General presentation of Commander88

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Machine management

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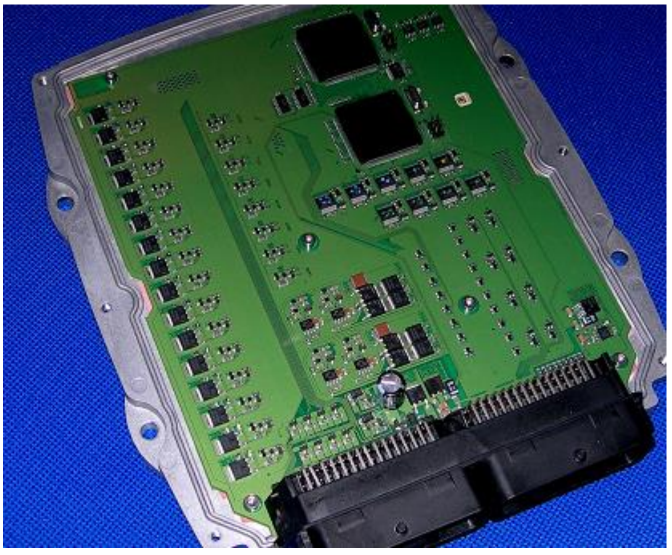

TECHNICAL CHARACTERISTICS
- SUMMARIZE-

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

ELECTRICAL CHARACTERISTICS

Power supply from 5,5 volts to 18 volts DC.
Power supply and power grounds separated
Consumption minimum while operating at 13 volts: 700 milliamperes,
Consumption on stop: 0 milliampere,
5volts sensors power supply: 400 milliamperes maximum,
10volts external devices power supply: 200 milliamperes maximum.

TEMPERATURE CHARACTERISTICS

In operation, -40°C to 85°C.

SEALING CHARACTERISTICS

IP 67 (on request).

COMMUNICATIONS

Three CAN-BUS:
- Tuning and networking of ECUs (externalized sensors and commands) by main CAN-BUS WinjNet (™ Skynam).
- Two auxiliary CAN-Buses on external CAN-BUS 2.0B (11 or 29 bits identifiers selection for every frame), speed of transmission 125 Kbits to 1 Mbits, for access to an OEM CAN-BUS, a Dashboard or for third party data recording.

HACKER PROTECTION

Tunings protected by selectable locking.
Unlocking only possible by the owner of the ECU or in factory at Skynam.
Total deletion of the data if attempt of violation.

MANAGEMENT OF ENGINE CYLINDERS

The number of engine cylinders is configurable by the motorist, as well as the angle between cylinders for the irregular engines.
The number of cylinders can be 1, 2, 3, 4, 6, 8, 12
The angular distribution of cylinders can be

- regular: the angle between cylinders is regularly distributed on the engine cycle. For a 4-cylinder, it is 180°, for a 6-cylinder, it is 120°...
- specific by calibration: the specific angle can be calibrated in 1/100th of degree. With more than 8 cylinders, this configuration can only be used with an even number of cylinders.

MANAGEMENT OF ENGINE CYLINDERS BANK

The ECU can be configured for straight engines (1 bank of cylinders) or for 'V' or flat engines (2 banks of cylinders).
To declare the existence of the 2nd bank, simply allocate to it some cylinders (if the engine is straight, all the cylinders must be allocated to bank 1).
- The ECU can manage the intake and exhaust camshafts shifting for each bank of cylinder.
- One measure of intake pressure and one turbo can be allocated to each bank of cylinders (see management of turbos).

- One measure of throttle position can be allocated to each bank of cylinders.
- One Lambda sensor and one richness correction can be allocated to each bank of cylinders.
- As an ignition advance and injection time correction is allowed for each cylinder, it is no need to have a bank by bank correction.

ANALOG CONVERTIONS INPUTS

- 1 internal input measures tension power supply.
- 8 resistive inputs (CTN-CTP or logics), with 1.21 KOhm pull-up resistor to 5 volts
- 10 analog inputs 0-5 volts, with 1 MOhm pull-down
- 8 selectable analog - resistive inputs, with 1 MOhm pull-down or 1.21 KOhm pull-up to 5 volts, following selection

According to the chosen type of application, they are used for:

- switch of race configuration (inhibit launch limiter),
- switch of gear shifting configurable logical or analog,
- battery tension,
- calibrable pedal position,
- calibrable throttle positions(one per cylinders bank allowed),
- calibrable turbo servo position (one per cylinders bank allowed + sequential turbo),
- intake pressure (one per cylinders bank allowed),
- intake air flow (one per cylinders bank allowed),
- atmospheric or dynamic pressure,
- engine temperature,
- intake temperature,
- oil temperature,
- fuel temperature (one per cylinders bank allowed),
- exhaust temperature (one per cylinders bank allowed),
- oil pressure,
- fuel low pressure (one per cylinders bank allowed),
- fuel high pressure (one per cylinders bank allowed),
- wideband Lambda sensor (one per cylinders bank allowed),
- thermocouple (with analog interface),
- programmable auxiliary inputs to create specific sensors (for example position of intake flaps, pressures, temperatures and different switches).

FREQUENCIAL INPUT

Frequencial inputs are self adaptive in level and shape of signal to limit the impact of the possible parasites (starter, injectors). To do it, a specific microprocessor is allocated to each input to handle and shape its analog signal.

- 1 measure of rpm on flywheel, programmable inductive – Hall,
- 1 measure of main camshaft phase, programmable inductive – Hall,
- 3 measures of auxiliary camshaft phase, programmable inductive – Hall,
- 4 auxiliary measures, programmable inductive – Hall.

When a sensor is in Hall effect mode, it is necessary to put in the loom a 1KOhm to 10KOhm pull-up resistor between the sensor signal and 12 volts after key or 5 volts, following the type of sensor Hall.
According to the selected type of application, they are used for:

- 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 on configurable type of marks,
- measure of turbo rpm on programmable number of pulse by round,
- measures of auxiliary rpm on programmable number of pulse by round,
- measures of wheels speeds on programmable number of pulse by round,
- measures of vehicle speed,

Note that any camshaft can be declared as main (only one) or as auxiliary (all the others), the cylinder 1 TDC selection being done on the main camshaft.

PARAMETRIZATION OF THE INPUTS

Every measure of the ECU (pressure, pedal, throttle, speed) can be allocated to one of the physical inputs of the ECU, or has a value received by the CAN from an external sensor, or from a calculated value, including from the auxiliary CAN-BUS.
So, it is possible
- to add measures when all the physical inputs are used,
- to change physical input for a fast repair if an used input is damaged and that there are free inputs (naturally with changing the pin of the ECU connector).
- to use special sensors, for example measure of NOx sensor supplying its values by CAN-BUS, measure of turbo speed outputting an analog tension function of the speed.
- to make calculations on several inputs before converting the result of these calculations in the chosen measure (example: several inputs potentiometers of pedal or electric motor position, several sensors of pressure)
See chapter advanced operation, configuration of inputs.

INPUTS DIGITAL FILTERING

Every measure of the ECU has a programmable digital filtering.

FAULTS STRATEGIES

For every measure of the ECU (pressure, pedal, speed), it is possible to define a strategy of fault detection, a strategy of value replacement in case of defect, or to use the standard strategies supplied by the ECU.
See chapter advanced operation, configuration of inputs.

DIAGNOSTIC

The ECU remembers the faults on the measures, the blackout or the short circuit, occasional or repeated, and allows the deletion of these defects under order of the motorist.
More, it remembers the system defects, miss of 30, loss of power supply, watch dog reset, …These systems defects ask for a particular attention and indicate an important problem of assembly or manipulation.

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.

The trigger of recording maybe made on an advanced strategy defined by the motorist.
Erasure by software (with possible protection).
Alarm light programmable (LED):

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

LOAD CALCULATIONS

- throttle / rpm,
- pressure / rpm (with or without turbo),
- airflow / Rpm (with or without turbo and additional intake pressure sensor).

INJECTION

8 channels with type of selectable command
- ON-OFF,
- for the Peak and Hold commands, or direct injection commands, it is necessary to add a Skynam specific device (example: Peak and Hold programmable in duration and intensity of the peak, and intensity of the hold).

Selectable types of injection:
- Sequential phased (phase sensor needed),
- Sequential not phased (phase sensor not needed),
- direct phased (phase sensor needed),
- semi sequential (phase sensor not needed).

INJECTION RAILS

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

- rail 1 to 2: allows to move gradually from a rail to the other one. When we increase the rail 2, the rail 1 is decreased in the same way to compensate. Both rails can have different type of injectors, and thanks to the fuel flow coefficient between the two rails, the fuel quantity remains stable when moving from one to the other.
- 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. Both rails can have different types of injectors.

IGNITION

8 channels to command ignition power modules (the Commander does not directly command the coils).
Types of selectable ignition
- twin spark (phase sensor not needed),
- static (phase sensor needed).

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.

AUXILIARY COMMANDS

23 programmable auxiliary commands from which 8 are ECU physical outputs and 4 by CAN-bus
- ON-OFF,
- PWM from 10 Hz to 10 KHz,
- PWM software from 10 Hz to 1 KHz,
- angular (square signal the period of which is the engine cycle and the cyclical ratio of which is adjustable)
- engine synchronous (angular phased).

Types of control of physical outputs:
- 4 programmable push-pull or open drain commands,
- 18 open drain commands,
- 1 LED output,

The command type of CAN-bus outputs depends on the WinjNet device used to operate the command.
For the Peak and Hold auxiliary commands, it is needed to add a specific Skynam device (example: Peak and Hold programmable in duration and intensity of the peak, and intensity of the hold).
According to the selected type of application, the outputs commands are used for:
- turbo rpm or pressure management,
- low pressure fuel pump,

- high pressure fuel pump,
- motorized throttles,
- camshaft proportional shifting by PWM command,
- electric motors positioning (with looping on a potentiometer), to use for example a throttle of intake or exhaust or some other devices with precise angular positioning.
- proportional electrovalve two wires (standard closed by spring) or three wires (opening and closure electrically controlled).
- electric motors of rotation (adjustable speed, with possible looping on frequential inputs),
- shift light,
- alarm defects,
- programmable type by the motorist.

TURBO

The Commander ECU can manage:

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

Turbos in sequential mode are started only under selectable conditions.

The command is normally made by the command of a pneumatic leak electrovalve or a servo motor.

The management maybe made according to the intake pressure or the rpm of turbos, with possible switching of one to the other one in case of not validity of measure.
For 'V' engines with separated intake by bank, it is possible to read 2 sensors of pressure, allocated each to a bank of cylinder, to manage each of the twin turbos with its own pressure.
Furthermore, it is possible to integrate a restrictor pressure into the management of the target of overboost, by using one of the auxiliary inputs to measure this restrictor pressure and by integrating this measure into the calculation of the target of overboost.

The Commander ECU also manages post combustion (bang-bang).

CAMSHAFTS

The Commander ECU can manage the proportional positioning of 4 camshafts:

- two intake and two exhaust,

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

- by the management of a unique pneumatic leak electrovalve.
- by the management of two electrovalves (type BMW M3), of which one advances the camshaft and one delays it.

FUEL PRESSURE

For fuel injection engines direct, the Commander manages the fuel high pressure.
It is also possible to manage the fuel pressure for the standard engines.
The management of fuel pressure can be made by a PWM or by a command synchronized with engine speed (VW FSI engines).
Each engine bank can have its own fuel pressure management.

RPM LIMITER

On injection, ignition or both.
Configurable launch limiter,
Configurable race limiter.
Cutoff made on turning cylinder (always begin with a different cylinder).

DECELERATION CUTOFF

On injection, ignition or both, or no cutoff.

SEQUENTIAL GEARBOX

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

- ignition cutoff
- modification of the ignition with slope on go back to normal (by maps with selectable inputs)

Downshift:

- modification of motorized throttle position (autoblip), which allow to accelerate the engine to ease the downshift. This obviously needs that the motorized throttle in present and managed by the ECU

ENGINE MULTIMAPPING

Groups of modification allow modifying the engine tuning, for example to have several tunings according to a rotator.
Three groups of modification are available, allowing, with the original tuning, to obtain four different engine tuning.
A group of modification is constituted by a map of modification of ignition advance, by a map of modification injection time, by a map of modification of richness target and a map of modification of turbo pressure and rpm target (if turbo exists).
Every group of modification can be activated by the one or other one of the variables known by the ECU (measures or generic results of calculation of the ECU, or values received by the auxiliary CAN-BUS, or results of calculations of pilot modules).
One of the applications frequently used in racing is to change engine tunings according to the positions of a rotator.

SELF LEARNING: ADVANCED HELP TO ENGINE TUNING

- The injection time base map is pre filled with values allowing an easy engine starting up. Furthermore, a complete function of self learning was added to it to boost and facilitate the tuning of the engine, based on the richness target map and the reading of the Lambda sensor(s).
- The base ignition advance map has values allowing an easy engine starting up, but must be specifically adapted to the engine by the motorist.
- All other maps of the ECU are pre filled with values allowing a good engine working in the majority of the cases, notably the maps of starting up enrichment and rising in temperature, of altimetric adaptation, …
- The PID of motorized throttle management, the PID of turbo management, the PID of camshafts positioning management and the PID fuel high pressure management for direct injection engines are also pre filled and most of the time require no or little supplementary adaptation.

AVANCED FUNCTIONS

The Commander 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**.

SKYMCOD corresponds to a way of thinking natural. This technique of functional programming is even better used by the motorists than by the computer specialists.
It can be used in all the functions of the ECU to complement or add calculations or replace those of origin.

1) Pilot modules:

Every module is a box of calculation with zero, one or two values in input and a value to output, and boxes can be linked or be nested ones with the others.
The values of inputs of modules can be either the measures or the generic results of calculation of the ECU, or the values received by the auxiliary CAN-BUS, or the results of calculations of pilot modules, with possibility of recursive calculation.
These modules of calculation are able to control the auxiliary commands and the complementary commands, of supplying procedures of detection of defects and degraded operation, and thus of intervening in all the domains of management of the ECU.

