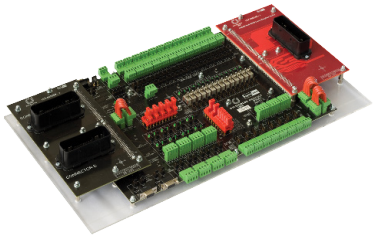
Pi Innovo™

OpenECU Accessories

The **Breakout Board Kits** are designed to provide access to the inputs/outputs of most M-series OpenECU electronic control units. The ECU is connected to one end of the board and signals can be routed to either an existing vehicle harness or external connectors.



Pigtail Harness products are braided wiring harnesses of various lengths that have a connector compatible with the target OpenECU at one end and individual stripped wires (pig-tails) at the other.

The **Breakout Board Conversion Kits** convert a baseboard for use with another member of the same family. For example, any M2XX BoB Kit can be converted for use with any other M2XX family member.

Programming Harness products are braided wiring harnesses that have only those connections required to reprogram the target OpenECU.

Corporate Headquarters

47023 West Five Mile Road
Plymouth, Michigan
48170
USA

+1 734 656 0140

info@pi-innovo.com

Pi Innovo™

Innovation in the Making

OPEN ECU™

By Pi Innovo

Rapid Prototype to Production

- Customizable Production Ready Hardware
- Proven Software Platform
- Truly Open Simulink® Development Environment
- Uses Industry Standard Tools
- Assurance and Flexibility of Supply
- Full Service Engineering Support

www.pi-innovo.com

Hardware Overview

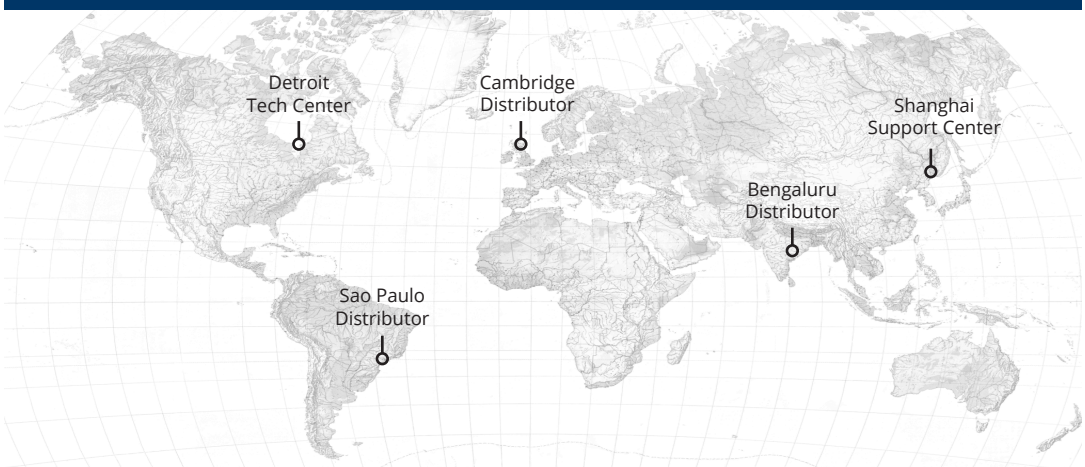
Typical Applications

OpenECU is a comprehensive family of off-the-shelf ECUs and software designed to support your control system development from prototyping to production. The philosophy behind OpenECU is the creation of modular reusable technology that is implemented to volume production standards and is fully "open" to custom configuration, adaptation and further development. Pi Innovo's ability to cost-effectively customize this production level hardware allows it to be used in a broad range of applications.

OpenECU hardware has been designed and validated through industry-standard formal development processes. Pi Innovo owns the designs and can manufacture or license the product for manufacture elsewhere.

