USER MANUAL

EMU PRO Manual

Document version: 1.1
Firmware version: 216.1 or later
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ECU MASTER

Contents

1. Device description

EMU PRO is a standalone engine management unit designed for motorsport applications. It provides precise control over the powertrain and allows for extensive configuration to support a wide range of engines.

The system is available in two variants:

- **EMU PRO-16** – designed for applications requiring a high number of inputs and outputs.
- **EMU PRO-8** – intended for smaller engines with up to 8 cylinders.

Both versions support various engine configurations, including four-stroke, two-stroke, and rotary engines. The unit is equipped with multiple inputs and outputs, allowing integration with sensors, actuators, and other control modules.

For engines with direct injection, the EMU PRO can be paired with the **GDI Driver** expansion module, enabling precise control over high-pressure fuel injectors. More information about the GDI Driver: https://www.ecumaster.com/files/devices/GDIDriver/GDIDriverManual.pdf.

The system utilizes a flexible software environment where users can customize tables, define custom functions, and configure communication protocols such as CAN and LIN. Advanced strategies for gearbox control, variable valve timing (VVT), and drive-by-wire (DBW) systems are also supported.

The EMU PRO features an IP65-rated enclosure, providing resistance to water and dust. Data logging capabilities include support for external USB storage and logging rates of up to 500 Hz.

> ⚠️ **Warning:**
> This product is not intended for use on public roads.

Key Features

- **Advanced Fueling Model** – includes closed-loop short- and long-term trim algorithms combined with a fuel film model for precise fuel dose control.
- **Customizable Software** – users can adjust table sizes, select channels for table axes, and modify bin values to improve accuracy.
- **Flexible System Configuration** – supports custom functions, numbers, CAN inputs, and exports, similar to PMU and ADU devices.

- **Gearbox Control** – standalone sequential gearbox and paddle-shift strategy with up to four closed-loop stages and PWM solenoid control.
- **Comprehensive Sensor Support** – includes knock sensors, wideband oxygen sensors, exhaust gas temperature inputs, and variable valve timing.
- **Robust Communication Interfaces** – features dual CAN bus support, LIN bus.
- **High-Speed Data Logging** – supports high-frequency logging via external USB storage or direct PC connection, up to 500 Hz.
- **Durable Enclosure** – IP65-rated CNC-machined aluminum housing, providing water and dust resistance.

2. Specification

| Specification	
Temperature range	AECQ100 GRADE1 (-40 to +125˚C)
Operating voltage	6-22V, immunity to transients according to ISO 7637
Inputs	24 (EMU PRO-8) 30 (EMU PRO-16)
Outputs	31 (EMU PRO-8) 46 (EMU PRO-16)
Weight	464 g (EMU PRO-8) 561 g (EMU PRO-16)
Dimensions	165 x 95 x 38 mm (EMU PRO-8) 197 x 95 x 38 mm (EMU PRO-16)
Enclosure rating	IP65
PC communication	Using USB to CAN interface (Ecumaster USBtoCAN, Peak, Kvaser)
Number of CAN buses	2 x CAN 2.0A/B
Number of LIN buses	1 x LIN bus
CAN1 bus bitrate	1 Mbps
CAN2 bus bitrate	1 Mbps, 500 kbps (default), 250 kbps, 125 kbps
CAN termination	CAN1 - none, CAN2 - software-selectable
Number of injector outputs	8 (EMU PRO-8) 16 (EMU PRO-16)

Number of ignition outputs	8 (EMU PRO-8)
	12 active or 10 passive ignition coils (EMU PRO-16)
RPM limit	Tested for up to 20,000 RPM
Oxygen sensor support	2 x LSU 4.9 (internal), up to 4 sensors supported
Drive-by-wire (DBW) support	2 channels, auto-calibration
Variable Valve Timing (VVT)	Up to 4 channels, auto-calibration
Knock sensor inputs	2
Exhaust Gas Temperature (EGT) inputs	4 high-precision analog inputs (EMU PRO-8)
	8 high-precision analog inputs (EMU PRO-16)
Data logging	Up to 500 Hz