2) Parameterization of the inputs of measures:

Every measure of the ECU (pressure, pedal, speed) can be allocated to one of the physical inputs of the ECU, or has a value received by the CAN of an external sensor, or to a calculated value, including the auxiliary CAN-BUS.
So, it is possible
- to add measures when all the physical inputs are used,
- to change physical input for a fast repair if an used input is damaged and what there are free inputs (naturally there changing pin of the connector ECU).
- to use special sensors supplying values by CAN-BUS, or supplying tensions according to the measure.
- to make calculations on several inputs before converting the result of these calculations in the chosen measure.

3) Auxiliary PID:

A PID is an organ of control allowing to make closed looped regulation by a process.
The Auxiliary PID is not originally dedicated to the control of a particular process.
The processes which they are going to control are left to the choice of the motorist, contrary with some other which are dedicated to particular tasks as the management of the electric throttle, the turbo pressure, the fuel pressure or the positioning of camshafts …
Every auxiliary PID is a module of calculation of regulation with an input (the variable on which is made the looping), and an output: the value of command of the PID.
All the variables of the ECU can be selected as value of looping to be regulated by one of the modules of auxiliary PID.
All the outputs of the ECU, the auxiliary commands, the complementary commands (see lower) can be controlled by the values of commands of the auxiliary PID.
By comparison, the PID fixed by management of fuel pressure has for looping value the fuel pressure and as command the electrovalve of fuel pressure.
This auxiliary PID can be used for example to manage flaps in the intake, …

4) Auxiliary measures:

The inputs of measure not used by the selected type of application are left at the disposal of the motorist to add sensors or switches, to use them as active inputs of pilot modules and special procedures of calculation, or as simple information of display.
These auxiliary measures, as the other measures, can either use internal inputs of the ECU, or the values received by CAN-BUS Skynam sensors, or calculations already made by the ECU including values received from the auxiliary CAN-BUS.

5) Filtering of the measures:

Every measure of the ECU (pressure, pedal, speed, auxiliary measures) has a calculation of filtering by weighted average, the weight being given by a map an input of which depends on the difference between the measured value and the average, and of which the other input is selectable.
An adaptive filtering is so realized, allowing shorter response times in case of real movement of the measure.

6) Strategies of defect of the measures:

For every measure of the ECU (pressure, pedal, speed), it is possible to define a strategy of fault detection, a strategy of value replacement in case of fault, or to use the standard strategies supplied by the ECU. For the measures of speed (turbos, wheels) a configurable strategy very elaborated by correlation analysis of speed and of acceleration is supplied.

7) Auxiliary commands:

The auxiliary outputs of the ECU not used by the selected type of application are left at the disposal of the strategies of the motorist and can be controlled by pilot modules.

8) Complementary commands:

They are hooks which allow to intercept and to modify at will all the targets of the ECU so that the motorist can intervene with its own strategies there:

- ignition channels cutoff
- injection channels cutoff
- richness correction cutoff
- modification of ignition advance
- modification of injection time
- modification of injection phase rail 1
- modification of injection phase rail 2
- modification of richness target
- modification of motorized throttle target
- modification of turbo 1A and 1B pressure target
- modification of turbo 1A and 1B rpm target
- modification of turbo 2 pressure target
- modification of turbo 2 rpm target
- modification tick over rpm target
- modification of rpm limiter target
- modification of intake camshafts position target
- modification of exhaust camshafts position target
- modification of fuel pressure target

9) CAN-BUS auxiliary values:

The values received from the two auxiliary CAN-Buses can be used in the strategies of the motorist, as active inputs of pilot modules or as simple information of display.

The motorist can also send data on the auxiliary CAN-Buses to supply information to the connected devices, the dashboard, the Grid, the data recordings, …

Furthermore, a temporal control of reception of frames allows to declare received frames in error.

ECU LOOM

J90 CONNECTOR		FUNCTIONS	COMMENTARIES
1	CAN	CAN1_H	CAN Sybele
2	CAN	CAN1_L	CAN Sybele
3	OUT	10V REGULATED POWER SUPPLY	10V output for external device supply
4	IN	PHASE B SENSOR	Phase sensor input on camshaft
5	IN	PHASE C SENSOR	Phase sensor input on camshaft
6	IN	SPEED INPUT 4	Speed input 4 - selectable inductive or Hall
7	IN	MIXED INPUT 1	analogic - resistive selectable input
8	IN	MIXED INPUT 4	analogic - resistive selectable input
9	IN	MIXED INPUT 7	analogic - resistive selectable input
10	IN	ANALOG INPUT 9	0-5 volts analogic input
11	IN	ANALOG INPUT 6	0-5 volts analogic input
12	IN	ANALOG INPUT 3	0-5 volts analogic input
13	MASSE OUT	SENSORS GROUND	Ground output for sensors supply
14	IN	RESISTIVE INPUT 6	0-5 volts resistive input
15	IN	RESISTIVE INPUT 3	0-5 volts resistive input
16	MASSE IN	POWER ENGINE GROUND	Ground input for power commands
17	MASSE IN	POWER ENGINE GROUND	Ground input for power commands
18	OUT	LED DIAG-ALARM	LED command
19	MASSE OUT	SENSORS GROUND	Ground output for sensors supply
20	OUT	AUXILIARY COMMAND 20	Ground command open drain
21	OUT	AUXILIARY COMMAND 19	Ground command open drain
22	OUT	IGNITION H	12volts push-pull command - 8th ignition channel
23	OUT	IGNITION G	12volts push-pull command - 7th ignition channel
24	OUT	IGNITION F	12volts push-pull command - 6th ignition channel
25	OUT	IGNITION E	12volts push-pull command - 5th ignition channel
26	OUT	IGNITION D	12volts push-pull command - 4th ignition channel
27	OUT	IGNITION C	12volts push-pull command - 3rd ignition channel
28	OUT	IGNITION B	12volts push-pull command - 2nd ignition channel
29	OUT	IGNITION A	12volts push-pull command - 1st ignition channel
30	OUT	AUXILIARY COMMAND 3	Ground command open drain
31	CAN	CAN2_H	Auxiliary CAN (external)
32	CAN	CAN2_L	Auxiliary CAN (external)
33	OUT	5V SENSORS POWER SUPPLY	5v output for sensors supply
34	IN	PHASE A SENSOR	Phase sensor input on camshaft
35	IN	PHASE D SENSOR	Phase sensor input on camshaft
36	IN	SPEED INPUT 3	Speed input 3 - selectable inductive or Hall
37	IN	MIXED INPUT 2	analogic - resistive selectable input
38	IN	MIXED INPUT 5	analogic - resistive selectable input
39	IN	MIXED INPUT 8	analogic - resistive selectable input
40	IN	ANALOG INPUT 8	0-5 volts analogic input
41	IN	ANALOG INPUT 5	0-5 volts analogic input
42	IN	ANALOG INPUT 2	0-5 volts analogic input
43	IN	RESISTIVE INPUT 8	0-5 volts resistive input
44	IN	RESISTIVE INPUT 5	0-5 volts resistive input
45	IN	RESISTIVE INPUT 2	0-5 volts resistive input
46	ALIM	PERMANENT POWER SUPPLY +30	12 volts permanent power supply
47	MASSE IN	SUPPLY ENGINE GROUND	Ground supply for ECU
48	OUT	AUXILIARY COMMAND 2B	Disconnectable Vbat push-pull command
49	OUT	AUXILIARY COMMAND 2A	Disconnectable Vbat push-pull command
50	OUT	AUXILIARY COMMAND 1B	Disconnectable Vbat push-pull command
51	OUT	AUXILIARY COMMAND 1A	Disconnectable Vbat push-pull command
52	OUT	INJECTION H	Ground command open drain - 8th injected channel
53	OUT	INJECTION G	Ground command open drain - 7th injected channel
54	OUT	INJECTION F	Ground command open drain - 6th injected channel
55	OUT	INJECTION E	Ground command open drain - 5th injected channel
56	OUT	INJECTION D	Ground command open drain - 4th injected channel
57	OUT	INJECTION C	Ground command open drain - 3rd injected channel
58	OUT	INJECTION B	Ground command open drain - 2nd injected channel
59	OUT	INJECTION A	Ground command open drain - 1st injected channel
60	OUT	AUXILIARY COMMAND 4	Ground command open drain
61	CAN	CAN3_H	Auxiliary CAN (external)
62	CAN	CAN3_L	Auxiliary CAN (external)
63	OUT	5V SENSORS POWER SUPPLY	5v output for sensors supply
64	IN	RPM +	crankshaft rpm sensor input
65	IN	SPEED INPUT 1	Speed input 1 - selectable inductive or Hall
66	IN	SPEED INPUT 2	Speed input 2 - selectable inductive or Hall
67	IN	MIXED INPUT 3	analogic - resistive selectable input
68	IN	MIXED INPUT 6	analogic - resistive selectable input
69	IN	ANALOG INPUT 10	0-5 volts analogic input
70	IN	ANALOG INPUT 7	0-5 volts analogic input
71	IN	ANALOG INPUT 4	0-5 volts analogic input
72	IN	ANALOG INPUT 10	0-5 volts analogic input
73	IN	RESISTIVE INPUT 7	0-5 volts resistive input
74	IN	RESISTIVE INPUT 4	0-5 volts resistive input
75	IN	RESISTIVE INPUT 1	0-5 volts resistive input
76	ALIM	AFTER KEY POWER SUPPLY +15	After key 12V power supply
77	OUT	AUXILIARY COMMAND 18	Ground command open drain
78	OUT	AUXILIARY COMMAND 17	Ground command open drain
79	OUT	AUXILIARY COMMAND 16	Ground command open drain
80	OUT	AUXILIARY COMMAND 15	Ground command open drain
81	OUT	AUXILIARY COMMAND 14	Ground command open drain
82	OUT	AUXILIARY COMMAND 13	Ground command open drain
83	OUT	AUXILIARY COMMAND 12	Ground command open drain
84	OUT	AUXILIARY COMMAND 11	Ground command open drain
85	OUT	AUXILIARY COMMAND 10	Ground command open drain
86	OUT	AUXILIARY COMMAND 9	Ground command open drain
87	OUT	AUXILIARY COMMAND 8	Ground command open drain
88	OUT	AUXILIARY COMMAND 7	Ground command open drain
89	OUT	AUXILIARY COMMAND 6	Ground command open drain
90	OUT	AUXILIARY COMMAND 5	Ground command open drain

MODULES OF STANDARD CALCULATIONS
- ELEMENTS OF CALCULATION-

According to the chosen type of application, Commander ECU uses or not the various modules of calculation.

Standard maps:
For the majority of the calculations, Skynam supplies preset maps, which do not need to be retouched. These maps are noted 'standard map' in the list of the calculations below.
In some cases, Skynam supplies a sets of standard maps to choose by the motorist, as for example for the sensors conversions (tension/physical value) or the various PID of command of regulation (motorized throttle, tick over electrovalve, overboost pressure, fuel high pressure).
Specific maps:
The motorist does not have more than to make the calibration of the engine really specific (injection time, ignition advance, the cylinders corrections, turbo pressure target).
Calculation of load:
The engine can be equipped with an airflow meter and with an intake pressure sensor, in that case the calculations of load will be made from the measurement of intake airflow.
If the engine is equipped only with an intake pressure sensor, the calculations of loads will be made from the intake pressure measurement.
If the engine is only equipped with a throttle potentiometer, the calculations of loads will be made from the measure of throttle position.

IGNITION ADVANCE
Base advance: map, on rpm / load, in 1/100 crankshaft degree relative to the TDC.
Groups of modifications: 3 maps of advance modification with programmable activation, allowing 3 supplementary engine tunings.
Cylinders correction: 1 map by cylinder, on rpm / load, in 1/100 degree, applied to basic advance.
Dynamics tick over advance: standard map, on engine temperature / rpm, in 5 decimals coefficient of advance modification by the difference between the average engine rpm and the immediate engine rpm. Calculation used to stabilize the tick over.
Engine temperature correction: simplified 3D standard map, on engine temperature / rpm / load, in 1/100 degree.
Intake temperature correction: simplified 3D standard map, on intake temperature / rpm / load, in 1/100 degree.
Atmospheric pressure or dynamic pressure correction: simplified 3D standard map, on atmospheric pressure / rpm / load, in 1/100 degree.
Cutoff advances smoothing: standard map, on engine rpm / throttle speed, in coefficient 5 decimals to smooth the advance modification in input and output of deceleration cutoff to limit jolts.
Complementary command: hook map of advanced calculation for addition of strategies on the ignition advance by the motorist, in 1/100 degree.
Complementary command of ignition cutoff: hook map of advanced calculation for addition of strategies of ignition channels cutoff by the motorist.

INGNITION COIL LOAD
Angle of coil load: map, on rpm / battery tension, in 1/100 degree. This map can be automatically calculated by Winjall by supplying load times according to the various battery power supply.

INJECTION
Base injection time: map, on rpm / load, in microseconds (possibility display in crankshaft degrees)

Groups of modifications: 3 maps of modification of injection time with programmable activation, allowing 3 supplementary engine tuning.
Phase injection rail 1: map, on rpm / load in 1/100 degree relative to the TDC
Phase injection rail 2: map, on rpm / load in 1/100 degree relative to the TDC
Cylinders correction: 1 map by cylinder, on rpm / load, in 5 decimals coefficient, applied to the basic time
Engine temperature correction: simplified 3D standard map, on engine temperature / rpm / load, in 5 decimals coefficient.
Intake temperature correction: simplified 3D standard map, on intake temperature / rpm / load, in 5 decimals coefficient.
Atmospheric pressure or dynamic pressure correction: simplified 3D standard map, on atmospheric pressure / rpm / load, in 5 decimals coefficient.
Permission of deceleration cutoff (inhibited during bang-bang if turbo): parameter, value: injection, ignition or both, or no cutoff.
Complementary command: hook map of advanced calculation for additional strategies on injection time by the motorist, in 5 decimals coefficient.
Complementary command: hook map of advanced calculation for additional strategies on the rail 1 injection phase by the motorist, in 1/100 degree.
Complementary command: hook map of advanced calculation for additional strategies on the rail 2 injection phase by the motorist, in 1/100 degree.
Complementary command injection cutoff: hook map of advanced calculation for additional strategies of injection channel cutoff by the motorist.

