Short presentation of Meteor86

Release: V1.20 – 10/05/2022
http://www.skynam.com

SYBELE by Skynam Machine management

The Meteor86 is an engine management ECU with a very high computing power, numerous inputs and configurable outputs, allowing a very flexible and effective use.

GENERAL CHARACTERISTICS

Power supply range 5.5 to 18 volts DC
Consumption on stop: 0 milliampere
5volts sensors power supply: up to 400 milliamperes
Size (mm) and weight (g)   140x180x40, 520
Automotive type connector FCI 90-way
ECU maps and tables: sizes adjustable by the user, with no size limit.
Flex fuel (Ethanol content) measurement and engine tuning.

COMMUNICATIONS

High speed serial interface (1 Mbits) on USB base for the engines tuning.
Two CAN-Buses standard 2.0B (11 or 29 bits identifiers selection for every frame), speed of transmission 125 Kbits to 1 Mbits, for sending or receiving data with an OEM CAN-BUS, a Dashboard or for third party data recording.

HACKER PROTECTION

Tunings protected by selectable locking.
Unlocking only possible by the licensed owner of the ECU.
Total deletion of the data if attempt of violation.

LOAD CALCULATIONS

- throttle position / rpm,
- intake pressure / rpm (with or without turbo),

PRE-FILLED ENGINE TUNING

- The base ignition advance and injection time maps are provided with values allowing an easy engine starting up. They must be then specifically adapted to the engine by the motorist (self-learning for injection time).

- All other maps of the ECU are pre-filled with values allowing a good engine operation in the majority of the cases, notably the maps of starting up enrichment and rising in temperature, of altimetric adaptation, …
- The PIDs of idle management, motorized throttles management, of turbos management, of camshafts positioning management and of fuel high pressure management (for direct injection engines) are also pre-filled and most of the time require no or little supplementary adaptation.

ENGINE MULTIMAPPING

Groups of modification allow modifying the engine tuning including while the engine is runing, for example to have several tunings according to a rotator position or a CAN-Bus command (Dashboard, …) or a modification of fuel type, or any other calculation.
Three groups of modification are available, allowing, with the original tuning, to obtain four different engine tunings.
A group of modification is constituted by maps of modification of ignition advance, of injection time, of richness target and of turbo pressure and turbo speed targets (if turbo exists).

MANAGEMENT OF ENGINE CYLINDERS

The number of engine cylinders is configurable, as is the angle between the cylinders for irregular engines.
The number of cylinders can be 1, 2, 3, 4, 5, 6, 8, 10, 12
For irregular engines the specific angle between the cylinders is calibratable in 1/100th of degree.
- ignition correction per cylinder
- injection correction per cylinder

MANAGEMENT OF ENGINE CYLINDERS BANKS

The ECU can be configured for inline engines (1 bank of cylinders) or for 'V' or flat engines (2 banks of cylinders), by a simple allocation tuning of the cylinders to bank 1 or bank 2.
Per bank of cylinders:

- One measure of throttle position and one motorized throttle.
- Management of the intake and exhaust camshafts position (VVT).
- One measure of intake pressure and turbo speed with twin turbo management.
- One Lambda sensor and one richness correction.
- One knock sensor

As an ignition advance and injection time correction is allowed for each cylinder, it is of no need to have a per bank correction.

STATIC SENSORS INPUTS

- 1 measure of the power supply tension.
- 5 logic inputs On-Off switch type
- 3 resistive inputs (CTN-CTP or logics), with internal pull-up resistor bridge to 5 volts
- 3 analogic inputs 0-5 volts, with internal pull-down resistor (black-out detection)
- 8 selectable analogic or resistive inputs
- 2 knock sensors with differential inputs (much more secured and precise than a simple analogic input)
- 16 inputs from Can-Bus (e.g. switches and rotators provided by Dashboard)

Sensors:

- battery tension,
- Switches and rotators:
    - switch of race configuration (inhibits launch limiter and ALS),
    - clutch pedal switch (or by pressure measurement),
    - traction control sensitivity selection by rotator or by CAN-Bus (no limit of number of positions),
    - vehicle speed limiter selection by rotator or by CAN-Bus (no limit of number of positions),

