POWER FROM WITHIN

PTO250 CONTROLLER

SMARTECH

A DIVISION OF MECC ALTE

TECHNICAL MANUAL

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Revision	Date	Notes
00	14/06/2034	First version of the manual for the version 01.00 of the controller.
01	03/10/2025	Valid for the firmware version 2.01 7.4.4, 7.4.6, 7.4.9.1, 9.1, 9.5.5, 10.7.35, 10.7.36

Table of Contents

1 Introduction

1.1 References

[1] Mecc Alte EAAS0887xxXA (PTO250 ModBus table).

1.2 Information on safety

Many accidents are caused by poor knowledge and the non-observance of safety regulations, which must be observed when operating and/or servicing the machine.

To prevent accidents, before using or servicing the machine you should read, understand and observe the precautions and warnings in this manual.

This manual contains the following indications:

WARNING!	**This indication is used in the safety messages of the manual when there are danger situations that may cause injuries or death if the danger is not avoided.** **This safety messages describe the normal precautions needed to avoid danger. Ignoring these precautions can cause serious damages to property and/or injury to persons.**
ATTENTION!	**This indication is used in the safety messages for dangers that, if not avoided, may cause injuries, damages or malfunctioning.** **The message can also be used only for minor dangers that may cause damage to equipment and/or people.**
INFORMATION!	**This term indicates that the message includes useful information for the development of the operation or procedures clarifications.**

1.3 Introduction and prerequisites

For the appropriate use of this manual, it is required knowledge of the use and of the installation of PTOs.

WARNING!	**Every intervention must be carried out by skilled personnel. There are dangerous voltages on the terminals of the controller; before carrying out any operation on them, make sure to open the related fuses.** **Do not remove or change any connection when the engine is running. Do not disconnect for any reason the terminals of the current transformers (CT).**

WARNING!	**Wrong operations on the connections can result in leaving the loads unsupplied.**

WARNING!	**Please read this manual carefully before using the controller.**

WARNING!	**The controller uses many configurable parameters, and it is therefore impossible to describe all their combinations and effects.**

WARNING!	**The controller is provided with a "default" configuration; the installer's must adapt the configuration to its application.**

WARNING!	**Mecc Alte carries out a significant effort to improve and update its products; therefore, they are subject to both hardware and software modifications without notice. Some of the features described in this manual may therefore differ from those present in your controller.**

1.4 Notes on the parameter's configuration of the controller

The controller **does not allow** to modify the configurable parameters directly from its front panel. For this purpose, you must use the BOARDPRG4 configuration software, which can be downloaded free of charge after registering on the Mecc Alte website www.meccalte.com.

It simplifies the configuration of the controller, and its use is highly recommended. Furthermore, it allows saving the controller configuration to a file, for any restores or for the configuration of identical systems.

BOARDPRG4 allows the configuration of all Mecc Alte controllers; for the connection, you must use the USB interface of the controller.

1.5 Definitions

In this document, the term "**ALARM**" indicates an anomaly that disconnects the loads from the generator, and, where possible, stops the engine.

The term "**WARNING**" indicates an anomaly that does not disconnect the loads from the generator but requires some actions by the operator.

1.5.1 Acronyms

AIF Identifies a function for configuring analogue inputs ("ANALOGUE INPUT FUNCTION"). The number following the wording "AIF" is the code to set in the parameter that configures the function of the desired analogue input.

AL Identifies an anomaly. The number following the wording "AL" is the code of the anomaly.

AOF Identifies a function for configuring the analogue outputs ("ANALOGUE OUTPUT FUNCTION"). The number following the wording "AOF" is the code to set in the parameter that configures the desired analogue output function.

AVR Identifies the electronic controller of the alternator ("AUTOMATIV COLTAGE REGULATOR").

DIF Identifies a function for configuring digital inputs ("DIGITAL INPUT FUNCTION"). The number following the wording "DIF" is the code to be set in the parameter that configures the function of the desired digital input.

DOF Identifies a function for configuring digital outputs ("DIGITAL OUTPUT FUNCTION"). The number following the wording "DOF" is the code to set in the parameter that configures the desired digital output function.

DTC Identifies a diagnostic code ("DIAGNOSTIC TROUBLE CODE") acquired from an external controller (ECU or AVR) through a communication interface.

ECU Identifies the electronic controller of the engine ("ENGINE CONTROL UNIT").

EVT Identifies an event stored in the historical archive. The number following the wording "EVT" is the numeric code of the event.

GCB Identifies the circuit breaker that connects the generator to the loads ("GENERATOR CIRCUIT BREAKER").

ST Identifies an internal status of the controller, provided for the AND/OR logics. The number following the wording "ST" uniquely identifies each single status.