INJECTORS CORRECTION

Injectors correction time: map, on battery tension, in microseconds. Allows to integrate into the electric command of injectors the fuel loss due to the (relative) slowness of injectors reaction.
A map of correction by injector rail allows to use different injectors on the two rails.
Furthermore, these maps can be also indexed to the fuel pressure (high or low according to engine configuration).

INJECTION RAILS

Progressive distribution between rails: map with programmable inputs (choice by the motorist), in coefficient on the basic I.T. in 5 decimals. Working dependent on the type of 2nd rail, 1 to 2 or 1 to 1+2.

ENGINE ROTATION START

Engine start rpm limit: standard map, on engine temperature, giving the rpm from which the engine is considered as running by itself (end of cranking).
Modification of injection time: simplified 3D standard map, on engine temperature / rpm / number of round since rotation start, in 5 decimals coefficient on basic I.T.

ENGINE START (STARTER)

Post start enrichment: standard map, on engine temperature, applied to the basic I.T. in 5 decimals coefficient. This coefficient is fixed at the end of cranking phase and linearly decreased according to elapsed time at the speed of 100 % in 30 seconds.

ACCELERATING PUMP

Rise: simplified 3D standard map, on load position / load speed / regime, in 5 decimals coefficient.
- In load calculation by throttle angle, the calculation of accelerating pump is made on the throttle movements

- In load calculation of intake pressure or airflow meter, two calculations of accelerating pump are available simultaneously.one on the load movements (intake pressure or airflow), and one on the throttle position movements. The pump used by the ECU is the biggest of both.

Decay: standard map, engine acceleration / rpm, in 5 decimals coefficient.
Correction level of accelerating pumps: parameter, 5 decimals coefficient of fast tuning of accelerating pump: the standard maps supplied by Skynam must almost never be modified, we use this coefficient to enrich or to lean accelerating pumps.
A coefficient by injection rail is available.
In load calculation of intake pressure or airflow, a coefficient for the accelerating pumps on pressure or airflow movement and a coefficient for the accelerating pumps of throttle movement, what gives four coefficients in two rail injection.

TICK OVER AND DECELERATION CUTOFF

Accelerator pedal tick over limit: parameter, in thousandth (give the pedal position under which the pedal is in tick over zone).
Tick over rpm target: parameter, rpm (give the basic value of tick over).
Modification of tick over rpm target: map, on engine temperature, rpm.
Complementary command of tick over rpm target: hook map of advanced calculation for additional of strategies of tick over rpm target by the motorist.
Offset deceleration cutoff: parameter, rpm (give the offset of rpm above the tick over rpm target for which we enter in deceleration cutoff zone).
Cutoff smoothing: map, on rpm / pedal speed, gives the slope of advance smoothing to enter and go out of deceleration cutoff from and to the load.
Tick over smoothing: map, on engine acceleration / difference engine rpm –tick over rpm target, gives the slope of advance smoothing to enter and go out of deceleration cutoff from and to the tick over.

RPM LIMITER

limiter target: parameter, rpm.
Channels cutoff: standard map, on which the variable of input lines is the difference actual rpm - current limiter rpm target, and the variable of input columns is left with the choice of the motorist. Give the number of channels with 5 decimals to cutoff (on injection, ignition or both). Rolling cylinder cutoff (always begin with a different cylinder).
Complementary command of rpm limiter: hook map of advanced calculation for additional strategies of rpm limiter target by the motorist.

RICHNESS CORRECTION

Target: map of richness target, on rpm / load, expressed in richness.
Groups of modifications: 3 maps of modification of richness target with programmable activation, allowing 3 supplementary engine tunings.
Complementary command of richness target: hook map of advanced calculation for additional strategies of richness target by the motorist.
Permission of richness correction: parameter, ON-OFF.
Complementary command of unlooping: hook map of advanced calculation for additional strategies of richness regulation unlooping by the motorist.
Looping start wait: standard map, on rpm / load, expressed in milliseconds giving the maximum waiting time before use of the Lambda sensor.
Re-looping wait: standard map, on rpm / load, expressed in milliseconds giving the waiting time before re-looping when the conditions of looping are correct.
Speed of richness regulation: simplified 3D standard map, on rpm / load / relative distance richness-target richness.

MOTORIZED THROTTLE

Target: map of motorized throttle position target, on engine rpm / pedal.
Additional command of position target: hook map of advanced calculation for additional strategies of throttle position target by the motorist.
Standard maps of PID of regulation of motorized throttle command.

TURBO (FOR EACH TURBO PACK)

Target: map of overboost pressure target, on rpm / throttle position.
Complementary command of pressure target: hook map of advanced calculation for additional strategies of overboost pressure target by the motorist.
Standard maps of PID of regulation of turbo command by electrovalve of leak.
Throttle minimum position of Integral correction: parameter, value of throttle below which the Integral correction of PID is maintained in 0.
Maximum pressure target speed of Integral correction: parameter, value of overboost pressure target speed above which the Integral correction is maintained to 0.
Complementary command: hook map of advanced calculation for additional strategies on the turbo pressure target by the motorist, in signed millibars.
The turbo pressure can also be managed by means of the turbo speed.

BANG-BANG

Maximum time of bang-bang: parameter, bang-bang time after which it is cutoff. If this value is set to 0, there will be no bang-bang.
Bang-bang command state: map with programmable inputs (choice by the motorist) allowing to define the strategies of input and of output of bang-bang. The Skynam pre programmed strategy is based on the rpm / load of the engine, with hysteresis of throttle position or pedal position (in motorized throttle) of output of bang-bang in the re-acceleration and rpm hysteresis of output of bang-bang in the rpm drop.

FUEL PRESSURE

Target: map of fuel pressure target, on rpm / load.
Complementary command of fuel pressure target: hook map of advanced calculation for additional strategies of fuel pressure target by the motorist.
Map of dynamic increase of target: in bars, on speed load. The second input of the map is selectable so that the motorist can insert its own strategies of increase of target.
Map of wait of decrease of target: in milliseconds, on rpm. The second input of the map is selectable so that the motorist can insert its own strategies of wait of decrease of target.
Map of maximum slope of decrease of target: in bars / second, on rpm. The second input of the map is selectable so that the motorist can insert its own strategies of slope of decrease of target.
Standard maps of PID of regulation of the fuel pressure command.
Fuel pressure reference: parameter, reference value of fuel pressure in bars for which the map of basic Injection Time is calibrated. The correction of I.T. is then automatically made by the ECU following the formula:
Corrected I.T. = base I.T. / fuel flow
With:
Fuel flow = square root (fuel pressure / reference pressure).

CAMSHAFT POSITIONING (FOR EACH CAMSHAFT TYPE)

Target: map of camshaft position target, on rpm / load.
Complementary command of camshaft position: hook map of advanced calculation for additional strategies of camshaft position target by the motorist.
Standard maps of PID of regulation of the camshaft position command.

ELECTRIC MOTOR OF POSITIONING (FOR EACH ELECTRIC MOTOR)

Target: map of angular position target of the motor, on selectable inputs.
Standard maps of PID of regulation of electric motor position command

FILTERINGS

Weighted average of measures: each input of measure has a filtering by weighted average (previous average + current measure) / (weight coefficient + 1).

For each measure, the coefficient of weight is given by a map to allow an adaptive filtering.
For the static measurements (pressures, throttle, …), one of the inputs of this map depends on the signed difference between the measured value and the average value (value-average), and the other input is selectable by the motorist.
For the speed measurements (wheel, turbo, …), one of the inputs of this map depends on the signed relative difference between the measured value and the average value (value-average) / average, and the other input is selectable by the motorist.
The input selectable by the motorist uses generally advanced calculations for a higher adaptability of the averaging weight coefficients.

GENERAL TECHNICAL CHARACTERISTICS

AN ECU VERY POWERFUL AND VERY FLEXIBLE

The Commander is a machine owning very high computing power and having numerous inputs and configurable outputs, allowing from the very beginning a very flexible and effective use.
Furthermore, thanks to very powerful advanced functions, the motorist can implement itself sophisticated functions not foreseen in the original software, or complement or modify the existing functions in the original software.

The Commander also owns in standard diagnostic functions of defects of the sensors and sophisticated functions of recording of overshoots completely configurable (monitoring of the engine and its devices).

COMMUNICATION, TUNING AND CHAINING

The Commander can communicate and be configured by means of the PC software Winjall (™ Skynam), and this communication is made by means of the CAN-BUS only.

1) Can-bus WinjNet (™ Skynam):

Several Commander ECUs can be chained by this network in a vehicle and exchange data to manage the same engine as the V10 or V12.
Sensor or command modules can be added on the network to complete the functions of an ECU or a group of ECU.
One or some of these Commanders can be declared masters, the others being slaves. Every master has to manage a unity in the vehicle, for example the engine, and the slaves become then extensions of the master.
All these ECUs will be together seen and controlled by the software Winjall, for an integrated tuning, the master owning the maps and the common tunings (as for example the injection time basic map) and taking charge with redistributing these common data to the slaves: it is not need to load or to modify these common data in every ECU of the chain.
On the other hand, every slave owns the maps and the tunings of its own tasks, as for example the maps of correction of injection by injector, for the cylinders that it has to manage, but the integrated presentation by Winjall allows a simple and easy access to the various ECUs at the same time.

2) Auxiliary Can-buses:

The Commander owns two auxiliary CAN-BUSES with configurable speed by which it can send or receive chosen data, for example from OEM CAN-BUS, OBD or from external data recording.
The Commander uses these auxiliary CAN-BUSES in the standard 2.0B (11 bits or 29 bits identifiers, selected for every frame).

POWER SUPPLY

The Commander is capable to work in a range of tension of power supply battery going from 7 volts to 18 volts, although the nominal power supply tension is 13,5 volts.
It allows to work perfectly on vehicles without alternator, and generally, the other devices of the vehicle stop working well before itself.
If the battery tension falls in the neighborhood of 5 volts during the activation of the starter, as by cold time and damaged battery, the problem on starter is remembered in diagnostic system for control.
If the battery tension falls in the neighborhood of 5 volts during the working, the loss of power supply is remembered in diagnostic system for control.

TEMPERATURE

The Commander it is capable to work in a range of temperature going of-40°C in +85°C. It must not however be too much near the sources of heat of the engine (exhaust, cylinders cooled by air). It is necessary to take into account the internal temperature of the electronics which borders 70°C at ambient temperature.

SEALING

The Commander has a waterproof ness of type IP67, meaning that is it is waterproof in the dust, and in a complete dumping in the water during at least 30 minutes (on request).
However, this waterproof ness is really insured only if the loom was correctly made on the ECU side, that is pins are crimped with appropriate tool and provided with their rubber terminator and that is the not used channels are also provided with rubber terminators of suited blindness.

WATCH DOG

The Commander has an electronic watch-dog which allows it to make a complete reset (reset hardware) in case of not recoverable internal defect.
The complete ECU, and not only the microprocessor, restarts then completely, not generating notorious dysfunction more important than an impression of miss fire.
This type of event should occur only exceptionally rarely, and denotes generally of a serious problem of assembly of the ECU loom and\or a ground connection, or an overshoot of the characteristics of operation (example: internal temperature, internal presence of water).
The reset is then remembered in diagnostic system for control.
If several resets are made, the repetition is also noted in diagnostic system.

MEMORY CHARACTERISTIC

The permanent memory of Commander is a FLASH EPROM, allowing the update of the softwares (and data) by transmission since the PC.
The internal memorization of the data of tuning and recording is also made in this permanent memory: no inside battery is necessary.
To make this memorization, the Commander needs a permanent power supply that it uses only some fractions of a second to some seconds after the contact is switched off.
While it uses this permanent power supply, it makes its diagnostic LED flash.
It is imperative not to switch off the permanent power supply (it is a 'permanent' power supply) during this lapse of time.
It is the same strongly disadvised to disconnect the ECU of its loom directly without having switched off the contact at first and since the diagnostic LED goes out.
The problems of loss of permanent power supply were minimized, and in normal working, the miss of this power supply will simply prevent the ECU from remembering the last data to be recorded.
The miss of permanent power supply is then remembered in diagnostic system for control.

CHARACTERISTIC OF CALCULATION

The heart of Commander is made by two fast microcontrollers, having a DSP calculation coprocessor (Digital Signal Processing).
Its numerous capacities of input-output give it an outstanding flexibility:

- correction of fuel quantity cylinder by cylinder,
- correction of ignition advance cylinder by cylinder,
- management of injectors rails progressive shifting,
- programmable auxiliary outputs following various modes,
- …
- addition of programmable auxiliary sensors,
- combinations of inputs for the measures,
- definition of strategies on measurements defects.

Besides the generic functions of engine management, the computing power of Commander allows to implant multiple additional functions of calculation, directly accessible to the motorist.
This one can so implement, if it is need, its own strategies to adapt even better its ECU to the needs of the engine and its devices, the whole without damaging the main calculations which are made as often as it is necessary for an immediate management of the events and the state of the engine.

BASIC ENGINE CONFIGURATION

I) CALCULATIONS OF LOAD:

The Commander knows how to make various types of calculations of load:

- throttle / rpm,
- pressure / rpm (with or without turbo),
- airflow / rpm (with or without turbo and additional intake pressure sensor).