- engine protection prohibition switch,
- Sequential gearbox:
  - gear shifting switch configurable logical (On-Off) or analogic (strain gauge measurement with tuning of the sensitivity),
  - gear position sensor,
- Positions:
  - calibratable pedal position,
  - calibratable throttles positions (one per cylinder-bank allowed),
  - calibratable turbo servo or VGT position (one per cylinder-bank allowed + staged turbo),
- Pressures:
  - intake pressure (one per cylinder-bank allowed),
  - atmospheric or dynamic pressure,
  - oil pressure,
  - fuel low pressure,
  - fuel high pressure (direct injection),
  - phase pressure (pressure sensor used to phase the engine on some motorcycles engine),
- Temperatures:
  - engine temperature (coolant or air refresh),
  - intake temperature,
  - oil temperature,
  - fuel temperature,
  - exhaust temperatures (one per cylinder allowed),
- Richness:
  - wideband or narrowband Lambda sensors (one per cylinder-bank allowed),
- Knock:
  - knock sensor signals (two channels with differential inputs - better resistance to spikes),
- Ethanol content:
  - Fuel Ethanol content sensor (frequency or analogic input)
- Auxiliary sensors:
  - programmable auxiliary inputs to create specific sensors (for example position of flaps, pressures, temperatures and different switches).

<u>Digital filtering:</u>

Every measurement of the ECU has a programmable digital filtering (essential for example for removing pressures instabilities).

The digital filtering of each measurement is pre-tuned.

<u>Parameterization of the inputs:</u>

Every measure of the ECU (pressure, pedal, throttle, speeds, …) can be allocated to one of the physical inputs of the ECU, or from a calculated value, including from the auxiliary CAN-BUSes. Allows to make calculations on several inputs before converting the result of these calculations in the chosen measure (e.g. two pots on the accelerator pedal or on the throttles).

SPEED AND FREQUENCY SENSORS INPUTS

Speeds inputs are self-adaptive in signal level and shape: A specific microprocessor is allocated to each input to handle and shape its analogic signal.

- 1 measure of rpm on flywheel, programmable inductive – Hall,
- 1 measure of main camshaft phase, programmable inductive – Hall,
- 1 measures of auxiliary camshaft phase, programmable inductive – Hall,
- 2 auxiliary measures, programmable inductive – Hall or magneto-resistive.

<u>Measurements:</u>

- measure of rpm and phase of crankshaft on configurable type of flywheel,
- measure of angle of phase mark on main camshaft on configurable type of marks,
- measure of angle of phase mark on auxiliary camshafts (up to 3) on configurable type of marks,
- measure of turbos speeds on programmable number of pulses per round,
- measures of wheels speeds on programmable number of pulses per round,

- measure of vehicle speed,
- measures of auxiliary speeds on programmable number of pulses per round,
- measure of frequency on auxiliary speed measure input of the fuel Ethanol content sensor

Crankshaft flywheel singularities:

- Top Dead Center tunable from 0° to 720°, 1/10° resolution
- From 8 to 60 teeth
- Singularity: N-2, N-1, N, N+1, Multitooth, with up to 4 repetitions (e.g. Audi, BMW, Porsche, Mercedes, Peugeot, Renault RS, Ford, Opel, Toyota, Yamaha, Mitsubishi, Kia, …)

Camshaft flywheel singularities:

- From 1 to 16 teeth
- Singularity: On teeth state, On teeth position, N-1, N, N+1 (same OEM list than for the crankshaft)

PHASE PRESSURE

The ECU can phase on cylinder 1 TDC with a pressure sensor reading the pressure in one of the cylinders inlets ducts (more often on Yamaha engines).
Self-adaptive tuning of pressure level.

DYNAMIC ENGINE PHASE

When the engine does not own any phase sensor, the ECU can phase on the engine by using a method of dynamic phase synchronization at each engine start.