All dimensions in mm

EMU PRO-16
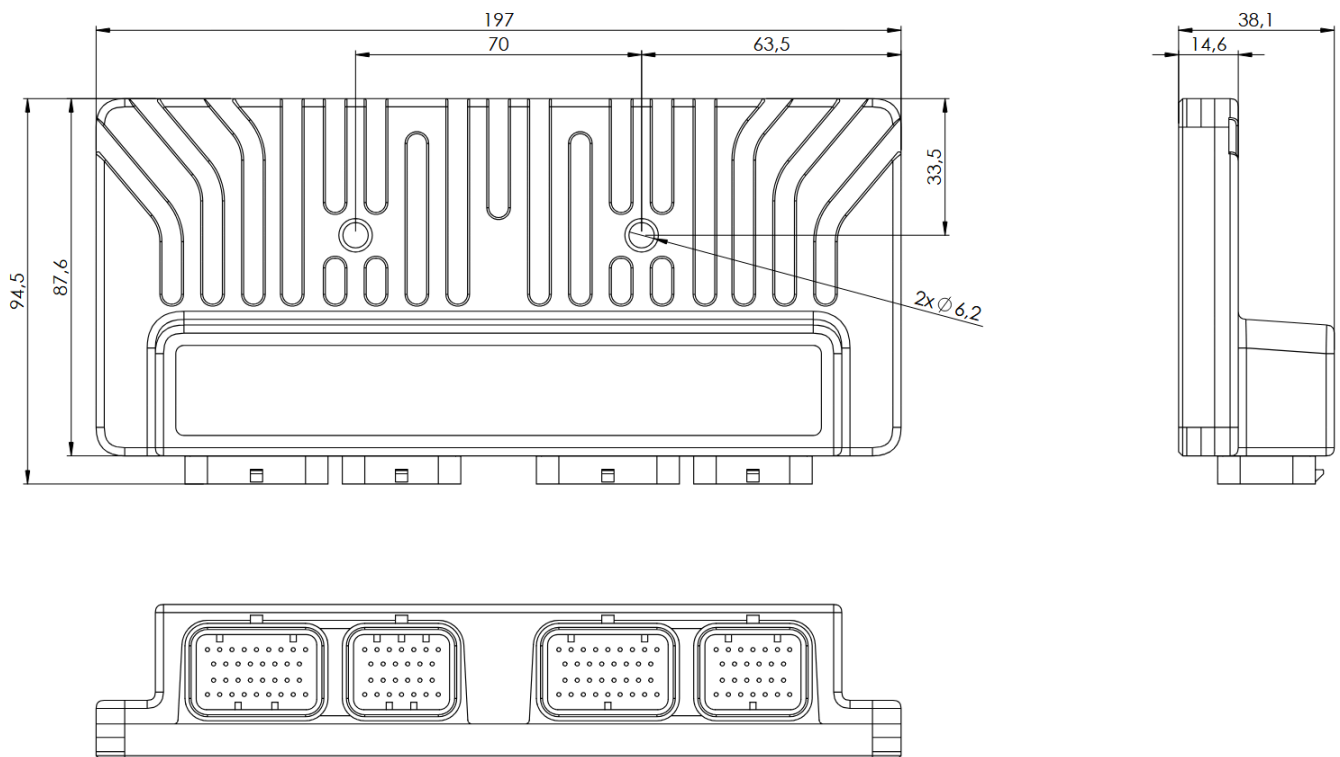
EMU PRO-8
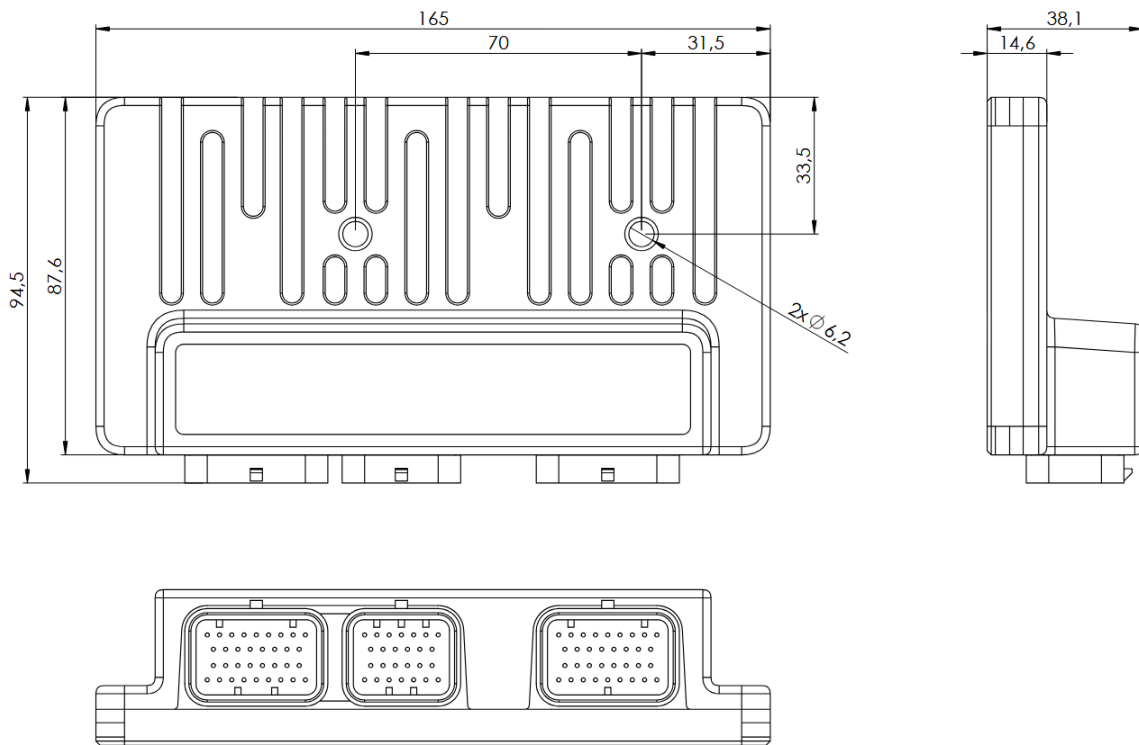
3. Pinout