II) NUMBER OF CYLINDERS AND ANGLE BETWEEN CYLINDERS:

The number of engine cylinders is configurable by the motorist, as well as the angle between cylinders for the irregular engines.

1) Regular angle:

The angle between cylinders is regularly distributed on the engine cycle. For a 4-cylinder, it is 180°, for a 6-cylinder, it is 120°...

2) Specific angle:

With more than 8 cylinders, this configuration can be used only with an even number of cylinders.
For each cylinder, it is allowed to set the angle made with the cylinder 1. The angle is given with a 1/100 crankshaft degree precision.

III) DISTRIBUTION OF THE BANKS OF CYLINDERS:

The ECU can be configured for straight engines (1 bank of cylinders) or for 'V' or flat engines.

1) Declaration of the existence of the 2nd bank:

Each engine cylinder can be configured as belonging to one of both banks of the engine.
If the engine is straight, all the cylinders must be allocated to bank 1.
If at least 1 cylinder is allocated to bank 2, the ECU considers that the engine has two banks of cylinders, and if the number of cylinders is higher than 8, the number of cylinders allocated to bank 1 and to bank 2 has to be the same.

2) Case of engines with odd number of cylinders:

If the number of cylinders does not exceed 8, it is allowed to declare specific angles and/or two banks of cylinders for engines with odd number of cylinders, as in the case of one irregular 5 cylinders (8 cylinders the designer of which has been removed 1 cylinder).

3) Separated intakes and management of turbos:

For engines managed in pressure/rpm, one measure of intake pressure and one turbo can be allocated to each bank of cylinder (see management of turbos).
For engines managed in throttle/rpm, one measure of throttle position can be allocated to each bank of cylinder.

4) Correction bank by bank:

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

5) Management of lambda sensors:

If Lambda sensor 2 exists, lambda 1 is allocated to the bank 1 and Lambda 2 allocated to the bank 2.
In that case, if no cylinder is allocated to the bank 2, the Lambda sensor 2 is read but makes no correction.
If two banks and two Lambda sensors are declared, the richness correction is done bank by bank.

6) Management of camshafts:

The ECU can manage the proportional shifting of the camshafts (see auxiliary commands).

IV) ENGINE MEASURE OF RPM AND PHASE:

To measure its rpm and calculate and set the events phased with the engine, the Commander needs two devices:

- a flywheel target on the crankshaft with its sensor,
- a flywheel target on each camshaft with its sensor,

We have to declare the existence of a camshaft sensor for each camshaft of which we need to manage the proportional positioning.

FLYWHEEL

The flywheel sensor can be inductive or Hall effect.
The number of teeth is programmable, from 8 to 60 teeth.
Although the computing power of Commander is sufficient to support an engine rpm far beyond the mechanical possibilities of an engine, the flywheel should be chosen with a number of teeth all the more minimized as the foreseen maximum rpm must be raised, for quality questions of sensor's signal rpm. **A good balance precision of the low rpm - quality of the high rpm is reached around 500 000 teeth / minute.**
On the contrary, if the engine must be able to start from very low rpm, it is necessary to increase the number of teeth of the flywheel. The engine can start only when the biggest tooth (see typical of mark) becomes lower than 100 milliseconds.
The type of mark is programmable too:

- a supplementary tooth,
- a missing tooth,
- two consecutive missing teeth,
- regular teeth (in that case, the sensor camshaft is imperative, and it is necessary to ensure that the tolerances of camshaft are small enough so that the mark of cam always passes on the same tooth of the crankshaft).

MINIMUM RPM OF SYNCHRONIZATION CONTROL

A test of loss of synchronization is made in every engine round by the ECU, allowing it to control that the flywheel is correctly read.
If a tooth was missed or if an excess tooth is seen (a strong parasite), or if the rpm is too much disrupted, the injection is stopped and the search for the flywheel mark is restarted.
We can indicate the rpm below which the test of loss of synchronization of the flywheel will not be made.
This rpm is normally 0, and the test of synchronization is made as soon as the engine runs.
For certain engines with a very light flywheel or with few cylinders, it is better not to make this test before certain rpm is reached because the engine turns too irregularly at low rpm, preventing the ECU from letting start the engine.

CAMSHAFT MARK

The camshaft sensor is optional. If it is not present,

- the direct injection types is not allowed
- the sequential injection and the static ignition are not phased, while keeping the specific angles of cylinders. The ignition will produce a spark each 360 crankshaft degree.

The camshaft sensor(s) can be inductive or Hall effect.
It is allowed to declare two camshaft sensors to read the phase of two camshafts. The sensors are then assigned to camshafts following the configuration of the engine, the main phase sensor reading the teeth of the main camshaft which is the one the ECU uses to find the 1st cylinder TDC
For the main phase measurement, the type of camshaft target can be:

- mark on position: all the teeth of the target camshaft have to be in the same half round of camshaft. It means that the other half round of camshaft must be empty.
- one missing tooth: on the regular teeth of the camshaft target, one tooth has been removed.
- one supplementary tooth: on the regular teeth of the camshaft target, one tooth has been removed every two teeth, except on one place, where we so have 3 consecutive half teeth.
- mark on state: on the flywheel mark of one of both rounds of the engine cycle, there has to have a camshaft tooth, and on the other engine round, it does not have to have it. This configuration is often used for gasoline direct injection or common rail diesel engines. For this configuration, the camshaft sensor has to be a Hall effect one.

For the auxiliary phases measurement the type of camshaft target can be:

- mark on position,
- one missing tooth,
- one supplementary tooth,
- regular teeth (all the same teeth)
- mark on state

TOP DEAD CENTER MARK

A calibration allows adapting the angular distance between the mechanical Top Dead Center and the Top Dead Center Mark on the flywheel seen by the sensor. It allows to give the real phase in degrees in the maps of engine phase (the phase injection).
Furthermore, if the flywheel must be changed or angularly repositioned, it would be enough to redo this calibration without having to modify the maps to find back the engine tunings.

For each measure of camshaft phase, a calibration also allows to set the measure to top dead center 0°.

ENGINE COMMAND

I) INJECTION:

The precision of the calculation of injection of Commander is 1µs, what is about 0,05% at tick over and 0,005% in full load.
Commander88 has 8 injection channels.

ELECTRICAL COMMANDS

The electrical commands of these channels are ON-OFF.
For the Peak and Hold commands or the commands of direct injections, it is necessary to add a specific Skynam device (example: programmable Peak and Hold in duration and level of the peak, and level of the hold).

INJECTION RAILS

Injectors can be grouped in one rail, or two rails.
If they are grouped in two rails, a map allows to gradually choose the injected quantity for each banister according to parameters left with the choice of the motorist.
Each injection rail owns its own accelerating pump and its own injection phase: the 2nd rail being generally further from valves than the first one, the wetting of the intake must be more intense and the injection phase more early.
Two types of double rails working are possible:

1) Rail 1 to 2:

This configuration allows to move gradually from a rail to the other one: when we increase the rail 2, the rail 1 is decreased in the same way to compensate. Both rails can have different type of injectors, and thanks to the fuel flow coefficient between the two rails, the fuel quantity remains stable when moving from one to the other. Each rail has its maps of correction and delay of injectors opening.

2) Rail 1 to 1+2:

This configuration allows to add gradually the rail 2 to the rail 1: we use this configuration to give more of fuel to the engine when we engage the rail 2. Both rails can have injectors of different types and each rail has its maps of correction and delay of injectors opening.

TYPES OF INJECTION

The injection can be:

1) Sequential phased: (necessary phase sensor)

It is an injection phased on the end of the injection.
The management of the phase is made by the map of phase injection, function of the rpm and the load.
Injectors are normally connected 1 by 1 to the outputs of the ECU by respecting the order of cylinders.

2) Direct phased: (necessary phase sensor)

It is a sequential injection phased on the beginning of the injection.
The management of the phase is made by the map of injection phase, function of the rpm and the load.
Injectors are normally connected 1 by 1 to the outputs of the ECU by respecting the order of ignition of cylinders.

3) Sequential not phased: (no phase sensor)

It is an injection relative to the end of the injection.
The management of the phase is made by the map of phase injection, function of the rpm and the load, but the engine round in the engine cycle is selected randomly at the engine start.
Injectors are normally connected 1 by 1 to the outputs of the ECU by respecting the order of cylinders.

4) Semi sequential:

The engine has to have an even number of cylinders.

Injectors are opened 2 by 2: two injectors are commanded by each injection output of the ECU. This type of injection is not phased.

CORRECTION OF CYLINDERS
For the sequential injection (phased ort not) and the direct injection, each cylinder has a map rpm / load of correction to balance the richness in case of disparity of filling.

BANKS CORRECTION
As an injection time correction is allowed for each cylinder, it is no need to have a bank by bank correction.

II) IGNITION:

The precision of the ignition calculation of Commander is 1µs that is 1/10° at 16000 rpm.
Commander88 has 8 ignition channels.

ELECTRICAL COMMANDS
The electrical commands of these channels are signals of command of external power modules, which can be or not integrated into ignition coils: The Commander does not directly command the primary of ignition coils.

TYPES OF IGNITIONS
1) Static ignition: (necessary phase sensor)
It is the ignition with a coil by cylinder.
Modules are normally connected 1 by 1 to the outputs of the ECU by respecting the order of ignition of cylinders.
2) Static ignition not phased: (no phase sensor)
It is the ignition with a coil by cylinder.
Modules are normally connected 1 by 1 to the outputs of the ECU by respecting the order of ignition of cylinders, but the ECU could not determine the good engine round in the engine cycle, it executes a spark every 360°
3) Twin spark ignition:
For engines with an even number of cylinders, 360° opposed two by two.
Cylinders are lit 2 by 2: it is necessary to use a double coil by ignition module, and a module by ignition output of the ECU. We can also use coils with integrated module.

CORRECTION OF CYLINDERS
- For the static ignition (phased or not phased), each cylinder has a correction map rpm/load to compensate for an unbalanced combustion.
- For the lost spark ignition, no correction per ignition channel.

BANKS CORRECTION
As an ignition advance correction is allowed for each cylinder, it is no need to have a bank by bank correction.

TIME OF IGNITION DELAY
A calibration allows to inform the ECU of the time of execution of the ignition command. Indeed, between the order given by the ECU to the coils through the modules, and the real peak of spark, there is a delay time characteristic of the power modules and the coils. This time is typically of about 15 microseconds, inconspicuous at low rpm, but which borders 1 advance degree at 11000 rpm.

III) RICHNESS CORRECTION:

The Commander can be configured to measure the richness with its Lambda sensor, and correct it.
The use a wideband Lambda sensors (with electronic interface) is mandatory.
- If two banks and two Lambda sensors are declared, the richness correction is done bank by bank.
- To drive this correction, we use a map of target to indicate the desired richness according to the load and to the rpm.
- We also have two programmable limits of correction, forbidding to the Commander to enrich or to lean too much during this correction.
- When the richness correction is allowed, we can also define the load, the rpm and the engine temperature below which the richness correction must not be made.
- In addition, a fully programmable map allows the motorist to define additional strategies of richness regulation unloop.

IV) ENGINE MULTIMAPPING:

Three groups of modification allow to modify the engine tuning, for example to have several tunings according to a rotator, allowing, with the original tuning, to obtain 4 different engine tuning (the original tuning plus 3 modifications).

A group of modification is constituted

- of a map of modification ignition advance,
- of a map of modification of injection time,
- of a map of modification of richness target,
- of a map of modification of turbo pack 1 pressure (if turbo exists).
- of a map of modification of turbo pack 1 rpm target (if turbo exists).

Every group of modification can be activated by the one or other one of the variables known by the ECU (measures or generic results of the ECU calculations, or values received by the auxiliary CAN-BUS, or results of pilot modules calculations).
Once defined with which ECU variable a group will be activated, one defines the range of value of this variable which will activate the group.

One of the applications frequently used is to change engine tuning according to the positions of a rotator, by defining this measure of position of rotator as variable of activation for all the groups, and by activating each group on one of the positions of the rotator.

AUXILIARY COMMANDS

The 8 direct auxiliary outputs of Commander are generally power outputs of ground command in open drain (ground or nothing).
The 4 auxiliary outputs by CAN-bus of the Commander ECU depend on the type of WinjNet device used to execute the command. Skynam can supply WinjNet command devices with open collector (ground or nothing), in push-pull (ground or battery tension or in H bridge (double inverted ground or battery tension command, specific for electric motors of positioning including electric throttles).

Two direct outputs can be programmatically configured in push-pull (ground or 12 volts power supply). Some of the auxiliary outputs can be coupled so that a single command controls two electric outputs. In that case both outputs are set, that is if the one is active, the other one is passive. In the change of state of the double commands in push-pull, a very light phase shift is made. It allows for example to create H bridges.

I) FIXED COMMANDS:

DIAGNOSTIC LED

The Commander uses a special output among 12 to command its LED to specifically manage the state signals of the ECU and its diagnostic.

II) FIXED COMMANDS FOLLOWING TYPE OF APPLICATION:

FUEL PUMP

The Commander uses one of the 8 direct outputs to command the low pressure fuel pump following the FISA regulations: pump running 5 seconds at the start up of the ECU, then pump switch off if the engine does not run.
As soon as the engine rotates, restart of the pump.
As soon as the engine stops, stop of the pump.

MOTORIZED THROTTLES

Is managed by a regulation of type PID on a H bridge PWM command (double push-pull) the command frequency of which we select. It can also manage one motorized throttle per engine bank.
For this management we use a map of target to indicate the throttle position according to the accelerator pedal position and the rpm, allowing to slow down or to accelerate the movement of the throttle with regard to that of the pedal.
It sometimes allows to win torque at low rpm by not allowing to open completely the throttle.
It also allows to bring the necessary air quantity for the good working of the bang-bang on turbo engines.
The measure of pedal position can be made on one or two potentiometers, as well as the measure of throttle position.