FAULTS STRATEGIES

For every measurement (pressures, throttles, speeds, …), the ECU provides in standard a failure detection strategy and an error replacement value.
The user can also define his own fault detection strategies, and his own replacement values in the event of a failure.

DIAGNOSTIC

The ECU records the faults on the measures, the blackout or the short circuit, occasional or repeated, and allows the deletion of these failures when required by the user.
More, it remembers the system defects, miss of +30, loss of power supply, watch dog reset, …These systems failures require a particular attention and indicate an important problem of assembly or manipulation.
With alarm lights or Dashboard failure state display.

MONITORING

Programmable recording of values overshoots on the measures or the calculations selected by the motorist:

- in extreme value,
- in duration on the extreme value,
- in total duration,
- in number of overshoots.

Erasure by software (with possible protection).
Alarm light programmable:

- immediate or with programmable delay,
- cumulative (on the total duration) with programmable switch on and off.

ENGINE PROTECTION

A switch allows to deactivate the engine protections.
Two general types of protection exist:

- engine stop protections, used in the event of a serious engine problem
- engine torque protections, in the event of a simple exceeding of limit, are reducing the engine torque (by decreasing the motorized throttle positions, the turbo pressures and speeds)

- With alarm lights or Dashboard protection state display.
- In addition, an engine stop regulation can be requested so as not to stop abruptly the engine during an engine stop protection, for example to allow the turbos to cool down before the complete stop.

<u>1) Engine stop protection on:</u>

- low oil pressure (following engine speed and startup state)
- low fuel pressure (according to startup state)
- high oil t °
- high engine t°
- high intake t°
- high exhaust t°
- too high exhaust temperatures difference between cylinders

<u>2) Engine torque protection on:</u>

- high exhaust t°
- high intake t°
- high oil t°
- high engine t°
- high intake pressure
- high Turbo speeds (each of the three turbos)

INJECTION

<u>Up to 8 channels with fixed type of command</u>

- saturated command (On-Off),
- for the Peak and Hold commands or direct injection commands, it is necessary to add a Skynam external injectors driver.

<u>Selectable types of injection:</u>

- sequential phased (needs phase sensor or dynamic synchro),
- sequential not phased (no phase sensor nor dynamic synchro needed),
- phased direct injection (needs phase sensor or dynamic synchro),
- semi sequential (no phase sensor nor dynamic synchro needed).

Following the type of injection, the injection is phased on the beginning or the end of the injector command. Phase from 0-720° in function of the engine speed and load, in 1/10°.

<u>Injectors dead time correction:</u>

Tunable in function of the on-board tension and of the fuel pressure.

<u>Injection time calculation:</u>

- In function of the engine speed and load, microsecond resolution, multimapping, ALS
- Cylinder per cylinder correction,
- Enrichment procedure at engine start depending on the engine t°, the elapsed engine rounds and the engine speed reached,
- Correction by engine t°, intake t°, exhaust t°, atmospheric pressure, Ethanol content, rpm limiter, traction control, vehicle speed limiter …
- Correction by fuel pressure (notably in direct injection),
- Correction by rpm limiter (by launch procedure and by hard cut),
- Accelerations correction (accelerating pump),
- Correction of richness by looping on Lambda sensor(s) according to the richness target map, with tunable correction range limits.

<u>Injection time self-learning:</u>

- A function of injection map complete self-learning is based on the richness target map function of the load and the engine speed and on the reading of the Lambda sensor(s).

INJECTION RAILS

Injectors can be grouped in one or two rails. Both rails can have different types of injectors.
Each injection rail possesses its own accelerating pump and its own injection phase.
Two types of double rail operation are possible:

- rail 1 to 2: allows to move gradually from a rail to the other one. When both rails have different types of injectors, the fuel quantity remains stable with the use of a fuel flow coefficient.
- rail 1 to 1+2: allows to add gradually the rail 2 to the rail 1. Configuration used to inject more fuel in the engine when we engage the rail 2.

IGNITION

Up to 6 channels to command ignition power modules (the Meteor does not directly drive the coils).