OpenECU Hardware Overview

- FreeScale 32-bit high-performance microcontrollers
- Integrated calibration memory space
- Sealed connectors and aluminium enclosures
- Automotive engine compartment capability
- Excellent vibration and EMC performance
- Protected outputs with status feedback options
- Many input signal conditioning options
- Proven driver software
- Secondary micro for safety watchdog available
- Provision for additional customization with daughter card



M220
- Engine Control
- EV/HEV Supervisory Control
- CNG/LPG Tank Control
- Autonomous Vehicle Control

Page 4

M250
- EV/HEV Supervisory Control
- Engine Control
- Exhaust Aftertreatment

Page 5

M460
- ABS/TCS/ESC
- Active Suspension
- Autonomous Vehicle Control

Page 6

M670
- High I/O Applications
- Diesel/GDI/PFI Engine Control

Page 7

S070
- Compact injector driver
- Diesel Solenoid applications
- Common Rail Diesel

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Accessories

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See page 10 for a full list of distributors and development partners.

Software Overview

OpenECU Development Toolchain

OpenECU® SOFTWARE DEVELOPMENT

The OpenECU Developer Platform Sim-API is a blockset and set of software libraries which enable control algorithms and strategies developed as MATLAB® Simulink/Stateflow models to be quickly built and tested on real OpenECU hardware.

The OpenECU blockset integrates with Simulink to enable developers to directly incorporate the input, output and utility functions of openECU hardware within the functional simulation and analysis of their overall system design.

When a control system has been successfully simulated, a single key-press initiates the OpenECU automated build process. The build process combines C code generated by Mathworks Simulink Coder or Embedded Coder, with the required software components from the OpenECU software libraries, and calls a compiler to build an executable software file for download to the OpenECU module.

To compile the generated C code during the build process, one of the following compilers is required:

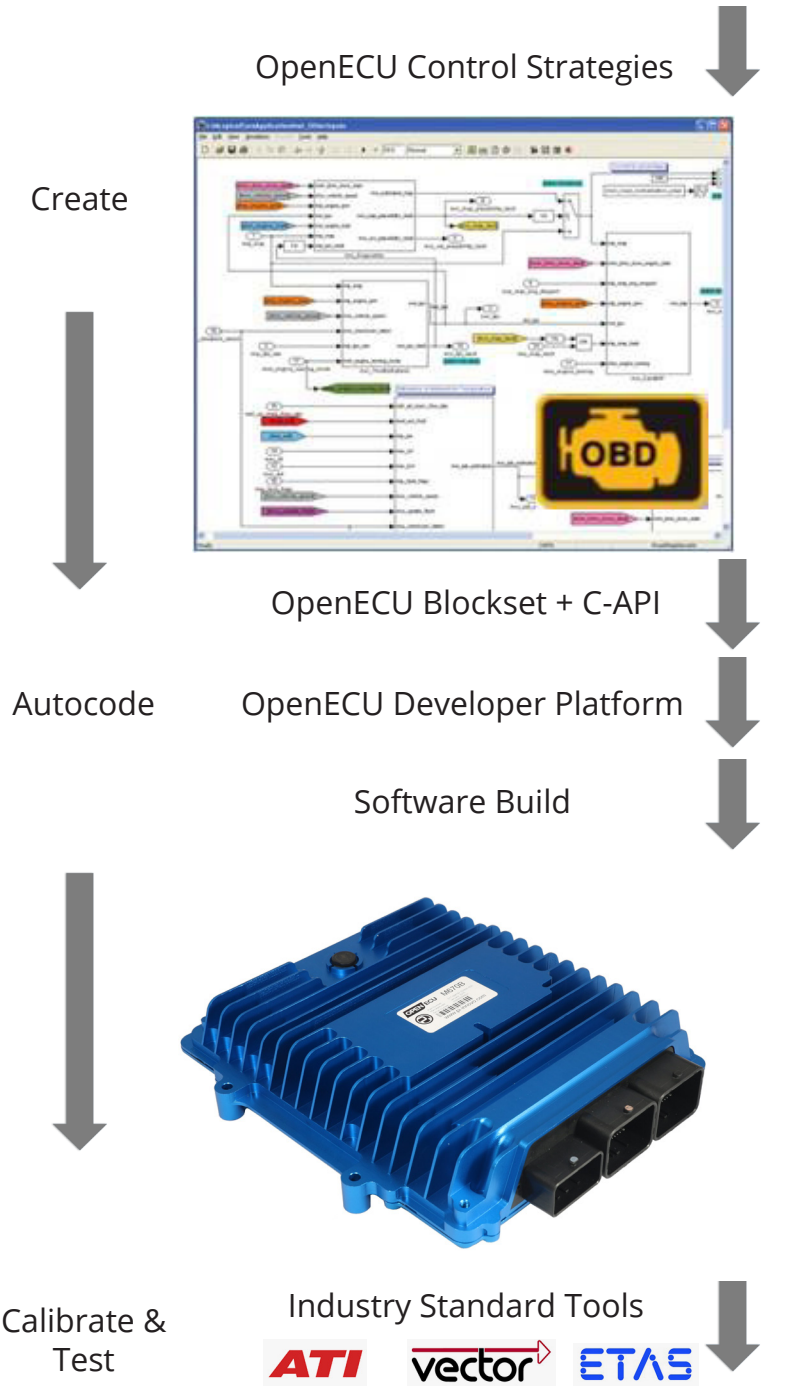
WindRiver Diab compiler
GCC compiler (provided with OpenECU installer)