FUEL PRESSURE

For direct fuel injection engines, it is necessary to control the fuel high pressure by a regulation. Some engines fuel low pressure also require a management of the fuel pressure.
The ECU can also measure and manage one fuel pressure per engine bank.

Two types of management are possible: either with an engine synchronous command, or with a PWM command. In the first case, we give the number of pulse to make by engine cycle and in the second the

frequency of the PWM command. The electric command can be inverted by the configuration of the output.
If the output is an engine synchronous command, the phase of the pulses is controlled by a map inputs of which are selectable, to allow the motorist to choose on which engine element will be made the command phase (for example the position of the camshaft).

In both cases, a PID regulation will give the cyclical ratio of pulse so that the fuel pressure conforms to the target given by a set of maps:

- basic map of target, on rpm / load
- map of modification of target with selectable inputs allows the motorist to insert its own strategies of modification of fuel high pressure target.
- map of dynamic increase of target in bars, on load speed and rpm. This map allows to anticipate the need of fuel pressure.
- map of control of target drop in milliseconds, on engine rpm and elapsed time in milliseconds since the beginning of the drop. It gives the maximum slope of target decrease and allows to slow down the decrease of fuel pressure, in case this decrease would only be punctual, and would be followed by a re-increase.

Furthermore, a procedure of injectors rail emptying allows to lower the fuel pressure during deceleration cutoff to be able to hitch back with functional injection times (a high pressure for small fuel quantities gives too short injection times so that injectors cant work correctly, generating instability of working and polluting emission).

CAMSHAFTS PHASE POSITIONING

The Commander ECU can manage the proportional positioning of 4 camshafts:

- two intake and two exhaust.

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

- by the management of a unique pneumatic leak electrovalve.
- by the management of two electrovalves (type BMW M3), of which one advances the camshaft and one delays it.

a) In the case of standard command: the camshaft position management is done by a PID regulation on a PWM command the frequency of which we can choose. The electrical command can be inverted by the configuration of the output.
b) In the case of double electrovalve command: the camshaft position management is done by a PID regulation on two PWM commands the frequency of which we can choose. The electrical commands can be inverted by the configuration of the outputs.
If the camshaft must be advanced, the PWM of the advance electrovalve is activated while the delay electrovalve is not commanded, and vice versa if the camshaft must be delayed.

A map of target of angular position indicates the desired camshaft position according to the load and to the rpm.
a) If one bank of cylinders is declared with one command of camshaft shift:

- the main phase sensor is assigned to this camshaft and the Commander works with it to find out the cylinder 1 TDC.
- the camshaft has a target map to give its desired position.

b) If one or two banks of cylinders are declared with each one or two variable camshaft (intake and/or exhaust):

- each camshaft has its own phase sensor, the one assigned to the main phase sensor being the one with which the Commander works to find out the cylinder 1 TDC.
- the intake camshafts have a common position target map that gives the camshaft desired position for both the two bank: the two camshafts are identically positioned.
- the exhaust camshafts have a common position target map that gives the camshaft desired position for both the two bank: the two camshafts are identically positioned.

TURBO PRESSURE

For overboost engines. See below the details of the management of turbos.

ELECTRIC MOTOR OF POSITIONING

Two electric motors of positioning can be managed by the ECU.
To use for example an exhaust throttle or other devices with precise angular positioning, with looping on a measurement position. Is managed by a PID regulation on a PWM command the frequency of which we can choose.
For this management we use a map of target to indicate the angular position of the electric motor. The inputs of this target map are selectable and the target of position of the engine is thus a function of what needs the motorist.

ELECTRIC MOTOR OF ROTATION

Allows to manage the speed of an electric motor by a PWM command with frequency and selectable cyclical ratio, with possible looping on one of the speed inputs, which allows to control very finely the speed of the electric motor, according to parameters selectable by the motorist.
This function is not pre programmed but must be built on the basis of the 'Advanced functions' (see examples in the example files).

PROPORTIONAL ELECTROVALVE

Allows to manage the gradual opening of electrovalves, by a PWM command with selectable frequency and cyclical ratio.
The commander possesses a particular mode of control of electrovalve by making an effect of small hammering to force the precise positioning of electrovalves. If this operation mode is not desired, we shall rather configure the output in simple tunable PWM.
The type of electrovalve can be two wires (standard electrovalve with closure by spring) or three wires (electrovalve with opening and closure electrically commanded).

III) PROGRAMMABLE COMMAND:

The auxiliary outputs of the ECU not used by the type of application are at the disposal of the motorist to implement its own strategies. See 'Advanced functions' lower to find a description.

IV) TURBO:

The Commander can manage:
- 1 turbo,
- 2 twin turbos in parallel (1 by bank of cylinders)
- 2 sequential turbos in parallel
- 2 serial sequential turbos
- 3 turbos, with two in parallel and the third serial with both first ones

Sequential Turbos mode are started only under selectable conditions.

The management of turbos maybe made according to the intake pressure or the rpm of turbos.
For V engines with separated intake by bank, it is possible to read two pressure sensors, each allocated to a bank of cylinder, and to manage each of the twin turbos with its own pressure.
Furthermore, with the fully programmable maps of target modification, it is possible to integrate a restrictor pressure into the management of the target of overboost, by using one of the auxiliary inputs to measure the restrictor pressure and by integrating this measure into the calculation of the overboost target.

COMMAND OUTPUTS

The management of turbos has 3 output commands, one for every turbo.
The management of the commands of turbos (waste-gate or variable geometry) is made in PWM. . It can control a leak electrovalve or a servo command (loop positioning with an electric motor).
The electric command can be inverted by the configuration of the output.
The frequency of the PWM can be chosen by the configuration of the output.
- The ECU commands outputs of the turbos are ground commands, controlling normally pneumatic electrovalves. The frequency of the PWM can vary from 30 Hz up to 250 Hz following the type of electrovalve. If it cannot be verified with the parts manufacturer, the frequency advised by the PWM is around 100 Hz.
- Some turbos have a variable geometry commanded by an electric motor. The frequency of the PWM can vary from 500 Hz up to 1000 Hz following the type of motor. If it cannot be verified with the parts manufacturer, the frequency advised by the PWM is around 500 Hz.

If it is need to control supplementary electrovalves to engage or bypass the turbos by flaps, or more to manage one wastegate back pressure, programmable auxiliary outputs can be used to make these additional controls.
According to the engine equipment, these outputs can then be managed according to the rpm of the sequential turbo or one or several turbos of the Pack 1, either according to the engine rpm, the intake pressure, or any other parameter needed by the motorist.

TOOLS OF TURBO MANAGEMENT

Turbos are named 1A, 1B, and 2, as much for the output command as for the measure of turbo rpm.
Turbos 1A and 1B have to be twin turbos.
The turbo 2 benefits itself of a completely separated management.
The Commander has 2 packs of turbo management:

Pack 1 manages twin turbos 1A and 1B. It is made of:

- a map of selection of type of management (in rpm or in pressure) from the difference between the actual turbo speed and the maximum turbo speed allowed.
- a map of turbo rpm target from engine rpm and throttle (or pedal) position
- a map with selectable inputs of modification of turbo rpm target
- a map of intake pressure target from engine rpm and throttle (or pedal) position
- a map with selectable inputs of modification of intake pressure target
- a parameters setting of PID of management of turbo rpm
- a parameters setting of PID of management of turbo pressure
- a set of parameters to reset to zero the integral of the PID

More, it owns correction maps for engine multimaping (for example for multimaping with a rotary switch)

- a map of intake pressure target modification
- a map of turbo speed target modification

Pack 2 which manages turbo 2 (sequential) has fully selectionnable driving conditions. This pack is made of:

- a map with selectable inputs of type of management wished (in rpm or in pressure)
- a map with selectable inputs of turbo rpm target
- a map with selectable inputs of modification of turbo rpm target
- a map with selectable inputs of intake pressure target
- a map with selectable inputs of modification of intake pressure target
- a parameter setting of PID of management of turbo rpm
- a parameter setting of PID of management of turbo pressure
- a map with selectable inputs of reset to zero of the integral of the PID

TURBO RPM MANAGEMENT

The choice of the management in turbo rpm or in pressure is made Pack by Pack, that is if 2 turbos 1A and 1B of the Pack 1 exist (commands of outputs validated), the 2 will be managed in pressure at the same time, or managed in rpm at the same time. The turbo 2 managed by the Pack 2 can be managed in rpm or in pressure independently of turbos 1A and 1B.
If during the management by rpm, one of the measures of turbo rpm of a Pack is declared in error:
a) If the management by pressure of the Pack is validated: (see paragraph 'Management in pressure')
The switching to the management by pressure is made. This switch is made in a common way inside every Pack of turbo management: for example, if the measure of turbo rpm 1A either if the measure of turbo rpm 1B falls out of order, the management of the Pack 1 completely switches to pressure management.
b) If the management by pressure of the Pack is not validated:
As long as the pack is in error, only the map of basic leak of the PID will be used, no correction being brought to it any more.

TURBO PRESSURE MANAGEMENT

For V engines with separated intake by bank of cylinders, we shall declare in the configuration of inputs the existence of bank 1 and bank 2 intake pressures, each being measured with its own sensor. We shall also declare the main pressure in automatic calculation, as resultant of the 2 banks, which will be used for the calculations of the injection management and the other one …
The 2 turbos of the Pack 1 will be managed so separately, each with its own pressure. The pressure of the bank 1 is automatically allocated to the turbo 1A and that of the bank 2 to the turbo 1B.
If only the main intake pressure is declared, both turbos 1A and 1B will be managed in the same way according to the unique pressure.
If during the management by pressure, one of the measures of turbo pressure of a Pack is declared in error:
a) If the management by rpm of the Pack is validated: (see paragraph 'Management in rpm')
The switching to the management by rpm is made. This switch is made in a common way inside every Pack of turbo management: for example, if the measure of turbo pressure 1A either if the measure of turbo pressure 1B falls out of order, the management of the Pack 1 completely switches to rpm management.
b) If the management by rpm of the Pack is not validated:
As long as the pack is in error, only the map of basic leak of the PID will be used, no correction being brought to it any more.

CHOICE OF MANAGEMENT TYPE TURBO RPM OR PRESSURE

If 2 types of management turbo pressure or turbo rpm are validated, the ECU allows changing the type of management in the other one.
The target and the difference with the target of both types of management are continuously calculated, even for the type of management that is not in use.

1) Map of selection:

A map allows to dynamically choose which one of both is used, to be able to use at best the 2 types of management.
For Pack 2, its inputs are selectable, and the strategy of use is thus left with the choice of the motorist.
For Pack 1, the selection of type of management is done from the difference between the actual turbo speed and the maximum turbo speed allowed.
This map accepts the hysteresis mode of operation to avoid oscillations between the 2 modes at the time of the switching from one to the other.
For example, we can choose to work in pressure up to a maximum turbo rpm, to switch to rpm management beyond this threshold to be sure to avoid overboosts, and to go back to pressure only if the rpm comes down below some lower threshold.

2) Automatic change on error of measure:

If the error concerns the measure in use (pressure or turbo rpm), the ECU tries to switch type of management:

- If the other management is allowed (no error), the change of management is made.
- If the other management is not allowed (also in error), no management is more allowed, the management by pressure is chosen and only the map of basic leak of its PID is used (the proportional and the integral are not used during the errors).

If the error concerns the not used measure, the ECU will not switch to the type of management of this measure even if the map of working mode selection asks for it.

PID OF CONTROL

Every Pack has 2 parameter settings of PID, one for the management in rpm and one for the management in pressure.

1) The Target:

It gives the absolute intake pressure wished for the PID of management pressure and the speed turbo wished for the PID of management turbo rpm.

For Pack 2, it is possible to select according to which parameters this target will be given.

For the standard turbo management of Pack 1, it will be the engine rpm, and the throttle position or the accelerator pedal position.

A map of complementary modification allows to make modifications of target according to parameters chosen by the motorist, as the atmospheric pressure, the intake temperature....

Pack 1 owns in more map of engine multi mapping.

2) The basic leak:

It is a function of the engine rpm, and the target of turbo rpm for the management in rpm or the target of intake pressure for the management in pressure.

3) The leak immediate correction:

It is a function

a) Of the speed of the target (turbo rpm or intake pressure). Indeed, the more the target varies fast, the more it is necessary to anticipate the demand in pressure or in turbo rpm.

b) Of the distance between the target and the measure:

- for the management in rpm, the measure is the rpm of the turbo.
- for the management in pressure, several cases are possible:
    - for the Pack 2: the measure is always the main intake pressure.
    - for Pack 1: for the twin turbos, if it was declared a measure of pressure for every bank of cylinder, the measure is the pressure of the bank 1 for the turbo 1A and the pressure of the bank 2 for the turbo 1B. If the intakes of banks are not separated or if we manage only a single turbo, the measure of main pressure will be selected.

4) The long term leak correction:

It is a function of the same variables as the differential (see above).

In every cycle of calculation, (every milliseconds), a value is added to the value of correction calculated at previous calculation cycle, generating a new value of correction. We approach so gradually the perfect correction.

5) The reset to zero of the integral:

a) For Pack 1 which does a standard turbo management:

To avoid unwanted overboosts, we cancel the integral correction which can generate a very important overshoot of target if, when the exhaust flow being too low, the turbo rpm or the pressure does not manage to rise at the level of the target: the calculation of PID then increases the integral at most to try to generate a higher leak to reach the impossible target, and when we accelerate brutally, the leak is wide open and the pressure rises very high.

It is thus necessary to force the integral to 0 in these circumstances, letting only the differential correct the basic leak.

Pack 1 owns a set of parameters which allows managing this reset to zero of the integral.

b) For Pack 2 which manages a sequential turbo:

The integral can be maintained to 0 as long as the sequential turbo is not used.