Types of selectable ignition

- static phased (needs phase sensor or dynamic synchro) one spark every 720°
- static not phased (no phase sensor nor dynamic synchro needed) one spark every 360°
- twin spark (no phase sensor nor dynamic synchro needed) one spark every 360°

Ignition advance calculation:

- In function of the engine speed and load, 1/10° resolution, multimapping, ALS
- Cylinder per cylinder correction,
- Correction by engine t°, intake t°, exhaust t°, atmospheric pressure, Ethanol content, rpm limiter, traction control, vehicle speed limiter, gear shifting
- Correction by rpm limiter (by launch procedure and by hard cut),
- Correction by knock detection.

Coil loading angle calculation:

- Tunable in microseconds in function of the on-board tension (8v, 10v, 12v, 14v, 16v)
- Skynam provides the coil loading times of a large number of the most popular coils

KNOCK CORRECTION

The Meteor owns two differential measurement channels of knock sensors:

1) Knock detection adjustment:

- Each cylinder can be individually assigned to any one of the two sensors.
- Auto-calibration function of the average signal level of each sensor.
- Autocalibration function of balancing the signal level between the cylinders, because the cylinders farther from the knock sensor which measures them give a less strong signal than the cylinders which are close to it.
- Center frequency of the knock signal gradually adjustable from 1 KHz to 20 KHz
- Adjustable angular detection window.
- Selection of the type of reaction during a failure (or disconnection) of a knock sensor.

2) Adjusting the knock correction:

- Maximum ignition advance correction map in function of engine speed and load.
- Maps of ignition advance reduction speed and ignition advance increase speed in function of engine speed and load.

3) Correction of knock:

The knock correction is carried out by a knock correction map in function of engine speed and load: The ECU itself, by a continuous self-learning, fills this map with the level of advance correction needed. Having a knock correction map allows the ECU to memorize which correction of the main ignition advance map has to be made.
It is much more efficient and safe than simply removing advance each time a knock noise is detected (because in that case, one waits to have some knock before removing advance).

FLEX FUEL

Complete adjustment of the engine tuning according to the fuel Ethanol content measured with the Ethanol sensor, with sensor reading inhibition if the fuel flow passing through the sensor is insufficient for a correct reading of the Ethanol content.

- Correction of injected quantity according to Ethanol content, engine t°, engine load and engine speed.
- Ignition advance correction based on Ethanol content, engine t°, engine load and engine speed.
- Specific injected quantity at engine starting according to the Ethanol content and the engine t°.
- Specific ignition advance at engine starting according to the Ethanol content and the engine t°.

- Specific richness target according to the Ethanol content and the engine load.
- Specific turbo pressure and turbo speed targets according to the Ethanol content and the throttle position.

AUXILIARY COMMANDS

Up to 14 programmable auxiliary commands

- 4 half-bridges, allowing 2 full-bridges. Each half-bridge can also be used as open drain command.
- 9 open drain commands,
- 1 LED output,

Types of control:

- ON-OFF
- PWM from 10 Hz to 10 kHz
- engine synchronous (engine phased pulses - number of pulses per engine cycle selectable, with cyclical ratio and phase maps adjustment).

The outputs commands are used for:

- management of the turbos (double turbo or triple turbo possible) with or without servo control,
- low pressure fuel pump,
- high pressure fuel pump (direct injection),
- 2 motorized throttles,
- intake air bypass stepper motor (4, 5 or 6 wires),
- intake air bypass solenoid valve (2 or 3 wires),
- 4 camshafts proportional positioning (VVT) with one or two solenoid valves
- electric motors positioning (with looping on a position measurement), for example proportional intake or exhaust valves, or other devices with precise angular positioning.
- electric motors of rotation (adjustable speed, with possible looping on speed inputs),
- On-Off fans or speed controlled fans,
- electric water pump with variable speed,
- electric thermostat with proportional opening,
- shift light,
- alarms,
- type programmable by the motorist.

FISA FUEL PUMP

Managed in the standards FISA regulation:

- runs 5 seconds at ECU switch on and stops if the engine does not run,
- runs as soon as the engine starts,
- Stops as soon as the engine stops.