For embedded software programmers, the OpenECU Developer Platform C-API provides a library of C code functions that conform to a defined application programming interface (API).

THIRD PARTY TOOL COMPATIBILITY

OpenECU is continually tested for compatibility with the latest Windows operating systems and versions of third party tools that form part of the OpenECU application build process. OpenECU integrates seamlessly with the following calibration tools:

PiSnoop
ATI Vision
ETAS INCA
Vector CANape



For a complete list of compatible third party tools visit pi-innovo.com/compatibility

OpenECU Hardware

M220 Module

- Engine Control
- EV / HEV Supervisory Control
- CNG / LPG Tank Control
- Autonomous Vehicle Control

The M220 is an ultra-compact electronic module suited to computationally intensive applications. The robust chassis mountable housing, a mix of I/O functionality, customizability, and the low cost point make the M220 a perfect fit for taking an application from demonstration to production.

Product Highlights			
Processor	80Mhz Freescale MPC5534	Dimensions (mm)	155 x 115 x 46
Memory: Code / RAM / Cal	up to 768KB / 832KB / 236KB	Weight	520g
Supply Voltage	7V to 32V	Connector	46 pin
Standby Current	0.25mA @ 12V	Vibration	6g random RMS
Communication	2 x CAN 2.0	Enclosure	Aluminium, IP67, Chassis
Sensor Supply	1 x 5V / 250mA	Operating Temperature	-40C to 105C
I/O Summary			
Inputs		Outputs	
Analog	12	H-Bridge	1 (2 pins) - 5A
Differential VRS	1 x (2 pins)	High Side Switch	1 x 20A
Single Ended VRS	2	PWM Low Side	2 x 100mA
Frequency	1	PWM Low Side	2 x 250mA
Digital	4	PWM Low Side	6 x 2A
Wake	1	Low Side Injector	1 x 15A / 5A (software configurable)
FEPS	1		
Features			
Output pin voltage monitoring, high side output current monitoring, reprogrammable, calibratable.			
Available Configurations			
Angular scheduled inputs, angular scheduled outputs, current monitoring on up to 4PWM low sides (2A), coil on spark drive, EEPROM, KLine			

For more information visit pi-innovo.com

OpenECU Hardware

M250 Module

- Engine Control
- EV/HEV Supervisory Control
- Exhaust Aftertreatment

The M250 is a compact electronic module suited to computationally intensive applications requiring a chassis mounted, sealed metal housing with IP67 environmental protection. Based on the same Freescale MPC5534 32-bit microcontroller as the M220, the M250 features 2 CAN interfaces, precision analog 12-bit inputs and configurable high current switching outputs. This group of inputs and outputs are particularly suited to emissions control applications with appropriate sensor signal conditioning and drive characteristics.

