

ALMA AUTOMOTIVE ENGINE TESTING



Our Expertise

Alma Automotive designs and provides customer-tailored solutions for engine testing, including turnkey engine test cells equipped with hydraulic, eddy current brake and dynamic (asynchronous or permanent magnet motors) benches.

The test cell automation and acquisition software is based on National Instruments VeriStand, offering to the final user the possibility of implementing real-time code using compiled Simulink/LabVIEW models. The use of an open software platform for the Test Cell management facilitates the interactions with ECU and Combustion Analysis systems.

Engineering services include the development of automatic calibration procedures, with the possibility of interacting with Electronic Control Units using several calibration management applications (INCA, CANape, Sysma, Vision...). The interaction between the Test Automation System, the Combustion analyser and the calibration management system can be carried out using CAN, XCP, iLinkRT, creating automatic calibration procedures. ECU strategies can be bypassed (e.g., using iLinkRT, or CAN), with algorithms running on Real-Time platforms.

Prototype ECUs are available to run the engine with custom control software.

Engineering services can be provided to manage the post processing of sampled data using Matlab, LabVIEW, Diadem, Wintax, INCA MDA, Concerto, or other standard automotive tools.

Our Offer

- Engine test cells design and turnkey customer-tailored solutions delivered to the customers
- Engine testing services (with test bench operators and/or engineers):
- Performance evaluation
- Engine and engine components development, durability tests
- Driving cycles and track laps simulation
- Engineering and technical support availability
- Engine calibration
- Combustion systems development
- Rapid Control Prototyping
- Engine test cell rental without operators/engineers on already existent or custom designed test cells.

Our benefits

- Uncompromising confidentiality
- Cost effectiveness
- Unbeatable responsiveness
- Great experience with local manufacturers on gasoline and diesel engines testing and calibration

Case Study: Test Bench/Drive System

Oswald AC asynchronous machine, with the following characteristics:

- 221 (266) kW, 455 (546) Nm from 0 to 4636 rpm when used as generator, max speed: 10000
- Moment of Inertia: 0.3 kgm²
- Encoder BAUMER HG16 M D 512 CI, 512 pulses/rev, redundant sensing

REEL (KSB GROUP) DRIVE SYSTEM

- Cabinet placed in dedicated technical room
- Two (master/slave) 160 kW Emerson Unidrive M701 set at 6kHz switching frequency, one AFE OPDE S460
- Possibility to set the amount of regenerated energy (the rest is dissipated on the 240kW load bank)
- Wiring from drive to motor: shielded, 5m length; wiring from chopper to load bank: shielded, 10m length



Case Study: Automation/ECU/Indicating system

Automation software based on National Instruments VeriStand (and compiled Real-Time models created with LabVIEW/Simulink) running on a Real-Time OS PC

Test bench signals acquisition hardware based on National Instruments cRIO and PCI/PCIe boards

- 16 TC channels, 24 bit, 75 Hz sampling
- 16 PT100 channels, 24 bit, 50 Hz simultaneous sampling
- 24 Voltage AI ($\pm 10V$), 16 bit, differential channels, simultaneous sampling@100kHz, downsampled, filtered and re-sampled at 1kHz
- 16 Voltage AI ($\pm 10V$), 16 bit, pseudo-differential channels, multiplexed sampling@250kHz, downsampled, filtered and re-sampled at 1kHz
- 16 Current AI ($\pm 20mA$), 16 bit, sampled at 12.5 kHz (8 channels multiplexed sampling at 200kHz), filtered and re-sampled at 1kHz
- 36 AO 16 bits 1 kHz

Test bench signals acquisition hardware based on National Instruments cRIO and PCI/PCIe boards

- 12 DI TTL fast lines (10 MHz) for frequency/PWM duty cycle measurements
- 4 DO TTL fast lines (10 MHz) for frequency generation
- 16 DI 6-24V, 140 kHz
- 16 DO 6-24V, 2kHz, max 125 mA (500 mA for 1 channel active) coupled to relays
- 24 DI protected @ 220V, monitored @ 1kHz
- 24 DO coupled to relay (220V) managed @ 1kHz
- 4 CAN lines
- 2 RS232 lines
- 8 RS485 lines

The test cell is equipped with 3 PTZ ethernet cameras, directly connected to the data server.