1.6 Conventions

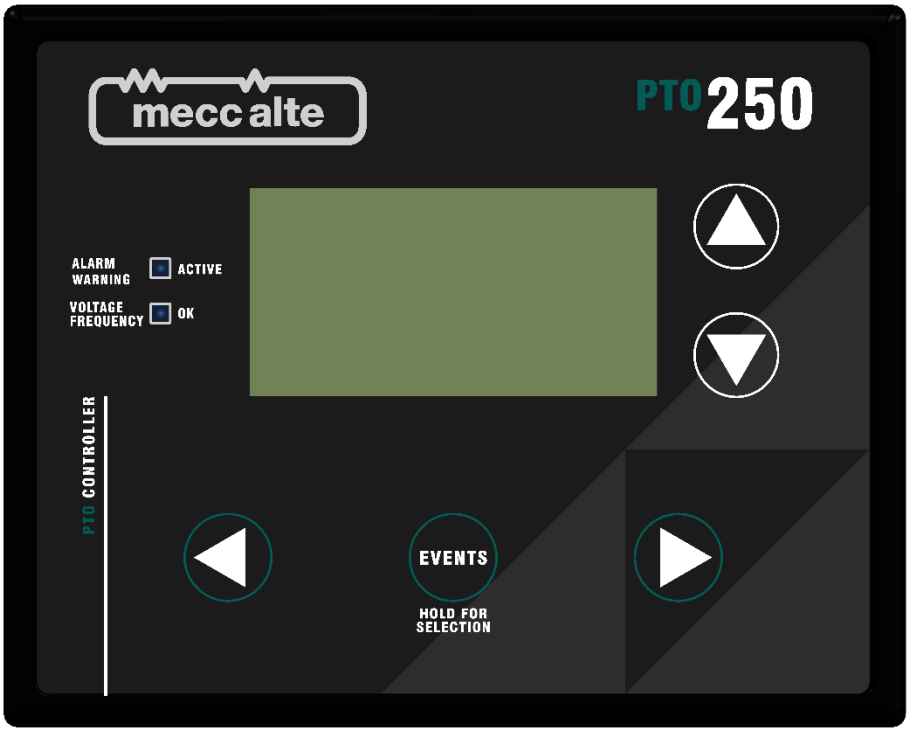
Changes from the previous version of a paragraph are highlighted with a vertical bar on the right of the paragraph. Changes to table fields are highlighted with a grey background colour.

1.7 Revisions of the software

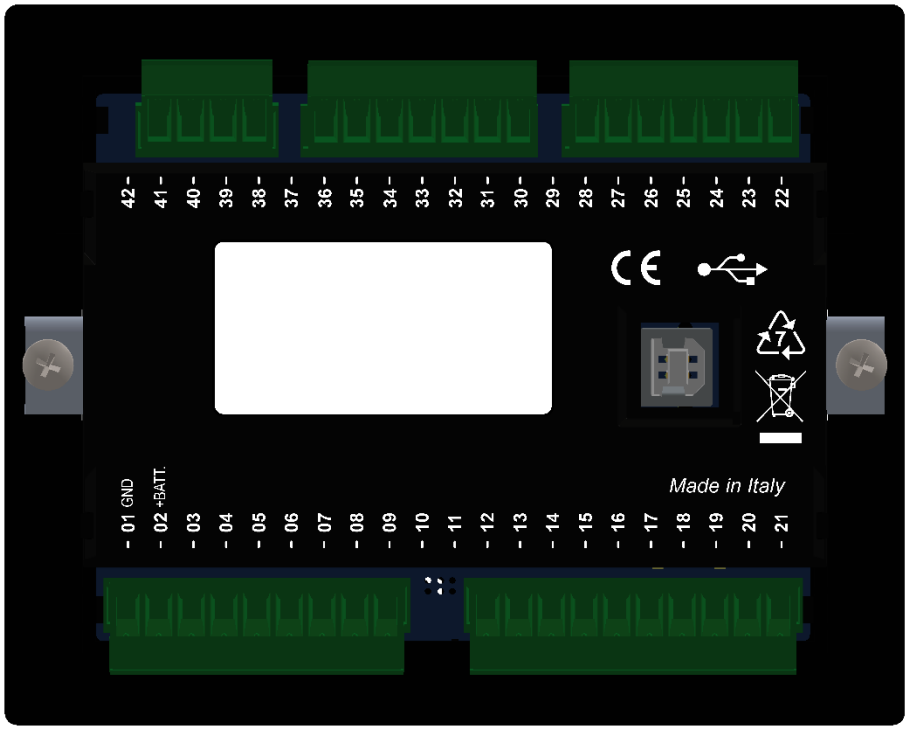
This manual refers to the firmware revision of the controller at various points.

A revision is identified by the Mecc Alte code assigned to it (visible on the back side of the controller). The code format is: EB0250444XXYY, where "XX" is the main firmware revision, and "YY" is the secondary revision. So, for example, the code EB02504440200 refers to the revision "2.00" of the firmware. The controller shows the firmware revision on the "S.02" page of the front panel.