Product Highlights			
Processor	80Mhz Freescale MPC5534	Dimensions (mm)	228 x 158 x 50
Memory: Code / RAM / Cal	up to 768KB / 832KB / 256KB	Weight	1.1Kg
Supply Voltage	7V to 32V	Connector	46 pin
Standby Current	0.01mA @ 12V	Vibration	Ford class IIIB
Communication	2 x CAN 2.0	Enclosure	Aluminium, IP67, Chassis
Sensor Supply	2 x 5V / 250mA	Operating Temperature	-40C to 105C

I/O Summary			
Inputs		Outputs	
Analog	6	H-Bridge	2 (2 pins each 8A)
RTD	7	High Side Switch	1 x 20A
Angular	1	Peak / Hold Low Side Injector	1 x 5A / 2A
Frequency / Digital / Analog	5	PWM Low Side	1 x 10A
Wake	1	PWM Low Side	1 x 2A
FEPS	1	PWM Low Side	1 x 0.5A
		Spark Low Side	1 x 8A

Features
Output pin voltage monitoring, output pin digital state monitoring, high side output current monitoring, H-bridge output high side current monitoring, injector low side output current monitoring, 10A and 2A PWM low side output current monitoring, reprogrammable, calibratable.
Available Configurations
Angular scheduled inputs, angular scheduled outputs, angular and frequency/digital inputs are threshold configurable, angular and frequency/digital inputs are configurable as VRS or Hall Effect. All RTD inputs configurable as analog input, output current thresholds are configurable. EEPROM, LIN, IMU, Secondary Quizzer, wake-on-CAN, custom daughter board development.

OpenECU Hardware

M460 Module

- ABS/TCS/ESC with optional IMU
- Active Suspension
- Autonomous Vehicle Control

The M460 is a ruggedized, high I/O count electronic module that serves as a versatile development platform. The M460 is an excellent fit for heavy duty, stationary, on-road and off-road applications. The highly configurable mix of available inputs and outputs makes the M460 ideal for rapid prototyping of complicated vehicle and non-vehicle control systems.

Product Highlights			
Processor	80Mhz Freescale MPC5534	Dimensions (mm)	238 x 202 x 50
Memory: Code / RAM / Cal	up to 768KB / 832KB / 256KB	Weight	1.5Kg
Supply Voltage	8V to 32V	Connector	2 x 40 pin
Standby Current	0.15mA @ 12V	Vibration	6g random RMS
Communication	2 x CAN 2.0	Enclosure	Aluminium, IP68, Chassis
Sensor Supply	2 x 5V / 250mA	Operating Temperature	-40C to 105C
I/O Summary			
Inputs		Outputs	
Analog	14	High side switch	26A max (on 4 pins, 7A max per pin)
RTD	11	Peak / Hold Low Side Injector	4 x 5A / 2A
Thermocouple	2 (2 pins each)	PWM Low Side	3 x 8A
Frequency / Digital / Analog	5	PWM Low Side	3 x 2A
Frequency/ Digital	5	Spark Low Side	2 x 2A
Wake	1	Spark Low Side	1 x 8A
FEPS	1	Lamps	3 x 500mA
Features			
Output pin digital state and analog level monitoring, high side voltage monitoring, one analog output pair capable of differential measurement, selective recirculation on peak/hold outputs, reprogrammable, calibratable			
Available Configurations			
Internal IMU and Gyro, wake-on-CAN, can configure up to 4 sensor supplies, peak/hold outputs can be configured as PWM outputs, secondary quizzer micro-controller, angular scheduled inputs, angular scheduled outputs, custom daughterboard development			

OpenECU Hardware

M670 Module

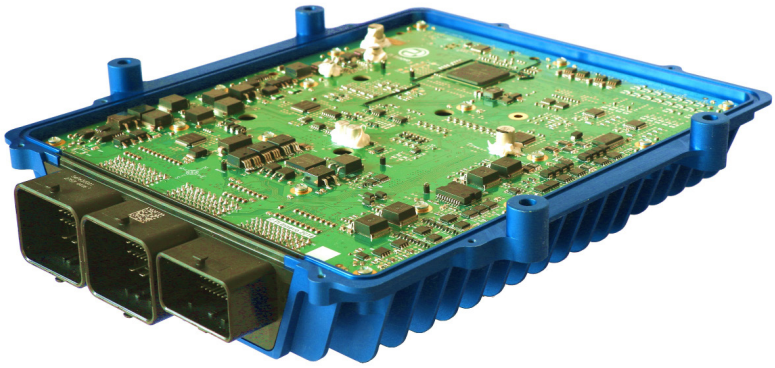
- High I/O Applications
- Engine Control
- PFI / GDI / CRD

This 154-pin high feature controller was designed with engine control in mind, but can support a broad range of high I/O applications. It supports gasoline, PFI, GDI, diesel solenoid, and alternative fuel applications such as CNG or LPG. The M670 offers a high capacity boost power supply to support high pressure injection systems.

