

TEST BENCH MANAGEMENT AND AUTOMATION



What we offer

The Alma Automotive Test Bench Control System adapts to the available test system layout: besides the control of engine speed and torque it can be used to manage air, oil, water and fuel conditioning systems, directly implementing the actuators real-time control, or simply dispatching demand targets to external controllers. Every component of the test cell (e.g., the ventilating, fuel supply, fire extinguishing systems, etc.) can be directly controlled or remoted, and any type of test cell transducer can virtually be managed. Finally, the Test Bench Control System can interact with calibration tools, such as INCA, CanAPE, Sysma.

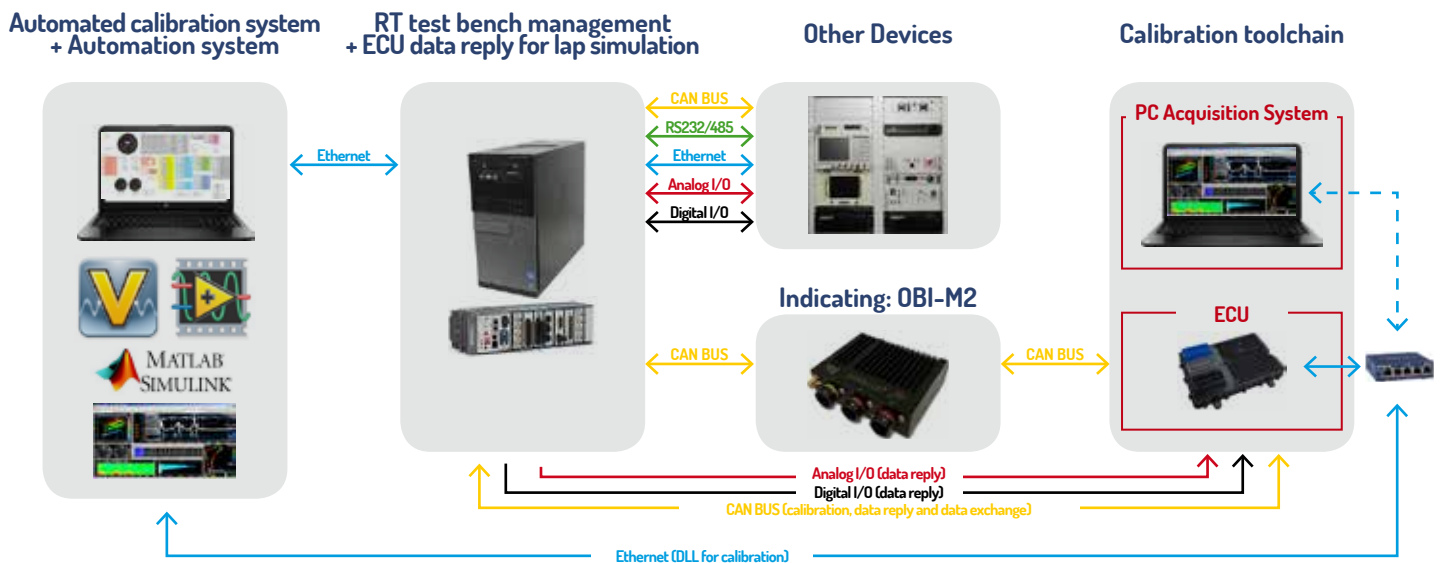


Alma Automotive test bench control software is based on NI VeriStand

VeriStand is a software environment for developing Real-Time testing applications, that allows to:

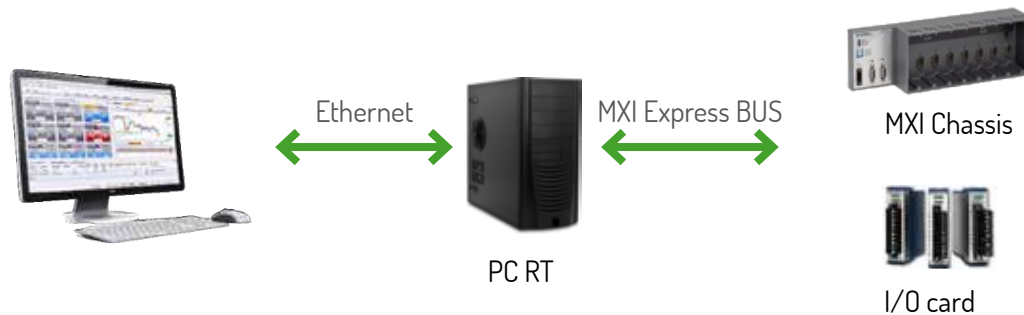
- Configure automatic procedures to control devices
- Perform data acquisition
- Manage channels (scales, alarms, mapping) and create calculated channels
- Run simulation models based on Simulink, Labview, etc...

The strength of Alma Automotive approach is the use of a standard interface (VeriStand) customized with models and custom components, running both on the Real-Time and host-PC environments.



Hardware

The dyno bench control system is based on hardware platforms compatible with NI Real-Time software. Hardware-wise, several options can be chosen, depending on the application: cRIO, PXI or MXI+PC-RT. In the latter case, the Real-Time OS runs on a high performance desktop PC, connected to the Chassis containing the I/O Modules via MXI Express BUS interface. Finally, the Host PC is connected via Ethernet to the Real-Time controller, offering a user interface for tests management and monitoring.



Software

The test bench software is divided in two parts:

- **Logical:** the test bench code, included in the System Definition File, that is the focal point of the VeriStand Project and all the custom pieces of code that increase VeriStand's native features, such as simulation models, custom devices, custom tools, ecc... Moreover, this section includes also the profile generator tool, useful to create and edit automatic tests that can run in Real-Time, replaying complex profiles on bench outputs.
- **Interface:** the front panel that allows the operator to safely monitor and manage the test bench.

Features in detail

Alma Automotive Test Bench Control System consists of subcomponents making it easy to manage several types of tests, keeping under control engine and environment conditions:

- **The system definition file:** a built-in VeriStand interface to manage
 - Test bench hardware I/O (CAN, DAQ, FPGA,...) configuration
 - Custom Devices, based on LabVIEW, to expand the features of the base platform
 - Simulation models developed in LabVIEW, Simulink or other modelling environments
 - User channels and calculated channels
 - Alarms and related automatic procedures
 - Event-triggered procedures.
- **Simulation models:** user-defined models developed in LabVIEW or Simulink and compiled, can be uploaded and run on the real-time processor or on the host-pc. Tasks as vehicle simulation, actuators control, generation of inputs for the ECU, can be easily achieved.
- **User interfaces:** custom interfaces can be easily built using the built-in VeriStand library, or creating custom objects in LabVIEW. Many functionalities, such as the Alarm Monitor, the Model Parameter Manager, the Channel Faults Manager, the Channel Data Viewer, the Channel Calibration Tool, the xNET Bus Monitor, etc. are available within VeriStand: Alma Automotive provides a set of custom objects developed for test bench control applications.
- **The stimulus profile:** the VeriStand native generator of automatic profiles can be used to build real-time sequences (i.e., conditionally read/write channels defined in the system definition file) and stimulus profiles (a test executive that can call real-time sequences, open/close VeriStand projects, perform data logging and pass-fail analysis).
- **The Test Manager:** a custom tool, developed in LabVIEW, allowing the operator to build automated cycles, where test bench channels (e.g., speed, load, air/oil/water temperature, etc.), can be scheduled, together with ECU parameters, for automated calibration tasks.

Simulation Models

Simulation models are one of the main characteristics of a VeriStand Project. In fact, they represent an important way to increase the test bench software functionalities.