Pinout for EMU PRO 8	https://www.ecumaster.com/files/EMU_PRO/EMU_PRO_8_Pinout_v1.0.pdf
Mini pinout for EMU PRO 8	https://www.ecumaster.com/files/EMU_PRO/EMU_PRO_8_Pinout_mini_v1.0.pdf
Pinout for EMU PRO 16	https://www.ecumaster.com/files/EMU_PRO/EMU_PRO_16_Pinout_v1.1.pdf
Mini pinout for EMU PRO 16	https://www.ecumaster.com/files/EMU_PRO/EMU_PRO_16_Pinout_mini_v1.1.pdf

4. Installation

Mounting the EMU PRO

1. Mounting Location:

- It is recommended to mount the EMU PRO in a safe location, preferably inside the cabin, rather than in the engine compartment.
- Although the EMU PRO has an IP65 rating for water and dust resistance, avoid areas where the device could be exposed to water, mud, or excessive moisture.
- Keep the unit away from heat sources such as exhaust system or the turbocharger.
- Avoid areas where high temperatures or moving mechanical components could affect the EMU PRO from behind.
- Ensure the location minimizes the risk of accidental contact by the driver, co-driver, or passengers.

2. Device Orientation:

- The EMU PRO can be mounted in any orientation.
- For optimal heat convection, it is recommended to mount the radiators facing upwards or in an orientation between 0 to 90 degrees.
- Avoid mounting the device upside down to ensure proper heat dissipation.

3. Stable Mounting:

- Use the factory mounting points in the housing (2 x M6 bolts) to securely mount the device.
- Avoid mounting the EMU PRO directly to structural parts of the vehicle, such as the chassis, firewall, or other rigid components. These parts can transmit strong vibrations or mechanical stress, which may negatively affect the device over time.
- While vibration isolators are not mandatory, if the device is exposed to significant shocks or vibrations, consider using rubber-metal silent blocks for added protection.

4. Additional Guidelines:

- Ensure plugs are easily accessible for servicing, diagnostics, or emergency disconnection.
- Leave sufficient "working clearance" around the plug side of the harness to allow for easy unplugging.
- Allow at least 20mm of free space around the EMU PRO case to facilitate air circulation and effective heat dissipation.

Wiring Guidelines

- Keep wiring lengths as short as possible to reduce signal interference and voltage drops.
- Use shielded cables for sensitive sensor inputs, particularly for crankshaft and camshaft position sensors.

- Route power and ground cables separately from signal wires to minimize electrical noise.
- Ensure all grounds are connected properly to a common grounding point to prevent ground loops.
- CAN bus wiring should be twisted pair and properly terminated with 120-ohm resistors at both ends of the network.
- The wire gauge (AWG) should be selected according to the current load expected to flow through the wires. Ensure that the wire diameter is suitable for the current to prevent overheating and voltage drop.

Minimal Configuration

To establish basic communication and functionality for bench testing, the following connections must be made:

- **Power Supply**: Connect to one of the available pins: **B8** or **B14**.
- **Ground**: Connect to one of the available ground pins: **A11**, **A17**, **A19**, **B19**, or **C30**.
- **+12V Switched:** Connect to **B15**.
- **CAN1 High (CAN H):** Connect to **A31**.
- **CAN1 Low (CAN L):** Connect to **A32**.
- **CAN Termination**: Use a 120-ohm resistor at both ends of the CAN bus if required.