2 Views of the controller



PTO250 Front view



PTO250 Back view

3 Technical features

Description	Specification
Supply voltage (T.01…T.02).	7...32 Vdc for continuous operation, protection trips at 60 Vdc. Protection against the polarity inversion. Integrated self-restoring fuse. The controller identifies the rated supply voltage (12 or 24 Vdc) when powered (used for the protections on the power supply voltage).
Maximum power consumption in operating conditions (backlight of the display activated, digital inputs active; ongoing communicating on CAN interface; analogue inputs connected to GND; static outputs not active).	• 230 mA @ 7 Vdc • 110 mA @ 27 Vdc • 132 mA @ 13.5 Vdc
AC measurements (T.30…T.41).	12-bits analogue/digital conversion; sampling frequency 10kHz. TRMS measurement of the L-N and L-L voltages; measurements of the neutral voltages referred to the negative power supply terminal of the controller. Input impedance of the voltage measurements: • minimum 280 kOhm L-N. • minimum 560 kOhm L-L. • minimum 1600 kOhm L-GND. • minimum 1450 kOhm N-GND. Three currents measurement (through shunts) with common negative terminal and external CTs ratio. It is required to use external CTs with a secondary current of 5A and a minimum power of 1 VA (5 VA suggested). **It is mandatory to connect the negative terminals of the CTs (T.41) to the negative power supply terminal of the controller.** External CTs must provide at least one REPEATED (DOUBLE) insulation if you want to use the controller in the Overvoltage Cat. III.
Maximum allowed AC voltages.	• 300 Vac in CAT.III for L-N. • 520 Vac in CAT.III for L-L.
Maximum measurable AC voltages.	See below the minimum voltages required for the frequency measurement.
Maximum allowed AC currents.	Continuous 5 Aac. Transitory over current up to 20 Aac (sine wave, maximum 3 s) with progressive loss of precision. Maximum transitory over current up to 50 Aac (sine wave, maximum 1 s).
Frequency measurements.	Rated frequency 50 or 60 Hz, measurement from 3 to 99.9 Hz. The controller measures the frequency on the L1 voltage (T.34). Minimum voltage for reading the frequency: • 29 Vrms L-N @ 50Hz. • 32 Vrms L-N @ 60Hz.

Description	Specification
Digital inputs (T.16…T.19)	Four digital inputs with GND-activation. You can revert the activation logic by configuration. When open, the voltage on the terminals is: • 4.1 Vdc for the input T.16. • 4.6 Vdc for the other three inputs. The activation/deactivation threshold is 1.55 Vdc. Typical current when activated: • 4 mA for T.16. • 4.6 mA for the other three inputs. Maximum voltage applicable: 60 Vdc. Minimum voltage applicable: -24 Vdc. The input T.16 can be used as analogue input (using configurable parameters).
Statics outputs (T.03…T.08)	**Use external opening overvoltage damping diodes, especially for inductive loads.** For all outputs, the outgoing current is supplied through the positive supply terminal (T.02) of the controller. T.05…T.08: four independent configurable outputs, providing (when activated) the positive power supply voltage. Maximum load: 500 mA each (continuous). The overload protection cuts in to limit the current spikes to an instantaneous value of 4 A, to allow the activation of loads that require a transient inrush current greater than the rated. If this condition persists, after 150 µs the thermal protection cuts in progressively, until the output is turned off. Integrated protection: overheating, overload, short-circuit, voltage surge and reverse polarity. Two independent configurable outputs (T.03…T.04), providing (when activated) the positive power supply voltage. Maximum load: • 10 A resistive for 10 s. • 5 A resistive continuous at 32 Vdc. Integrated protections: thermal, overload, short circuit and reverse polarity.
Analogue inputs (T.09).	DC voltage input, with a range 0 to 32 Vdc (referred to T.01-GND). Configurable as digital input, with a positive Vdc activation (activation threshold 4 Vdc).
Analogue inputs (T.13…T.15).	Three inputs for resistive sensors, with an additional terminal (T.12) for the measurement and compensation of the reference potential of the common negative pole of the senders. Resistance measuring range: • Standard: 0...1 kOhm with error < 1 %. • extended: 0...3 kOhm with error < 2%. The three measurement inputs can also be used as digital inputs (with GND activation): the activation/deactivation threshold is 1.17 Vdc. Voltage compensation range of the reference point: -2.7...+3.5 Vdc (with 100-Ohm senders).
Analogue inputs (T.16).	DC voltage input, with a range 0 to 32 Vdc (referred to T.01-GND). Configurable as digital input (with GND activation).
USB interface.	USB 2.0 for non-permanent connection to PC (max 6 m) only for the configuration of parameters with BOARDPRG4. The controller can be powered directly from the USB, with a maximum consumption of 250 mA.
CAN interface (T.20…T.21)	CAN interface without galvanic isolation. Fix internal termination of 120 Ohm. Suitable for ECU and AVR connection.