The reset to zero of integral made by a map common to the rpm management and pressure management of the 2 parameter settings of PID of the pack. Its inputs are selectable: the motorist can choose its strategy for this reset to zero.

POST COMBUSTION

Three parameters allow to manage the bang-bang:

- maximum time of bang-bang: the duration maxi of the bang-bang in milliseconds allows to cut it off after a while to avoid a too important heating of the turbo and the exhaust part of the engine. If this value is set in 0, there will be no bang-bang.
- map with programmable inputs: allowing to define the strategies of input and of output of bang-bang. The strategy pre programmed by Skynam is based on the rpm / load of the engine, with throttle position or pedal position (in motorized throttle) hysteresis of output of bang-bang on re-acceleration and the rpm hysteresis of output of bang-bang on engine rpm decrease. The complete modification of the strategies by the motorist is possible, because the inputs of the map are programmable: we could imagine to need the bang-bang at the race start, what requires a limit of rpm of very low input to bang-bang, but to return then to a higher limit of rpm, because the vehicle could be undriveable. We could so simply add a condition of output on the measured exhaust temperature by means of a thermocouple.
- map of management type selection: the map of management type selection (turbo rpm or pressure) also allows to specifically set the type of management during bang-bang.

Once fixed the parameters of input and output of the bang-bang, the tuning of the bang-bang itself is made by means of three maps:

- the ignition advance,
- the injection time,
- the motorized throttle target or the tick over electrovalve, or an auxiliary output commanding throttle opening by a pushing device.

A special mode of operation of these maps allows to define the values of air, fuel and advance in bang-bang mode separately from the normal mode of working.

VARIOUS FUNCTIONS

I) RPM LIMITER:

ACTION OF THE LIMITER

The limiter can be chosen to act on the injection, the ignition, or both.
A map allows to gradually cutoff the cylinders as we approach the limiter instead of cutting them all at the same time.
To protect the engine, the limiter begins every time with a different cylinder.
If the map gives a coefficient of cylinder cutoff which demands to cut off a not integer number of cylinder (for example 1/4 of cylinder, or 2.5 cylinders) the cylinder to be not completely cutoff is cutoff every N rounds, with N = 16 / fraction of cutoff.

TYPES OF LIMITER

Two types of rpm limiters exist in the Commander.
The Commander allows to give different rpm for these two limiters, as well as the conditions to switch from one to another.
Furthermore, a map of modification of rpm limiter with selectable inputs allows the motorist to insert its own strategies of modification of target limiter.

1) the launch limiter:

It allows by setting a rather low limiter to reduce the power of the engine at the takeoff of the vehicle, to avoid a too important wheels skating,

2) the race limiter:

It is used for the full power of the engine.

SHIFT LIGHT

It is the light which we switch on when the engine rpm is to reach the rpm limiter.
This light is commanded by the auxiliary output 7 in Tunewares supplied by Skynam.
It is possible to make very precise commands of this light, for example by modifying its ignition according to the gearbox position.

II) THROTTLE POSITION AND PEDAL POSITION:

DETERMINATION OF THE NUMBER OF POTENTIOMETERS

The standard working uses only one throttle potentiometer and one pedal potentiometer, but for each of these measures, throttle and pedal, it is possible to define 2 potentiometers by means of the advanced functions:
As all the measures, the information of input can be calculated instead of being measured. This calculation can result from an information of the auxiliary CAN-BUS, but also from another measure.
In this particular case, we shall define both inputs of potentiometer as auxiliary measure. These two auxiliary measures will be the inputs of a map of module which will make the comparison of both tensions (one can be rising and the other falling, with a tension ratio unitary or divided). The value of output of the module will then be injected as input of the throttle measure (or pedal), and the error of correlation of potentiometer inputs will be used to activate the error throttle (or pedal) and to launch the algorithms of replacement on error.

PEDALE AND THROTTLE CALIBRATION

The ECU supplies a calibration of throttle position and accelerator pedal position. This calibration allows the ECU to record the minimum and the maximum of the potentiometers values (or of calculation if double potentiometer) and will allocate them the angular position 0 and the angular position 1000, with a linear interpolation between these two values for the intermediate angles.

III) TICK OVER AND CUTOFF POSITION:

The ECU supplies a function of calibration of tick over, which allows to define three parameters:

- The angular opening of the throttle (or pedal in motorized throttle) until which the ECU has to consider that it is in tick over. The ECU calculates automatically a small hysteresis on this tick over position to avoid the oscillations of calculation.
- the basic tick over rpm value, which is originally only an information for the ECU, and not a real target.
- The offset of rpm above the tick over rpm for the deceleration cutoff zone. This adjustable offset is normally 800 rpm, that is for a tick over rpm 1000 rpm, the limit of cutoff zone will be 1800 rpm. The ECU adds a not adjustable hysteresis of 100 rpm to avoid the oscillations of calculation.

The tick over rpm defined by this calibration can be modified by:

- A map of modification of tick over rpm target according to the engine temperature. This map gives a signed offset in rpm.
- A map of modification of tick over rpm target with selectable inputs allowing the motorist to insert its own strategies of modification of tick over rpm target.

The advanced calculations allow with an electric throttle or a tick over electrovalve to use the tick over rpm target for a regulation of tick over rpm.

IV) DECELERATION CUTOFF:

The cutoff can be chosen to act on the injection, the ignition, or both, or no cut.
It is made when the throttle (or the pedal in mode electric throttle) is in the tick over zone and when the rpm is in the cutoff zone (normally throttle closed or pedal released and rpm above 1800 rpm).

SEQUENTIAL GEARBOXES

The Commander manages directly the sequential gearboxes.

I) NUMBER OF GEARS:

The number of gears can be chosen (up to 10 gears).
We can also indicate if the gearbox is organized in automotive (Back, neutral, 1st) or motorcycle (1st, neutral, 2nd) or special by choosing the name of the gears in function of the information of the potentiometer of gearbox position.
The name of gear is important because it is it which is used in the calculations of gearbox and the advanced calculations.

II) GEARSHIFT SWITCH:

The gear shift switch can be or
- logic: when it is put grounded, the ECU is informed about the gear shift, but only in the upshift direction.
- analog: of constraint gauge type, the switch gives a tension centered around 2.5 volts. If this tension passes below a minimum limit, or above a maximum limit, programmable by the motorist, the ECU is informed about the gear shifting and about the direction of the shift.
- calculated: as all the measures, the information of input can be calculated instead of being measured. This calculation can result from an information of the auxiliary CAN-BUS, but also from another measure. In this particular case, it is possible to define as switch the speed of the accelerator pedal, and to declare for example that we gear shift when we quickly raise the foot.

III) COMMON TUNING TO ALL THE GEARS:

We configure four common values to all the gears:
- Minimum engine rpm on downshift: it is the rpm below which the ECU does not intervene on the engine management when downshifting.
- Minimum engine rpm on upshift: it is the rpm below which the ECU does not intervene on the engine management when upshifting.
- Minimum pedal position on upshift: as for the rpm, on upshifting, the ECU does not agree to intervene on the engine management below a certain programmable throttle position.
- Wait before new gear: after a gearshift, the ECU refuses a new gearshift during a programmable time. It avoids intervening involuntarily a second time if the pilot keeps the hand on the gear lever.

IV) SPECIFIC TUNINGS FOR EACH GEAR:

CALIBRATION OF THE GEAR POSITIONS

We indicate to the ECU the position of the various gears according to the tension of the potentiometer of measure of position of the gearbox: for each gear, we give the ECU a range of tension (or of calculated value if we have defined the gearbox input position on a calculation) surrounding the value supplied by this potentiometer.
The tensions of the potentiometer must be rising.

The ECU supplies a function of automatic calibration of gears. Once this function launched, it is enough to shift all the gears. The ECU calculates then the range of tensions of potentiometer corresponding to every gear.

INTERVENTIONS DURING THE UPSHIFTING

A map allows to adjust differently the time of intervention for each gear.
The second input of this map is selectable by the motorist, to be able to modify the time of intervention according to another parameter: for example, modify the time of intervention of gear according to the rpm or the engine torque, …

The intervention is launched as soon as the ECU receives from the switch the signal of upshift, if the rpm and the throttle are above the programmed limits and if the waiting time before a new gear is elapsed, and lasts as long as the time of intervention defined for this gear is not reached.
The type of intervention on gearshift is selectable. It can be

- ignition cutoff
- modification of the ignition with slope on go back to the normal (by maps with selectable inputs)

For example, we can choose to cutoff and to modify the ignition:
The motorist will define in the map of modification of ignition the number of degrees of advance degradation, according to the parameters which interest him.
He will also define the slope (the speed) with which we go back to normal at the end of intervention in the map of slope of ignition, according to the parameters which interest him.
As we declared that we cut the ignition off at the gearshift, the ignition will be cut off during all the defined time of intervention. At the end of upshift, the ignition is degraded before being restarted: it thus restarts from a value lower than normal, and goes back up gradually to the normal value, at the speed defined by the map of slope.
This allows to limit jolts during the gearshift.

INTERVENTIONS DURING THE DOWNSHIFTING

A map allows for gear to adjust differently the time of intervention.
The second input of this map is selectable by the motorist, to be able to modify the time of intervention according to another parameter: for example, modify the time of intervention of gear according to the rpm or the engine torque, …

The intervention is launched as soon as the ECU receives from the switch the signal of downshift, if the rpm is above the programmed limit and if the waiting time before a new gear is elapsed, and lasts as long as the time of intervention defined for this gear is not reached.
The type of intervention on gearshift is selectable. It can be

- modification of the motorized throttle position (by map with selectable inputs). By the end of the intervention, the modification is neutralized and the motorized throttle position goes back to its normal opening.

This obviously needs the presence of the motorized throttle(s), and that it is managed by the ECU.
This intervention allows to accelerate the engine (autoblip) to ease the downshifting.

V) ROBOTIZED BOXES:

The wait before new gear also serves for programming the robotized boxes, that is the boxes for which it is needed to maintain the intervention all the time the switch is pushed or pulled (the time of programmable intervention does not then serve).

To inform the Commander that the gearbox is of this type, the wait before new gear must be simply set to 0.
The ECU adds systematically a 10 milliseconds blanking time to avoid bounces on the switch of the robotized gearbox.

CONTROL OF OPERATION

I) BREAKDOWNS DIAGNOSTIC:

The commander makes a permanent analysis of the operation of the system and the sensors, and remembers their defects, even past.

1) System diagnostic:

Diagnostic system is permanently displayed by the Winjall software below the name of the ECU.
It gives the defects such as watch-dog resets, problems of risks or losses of data application on heavy loss of power supply (or not of 30), …
A function of Winjall allows to set back to zero diagnostic system.

2) Diagnose application:

Two functions coexist: a function of display of application diagnostic, and a function of reset to zero of this diagnostic.
Application diagnostic consists essentially in the recording of the defects of the sensors and\or the channels of measures of these sensors in the ECU.
The recorded defects can be

- black out: permanent,
- short circuit: permanent,
- occasional black out: black out appeared once then disappeared,
- occasional short circuit: short circuit appeared once then disappeared,
- hardware cut: when the input of the measure is not a physical input of the ECU, for example received from the CAN-BUS, and when this measure is not received.

Furthermore, the ECU indicates if the breakdown is in progress, and thus the function is invalidated.

II) OVERSHOOTS RECORDING:

This function allows to record and to show values overshoots by recording exceeded values, overshoots number, durations of the extreme overshoot, and total times of overshoots.
The ECU Commander has 6 identical channels of recording of overshoot.
For every canal:

VALUE TO WATCH

The value to be watched is chosen in the list of the dozens measures and results of calculations known by the ECU (for example the engine rpm, the oil temperature, the speed of rise in engine temperature).
In the values to be watched, you also find the variables of pilot modules (see advanced operation).
The second condition to launch the recording can be added to obtain more elaborated recordings: for example, record the falls of oil pressure when the engine rpm is higher than 1500 rpm.

One chosen the level limits that the value has to overtake to launch the recording by adjusting the map of piloting of recording.
This map with hysteresis (see advanced operation) allows to define the start up and the stop of the recording according to the value of the variable to be watched and of the 2nd condition variable (if desired).
With this map, it is possible to make logical combinations of type ' and ', 'now', 'nor', ' nand ', …

RESULT OF RECORDING

A function of the Winjall software gives the results of the overshoot recording:

- the extreme value reached by the variable to be watched, and the direction of the monitoring (overshoot downward, or overshoot upward),
- the number of times when the variable exceeded the limit,
- the duration of the overshoot for the reached extreme value,

- the total duration of the value overshoots.

VISUAL ALARMS

It is possible to switch on alarms on the condition of overshoot.
The functions of visual alarm 'Light of immediate alarm' and 'Light of cumulative alarm' allow to switch on and to switch off the alarm light of the ECU, following different modes.
As there are 6 channels of recording of overshoot for a single alarm, the alarm will remain switched on as long as a canal of recording asks for it, even if the others do not ask for it.

1) Immediate alarm:

The immediate alarm lights when the value exceeds the allowed limit, that is when the recording is launched, and goes out as soon as the value returns in the allowed limits, that is when the recording stops.
We can add a waiting time before the alarm lights, to prevent for example that the alarm switch on if the defect is very short, or to not perturb the driver for a too temporary defect.

2) Cumulative alarm:

The cumulative alarm lights when the value exceeds the allowed limit and when the total time of overshoot overtakes the programmed 'time before alarm'.
It goes out when the defect disappeared since much longer that the asked 'time before alarm reset', if the number of defect did not exceed the programmed 'number of overshoots forbidding the extinction of the alarm'.
If the number of overshoot reaches this limit, the alarm will not go out any more before we made a reset to zero with the Winjall software.

