the assembly line.