open source
ecu project
Who We Are

Alma Automotive, established in 2002, is an academic spin-off of the University of Bologna; it provides custom solutions for engine development and testing. The strength of Alma Automotive is the synergy between the knowledge acquired in academic research activities and the years of experience in developing applied solutions.

Our partnership with National Instruments and the strong relationship we have with major automotive and motorsport companies is the testimonial of the high level of skill and quality of services offered to our customers.

Since 2010 Alma Automotive has been an official sponsor of UniBo Motorsport, Formula SAE Team of University of Bologna (www.motorsport.unibo.it).
The Open Source ECU project

Have you always wanted to design your own ECU but don’t know where to start?
Do you know the basics of engine control systems but find too hard starting from scratch?
Do you want to implement your control functions but don’t have a clue about C and VHDL?

We have the solution for you! It’s the open source ECU by Alma Automotive.

Do you think programming is black magic?
Load ready to run release

Open Source ECU
Open and Accessible Software for both Real-Time & FPGA

Have you got skills?
Load your own software

Alma Automotive
Official Open Source Software Release
Upgrades

Alma Automotive support
Development
Download the latest software
Add your own functions
Share ideas with other teams

Community
ALMA AUTOMOTIVE OPEN SOURCE PLATFORM

The open source ECU is a fully programmable control prototyping system based on the latest National Instruments System On Module (SOM) sbRIO-9651. The Xilinx Zynq™, with its Dual Core ARM® Processor, Artix-7 FPGA on top and 512MB RAM, provides outstanding flexibility, efficiency and accuracy, enabling complex control algorithms and signal processing to be performed. Such top-notch features provided by the National Instruments hardware are then expanded with our in-house designed hardware; the resulting product is an integrated engine and vehicle management system capable to meet the needs of any motorsport application.
Main features

A ready-to-use and fully accessible ECU will be provided, containing every single control strategy that has already been developed and successfully implemented both on the UniBo Formula SAE car or on other motorsport applications. The ECU software, both Real-Time and FPGA, will be completely accessible and open, so that you can read, edit or even replace everything you want.

Gasoline engines (both GDI or PFI) up to 8 cylinders can be controlled. Besides basic control functionalities, it features torque structure based control, electronic throttle control, lambda control, speed limiter, gear cut for sequential gear box, fuel cut off, traction control, launch control, turbo boost control, knock control.

Measurement and Calibration will be possible thanks to its compatibility with any commercial calibration tool (ETAS INCA®, Vector CANape®, ATI Vision®, etc.)* via XCP on CAN and XCP on Ethernet. A value calibration tool will also be provided by Alma Automotive in Open Source format.

*Trademarks are the property of their respective owners
Hardware description*

Signal I/O
- 2 x EPS (Hall and Inductive)
- 16 x Digital I/O (5V TTL)
- 20 x Temperature (Termocouple, NTC, PT100)
- 20 x Analog Input (12bit 100ksps)
- 8 x Fast Analog Input (12bit 200ksps)
- 2 x Analog Output (12bit resolution)

Supply
- 6-18V Power Supply
- 2 x narrowband
- 2 x wideband

Lambda Controller
- SoM SBRI0
  - 667 MHz Dual Core ARM Cortex A9
  - Artix-7 FPGA
  - 512 MB RAM
- Data Logging
  - 32 GB

Communication
- 4 x CAN
- 2 x RS232
- UART
- 1 x Ethernet
- Wi-Fi

Power Outputs
- 8 x Coil Driver (10A 600V)
- 8 x Peak&Hold Injector Driver (up to 10A)
- 8 x HS Driver (PWM 5A)
- 8 x LS Driver (PWM 5A)
- 2 x H-Bridge (5A)
- 2 x Sensors Supply (5V-2A + 10V-1A)

Software Modules
- Torque Structure Based Control
- Electronic Throttle Control
- Narrowband Lambda Control
- Wideband Lambda Control
- Gear Cut for Sequential Gear Box
- Speed Limiter
- Traction & Launch Control
- Turbo Boost Control
- Knock Control
- Fuel Cut Off

*All specifications are subject to change without notice
Why National Instruments and LabVIEW?

NI reconfigurable I/O (RIO) technology gives you the ability to define your own custom measurement hardware circuitry using reconfigurable FPGA chips and LabVIEW graphical development tools. The RIO core includes an FPGA chip and surrounding circuitry that enable LabVIEW to perform hardware synthesis.

The combination of NI LabVIEW FPGA module and NI LabVIEW Real-Time module is a complete solution for creating reliable, stand-alone embedded systems with a graphical programming approach.

Top 10 reasons to use NI LabVIEW for Designing Embedded Systems

What is an FPGA?

FPGA (Field-programmable gate array) is a reprogrammable silicon chip that has the same flexibility as software running on a processor-based system, with the difference of not being limited by the number of processing cores available.

Unlike processors, FPGAs are truly parallel in nature, so each independent processing task is assigned to a dedicated section of the chip, and can function autonomously without any influence from other logic blocks.

FPGA gives you the enormous flexibility of designing custom functionalities, by implementing the application logic in hardware circuits rather than executing on top of an OS, drivers and application software.

In order to configure your FPGA you don’t need to know any hardware description language (HDL), because LabVIEW translates your easy-to-write graphical code into the complex VHDL code.

The LabVIEW programming environment is distinctly suited for FPGA programming because it clearly represents parallelism and data flow, so even if you are inexperienced in traditional FPGA design processes, you can leverage FPGA technology. In addition, you can use LabVIEW to integrate existing VHDL into your LabVIEW FPGA designs.
Specific training regarding LabVIEW, engine control, as well as support for engine calibration will be offered by Alma Automotive as a service.

Where do you see yourself in the “User Pyramid”?

It doesn’t matter what category are you in, as everyone will get the same ECU as well as the same software... what use you make of it is up to you!

LabVIEW FPGA
For those who want to get the most out of it! We’re sure you’ll be pleasantly surprised by the impressive FPGA potential of our ECU

LabVIEW Real-Time
The personalization of your ECU will be easier than you think.

No LabVIEW knowledge needed
You can use the ECU “as is”, the software has already been implemented. When you feel ready to have a go you can always start to work your way up the pyramid!
Alma Automotive & UniBo Motorsport

Alma Automotive and UniBo Motorsport have been proactively collaborating for 5 years now. It all started in 2010, when UniBo Motorsport took its first step in the Formula SAE series, with something that no Team had ever done before: an engine control software designed from scratch and implemented on a NI Compact R10! From 2011 on UniBo Motorsport has developed its ECU year after year, until 2014, when the team developed a new ECU based on 2 NI Single-Board R10, a reliable product with excellent performance. Thanks to this new ECU, impressive results in the most challenging Formula SAE competitions have been achieved and remarkable feedback from technical judges from all over the world have been received. UniBo Motorsport will be the first one to test our Open Source ECU, which will finally debut at the Formula SAE Brasil 2015 on the UniBo Motorsport car.

2010
Team’s debut and first Engine Control on Compact R10

2011
Unibo Motorsport wins the NI award “Most innovative use of an embedded system in the car” at Formula Student UK in Silverstone.

2014
Upgrade from Compact R10 to 2 Single-Board R10

2015
Open Source ECU