Description	Specification
Display	Graphic transflective LCD, size 65 x 33mm, resolution 128 x 64. Self-regulation of the contrast depending on the internal temperature (manual correction is possible).
Operating conditions.	From -30 °C to +70 °C, 95 % not condensing humidity.
Stock conditions.	From -35 °C to +80 °C.
Size.	141 (L) x 113 (H) x 39 (P) mm.
Weight.	191 g the only controller. 250 g with connectors and fixing.
Dimensions of the mounting place.	118 x 92mm.
Protection degree.	IP 65 external with mounted seal, IP20 internal.

3.1 Measurement resolution

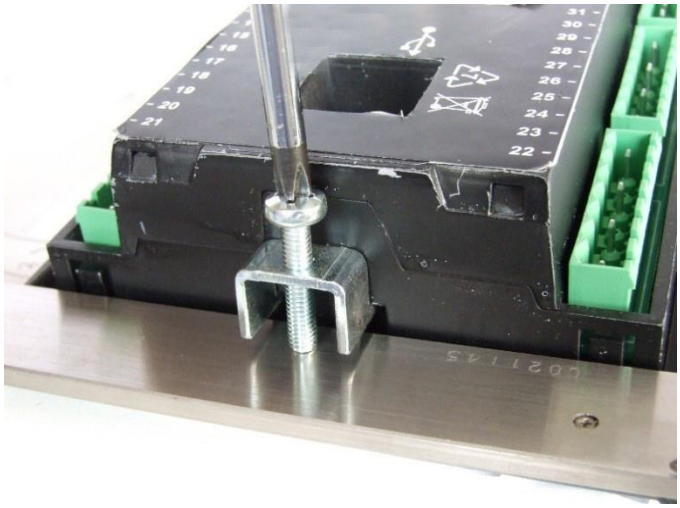
Instruments	Descriptions
AC voltages.	1 Vrms, accuracy < 1% F.S.
Ac Currents.	0.1 Aac (it depends on the CT ratio), accuracy < 1% F.S.
AC frequency.	0.1 Hz ± 50 ppm, 35 ppm/°C typical.
Powers	0.1 kW/kVA/kvar (it depends on the CT ratio).
Power Factor	0.01.
Energy	1 kWh/kvarh.
Engine speed	1 rpm (calculated from frequency).

4 Installation

4.1 Mounting

The controller must be permanently mounted on an electrical panel. The back side of the controller must be accessible only by keys or tools and only by authorized personnel for maintenance operations. It must be impossible to remove the controller without tools. The electric panel must guarantee an adequate protection against bad weather.

The mounting dimensions for the installation are 118 x 92mm. The mounting is carried out by four hooks with screws: once the controller is positioned, insert the hooks in the holes on the sides and tighten the screws. Pay attention not to tighten excessively the screws to avoid damaging the hook on the controller.



⚠ **WARNING!**	**Operating temperature within the panel may vary between -30 °C and + 70 °C.** **The outdoor operating temperature (ambient) may vary between -30 °C and + 60 °C.**

4.2 Wiring

Due to the high voltages connected to the measurement circuits of the controller, all conductive parts of the electrical panel should be connected to the protective earthing through permanent connections.

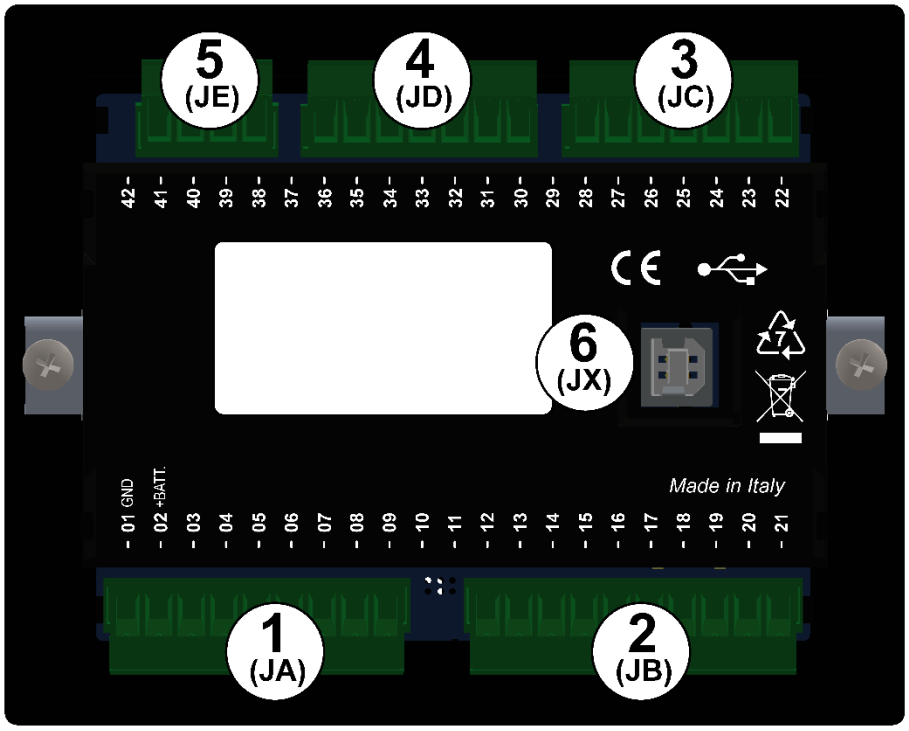
The installation of an overcurrent protection device is required for each phase of the AC voltage inputs. You can use 1A fuses.