ADVANCED OPERATION

The commander has three advanced very powerful, programmable types of commands, which can be combined to realize completely new functions.
Furthermore, the auxiliary channels of measure can directly use inputs not used by the type of application chosen (with or without turbo, sequential gearbox, fuel high pressure).
Finally, it is possible to send or to receive information by the auxiliary CAN and to use the information received in the advanced calculations.

The use of these advanced functions and the development of specific 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**.
SKYMCOD corresponds to a way of thinking natural.
A very didactic file 'ADVANCED OPERATION' explains and comments in detail on the use of these functions and gives it of numerous examples.

I) CONFIGURATION OF THE ECU:

The ECU can be configured to make pre programmed tasks, as management of an electric motor of positioning (example electric throttle), one or several turbos, fuel pressure, EGR, …
To use these additional functions, it is generally necessary to use two functions:

- the parameterisation of inputs
- the configuration of the outputs

For example, to use a motorized throttle, it is necessary to:
- declare that the throttle position measure exists by allocating it an input of the ECU (physical input, or by CAN or calculated) in the function of parameterisation of the inputs
- configure an auxiliary output to electric throttle management.

II) AUXILIARY MEASURES:

They are measures not used by the chosen type of application and set at the disposal of the motorist to add analog or resistive sensors or switches, or measures of speed, to use them as active parts of the advanced functions or as simple display information.
They can be used as inputs of pilot modules, auxiliary or complementary commands, or as inputs of doubling or tripling of measure (two potentiometers accelerator pedal or positioning electric motor, three measures of intake pressure).

For example, no input speed is used in the standard calculations, but the ECU has 4 measures of wheel speed, 3 measures of speed turbo, …
If we need to make a management of anti skating, it is simply enough to activate wheels speeds by allocating to them channels of inputs (physical input or CAN), and to make the necessary comparative calculations with pilot modules to manage an additional degradation of phase or injection quantity …

III) PARAMETERISATION OF INPUTS:

Every measure of the ECU (pressure, throttle, speed) can be allocated to one of the physical inputs of the ECU, or has a value received from an external Skynam sensor by the CAN WinjNet, or to a calculated value, including the frames of the auxiliary CAN-BUS.
So, it is possible
- to add measures when all the physical inputs are used,
- to change physical input for a fast repair if an used input is damaged and that there are free inputs (naturally with changing the pin of the ECU connector).
- to use special sensors, for example measure of NOx sensor supplying its values by CAN-BUS, measure of turbo speed outputting an analog tension function of the speed.
- to make calculations on several inputs before converting the result of these calculations in the chosen measure (example: several potentiometers pedal inputs or electric throttle, several pressure sensors).
To do it, Winjall supplies a function of configuration of the inputs from which we can choose as every measure:

- the canal of input by which it will be informed
- the type of release of error to be used (standard or calculated by an advanced function)
- the type of error replacement to be used (standard or calculated by an advanced function)

The advanced calculations are described below in pilot modules.

IV) DIGITAL FILTERING OF THE MEASURES:

Every measure of the ECU (pressure, pedal, speed, auxiliary measures) has a filtering calculation by weighted average, the weight being given by a map.
Weighted average = (the previous one average + current measure) / (coefficient of weight + 1).

STATIC MEASURES

For the static measures (pressures, pedal), one of the inputs of this map depends on the signed difference between the measured value and the average (value – average), allowing a first adaptation of the average to the movement of the measure.
Other input, selectable input by the motorist uses generally advanced calculations for a higher adaptability of the coefficients of weight.
The adaptive filtering so realized allows shorter response times in case of real movement of the measure.

MEASURES OF SPEEDS

For the measures of speed, one of the inputs of this map depends on the signed relative difference between the measured value and the average ((value - average) / average), allowing a first adaptation of the average to the movement of the measure.
Other input, selectable input by the motorist uses generally advanced calculations for a higher adaptability of the coefficients of weight.
The adaptive filtering so realized allows shorter response times in case of real movement of the measure.

MEASURE OF ENGINE RPM

The average rpm is calculated in a way adapted to the state of the actual engine rpm.
During the very low rpms, the measure is made tooth by tooth.
Then, it is made on a portion of engine cycle calculated according to the number of cylinders of the engine.

V) STRATEGIES OF MEASURE BREAKDOWNS:

For every measure of the ECU (pressure, pedal, speed), it is possible to define a strategy of detection of breakdown, a strategy of replacement value in case of breakdown, or to use the standard strategies supplied by the ECU.

STATIC MEASURES

The strategies of detection of standard breakdown consist in verifying that the value of input of the measure is in a range defined according to the type of input:

- analog sensor 0-5 volts: the value of input does not have to come down below 125 millivolts or rise above 4950 mv, that is the case of all the standard automotive sensors.
- resistive sensor (CTN-CTP): the value of input does not have to come down below 25 millivolts or rise above 4900 mv, that is the case of all the standard automotive sensors.
- calculated sensors: no standard check

The strategies of standard replacement consist in supplying a fixed value dependent on the measure itself:

- The engine temperature takes the value +80°C
- The intake temperature takes the value +20°C
- The richness takes the value 0 (null richness)
- The atmospheric pressure takes the value 1013 mbars
- The intake pressure takes the maximal value allowed by the map of conversion of pressure sensor, as if the sensor delivered 5000 millivolts, to enrich the engine at most.
- Pedal and position electric motor take the value angle 0
- …

MEASURES OF SPEED

For the measures of speed (turbos, wheels) a configurable strategy very elaborated by correlation analysis of speed and of acceleration is supplied.
These strategies are for example capable of tracking down a sensor breakage on one wheel speed from 2.5 km/h or a turbo from 5000 rpm.

SPECIFIC STRATEGIES

If for one or several inputs the motorist decides to program its own strategies of replacement of error or breakdown detection, it is necessary:

- for the replacement value to indicate which pilot module will supply the replacement value. He can so elaborate complex procedures, result of a complete chain of calculations, as for example to estimate an out of order intake pressure according to a turbo rpm and an engine rpm and …
- for the detection of error trigger he also has to define the variable which will serve to trigger the error, and the value range of this variable outside which the error is activated. The ECU also supplies error states for certain variables, as for example for the values received from the auxiliary CAN-BUS, when a frame is not received in the selected timeouts. For example, for an input calculated on this CAN value, the variable to trigger the error can be the state of error reception.

Furthermore, every measure possesses a variable correlated to state of error so that the motorist can activate also calculations when a measure passes in error. For example, to estimate the engine temperature from the past and from the load engine after the last valid temperature measure.

VI) MAP COMPLETELY PROGRAMMABLE:

The maps used in the advanced functions are completely programmable:

1) variables of input of the map:

We can choose the number of input variables of map and thus the number of axes of calculation: either two, or one, or none.

We can choose what will be these variables in the list of the dozens of measures and results of calculations known by the ECU (for example the engine rpm, the used gear position, the speed of rise in engine temperature, the state of error of a measure).

2) type of map interpolation:

We can also choose the way the calculation of interpolation will be made for every axis of map (the interpolation of lines can be different from that of the columns):

- standard interpolation with stop at the endpoints of scales,
- interpolation with continuation (extrapolation out of the endpoints of scales),
- without interpolation with truncated input (stairs downward),
- without interpolation with raised input (stairs upward),
- without interpolation, in hysteresis, for the maps with calculation of state.

VII) PILOT MODULES:

They are programmable modules of calculation allowing to develop specific strategies.
These modules are capable to control the auxiliary commands, the complementary commands and the maps with selectable inputs, and thus of intervening in all the domains of management of the ECU.
There are 32 identical pilot modules which can be chained.

A pilot module is constituted
- of a completely programmable map (we can choose its variables of input and its types of interpolation),
- of a variable called 'Pilot variable' the value of which is the result of the last calculation of the pilot module.

In the ECU, the calculations on pilot modules are made every 10 milliseconds (100 Hz) sequentially, by beginning with the module 1, then the module 2, then, up to the last module.
During the 10 milliseconds which follow, the Pilot variable of every module contains the result of this calculation.
We can make recursive calculations, that is the variable of input of the map of the module can be its own Pilot variable in which is then stored the new result of the calculation in the module.

TYPES OF CALCULATION

There are 6+1 types of possible calculations in a module:

- not enabled module
- calculation of coordinated
- calculation of average
- calculation of differential
- calculation of integral
- temporal calculation
- calculation of signed division

1) Coordinate calculation:

The value of the pilot variable is a quantity or a signed position, a direct result of the calculation of the map of this module.

2) Calculation of average:

The value of the pilot variable is the average of another variable.
This other variable is the variable of input of the vertical scale of the map of the module.
The calculation of average is a weighted average, in which the result of the calculation of the map of the module is the coefficient allocated to the previous average:
New average = [(former average * coefficient) + new variable value] / (coefficient + 1)

3) Differential calculation:

The value of the pilot variable is the differential or the speed of another variable.
This other variable is the variable of input of the vertical scale of the map of the module.

The map indicates the temporal distance in seconds used for the calculation of speed.
The temporal distance can go from 10 milliseconds to 10 seconds.
The calculation of speed is moving, that is if we ask for a speed over one second, we shall have every 10 milliseconds the speed of the value over the last second.

4) Integral calculation:

In every calculation (every 10 milliseconds), the direct result of the calculation of the map of this module is added (signed addition) to the previous value of this module:
Pilot variable = former pilot variable value + map calculation result.

5) Temporal calculation:

The temporal calculation uses an internal counter (not visible) which is set to 0 at the beginning of the count.
Every 10 milliseconds, this counter is increased by 1.
The result of the calculation on the map is the value which the counter has reached, expressed in seconds, so that the count is finished.
The value of the pilot variable is the remaining time before the count is finished.
When the count exceeds or reaches the target fixed by the map, the count is ended, and the value of the pilot variable of the module is thus set to 0.

6) Calculation of signed division:

The value of the pilot variable is a quantity or a signed position, a direct result of the calculation of the division of the variable of vertical input by the variable of horizontal input of the map of the module (the calculation is made every 10 milliseconds in the ECU).
Indeed, if it is easy to implement the 3 other basic operations (addition, subtraction and multiplication) with a map calculation, it is much more complicated to make a division. Pilot modules thus have directly this supplementary function.
In this signed calculation of division, the map serves for giving the precision of the calculation of division, that is the power of 10 with which the result is going to be given.

INITIALIZATION OF THE CALCULATIONS

The way of initialize modules at the start up of the ECU is chosen by the motorist:
Three types of initializations are possible in the calculations of modules:

- automatic initialization, fixed by the ECU,
- initialization by chosen fixed value,
- initialization by the value of the module remembered at the last extinction of the ECU, to continue the calculations from a session of ECU working to the other one.

VIII) AUXILIARY PID:

The auxiliary PID are organs of control allowing to make looped closed regulation by a process freely selected by the motorist.
Every auxiliary PID is a module of calculation of regulation with an input (the variable on which is made the looping), and an output: the value of command of the PID.

An auxiliary PID allows 3 simultaneous actions on the error between the target (the desired position) and the measure (the obtained position) of the value of looping:

1) a action proportional with the target (or wished position):

It is a not signed value between 0 and 1 (0.000000 and 1.000000): it gives the base of the command of the PID.

2) a differential action following the error of position:

The error of position is the difference between obtained position and wished position.
The differential value is a signed value between -1 and +1: it gives the immediate modification of the base of the command.

As its value goes from -1 to + 1 and as the base goes from 0 to 1, it can completely invert the direction of the command.
At every position measure of looping, we compare the position and the target and we get (by the map of differential) a signed value.
This value is generally positive if the position is too low with regard to the target, (in that case, we want to give more force with the command) and negative should the opposite occur.
The Differential Value can be considered as successive hammerings which are going to force the commanded device to go to the wished target.
The more we are far from the target, the more the knocks must be strong.
3) an integral action also following the error of position:
It is a signed value between -1 and +1: it gives the modification accumulated by the base of the command:
At first the accumulation 'Integral value ' is 0.
At every position measure of looping, we compare the position and the target and we get a signed value 'Integral increment'.
This value is generally positive too if the position is too low with regard to the target, (in that case, we want to give more force with the command) and negative should the opposite occur.
The Integral increment calculated is added all the milliseconds to the accumulation 'Integral value'.
The Integral value can be considered as a continuous push which is going to force the commanded device to go to the wished target, or to avoid the overshoots of position in the opening or in the closure.
The more we are far from the target, the more the push will become strong quickly, but a too strong push will exceed the target before beginning to be reversed.
We can also consider this integral value as fine correction of the command. Indeed, the values of Integral increment in the map are generally very small, because they are added to the accumulation 'Integral value' all the milliseconds.

CHARACTERISTICS OF THE AUXILIARY PID
The proportional and the integral can be set to null in function of criteria selected by the motorist.
The integral can be frozen, limited to a range of selected values, or reset and maintained to zero in function of criteria selected by the motorist.

The final command of the PID is the sum of the result of the calculation of these three parts.
The value of command of the auxiliary PID is given in standardized value between 0.000000 and 1.000000
It is also necessary to give to the ECU a means to make the command of the PID, for example one of the auxiliary outputs of the ECU which will command an actuator of the engine, or a complementary command if we want to insert a regulation into one of the standard calculations of Commander (modification of injected quantity, modification target of turbo, …).
It is possible to regulate the totality of the commands of the ECU, for example the injected quantity to limit the engine acceleration in certain phases of working of the vehicle.
The PID would then be based on the engine acceleration and would control the injected quantity through the complementary command of modification of injected quantity.

ACTIVATION OF THE AUXILIARY PID
So that an auxiliary PID is activated, it is enough to indicate to the ECU on which value of looping the PID has to work. This value of looping is freely chosen by the motorist.

TARGET
It is given by a completely programmable map, and the values of input of its scales can be freely chosen by the motorist in all the list of the calculations known by the ECU and thus the target can be freely determined.