> 📝 **Note:**
> This minimal setup is intended for bench testing only.
> For full installation in a vehicle, all power supply and ground pins must be connected.

Power Supply

- The EMU PRO requires a stable power supply within the specified voltage range (6-22V).
- Use appropriately rated fuses and relays to protect the power circuit.
- Ensure a solid ground connection to the chassis or engine block for reliable operation.

Sensor and Actuator Connections

- Verify that all sensors are correctly connected according to the engine configuration.
- Drive-by-wire (DBW) systems require correct calibration before use.
- Outputs for injectors, ignition coils, and solenoids should match the electrical characteristics of the connected components.

CAN Bus Communication

The EMU PRO is equipped with two independent CAN 2.0A/B buses, which can be used for communication with external devices such as dashboards, power management units, and expansion modules. When configuring the CAN bus:

- Use only twisted-pair wiring for CAN H and CAN L signals.
- Ensure that both ends of the bus are terminated with 120-ohm resistors.
- The CAN bus bitrate should be configured to match connected devices.
- Avoid branching connections; use a linear bus topology where possible.

PC Communication

The EMU PRO communicates with a PC through a USB-to-CAN interface. The software required for configuration, EMU PRO Client, must be installed on the computer before the first connection.

- Use a compatible USB to CAN interface, such as **Ecumaster USBtoCAN**, **Peak Systems PCAN-USB**, or **Kvaser USBcan**, to connect the EMU PRO to the PC.
- Ensure proper CAN termination and configuration if using an external CAN interface.

Wiring Diagrams

For connection examples and wiring diagrams, refer to the resources below:

- https://www.ecumaster.com/files/EMU_PRO/Wiring_Diagram_Example_4_cylinders_EMU_PRO.pdf
- https://www.ecumaster.com/files/EMU_PRO/Wiring_Diagram_Example_GDI_SENT_4_cylinders_EMU_PRO.pdf
- https://www.ecumaster.com/files/EMU_PRO/Wiring_Diagram_Example_GDI_8_cylinders_EMU_PRO.pdf

5. EMU PRO Client

The configuration of the EMU PRO is done through the EMU PRO Client. A detailed description of the software is available at: https://www.ecumaster.com/files/EMU_PRO/EMU_PRO_Software_Guide.pdf.

6. CAN Stream

EMU PRO uses the same CAN data structure as EMU Black for backward compatibility.

All multi-byte values use **Little Endian** byte order. CAN 1 bus bitrate is fixed at 1 Mbps. CAN 2 bus bitrate is configurable (500 kbps by default).

Detailed channel information is provided in the tables below.

Byte	Channel	Data Type	Range	Multiplier/ Divider	Factor	Offset	Unit
EMU stream base ID+0 (default: 0x600)							
0..1	Engine RPM	16-bit U	0 – 16000	1/1	1	0	RPM
2	Throttle 1 position	8-bit U	0 – 100	1/2	0.5	0	%
3	Intake air temperature	8-bit S	-40 – 127	1/1	1	0	C
4..5	Manifold pressure	16-bit U	0 – 600	1/1	1	0	kPa
6..7	Pulse Width Average	16-bit U	0 – 50	1/62	0.016129	0	ms
EMU stream base ID+1 (default: 0x601)							
0..1	AIN #1	16-bit U	0 – 5	5/1024	0.0048828125	0	V
2..3	AIN #2	16-bit U	0 – 5	5/1024	0.0048828125	0	V
4..5	AIN #3	16-bit U	0 – 5	5/1024	0.0048828125	0	V
6..7	AIN #4	16-bit U	0 – 5	5/1024	0.0048828125	0	V
EMU stream base ID+2 (default: 0x602)							
0..1	Vehicle speed	16-bit U	0 – 400	1/1	1	0	km/h
2	Baro pressure	8-bit U	50 – 130	1/1	1	0	kPa
3	Oil temperature	8-bit U	0 – 160	1/1	1	0	C
4	Oil pressure	8-bit U	0 – 12	1/16	0.0625	0	bar
5	Fuel pressure	8-bit U	0 – 12	1/16	0.0625	0	bar
6..7	Coolant temperature	16-bit S	-40 – 250	1/1	1	0	C
EMU stream base ID+3 (default: 0x603)							
0	Ignition Angle	8-bit S	-60 – 60	1/2	0.5	0	deg
1	Dwell time	8-bit U	0 – 10	1/20	0.05	0	ms
2	Sensors Lambda 1	8-bit U	0 – 2	1/128	0.0078125	0	lambda
3	-	-	-	-	-	-	-
4..5	Exhaust gas temperature 1	16-bit U	0 – 1100	1/1	1	0	C
6..7	Exhaust gas temperature 2	16-bit U	0 – 1100	1/1	1	0	C