The section of the protective earthing conductor should be at least equal to the section of cables used to wire the AC voltages to the control panel. In addition, it must comply with the limit value of the overcurrent protection used.

For CAT.III applications, the maximum allowed L-N voltage is 300 Vac, while the maximum allowed L-L voltage is 520 Vac. The maximum voltage related to the protective earthing is 300 Vac.

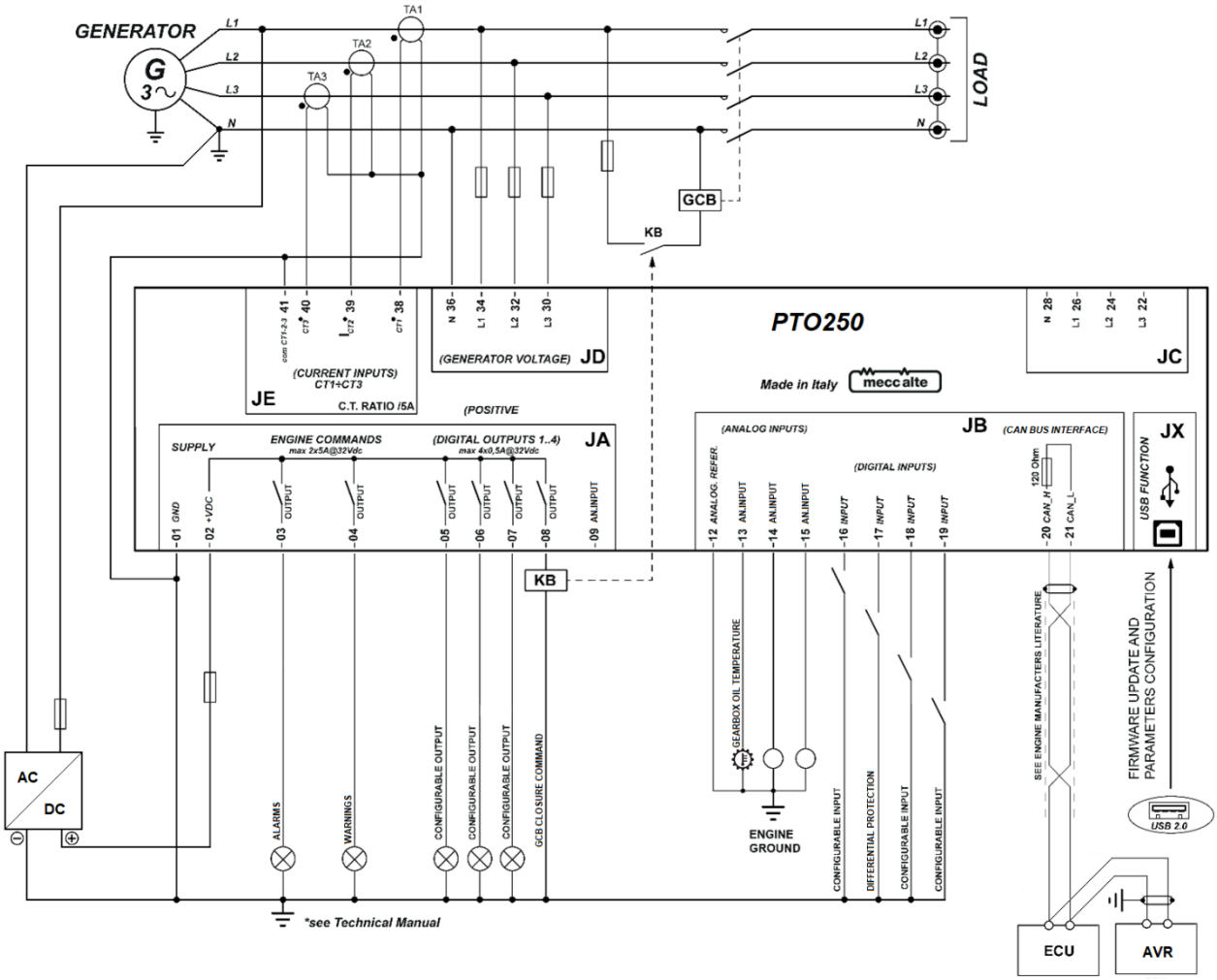
The controller can operate in CAT.III only if its negative power supply terminal and the neutral terminal of the AC voltages are both connected to the protective earth.