FUEL PRESSURE

Fuel high pressure management for direct fuel injection engines.
Fuel low pressure management for the standard engines.

Fuel pressure command calculation:

- Fuel pressure base target from engine speed and load, ALS positioning
- Separated target calculation on idle state.

The management of fuel pressure is made by an extended PID in PWM or in engine synchronous command with pulses phase dynamically modified (e.g. Audi-VW FSI engines).

MOTORIZED THROTTLES

Management of up to 2 twin motorized throttles in parallel (1 per bank of cylinders)

Throttle position target calculation:

- From accelerator pedal position and engine speed, with ALS positioning
- Correction on engine start
- Correction by engine t°

- Correction by traction control, vehicle speed limiter
- Blip at gear downshift
- Correction by idle management.

Commands by extended PIDs with static friction compensation and PWM frequency selection.

TURBOS

Management of:

- 1 turbo,
- 2 twin turbos in parallel (1 per bank of cylinders)
- 2 staged turbos
- 3 turbos, with two in parallel and the third staged with both first ones

For each turbo, command of leak solenoid valves or of servo motor (and VGT).
Management of turbo flaps (intake, exhaust and intermediate flaps), On-Off or proportional positioning

- The management is done according to the intake pressures and the turbos speeds, with dynamic switching of one to the other one.
- For engines with separated intake per bank, reading of 1 pressure sensor per bank, to manage each of the twin turbos with its own pressure.

Turbos command calculation:

- Turbo pressure base target from throttle position and engine speed.
- Turbo pressure and turbo speed targets multimapping.
- Turbo pressure and turbo speed targets correction by atmospheric (altimetric) pressure, engaged gearbox position (boost by gear), and Ethanol content.

Commands by extended PIDs with PWM frequency selection and overshoot limitation control.

POST COMBUSTION (ALS)

Additional air supply is provided by motorized throttle or air intake solenoid valve or air intake stepper motor.
To avoid engine and turbo damages due to high exhaust gas temperature, the ALS is controlled by time and by exhaust temperature.

- Turbo pressure and turbo speed targets are specific during ALS phases.
- Intake and exhaust camshaft position targets are specific during ALS phases.
- Fuel high pressure target is specific during ALS phases (direct injection).

CAMSHAFTS POSITION (VVT)

Proportional positioning of 4 camshafts:

- two intake and two exhaust,

Camshaft position calculation:

- Intake camshafts position target from engine speed and load, 1/10° resolution, ALS positioning
- Exhaust camshafts position target from engine speed and load, 1/10° resolution, ALS positioning

The command of every camshaft can be done in two ways:

- by the management of one solenoid valve.
- by the management of two solenoid valves (type double Vanos BMW M3), of which one advances the camshaft and one delays it.

Commands by extended PIDs with PWM frequency selection.

ENGINE SPEED LIMITER

The cylinders cutoff can be done on:

- ignition only: only the ignition is cutoff. This is the smoothest and most responsive cut and does not overheat the cylinders.

- injection only: only the injection is cut.

- injection and ignition together: injection and ignition are cut at the same time. It is not advised to use this mode

- **ignition then injection:** ignition is cut normally and injection will be cut 100 rpm above the limiter.
- **injection then ignition:** injection is cut normally and ignition will be cut 100 rpm above the limiter.

- Selectable Hard cut or Soft cut.
- Several configurable launch limiters, selectable by rotator or by CAN-Bus (no limit of number of positions).
- During the launch procedures, it is possible to reduce the ignition advance and to enrich the engine. This allows to have high turbo pressure even before the vehicle takes off for a cannonball start.
- Several configurable race limiters, selectable by rotator or by CAN-Bus (no limit of number of positions)
- The change from the launch limiter to the race limiter is done at a configurable slip speed, selectable by rotator or by CAN-Bus (no limit of number of positions).
- Soft cut: gradual cylinder per cylinder cutoff, and turning (always begins the cutoff sessions with a different cylinder to avoid always heating the same cylinder).
- Hard cut: all the cylinders are cutoff at the same time, with tunable hysteresis to uncut the cylinders with tunable modification of ignition advance and injection time.