Highlights		**I/O Summary**	
Processor	MPC5674F	Actuator Supplies	2 x 10A
Clock Rate	264MHz	Sensor Supplies	4 @ 5V @ 250mA
Code Space	3MB	Input Pins	59
RAM Space	128KB	Output Pins	53
Calibration Space	128KB	Communication	4 x CAN 2.0
Inputs		**Outputs**	
Digital Inpus	5 (low frequency 3 (high frequency)	H-Bridges	2 x 10A half bridge OR 4 x 10A half bridge 1 x 5A full bridge
Analog Inputs	17	Low Current Low Side Drives	4 x 0.2A 5 x 0.5A
Temperature Sensors	5 Thermistor and 4 RTD	Current Controlled Low Side Drives	8 x 2A
Knock Sensor	2	High Current Low Side Drives	2 x 6A/4A (peak/hold) 1 x 8A
Lambda Sensor	2 UEGO (Bosch LSU 4.9) & 2 HEGO	Sparks (Smart Coil)	8 x 5V
Camshaft	4 x Hall	Injectors	8 x 25A/15A (peak/hold) 8 x 4A saturating
Crankshaft	1 x Hall or VR	High Side Drives	2 x 10A (inj boost) 2 x 10A (VBat)
Internal Features		**Physical**	
Programmable injector boost power supply up to 65V		Dimensions	266 x 299 x 56.5
Wake on CAN		Material	Aluminum
Application		Weight	1.6kg
Location	Engine Compartment/Chassis	Connectors	2 x 53pin 1 x 48pin
Supply Voltage	6.5 - 36V	Vibration	ISO 16750
OPTIONAL DAUGHTER CARD		Environmental Protection	IP67 Sealed / GoreVent
Available for adding functionality: Flexray, LIN, etc.		Weight	1.6kg

OpenECU Hardware

M670 Module Engine Control Features



Capable of driving up to eight saturating, peak and hold, or boosted peak and hold injectors. An optional daughter board provides scope for additional customization and circuit prototyping, for maximum development capability and flexibility.

- E-GAS monitoring safety architecture, including secondary processor
- Internal diagnostics fault reporting for crank, spark, injection UEGO, knock
- 8 smart spark coil (additional digital outputs become available if not used)
- Lambda sensor - 2 UEGO (Bosch LSU 4.9) and 2 HEGO
- Crankshaft sensor - 1 x Hall or VR
- Measurement of inputs in time and angular domains
- Optional - VertiCal Base Boards designed to enable the use of new enhanced automotive calibration and debug tools
- Software configurable memory
- Dual ETC, quad VVT, VGT
- Dual Knock

Due to its high quantity of customizable I/O, advanced Freescale microprocessor, safety oriented architecture and user friendly OpenECU Simulink application interface, the M670 is a great rapid prototyping platform for a broad range of applications other than engine control:

- Autonomous Vehicles
- Stability Control (ABS / TCS / ESC)
- Active chassis (suspension, ride height)
- Automatic transmission
- Hybrid supervisory control

TYPICAL APPLICATION	INJECTOR DRIVE CIRCUIT SPECIFICATIONS	MODEL
PFI Saturating Injectors	• 8 x 4A saturating injectors	M670S
PFI Peak & Hold Injectors	• 8 x 4A / 6A peak/hold injectors	M670N
GDI / CRD Boosted Injectors	• 8 x 25A / 15A peak/hold injectors • Software configurable boost power supply up to 65V • 120W of internal injector supply power	M670B

OpenECU Hardware

S070 Injector Driver Module

Compact slave injector driver module with the following features:

- Injector boost voltage in range 40V to 130V
- 25A peak / 15A hold currents
- Capable of driving up to six non-overlapping solenoid injectors
- Capable of firing multiple injections per TDC
- Protection against reverse supply connection
- Inputs / outputs protected against short to supply or ground
- All outputs have over-current protection and are suitable for inductive loads