5 IN/OUT connections and configuration



N.	NAME	TERMINAL	FUNCTION	DESCRIPTION	CONNECTOR
1	JA	T.01	Power supply +	Power supply.	9 poles x 2.5 mm 2 screw terminals.
		T.02	Power supply -		
		T.03	Digital output.	Configurable outputs (providing the T.02 voltage when activated).	
		T.04	Digital output.		
		T.05	Digital output.	Configurable static outputs (providing the T.02 voltage when activated).	
		T.06	Digital output.		
		T.07	Digital output.		
		T.08	Digital output.		
		T.09	Analogue input.	Configurable digital/analogue input (0…32 Vdc).	
2	JB	T.12	Analogue reference.	Configurable digital/analogue inputs (resistive).	10 poles x 2.5 mm 2 screw terminals.
		T.13	Analogue input.		
		T.14	Analogue input.		
		T.15	Analogue input.		
		T.16	Digital input, analogue input 0...10V.	Configurable digital inputs.	
		T.17	Digital input		
		T.18	Digital input		
		T.19	Digital input		
		T.20	CAN_H.	CAN interface for ECU and AVR.	
		T.21	CAN_L.		
3	JC	T.22		Reserved.	4 poles x 2.5 mm 2 screw terminals.
		T.24			
		T.26			
		T.28			
4	JD	T.30	L3	AC voltages.	4 poles x 2.5mm 2 screw terminals.
		T.32	L2		
		T.34	L1		
		T.36	N		
5	JE	T.38	I1	Current measurement.	4 poles x 2.5 mm 2 screw terminals.
		T.39	I2		
		T.40	I3		
		T.41	Common 1-2-3		
6	JX		USB		USB B

5.1 Principle connection diagram


GENERATOR
L1
L2
L3
N
TA1
TA2
TA3
LOAD
GCB
KB
PTO250
Made in Italy
mecc alte
JE
(CURRENT INPUTS)
CT1+CT3
C.T. RATIO /5A
JD
(GENERATOR VOLTAGE)
JC
JA
SUPPLY
ENGINE COMMANDS
max 2x5A@32Vdc
(DIGITAL OUTPUTS 1..4)
max 4x0,5A@32Vdc
(POSITIVE)
JB
(ANALOG INPUTS)
(DIGITAL INPUTS)
(CAN BUS INTERFACE)
JX
USB FUNCTION
01 GND
02 +VDC
03 OUTPUT
04 OUTPUT
05 OUTPUT
06 OUTPUT
07 OUTPUT
08 OUTPUT
09 AN.INPUT
12 ANALOG. REFER.
13 AN.INPUT
14 AN.INPUT
15 AN.INPUT
16 INPUT
17 INPUT
18 INPUT
19 INPUT
20 CAN_H
21 CAN_L
120 Ohm
AC
DC
ALARMS
WARNINGS
CONFIGURABLE OUTPUT
CONFIGURABLE OUTPUT
CONFIGURABLE OUTPUT
GCB CLOSURE COMMAND
GEARBOX OIL TEMPERATURE
ENGINE GROUND
CONFIGURABLE INPUT
DIFFERENTIAL PROTECTION
CONFIGURABLE INPUT
CONFIGURABLE INPUT
SEE ENGINE MANUFACTERS LITERATURE
FIRMWARE UPDATE AND PARAMETERS CONFIGURATION
USB 2.0
ECU
AVR
*see Technical Manual

5.2 T.01…T.02 - Power supply.

⚠ **ATTENTION!**	**To respect safety rules, select the external power supply unit that guarantees an insulation level of the DC side from the AC side compliant with norm IEC61558-2-6 or equivalent**.

Connect a continuous DC power source to the terminal **T.01** (negative) and to the terminal **T.02** (positive).

The negative terminal **T.01** is the reference and the common return of the digital inputs, outputs, current and voltage measurement. **It must be connected to the protective earth.** Systems that require insulation between the negative power supply terminal and the protective earth can be used but can generate operating problems and may require particular care, as the use of insulation transformers for the AC voltage measurements.

Although the controller is protected by a self-restoring internal fuse, it is still necessary to protect the positive line **T.02** with an external fuse. **All the current supplied by the six static outputs T.03...08 flows through the terminal T.02, and it is therefore necessary to pay attention to the fuse dimension.**

The controller automatically detects the rated power supply voltage (12/24 Vdc) when it is powered (for managing the related logics and alarms).

The controller shows the measured power supply voltage on display page S.02

⚠ **WARNING!**	**During installation, connect the power supply positive terminal only after opening all fuses available in the panel.**

5.3 T.03…T.08 - Static digital outputs.

The six output are fully configurable per function and per polarity. The display page S.05 shows their status.

When activated, they provide the positive power supply voltage on their terminals. The current supplied by all the outputs flows through the **T2** terminal**; make sure that the safety fuse on this terminal has a capacity and a response time suitable to power and protect all the outputs and the controller under any conditions.**

Although all outputs provide an internal diode for damping opening over voltages, we recommend to always use external diodes; with particularly inductive loads (remote circuit breakers, electromagnets, etc.) **it is mandatory to use external damper diodes.**

⚠ **ATTENTION!**	**For currents above the nominal value, it is mandatory to use an external relay.**
⚠ **ATTENTION!**	**Outputs T.03…T.04: for inductive loads higher than 500 mH it is mandatory to use an external relay.**

The following table shows the default configuration for each digital output.

