ECUMASTER EMU

EMU BLACK
ENGINE MANAGEMENT UNIT

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The EMU Black is a class-leading, stand-alone engine management system, designed to operate the most advanced and complex engines presently available. It is a successor of our proven system, EMU. During the EMU lifetime we collected lots of data that allows us to substantially improve the device hardware and software.

EMU Black targets race cars, road cars, motorcycles, boats, and stationary engine applications.

The EMU Black controls fuelling, ignition and auxiliary systems on 1-12 cylinder engines including those with drive-by-wire throttles and VVT.

It can drive up to 6 passive or 12 smart coils directly and does not require external amplifier/power modules to achieve this. Sophisticated drive-by-wire strategies provide a wide range of throttle control along with advanced plausibility (fault/error) checking for safety.

The system capabilities increase over the time due to easily-upgradable, free of charge firmware (eg. new strategies, trigger patterns, CAN data streams).

The EMU features more built-in value than any other aftermarket ECU. It easily matches the functionality of other stand-alone management systems with advanced VE fueling strategies and multiple inputs and outputs. Unlike many
other ECU systems, EMU has built-in wideband lambda input (Bosch LSU 4.2, and LSU 4.9 sensors wire directly in), MAP control connector (4 bar MAP internal MAP sensor), 2 EGT probe inputs and an input to directly connect a Flex Fuel ethanol content sensor. All of this provides greater flexibility, reduces costs and negates the requirement for external or supplementary signal conditioning control systems and the associated wiring that other management systems require.

TECHNOLOGY

EMU Black is assembled according to IPC-S-815A standards to ensure high reliability of the product. The device is manufactured on an automated assembly line with optical inspection, automatically tested including burn-in. The PCB board quality and design, special surface coating and IP67 enclosure keeps the device operational in the harshest environments. The components used allows continued operation in a very wide temperature range (AECQ-100 GRADE 2 (-40 to +105˚C).

ECUMASTER EMU

Specification

GENERAL

Temperature range	AECQ100 GRADE2 (-40 to +105°C)
Reverse battery protection	Yes, internal
Operating voltage	6-22V, immunity to transients according to ISO 7637
Enclosure	IP 67, custom CNC machined aluminum
Size (mm) and weight(g)	150x72x31, 390
Connectors	1 x 24, 1 x 39 FCI Automotive connector
PC communication	USB (with PC client software), serial, CAN

OUTPUTS

Injector outputs	6 protected outputs 5A, low side
Ignition outputs	6 outputs 15A (passive and active coils supported)
Aux outputs	6 protected outputs 5A, low side
Aux outputs	Full bridge up to 7A, can be used as separate outputs or 2 H-Bridges
WBO heater	Protected low side up to 5A
Communication	Communication

INPUTS

Analog inputs	9 inputs, resolution 10Bits, 0-5V (protected)
EGT inputs	2 for K-Type thermocouple
Knock sensor	2 inputs
Oxygen sensor	LSU 4.2, LSU 4.9 or Narrow band
Trigger inputs	3 (primary, 2 cams) Hall/ VR software selectable
VSS	1 (Hall / VR)
Flex Fuel Sensor	Yes
Switch inputs	3 inputs, switched to ground

SENSORS

Temperature sensors	IAT, CLT, Oil temperature, AC evap temperature
Pressure sensor	MAP, Oil pressure, Fuel pressure (user defined characteristic), AC pressure sensor
Oxygen sensor	LSU 4.2 or 4.9 (built in controller), Narrow band, external WBO controllers
Speed	Vehicle speed sensor (VR/HALL), Gear sensor (sensor, calculated)

FUELING

Injectors	Up to 6 HiZ injectors (sequential)
Injection angle control	0-720 deg, start or end of injections
Battery compensation	User defined, wizard for popular injectors
Fueling strategies	VE based speed density, Alpha N
Air charge temp.	Based on IAT and CLT
VE table	2 tables 16x20 (Load x RPM), resolution of 0.1%
Individual cylinder trim	Yes
Staged injection	Yes
Additional correction	Oxygen sensor corrections, EGT correction (per cylinder), BARO, TPS vs MAP, TPS vs RPM, Warmup, Nitrous, LC, ALS, ASE, Fuel pressure, Knock sensor
Lambda based real time correction	Using Lambda/AFR target table
Acc. / Deceleration enrichment	Yes