The S070 injector driver module is the missing link for rapid prototyping engines with direct injection fuel systems. The S070 expands the capability of the M2XX series modules (and many other engine controllers) to drive high pressure common rail solenoid injectors. A single S070 can drive up to six injectors. Systems driving more than six injectors can be accommodated by multiple S070 modules. The injector drive profile can be configured for a boosted drive voltage with a customized peak and hold current control waveform. To date, over 50 variants have been delivered to customers who have used them on diesel, gasoline, and alternative fuel engines, as well as several other innovative concepts.

<table>
<tr><th colspan="4">Product Highlights</th></tr>
<tr><td>Supply Voltage</td><td>9V to 36V</td><td>Vibration</td><td>Ford class IIIB</td></tr>
<tr><td>Operating Temperature</td><td>-40C to 105C</td><td>Enclosure</td><td>Aluminium, Chassis, IP67</td></tr>
<tr><td>Dimentions (mm)</td><td>228 x 158 x 53</td><td rowspan="2">8 Input Pins</td><td>Digital: 8</td></tr>
<tr><td>Weight</td><td>1.1Kg</td><td>Wake: 1</td></tr>
<tr><td>Connector</td><td>46 pin</td><td rowspan="3">21 Output Pins</td><td>Actuator Supply: 1 x 8 (130V max)</td></tr>
<tr><td colspan="2" rowspan="2"></td><td>Peak/Hold Low Side Injector: 6 (2 pins each, 25A / 15A max)</td></tr>
<tr><td>Fault: 1</td></tr>
<tr><th colspan="4">Available Configurations</th></tr>
<tr><td colspan="4">Boost voltage, boost duration, peak current, peak duration, hold current, hold duration, injection timeout</td></tr>
</table>

Partners

Applus IDIADA

ATI ACCURATE TECHNOLOGIES

AUTONOMOUSTUFF

汉宜电子科技（上海）有限公司
Hanyi Technologies Co.,Ltd
HANYI 创新以人为本

HYBRID E-CONTROLS

MathWorks

TECHNICAL ASSOCIATE KVASER

POLELINK

WIND RIVER

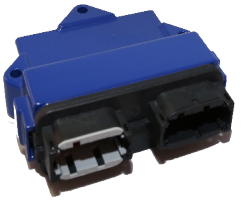
For more information visit pi-innovo.com/partners
or email info@pi-innovo.com

Custom Hardware

Although Pi Innovo is best known for the OpenECU product line, a large and growing portion of the business is to provide fully custom electronic hardware designs for clients in multiple markets; automotive, commercial vehicle, aerospace, off-highway, power generation and other niche markets. Pi Innovo designed products either in production or going to production include:

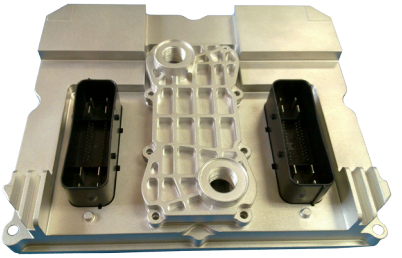
Multi-Megawatt Natural Gas Engine Control
Production stationary engine controller.

UAV Engine Control
Electronic engine controller for a light-weight UAV powered by single-cylinder 2-cycle heavy fuel engine.

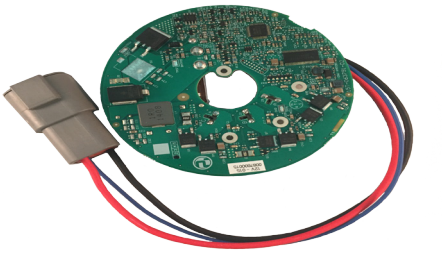


Transmission Downshift Protection
Currently in volume production on medium and heavy duty commercial vehicles.

Gasoline Engine Control
In production on the Volkswagen CitiGolf



Exhaust Aftertreatment Module
In volume production on European heavy duty commercial vehicles.



BLDC Motor Control
Commercial vehicle HVAC motor control.

For a more information about custom hardware development visit pi-innovo.com/custom-electronics-design