DECELERATION CUTOFF

On injection or ignition, or no cutoff.
Cutoff base engine speed tunable.

IDLE MANAGEMENT

The ECU manages the idle engine speed if an air actuator exists (motorized throttle, intake air bypass stepper motor or intake air bypass solenoid valve)
- A calibration allows to prohibit the management of idle speed.
- Calibrations allow to give the idle engine speed target and its modification as a function of the engine temperature.

Idle management done by extended PID.

SEQUENTIAL GEARBOX

Up to 10 gears with a selectable organization (automotive or special mode).
Gearshift switch can be logical (by grounding) or analogic (by programmable tension levels) or calculated (example: throttle or pedal speeds on foot release).
The time of intervention is adjustable by two maps, one for upshifting and one for downshifting. In both cases, the time is tunable for each gear position and by any other calculated or measured parameter (for example, modify the time of intervention for the gear position according to the engine speed or the engine torque).
The type of intervention on gearshift is programmable:

1) Upshift:
   - ignition cutoff up to the complete gear shift
   - modification of the ignition advance with slope on return to normal (by maps with selectable inputs)

2) Downshift:
   - ignition cutoff up to the dog declutching (for fast downshifting while braking hard)
   - modification of motorized throttle position (autoblip), which allows to accelerate the engine to ease the downshift.

ROAD GEARBOX

Up to 10 gears can be detected.
To read the engaged gear positions on a road gearbox, the ECU reads the gearbox tailshaft speed (in rpm) by means of a speed sensor, and it compares this speed with the engine speed.

Reading the gearbox tailshaft speed (rpm) can be done directly on the gearbox output (preferred method) but also by reading the speed of a driving wheel or of the vehicle speed if it gives the tailshaft gearbox speed.

TRACTION CONTROL

The Traction Control is based on a comparison between the speed of the driving wheels and the speed of the non-driving wheels:
The ECU can therefore only perform Traction Control if the driving wheels speed and the non-driving wheels speed are either measured, or calculated from the engine speed and the engaged gear position for the driving wheels, and of a modelization for the non-driving wheels.

Several traction control sensitivities are tunable and the selection is done by rotator or by CAN-Bus (no limit of number of positions).
When Traction control is active, the ECU can intervene on the engine with
- a modification of ignition advance
- a modification of injection time
- an ignition cut-off level (gradual cut-off)
- an injection cut-off level (gradual cut-off)
- a modification of the motorized throttle position (if it exists)
- a modification of the turbo speed (each of the 3 existing turbos)
- a modification of turbo pressure (each of the 3 existing turbos)

VEHICLE SPEED CONTROL

The speed limitation is based on a comparison between the speed limitation target and the real vehicle speed.
The ECU can therefore only perform the speed limitation if the vehicle or wheel speed is either measured, or calculated from the engine speed and the engaged gear position.

Several vehicle speed limits are tunable and the selection is done by rotator or by CAN-Bus (no limit of number of positions).
When Vehicle speed control is active, the ECU can intervene on the engine with
- a modification of ignition advance
- a modification of injection time
- an ignition cut-off level (gradual cut-off)
- an injection cut-off level (gradual cut-off)
- a modification of the motorized throttle position (if it exists)
- a modification of the turbo speed (each of the 3 existing turbos)
- a modification of turbo pressure (each of the 3 existing turbos)

AVANCED FUNCTIONS

The Meteor offers the motorist the possibility to develop its own strategies.
The development of these strategies does not require either the learning or the knowledge of a programming language.
Their programming uses a specific technique developed by Skynam called **SKYMCOD ™ mapped, intuitive and effective Programming**.
1) Pilot modules (see specific documents of Meteor tuning)
2) Auxiliary PIDs (see specific documents of Meteor tuning)
3) Programmable auxiliary measures
4) Parameterization of the inputs of measures
5) Filtering of the measures
6) Programmable strategies of failure of the measures
7) Programmable auxiliary commands
8) Complementary commands hooks (see specific documents of Meteor tuning)
9) CAN-BUS auxiliary values