PROPORTIONAL

It is given by a map among which a scale is fixed, the scale of lines, which is the value of target (desired value).
The other scale, that of the columns, is selectable by the motorist, allowing to work more finely on the proportional value.
This scale also allows to choose conditions in which the proportional will be annulled. The use of pilot modules will allow to calculate complex conditions of cancellation of proportional.

DIFFERENTIAL

It is given by a map among which a scale is fixed, the scale of lines, which is the error of position, given the difference between target (desired value) and value of looping (measured value). That is that if the position is higher than the target, the error is positive, and inversely.
The other scale, that of the columns, is selectable by the motorist, allowing to work more finely on the differential value.
This scale also allows to choose conditions in which the differential will be annulled. The use of pilot modules will allow to calculate complex conditions of cancellation of differential.

INTEGRAL

The value of integral is signed (it can remove as well as add to the command of the process).
At first, or at the exit of reset (see map of integral reset lower), the integral value is set to 0.
All the milliseconds, the result of the map integral increment is added (signed) to the integral value.

1) integral increment:

The map Integral increment is based on the error between the given target and the obtained position.
It thus has a fixed scale, the scale of lines, which is the error of position (difference between target and value of looping).
The other scale, that of the columns is selectable by the motorist.
The scale of the selectable columns allows to choose conditions in which the integral increment will be annulled, freezing the integral value on its position. The use of pilot modules will allow to calculate complex conditions of frost of the integral.

2) integral reset:

The auxiliary PID module possesses a map scales of which are selectable to set back the integral to 0.
The motorist can thus completely choose the conditions of reset and hold to 0 of the integral.
In this map, two values are possible:

- 'let': the calculation of the integral is allowed
- 'reset': the calculation of the complete is forbidden and the integral is forced to 0.

As in most part of the state maps, we can use the mode of interpolation with hysteresis to avoid the oscillations of permission at the passage of thresholds.

Integral reset is often used to prevent the integral from working in certain programmable conditions.
For example, for the management of the turbo pressure (PID already existing in the ECU), the complete is held 0 if the throttle position is too low, or if the speed of the target of turbo pressure is too high.
We put reset the integral to 0 generally when it is not capable of making a significant calculation, or when the correction which it can make is too slow or unwanted.
The use of pilot modules will allow to calculate complex conditions of reset to zero of the integral.

3) automatic integral limitation:

In a internal way, the integral cannot exceed a value bringing the PID to a final value of command lower than 0.000000 or higher than 1.000000
For example, if base+différential of the PID gives a value 0.250000, the value of integral cannot exceed -0.250000 downward or +0.750000 upward.
It is necessary because if in this example the integral could come down to -1, what is anyway useless because the final result of the PID stops at 0, and that this result of the PID suddenly had to increase, the integral would loose a precious time to hand on from -1 to -0.25 before the increase can be realized.

4) programmable integral limitation:

The auxiliary PID module also possesses two adjustable parameters to limit the sum of the proportional and integral.
These two parameters are the same that globally limit the RCO (see below).
A parameter limits downward and one limits upward.
For this limitation, as the proportional is directly fixed bay a map, the action of these two limits will in fact correct the integral (which is a signed value):
a) if: proportional+ integral < mini limit, then: integral = mini limit – proportional
b) if: proportional+ integral > maxi limit, then: integral = maxi limit – proportional

It can be useful in numerous cases to limit the action of a PID, because the integral is not controlled in itself by the maps, but rather its quickness of reaction: the map of management of the integral is not a value of integral but a value of increment of the integral.
It is as well possible to prevent the integral to add to the command (or remove) by setting one of the limits to 0.
For example, if we want to manage a decrease of injected quantity to calm an engine in certain circumstances, by giving a target of maximal acceleration, the integral should not increase the quantity if the engine acceleration is lower than the maximal acceleration given by the target.

LIMITATION OF RCO RANGE

The auxiliary PID module owns two adjustable parameters to limit the value of the RCO. A parameter limits the RCO downward and one limits it upward.
These two parameters are also used to limit the integral it self (see above).
They thus have a double action (they act twice).

Utility of the programmable limitations:

It happens that the organ managed by the PID does not have to take all the range of possible values.
For example the case of an actuator which would have a useful range of operation only on a certain range of RCO, we shall widely boost response times if we prevent the output of the PID from going beyond this range.
If the RCO could come down much lower than the useful range by a strong negative value of the integral and if the result of the PID suddenly had to increase to follow a modification of command, the integral would lose a precious time to go back positive before the increase can be realized. The same for too high values.

IX) COMPLEMENTARY COMMANDS:

These commands allow to intercept and to modify at will all the targets of the ECU.
It allows to insert calculations not foreseen in the original working of the ECU:

- ignition channels cutoff
- injection channels cutoff
- richness correction cutoff
- modification of ignition advance
- modification of injection time
- modification of injection phase rail 1
- modification of injection phase rail 2
- modification of richness target
- modification of motorized throttle target
- modification of turbo 1A and 1B pressure target
- modification of turbo 1A and 1B rpm target
- modification of turbo 2 pressure target
- modification of turbo 2 rpm target
- modification tick over rpm target
- modification of rpm limiter target

- modification of intake camshafts position target
- modification of exhaust camshaft position target
- modification of fuel pressure target

The complementary commands are based on completely programmable maps. We can choose the variables of inputs of scales, including the variables of pilot modules, and the type of interpolation to be used.
It means that a long chain of calculations can modify the original working of the ECU.
If no input is selected for one of these maps, it is not used in the calculations (its value is forced to a neutral value).

X) AUXILIARY COMMANDS:

The Commander owns 23 direct auxiliary outputs (others than injection and ignition).
It also owns 4 auxiliary outputs by CAN-bus.
These auxiliary commands, when they are not fixed as for the command of motorized throttle or fuel high pressure or the other options forced by the chosen type of application, possess a possibility of programming: they can be controlled by completely programmable maps, including by calculations of pilot modules or auxiliary PID.

TWIN OUTPUTS

4 of these outputs can be coupled 2 by 2. We call them twin outputs. One output in the couple is named output A and the other on is named output B.
When they are declared coupled, the two A and B outputs are controlled by the command A, but the state of the output B is the opposite of the output A.
- If the output A outputs of the ground, the output B is in opened drain (or 12 volts if push-pull).
- If the output A is in opened drain (or 12 volts if push-pull), the output B outputs the ground.

These outputs possess in more an option of electric control, by open drain or push-pull. These outputs have to be the outputs used to manage motorized throttles or electric motors of positioning.

PROGRAMMABLE OPERATIONS

To the various types of outputs corresponds various possibilities of working.
Four types of programmable outputs are:

- command ON-OFF,
- command PWM (from 10 to 10000 Hz), and PWM software (from 10 to 1000 Hz)
- angular command,
- synchronous command.

1) Command ON-OFF:

The output works as a relay controlled by a completely programmable map.
The output being ON-OFF, it is very recommended to use the mode hysteresis in the map of control of this output.

2) Command PWM:

This type is to be selected when we want that the output to be a PWM the cyclic report of which we can choose by a completely programmable map.
One chosen also the frequency of the PWM, 10 Hz to 10000 Hz, or 10 Hz to 1000 Hz for the PWM software and if we want that the first part of every cycle is passive or active.

3) Angular command:

An angular command is a square signal the period of which is the engine cycle and the cyclical ratio of which is flexible.
As the period of the engine cycle varies according to the rpm, the frequency of crenels also varies.

The cyclical ratio is controlled by a completely programmable map.
We chosen also the number of crenels in the engine cycle, and if we want that the first part of every cycle is passive or active.
The engine cycle is divided into equal parts between crenels. That is if we chosen 4 crenellations, each shall make 720°/4 = 180°
The start of the angular command is not specially phased: all that we know, it is the number of crenels to be made during the engine cycle, and the cyclical report in the crenel

4) Synchronous command:
A synchronous command is an angular command (see above) the phase of the beginning of the crenel of which we can choose. The phase of the first crenel, or the angular position of beginning of the crenel, is chosen by the second completely programmable map. The other crenels of cycles (if they exist) follow then, regularly phased in the cycle.

Nonstop acceptable outputs total intensity 15 amperes

Note: Skynam can supply
- electronic relays 20 amperes to control devices requiring more power than support the outputs or if the acceptable total power is exceeded.
- relays of transformation of command by the ground in Push-pull command to 12 volts.
- relays of transformation of command by the ground in H Bridge command to 12 volts.
- relays of Peak and Hold commands.

These devices can be either with electric input, either receive their driving command by the WinjNet Can-bus.

FUNCTIONS OF THE OUTPUTS

OUTPUTS		1A	1B	2A	2B	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
On-Off	fixed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	programmable	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	positive twin programmable	X		X																			
	negative twin programmable		X		X																		
	FISA low pressure fuel pump																						X
PWM	programmable	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X		
	software programmable					X	X	X	X														
	positive twin programmable	X		X																			
	negative twin programmable		X		X																		
	turbo 1A									X													
	servo turbo 1A									X													
	turbo 1B										X												
	servo turbo 1B										X												
	turbo 2											X											
	servo turbo 2											X											
	positive servo turbo 1A	X		X																			
	negative servo turbo 1A		X		X																		
	positive servo turbo 1B			X																			
	negative servo turbo 1B				X																		
	positive servo turbo 2			X																			
	negative servo turbo 2				X																		
	positive motorized throttle bank 1	X																					
	negative motorized throttle bank 1		X																				
	positive motorized throttle bank 2			X																			
	negative motorized throttle bank 2				X																		
	positioning electric motor 1 positive	X																					
	positioning electric motor 1 negative		X																				
	positioning electric motor 2 positive			X																			
	positioning electric motor 2 negative				X																		
	proportionnal electrovalve positive	X		X																			
	proportionnal electrovalve négative		X		X																		
	fuel pressure bank 1 (high or low)					X																	
	fuel pressure bank 2 (high or low)						X																
	intake camshaft positionning bank 1												X										
	intake camshaft positionning bank 2													X									
	exhaust camshaft positionning bank 1														X								
	exhaust camshaft positionning bank 2															X							
	intake camshaft advancing bank 1												X										
	intake camshaft delaying bank 1																X						
	intake camshaft advancing bank 2													X									
	intake camshaft delaying bank 2																	X					
	exhaust camshaft advancing bank 1														X								
	exhaust camshaft delaying bank 1																		X				
	exhaust camshaft advancing bank 2															X							
	exhaust camshaft delaying bank 2																			X			
Synchronous	programmable					X	X	X	X														
	fuel pressure bank 1					X																	
	fuel pressure bank 2						X																

Note 1:

It is not allowed to validate a command on bank 2 if the same command is not validated on bank 1.

Note 2:

The camshaft advancing and delaying commands are paired commands used to manage the positioning of camshaft, as BMW M3 type, with two electrovalves. If one is used, the second one must also be used.

XI) AUXILIARY CAN-BUSES:

The Commander88 ECU owns two auxiliary CAN-BUSES operating in the same way.
It is possible to ask the Commander to get or to send data on the auxiliary CAN-BUSES.
The Commander uses these auxiliary CAN-BUSES in the standard 2.0B (11 bits or 29 bits identifiers with the choice for every frame).
We select the speed of transmission of the CAN from 125 Kbits to 1 Mbit.
In the race software, a 5th type 'Injall', asks the ECU to generate automatically the frames of information necessary for the compatible dashboards with the previous ECUs Sybele, as for example dashboards AIM.

The communication by CAN is made by means of frames. They are the units of transmission, as a sentence in a text.
Frames transport the information to be exchanged between the various devices connected together.
This information is the data of the frame, as the words are the constituents of the sentences.
For every frame to be sent or to received, we supply its 11 bits or 29 bits identifier.
The frames data are constituted of 8 bytes which are grouped in 4 successive 16-bit values (LSB then MSB = little Endian) for the standard frames, or distributed at will for the specific frames.

DATA RECEPTION

1) Storage of the data:
To receive the data of the frames of the auxiliary CAN, the Commander has 16 specific variables called 'AuxCan variables '.
Each of these variables can be allocated to one or several bytes of data of the frames of reception and be then used in the advanced calculations (pilot modules, complementary commands and auxiliary commands).
2) Initialization of the data:
Every AuxCan variable can be initialized with a value chosen to fix its value at the start up of the ECU, before the reception of the first frame which corresponds to it.
3) Error of reception of the data:
An interval of maximum time between two receptions can be defined for every frame. If this interval of time is exceeded, the corresponding AuxCan variables are loaded with their value of error (identical to the value of initialization), and variables error AuxCan correlated are positioned in the state 'Error'.
This temporal control of error can also be deactivated frame by frame.

DATA TRANSMISSION

We can supply to the system of external data recording or to the original electronics of the vehicle the information which they need, as for example the engine torque and other for the automated gearboxes.
1) Frequency of transmission:
For every frame, we select the period of transmission between 10 milliseconds (100 Hz) and 10 seconds.
2) Choice of the data:
Each of 8 bytes of data (distributed in 4 16-bit variables for the standard frames) of the frame to be emitted can have a fixed value or be positioned to the value of a variable chosen in the list of the dozens measures and results of calculations known by the ECU, including the AuxCan variables themselves.

XII) SOME EXAMPLES OF USE OF THE ADVANCED FUNCTIONS:

Among others, these advanced functions allow the motorist to implement:
- counts of time or events,
- sophisticated procedures of breakdowns monitoring and intervention, for example engine gradual cutoff on drop of oil pressure, …
- commands of additive injection type or of water injection,

- control of speeds regulated by electric motors
- regulations on the engine itself, type tick over rpm regulation or additional injection, or regulations on external devices like intake flaps or others,
- modifications of original working if necessary, for example rpm limiter or overboost pressure according to the position of gearbox,
- a limiter of speed, or another type of launch limiter according to the vehicle speed received from the auxiliary CAN or directly calculated by the Commander.
- …