IGNITION

Ignition outputs	6 for passive and active coils (software selectable)
Supported triggers	N-1, N-2, N-3, N+1, Multitooth, Subaru triggers, Nissan trigger, Lotus Elise, Audi trigger, Renault Clio Wiliams / Alpine, Colt 1.5CZ
Ignition angle table	2 tables 16x20 (Load x RPM), resolution of 0.5 Deg
Per cylinder trim	Yes
Dwell time battery compensation	Used defined, wizard for popular coils
Odd fire compatibility	Application dependent
Additional correction	CLT, IAT, TPS vs MAP, Nitrous, Idle, Knock sensor, LC, Pit limiter, ALS, Flat shift, Timers, Acc. enrichment

KNOCK SENSING

Channels	2
Resonant frequency range	1-20kHz, 3rd order AAF
Sampling	Ignition event driven, knock window
Actions	Ignition retard, fuel enrichment, dashboard indication

VARIABLE VALVE TIMING

Supported systems	VVTi, MiVec, VANOS, Double Vanos
Number of camshafts	2
Control strategy	PID based closed loop, CAM angle target tables 12x12

IDLE CONTROL

Control type	PWM solenoids (2,3 wires), drive by wire, stepper motors (bi and unipolar), ignition cut, fuel cut
Control strategy	Open / Close loop, ignition angle control
VE correction	Yes, for Alpha-N
Corrections	AC clutch, coolant fan, analog input

BOOST CONTROL

Boost ref and target tables	2 sets 10x10 (TPS vs RPM)
Control strategies	Open / Closed loop (PID based)
Corrections	Gear, VSS, IAT, EGT

DRIVE BY WIRE

Control strategy	Advanced 3D PID + static friction compensation
Supported throttles	All with DC motor and current requirement lower than 6,5 A Wizard for 28 popular electronic throttles
PPS to throttle position characteristic	3D table
BLIP support	Yes
ALS support	Yes

TRACTION CONTROL

TC strategy	Delta RPM, gear compensation
Torque reduction	Spark cut using 3D table (16x20)
Sensitivity control	10 position rotary switch

FLEX FUEL

Ethanol content measurement	Yes
Fuel temperature measurement	Yes
Tables blending	VE, IGN, Lambda/AFR, Boost, Cranking fuel, ASE, Warmup
Fuel temperature PW correction	Yes

SPORT

ALS	2 independent ALS setting, DBW support
Shift light	Per gear shift light
Launch control	Yes
Gear cut	Yes (Open loop), DBW blip supported Source: Switch, load cell, CAN
Pit limiter	Yes
Rolling anti lag	Yes

CAN BUS

CAN standard	2.0A 125, 250, 500, 1000 kBps
Supported CAN Dashes	ECUMASTER, Motec M800 Set 1, Haltech E8 E11v2, Pectel SQ 6, AEM
Supported OEM CAN streams	BMW E46, Citroen C2, Mazda RX8, Ford ST, Polaris RZR, Mini Cooper R53, Fiat 500, Renault Clio, Lotus, Ford Fiesta, Ford ST EVO X (AYC support),

ENGINE PROTECTION

Fail safe values for critical sensors	Yes
Dashboard indication of failures	Yes, user defined
Over temperature engine protection	Yes (oil and coolant), user defined, RPM limit
Low oil pressure protection	Yes, user defined, shut off
Fuel pressure protection	Yes, fuel dose compensation, RPM limit, engine shut off
High exhaust temperature	Alarm, per cylinder fuel trim, boost limit

OTHER

Unused injection outputs can be used as AUX output	Yes
Output functions	Fuel pump, coolant fan, parametric outputs, nitrous control, PWM 3D table output, AC clutch, main relay, speedometer, tachometer
Password protection	Yes, 2 levels
Timers	Fuel, Ignition, Boost, timers controlled by virtual outputs
Serial dashboard support	AIM, RaceTechnology
Autotune	Yes
Built in trigger scope	Yes
Logging	Real time logging to PC computer, logging on external loggers (serial / CAN)

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SOFTWARE

All device configurations are managed using powerful user friendly software. The intuitive graphical help menu offers support for the user by presenting contextual help for each strategy. To meet users demands, most of the keyboard shortcuts can be user-defined. In addition to the configuration mechanism, there are tools to support installation, such as trigger oscilloscope, outputs tester, tune display, auto-tune tool and more.