- Models can be developed in several software environments (Labview, Simulink, etc) and it is very easy to integrate them into the VeriStand project.
- The control logic and strategies of test bench devices (such as chillers, heaters, fans, resistors, etc) can be developed with models running automatically as the project is started. Also the ECU can be fed by model outputs in order to test engine control strategies.
- Complex calculations can be executed by models in Real-Time thanks to the high computational power of available controllers

Automation system

The Alma Automotive test bed automation system allows implementing the automatic execution of test sequences defined by the user, or automatic calibrations of selected ECU parameters. The solution can be applied to the custom specific toolchain layout and for the needed test types or calibrations.

Features at a glance

- Open platform applications both hardware-wise and software-wise
- ASAM and non-standard protocols available
- Integrated with models designed and compiled in Simulink
- Possibility to read and write variables, or flash ECU software
- Integrated sequence generation
- Test manager custom interface
- Compatible with indicating systems for calibration based on combustion feedback
- Possibility to use it as a Data Hub for collecting and passing data to other test cell components



Automation benefits

The Automation can be useful in many phases of the testing and calibration process that can be carried out in steady state conditions or with dynamic approaches. Among others, these tests benefit of the test bench automation system:

- Execution of Design Of Experiment test plans
- Description of engine behaviour: overall volumetric efficiency, friction, torque, ...
- Optimal spark/injection advance setting: finding the optimal value, and exploring the whole timing-BMEP/IMEP for torque control strategies
- Optimal fuelling: cylinder-by-cylinder volumetric efficiency determination, optimal injection phase, transient conditions lambda compensation
- Reliability tests: replication of track laps feeding the ECU with recorded (or simulated) signals

The application is developed according to the customer requirements and is delivered as a LabVIEW project: the customer accesses the source code and is able to manage the evolution of the automatic calibration software.

Standard and custom cycles

Several base requirements can be satisfied using standard tools available in VeriStand (Stimulus Profile), other may require to add customized procedures (custom tools, custom devices). Alma Automotive is able to tailor custom tools to the user's need. Complex profiles and sequences of simple profiles of target settings (bench and ECU) can be uploaded from telemetry or built thanks to proper interfaces. Profiles may be repeated several times.



Rapid Control Prototyping systems

The toolchain provided by Alma Automotive makes it possible to read and write variables, or flash software. Additional hardware may be needed to add other functionalities, such as adding I/O, or to run custom software. Alma Automotive develops control solutions, based on Miracle2 or Spark, able to cope with the ECU to achieve the test of new control solutions. These RCP systems can change calibration parameters of the ECU (via INCA, e.g., using iLinkRT, or via CAN, if the ECU allows) or can directly manage the actuators.



Miracle2
Micro Rapid Controller & Logging Environment



SPARK
The open source ECU project

Toolchains: Other Devices

The Alma Automotive Automation System is an open platform application (both hardware-wise and software-wise) which **adapts to what is available in the test cell**, and can always be upgraded when the scenario changes.

One of the useful functionalities that can be included in the Automation System consists in using it as a Data Hub (collecting and passing data to other test cell components): this is possible thanks to its implicitly flexible structure.

Possible ways of exchanging/acquiring data are:

- CAN/CCP/XCP, iLinkRT, CANOPEN, DEVICENET, ETHERNET, ASAP3 (on ethernet or RS232), RS232/485
- Analog I/O (with the possibility of fast signal conditioning on FPGA)
- Digital I/O (with the possibility of fast signal conditioning on FPGA)



Originally established as a spin-off of University of Bologna, Alma Automotive represents the synergy between knowledge acquired in academic research activities and years of experience in developing applied solutions. The company has now evolved to offer both ready-to-use products and engineering services supported by bespoke hardware and software solutions.

Highly oriented towards new challenges, Alma Automotive's mission is to provide innovative solutions

and tools to help customers in the development of ever more efficient engines and powertrains. Our partnership with National Instruments and the strong relationship we have with top-tier automotive companies is testimonial to the high level of skill and quality of services offered to our clients.



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