DIGITAL OUTPUTS		
Terminal	**Reference in BOARDPRG4**	**Default Configuration**
T.03	DO_CONTROLLER_T03	DOF.4004 – “Alarms”
T.04	DO_CONTROLLER_T04	DOF.4001 – “Warnings”
T.05	DO_CONTROLLER_T05	DOF.0000 – “Not used”.
T.06	DO_CONTROLLER_T06	DOF.0000 – “Not used”.
T.07	DO_CONTROLLER_T07	DOF.0000 – “Not used”.
T.08	DO_CONTROLLER_T08	DOF.2034 – “Stable closing command for GCB”.

5.4 T.09…T.16 - Analogue inputs.

The controller provides five analogue inputs, allowing to acquire measurements from the field. They are fully configurable (scaling, measurement units…), and the controller provides two threshold each. The display page S.06 shows their electrical values (both voltage and resistance, when available).

If not required as “analogue”, you can configure all of them as “digital”, by using the function AIF.0100 – “Used as digital input”. The following chapter will describe the activation method when used as digital.

The following table shows the default configuration for each input.

Analogue input		
Terminal	**Reference in BOARDPRG4**	**Default Configuration**
T.09	AI_CONTROLLER_T09	Not used.
T.13	AI_CONTROLLER_T13	Not used.
T.14	AI_CONTROLLER_T14	Not used.
T.15	AI_CONTROLLER_T15	Not used.
T.16	AI_CONTROLLER_T16	Used as digital input.

5.4.1 T.09 - 0…32 Vdc.

This input allows measuring DC voltages, referred to the negative power supply terminal of the controller.

When used as “digital”:

- The input is active if the voltage on its terminal is higher than or equal to 4 Vdc.
- The input is not active if the voltage on its terminal is lower than or equal to 3.5 Vdc.
- The display page S.05 shows its activation status.

5.4.2 T.13…T15 - 0…1 kOhm.

These three inputs allow connecting resistive-type sensors.

All used resistive inputs must have a common negative point connected to terminal T.12. It is not a real measurement input: it is used only together with the other three terminals. Its purpose is to compensate the voltage difference between the negative power supply terminal of the controller (**T.01**) and the common return point of the resistive sensors. The input measures the voltage such voltage difference (with sign). The measured voltage is visible on display page S.06.

⚠ **ATTENTION!**	**Do not directly connect T.12 to T.01 in the electric panel. Use a dedicate wire to connect the common terminal of the senders (from the field) to terminal T.12.**

The system can efficiently compensate for both positive and negative potentials, ranging between -2.7 Vdc and +3.5 Vdc, with 100 Ohm sensors resistance. The range increases for lower resistor values and decreases for higher resistors values, being optimized for the normally used resistor values. If this potential is out of the previous range, the measurement accuracy gets worse.

Considering a 0 Vdc voltage on terminal T.12, the optimal measurement range of the three inputs is 0 to 1 kOhm. They can measure values up to 3 kOhm but with lower accuracy.

You can singularly configure the three inputs as “digital”; in this case:

- The input is active when its terminal is connected to T.01
- The input is not active when the terminal is disconnected.
- The display page S.05 shows its activation status.

5.4.3 T.16 - 0…10 Vdc.

This input allows measuring DC voltages, referred to the negative power supply terminal of the controller.

By default, it is configured to be used “as digital”. When used as “digital”:

- The input is active when its terminal is connected to T.01
- The input is not active when the terminal is disconnected.
- The display page S.05 shows its activation status.

5.5 T.17…T.19 - Digital inputs

The controller provides three specific digital inputs (T.17…T.19). Beside them, if not used as analogue inputs, it is also possible to use T.09, T.13, T.14, T.15 and T.16 as digital inputs (see par. 5.4).

In addition, the controller provides sixteen “virtual” digital inputs: they do not have physical terminals, but their value is the result of logical combinations of other digital inputs, digital outputs, alarms or internal states. You can program this logic with BOARDPRG4.

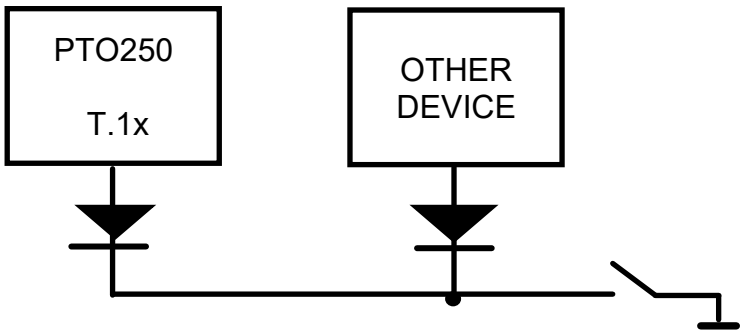
All inputs (including virtual) are fully configurable per function (for the physical ones it is possible to select the polarity). The display page S.04 shows their status.