PC REQUIREMENTS

Windows XP, VISTA, 7, 8, 10, 32 and 64 bits
Minimum screen resolution 1024x768
Open GL compatible video card

DRIVE BY WIRE

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EMU BLACK offers sophisticated support of electronic throttle bodies. The mathematical model is based on 3D PID control considering parameters such as springs stiffness, dynamic and static friction.

The 3D throttle characteristics (PPS/RPM) can be defined by the user and switched manually or procedurally.

To increase safety while using drive by wire strategy, the support is divided into two processor units that control each other.

In addition to this, the EMU device operates a stuck throttle strategy; in the situation of failure of electronic throttle, use of the brake pedal will cut the fuel dose to prevent an uncontrolled engine.

EMU BLACK utilises advanced fuelling mode based on engine volumetric efficiency. The model considers parameters like load type, lambda target, fuel type, fuel pressure, fuel temperature, air charge temperature, injectors characteristic (flow rate, dead time), engine displacement, and more. Due to hardware support of wide band oxygen sensors (LSU 4.2 / LSU 4.9) closed loop operation based on PID controller is possible.

EMU BLACK also supports multiple fuels and a FlexFuel sensor to work with any blend of ethanol. There are two sets of fuel and lambda target tables that could be switched procedurally, manually or blended, based on ethanol content. Advanced mechanisms for transient enrichment allow smooth engine operation in any condition.

Spark advance calculation algorithms implemented in EMU BLACK allow high precision ignition timing up to 15,000 RPM and a wide range of supported trigger patterns. The trigger inputs are compatible with VR and Hall/Optical sensors (software selectable), with the ability to enable pullups / pulldowns, as well as analogue filters to fit any sensor configuration.

Hardware design allows EMU BLACK to directly drive passive ignition coils, as well as "smart" coils with built-in amplifiers. The coil type is software selectable.

Advanced configuration enables fast starting the engine in wasted spark mode, and when synced with the camshaft position sensor to work in full sequential mode.

To protect the engine against knocking, dedicated two-channel knock sensing is available. When knock is detected, instant spark and fuel modifications can be introduced using closed loop control strategy.

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SUPPORTED TRIGGER PATTERNS
Toothed wheel with 1 missing tooth
Toothed wheel with 2 missing teeth
Toothed wheel with additional tooth
Multitooth
Nissan trigger
Lancer EVO X
Lancer EVO 3-9
Subaru 36-2-2-2
Subaru 6/7
Audi trigger (135 teeth)
Porsche triggers (129 teeth, 130 teeth)
Lotus Elise
Clio Williams
Others

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In modern cars, variable valve timing is key to achieving high engine power over a wide RPM range, also improving fuel economy and reducing emissions. EMU BLACK supports most variable valve timing systems on the market (On/Off, VANOS, MIVEC, VVTi, iVTEC, etc.). The hardware is capable of controlling two cams, based on high precision user configured PID control. Each camshaft has a set of two 3D tables (total 4 tables) directly defining target position that can be automatically or manually switched by the user.

EMU Black provides a wide range of strategies designed for engine protection in critical situations.

Oil cut protection	Engine turns off when oil pressure drops below defined for given RPM
Oil / Coolant temp. protection	RPM limit for low and high oil / coolant temperatures
Fuel pressure delta protection	RPM limit for improper fuel pressure delta
EGT based protections	EGT alarm, per cylinder EGT fuel enrichment, EGT-based boost limit
Stuck throttle	Stuck throttle detection (for DBW and cable throttle) and fuel cut based revs limiter
Check engine light	Indication of sensor malfunction

MOTORSPORT

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EMU Black is designed for use within Motorsport. With this in mind, the Black provides the user with many exciting and advanced sport functions.