ECU LOOM

J90		FUNCTION	COMMENTARY	CHARACTERISTICS
1	OUT	AUXILIARY COMMAND 3	Ground command open drain	4 Amperes (10A peak)
2				
3	CAN	CAN1_H	Auxiliary CAN (external)	Without integrated 120 Ohms resistor
4	CAN	CAN1_L	Auxiliary CAN (external)	Without integrated 120 Ohms resistor
5	IN	PHASE SENSOR B	Auxiliary camshaft phase sensor input	Inductive-Hall selection, gain automatic adaptation
6	IN	SPEED INPUT 1 OR PHASE D	Speed input 1 or auxiliary camshaft phase input	Inductive-Hall selection, gain automatic adaptation
7	COM	TX_FTDI	ECU tuning (WinjNet)	FTDI TTL level
8	IN	LOGIC INPUT 5	Logical input 0 volt	Measurement range 0-18 volts
9	IN	RESISTIVE INPUT 3	0-5 volts resistive input	Measurement range 0-5 volts
10	IN	LOGIC INPUT 2	Logical input 0 volt	Measurement range 0-18 volts
11	IN	LOGIC INPUT 1	Logical input 0 volt	Measurement range 0-18 volts
12	IN	ANALOG INPUT 3	0-5 volts analogic input	Measurement range 0-5 volts
13				
14	IN	MIXED INPUT 6	analogic - resistive selectable input	Measurement range 0-5 volts
15	IN	MIXED INPUT 3	analogic - resistive selectable input	Measurement range 0-5 volts
16	GROUND IN	POWER ENGINE GROUND	Ground input for power commands	
17	GROUND IN	POWER ENGINE GROUND	Ground input for power commands	
18	GROUND OUT	OUTPUT SPIKES PROTEC GROUND	Interferences protection ground (shield) output for rpm-phase sensors	Internally connected to pin 17
19				
20				
21				
22				
23				
24				
25	OUT	IGNITION F	12volts push-pull command - 6th ignition channel	50 milliamperes
26	OUT	IGNITION E	12volts push-pull command - 5th ignition channel	50 milliamperes
27	OUT	IGNITION D	12volts push-pull command - 4th ignition channel	50 milliamperes
28	OUT	IGNITION C	12volts push-pull command - 3rd ignition channel	50 milliamperes
29	OUT	IGNITION B	12volts push-pull command - 2nd ignition channel	50 milliamperes
30	OUT	IGNITION A	12volts push-pull command - 1st ignition channel	50 milliamperes
31	OUT	AUXILIARY COMMAND 9	Ground command open drain	4 Amperes (10A peak)
32				
33	CAN	CAN2_H	Auxiliary CAN (external)	Without integrated 120 Ohms resistor
34	CAN	CAN2_L	Auxiliary CAN (external)	Without integrated 120 Ohms resistor
35	IN	PHASE SENSOR A	Main camshaft phase sensor input	Inductive-Hall selection, gain automatic adaptation
36	IN	SPEED INPUT 2 OR PHASE C	Speed input 2 or auxiliary camshaft phase input	Inductive-Hall selection, gain automatic adaptation
37	COM	RX_FTDI	ECU tuning (WinjNet)	FTDI TTL level
38	IN	LOGIC INPUT 4	Logical input 0 volt	Measurement range 0-18 volts
39	IN	RESISTIVE INPUT 2	0-5 volts resistive input	Measurement range 0-5 volts
40	IN	INPUT KNOCK 1+	Knock sensor input	Differential input
41	IN	INPUT KNOCK 2+	Knock sensor input	Differential input
42	IN	ANALOG INPUT 2	0-5 volts analogic input	Measurement range 0-5 volts
43	IN	MIXED INPUT 8	analogic - resistive selectable input	Measurement range 0-5 volts
44	IN	MIXED INPUT 5	analogic - resistive selectable input	Measurement range 0-5 volts
45	IN	MIXED INPUT 2	analogic - resistive selectable input	Measurement range 0-5 volts