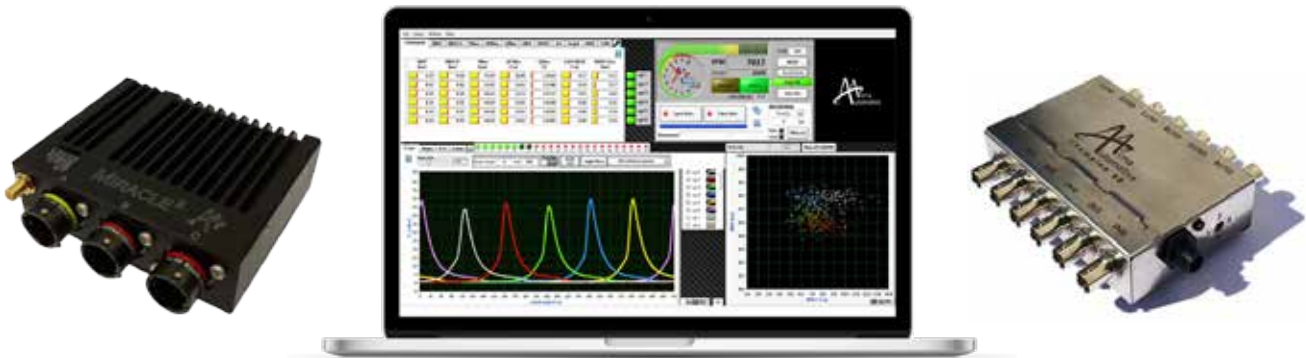
Case Study: Automation/ECU/Indicating system

ECU management/calibration:

- Possibility to use (and automate) several ECU calibration software (INCA, CANape, Sysma, Vision...)
- Data post-processing with Matlab, LabVIEW, Diadem, Wintax, INCA MDA, ...
- Capability of interacting with the ECU via iLinkRT, XCP, CAN, creating custom automatic calibration procedures
- The test bench control software is based on an open platform, that can interact with the indicating system and the ECU calibration software
- Capability of managing the engine with prototype ECUs by Alma Automotive
- Capability of bypassing ECU strategies (e.g., using iLinkRT, CAN, ...) with other implemented on real-time platforms (designed in Simulink or LabVIEW)

Indicating system:

- OBI-M2 by Alma Automotive: up to 12 cylinders up to 11000rpm, 4 cylinders up to 20000 rpm
- Can be used with encoder or standard sensor wheel
- Cylinder pressure and accelerometers signal processing
- Can be used for actuation tracking
- Connected to the automation system and/or to the ECU via CAN/XCP
- Fast cylinder-by-cylinder data output on the CAN bus for next-cycle combustion control
- mASTRO or Champion Charge amplifier
- Data saved in standard formats (tdms, mat, ifile, mf3, mf4)



Case Study: Heating and Cooling systems

Air Heating, Ventilating and Air Conditioning (HVAC):

- Carrier 39CX04005G08
- 1000 kg/hour flow
- 12 kW pre-heating resistors, 18 kW post heating resistors
- 27 kg/h steam generator (Carel UR027HL101)
- 18 kW chiller (Friulair QBE 18)
- +/-0.5°C (+/- 3% rel. humidity) during power curves or track laps simulation
- Volumetric air flow meter

Oil, water and gasoline Cooling and Heating:

- 250 kW cooling tower
- 1kW chiller for gasoline cooling
- Two independent volumetric pumps to manage (individually, by means of inverters) engine water and oil temperature
- Oil and water heat exchangers
- 15kW oil heater (diathermic oil, heated with resistors and cooled with water) with oil/oil heat exchanger
- Oval gear hot (engine) oil flow meter
- Vortex shedding hot (engine) water flow meter
- Ultrasonic warm (cooling tower) water flow meters
- Hot (engine) water pressure regulator
- Oil filtering: metal (40 µm, engine outlet) and paper (6 µm, engine inlet) filters on hot (engine) oil
- Water filtering: metal (10 µm) filter on hot (engine) water
- Gasoline filtering: 1 µm polypropylene filter

Test cell ventilation system:

- Air inlet: 38000 m³/h (measured): 3 centrifugal fans 14 kW
- Air Outlet: 27580 m³/h (measured): 3 centrifugal fans, 9 kW
- Exhaust gas extraction: high temperature 4kW centrifugal fan 5000 m³/h@122 mmH₂O
- Engine hot spots cooling: 4kW centrifugal fan 5000 m³/h@122 mmH₂O
- Exhaust pipes cooling: 2.2 kW axial fan, 9000 m³/h@35 mmH₂O
- Technical Room air circulation: 6kW axial fan



Case Study: Test Cell Equipment

Transducers:

- Torque: HBMT40 $\pm 1000\text{Nm}$
- Blow-by: J-Tec vortex shedding blow-by meter (4-140 l/min)
- Range of Wika S20 pressure transducers (0-1.6/2.5/4/6/10/16 bar, 0.8-1.2 bar, ...)
- Temperature: PT100 (class A) and TCJ
- Airflow: Elster-Instromet B.V.-IRM3-DUO, class G400 (32-650 m³/h)
- Water flow: Vortex shedding LiquiView (9-150 l/min)
- Oil flow: Oval gear Omec OM015 (1-40 l/min)
- Gasoline flow: Emerson Process Coriolis mass flow meter F025S172
- Cylinder Pressure: Kistler 6052C32U20
- Engine Encoder: Kubler 5000 360 pulses/rev
- Integrated ambient pressure, temperature and humidity sensors
- TUF2000-M ultrasonic flow meters (cooling water)



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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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