ANTI LAG SYSTEM (ALS)
- Full anti lag system based on open throttle, electric actuators or electronic throttle
- 3D tables for fuel, ignition and spark cut
- DBW target table for precise electronic throttle control
- Multiple switchable ALS tables set
- Cycling idle

LAUNCH CONTROL
- User switchable
- Wastegate DC control during LC operation
- Fuel, ignition, spark control
- Electronic throttle control

PIT LIMITER
- User activated speed limit
- Torque reduction table (spark or fuel)
- Electronic throttle control

TRACTION CONTROL
- Based on RPM delta
- Gear scaled
- 10 levels of sensitivity (rotary switch control)

GEAR CUT
- Open loop control based on switch, load cell, input signal or CAN BUS
- Throttle blip
- Ignition cut, ignition angle (with restore rate) and fuel control during operation

SHIFT LIGHT
- User defined per gear shift light

ROLLING START
- Closed loop rolling start strategy
- Controls boost level and RPM

EMU BLACK offers several ways to communicate with other devices like PCs, Dashboards, Data Loggers, and vehicle CAN bus systems.

The base communication with the calibration software is performed via USB port and does not require additional adapters. To ensure high immunity for noise the USB connection is galvanic isolated.

In addition to USB connection, the EMU Black offers CAN bus and serial connections that could be used for data logging and also support existing car CAN bus.

Thanks to our BT module, it is possible to send data to Android-based tablets and use Ecumaster software for a cost-effective dashboard.

SUPPORTED CAN DATA STREAMS

AEM

Ecumaster

Haltech E8 E11v2z

Motec M800 Set 1

Pectel SQ6

BMW E46

Citroen C2

Fiat 500

Ford Focus RS/ST

Ford Fiesta MK 7

Lancer EVO X (including AYC)

Mini Cooper S R53

Peugot 206

Renault Clio 2 and 3

SUPPORTED SERIAL STREAMS
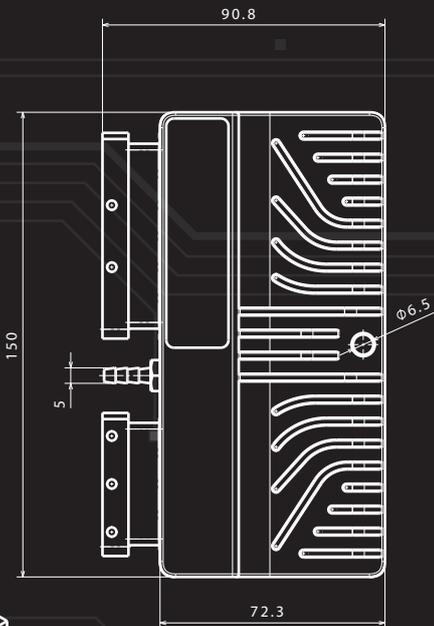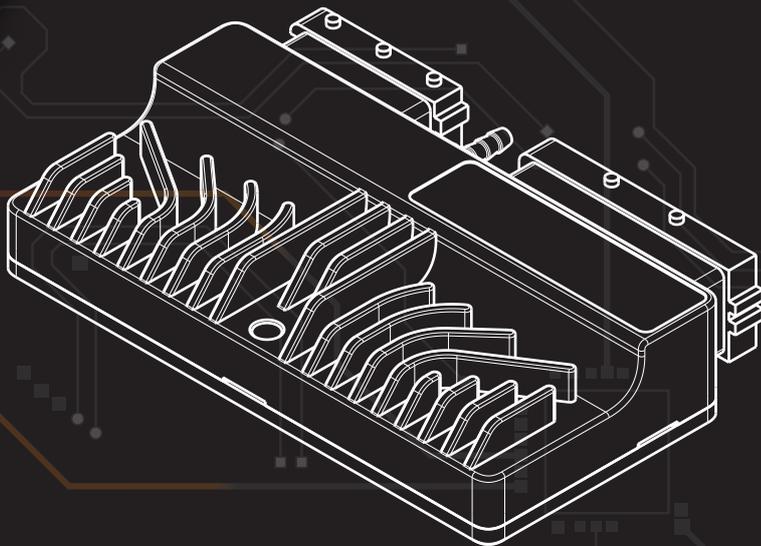
AIM

Race Technology

Ecumaster

TECHNICAL DRAWINGS

31.5

90.8

150

Ø6.5

5

72.3

● all dimensions are in mm