46	SUPPLY IN	PERMANENT POWER SUPPLY +30	12 volts permanent power supply	6-18 volts
47	GROUND IN	SUPPLY ENGINE GROUND	Ground supply for ECU	
48	GROUND OUT	SENSORS GROUND	Ground output for sensors supply	
49				
50				
51				
52				
53				
54				
55	OUT	INJECTION F	Ground command open drain - 6th injected channel	4 Amperes (10A peak)
56	OUT	INJECTION E	Ground command open drain - 5th injected channel	4 Amperes (10A peak)
57	OUT	INJECTION D	Ground command open drain - 4th injected channel	4 Amperes (10A peak)
58	OUT	INJECTION C	Ground command open drain - 3rd injected channel	4 Amperes (10A peak)
59	OUT	INJECTION B	Ground command open drain - 2nd injected channel	4 Amperes (10A peak)
60	OUT	INJECTION A	Ground command open drain - 1st injected channel	4 Amperes (10A peak)
61	OUT	AUXILIARY COMMAND 6	Ground command open drain	4 Amperes (10A peak)
62	OUT	AUXILIARY COMMAND 7	Ground command open drain	4 Amperes (10A peak)
63	OUT	AUXILIARY COMMAND 8	Ground command open drain	4 Amperes (10A peak)
64				
65	IN	RPM +	Crankshaft rpm sensor input	Inductive-Hall selection, gain automatic adaptation
66	OUT	5V SENSORS POWER SUPPLY	5volts output for sensors supply	Regulated 5 volts (total max 400 mA on the two 5 volts outputs)
67	OUT	5V SENSORS POWER SUPPLY	5volts output for sensors supply	Regulated 5 volts (total max 400 mA on the two 5 volts outputs)
68	IN	LOGIC INPUT 3	Logical input 0 volt	Measurement range 0-18 volts
69	IN	RESISTIVE INPUT 1	0-5 volts resistive input	Measurement range 0-5 volts
70	IN	INPUT KNOCK 1-	Knock sensor input	Differential input
71	IN	INPUT KNOCK 2-	Knock sensor input	Differential input
72	IN	ANALOG INPUT 1	0-5 volts analogic input	Measurement range 0-5 volts
73	IN	MIXED INPUT 7	analogic - resistive selectable input	Measurement range 0-5 volts
74	IN	MIXED INPUT 4	analogic - resistive selectable input	Measurement range 0-5 volts
75	IN	MIXED INPUT 1	analogic - resistive selectable input	Measurement range 0-5 volts
76	SUPPLY IN	AFTER KEY POWER SUPPLY +15	After key 12V power supply	6-18 volts
77	GROUND OUT	SUPPLY ENGINE GROUND	Output ground for LED Diag and FTDI	Internally connected to pin 47
78	GROUND OUT	SENSORS GROUND	Ground output for sensors supply	
79	OUT	LED DIAG-ALARM	LED command	10 milliamperes
80				
81	OUT	AUXILIARY COMMAND11	Ground command open drain	125 milliamperes (500mA peak)
82	OUT	AUXILIARY COMMAND 10	Ground command open drain	125 milliamperes (500mA peak)
83				
84				
85	OUT	AUXILIARY COMMAND 2B	Disconnectable Vbat push-pull command	4 Amperes (10A peak)
86	OUT	AUXILIARY COMMAND 2A	Disconnectable Vbat push-pull command	4 Amperes (10A peak)
87	OUT	AUXILIARY COMMAND 1B	Disconnectable Vbat push-pull command	4 Amperes (10A peak)
88	OUT	AUXILIARY COMMAND 1A	Disconnectable Vbat push-pull command	4 Amperes (10A peak)
89	OUT	INJECTION H - AUX COMMAND 5	Ground command open drain - 8th injected channel	4 Amperes (10A peak)
90	OUT	INJECTION G - AUX COMMAND 4	Ground command open drain - 7th injected channel	4 Amperes (10A peak)