Byte	Channel	Data Type	Range	Multiplier/ Divider	Factor	Offset	Unit
EMU stream base ID+4 (default: 0x604)							
0	Sensors Gear	8-bit U	0 – 7	1/1	1	0	
1	ECU Board temperature	8-bit S	-40 – 120	1/1	1	0	C
2..3	ECU Battery voltage	16-bit U	0-20	27/1000	0.027	0	V
4..5	Error Flag[1]	16-bit	bitfield	1/1	1	0	
6	FLAGS 1[2]	8-bit	bitfield	1/1	1	0	
7	Ethanol content	8-bit U	0-100	1/1	1	0	%
EMU stream base ID+5 (default: 0x605)							
0	Throttle 1 position	8-bit U	0 – 100	1/2	0.5	0	%
1	DBW Target	8-bit U	0 – 100	1/2	0.5	0	%
2..3	-	-	-	-	-	-	-
4..5	-	-	-	-	-	-	-
6	TC Torque reduction	8-bit U	0 – 100	1/1	1	0	%
7	PIT Limiter Cylinders cut	8-bit U	0 – 100	1/1	1	0	%
EMU stream base ID+6 (default: 0x606)							
0..1	AIN #5	16-bit U	0 – 5	5/1024	0.0048828125	0	V
2..3	AIN #6	16-bit U	0 – 5	5/1024	0.0048828125	0	V
4	OUTFLAGS1[3]	8-bit	bitfield	1/1	1	0	
5	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-
7	OUTFLAGS4[4]	8-bit	bitfield	1/1	1	0	
EMU stream base ID+7 (default: 0x607)							
0..1	Boost Target	16-bit U	0 – 600	1/1	1	0	kPa
2	Boost Control	8-bit U	0 – 100	1/1	1	0	%
3	DSG Mode[5]	4-bit U	enumeration	1/1	1	0	
4	Lambda target	8-bit U	0 – 1	1/100	0.01	0	lambda
5	-	-	-	-	-	-	-
6..7	Fuel Consum. Total volume	16-bit U	0 – 255	1/100	0.01	0	liter

[1]Bits of **Error Flag** bitfield

Bit index	Error name	Description
0	ERR_CLT	Coolant temperature sensor failed
1	ERR_IAT	Intake air temperature sensor failed
2	ERR_MAP	Intake air temperature sensor failed
3	ERR_WBO	Lambda 1 sensor failed
4	ERR_EGT1	Exhaust gas temperature 1 sensor failed
5	ERR_EGT2	Exhaust gas temperature 2 sensor failed
6	ERR_ALARM	Exhaust gas temperature max too high
7	KNOCKING	Knock Detected
8	FFSENSOR	Flex fuel sensor failed
9	ERR_DBW	DBW failure
10	ERR_FPR	Fuel pressure relative error

[2]Bits of **FLAGS1** bitfield

Bit index	Name	Description
0	GEARCUT	Gearcut active
1	ALS	ALS active
2	LC	Launch control active
3	IDLE	Is in idle state
4	-	-
5	TC INTERVENTION	1 - traction control intervention
6	PIT LIMITER	Pit limiter active
7	BRAKE SWITCH	Brake switch

[3]Bits of **OUTFLAGS1** bitfield

Bit index	Name	Description
0	PO1	Parametric output 1 state
1	PO2	Parametric output 2 state
2	PO3	Parametric output 3 state
3	PO4	Parametric output 4 state

Bit index	Name	Description
4	PO5	Parametric output 5 state
5	VPO1	Virtual output 1 state
6	VPO2	Virtual output 2 state
7	VPO3	Virtual output 3 state

[4]Bits of **OUTFLAGS4** bitfield

Bit index	Name	Description
0	FPS	Fuel pump state
1	CF	Coolant fan state
2	ACCLUTCH	AC clutch state
3	ACFAN	AC fan state
4	NITROUS	Nitrous active
5	STARTER_REQ	Starter motor request (from start / stop strategy)
6	BOOST MAP SET	Current set of boost parameters

[5]Values for channel: **DSG Mode**

Value	Description
2	P
3	R
4	N
5	D
6	S
7	M
15	fault

7. Document history

Version	Date	Changes
1.0	2025.04.11	Initial release
1.1	2025.04.18	Added *CAN Stream* section