The following table shows the default configuration for the digital inputs.

DIGITAL INPUTS		
Terminal	**Reference in BOARDPRG4**	**Default Configuration**
T.09	DI_CONTROLLER_T09	Used as analogue input.
T.13	DI_CONTROLLER_T13	Used as analogue input.
T.14	DI_CONTROLLER_T14	Used as analogue input.
T.15	DI_CONTROLLER_T15	Used as analogue input.
T.16	DI_CONTROLLER_T16	Not used.
T.17	DI_CONTROLLER_T17	Differential protection.
T.18	DI_CONTROLLER_T18	Not used.
T.19	DI_CONTROLLER_T19	Not used.

The inputs on terminals T.16…T.19 can be activated by connecting them to T.01. When left flowing, the voltage on the terminals is around 4.5 Vdc (4.15 Vdc for T.16). Avoid situations where intermediate or undefined voltage levels can occur.

If you are going to connect the same physical signal to digital inputs of different controllers, please add diodes as per the following figure:



5.6 T.22...T.28 - Reserved

WARNING!	**These terminals are not used for PTO application. Do not connect anything to these terminals.**

5.7 T.30...T.36 - Generator AC voltages

Use protection fuses (suggested 1 A).

The controller supports four wiring modes, selectable by parameter P.0101:

- Single phase:
  - Connect N to **T.36**
  - Connect L1 to **T.34**
- Two phases with neutral:
  - Connect N to **T.36**
  - Connect L1 to **T.34**
  - Connect L2 to **T.32**
- Three phases with neutral (star):
  - Connect N to **T.36**
  - Connect L1 to **T.34**
  - Connect L2 to **T.32**
  - Connect L3 to **T.30**
- Three phases without neutral (delta):
  - Connect L1 to **T.34**
  - Connect L2 to **T.32**
  - Connect L3 to **T.30**

For CAT.III use, the maximum working voltage is 300 Vac (L-N) and 520 Vac (L-L). Maximum voltage to T.01 is 300 Vac.

INFORMATION!	**Apart from the previous safety notes, the measuring circuit works correctly with maximum 353 Vac between each terminal and T.01. In case of higher voltage differences, the measured voltages may be wrong: in this case insert insulating voltage transformers, and, on their secondary side, connect the neutral to T.01. The insulating VTs can be 400/400.**

The controller measures the frequency on terminal **T.34**. The following table shows the measured quantities depending on the wiring mode:

	Single phase	Two-phases with neutral	Three-phases with neutral	Three-phases without neutral
Frequency	X	X	X	X
L1-N voltage	X	X	X	
L2-N voltage		X	X	
L3-N voltage			X	
L1-L2 voltage		X	X	X
L2-L3 voltage			X	X
L3-L1 voltage			X	X

Phases sequence		X	X	X

The controller shows these measurements on paged M.01…M.03.

5.8 T.38...T.41 – Generator AC currents

The measurement is carried out by internal shunts. You must connect external CTs to these terminals: select transformers with a 5 Aac rated current on secondary side, and which guarantee suitable isolation.

⚠ **WARNING!**	**Do not connect AC voltage to these terminals**.

Any current measurement needs a power of about 1 VA; however, we recommend using 5 VA CTs, to compensate for leaks along the connection cables.

The maximum current that the controller can directly measure is of 5.3 Aac, beyond which the measurement circuit gets saturated. The controller is still able to measure (but with gradually decreasing precision) down to about 20 Aac solely for transient situations and for a time lower than 3 s, such as measuring over currents or short circuit currents on the system, using an algorithm to compensate for the saturation of the measurement circuits.

Terminal **T.41** is the common return terminal for all CTs.

⚠ **WARNING!**	**IMPORTANT: connect terminal T.41 also to terminal T.01, with a wire as short as possible.**

If the external CTs must be connected to other devices in addition to PTO250, PTO250 must be the last in the series.

- Connect terminal T.41 to the common returns point of all CTs.
- Connect terminal T.38 to the CT located on L1.
- Connect terminal T.39 to the CT located on L2 (not for single-phase wiring).
- Connect terminal T.40 to the CT located on L3 (not for single and dual-phase wiring).

The P.0107 allows to configure the rated current on the primary side of the CTs; for example, if you are going to use 60/5 CTs, set P.0107 to 60.

6 Communication resources

6.1 USB interface

The controller provides a USB port (B-type connector) for temporarily connecting a PC, for parameter's configuration or firmware upgrade. The USB protocol specifications do not allow it to be used permanently in the industrial sector due to limited length of the cable and to the elevated sensitivity to electrical disturbances, including on the PC side. **For this reason, the USB connection cable must only be inserted when it is necessary to operate on the controller, and it must be removed when the operation is finished.**

INFORMATION!	**You can power the controller directly by the PC through USB cable, allowing its configuration without using external supply. Make sure that the PC can provide at least 300 mA through the USB port used. The backlight lamp of the display is turned off to reduce the consumption: this is normal, and it is not to be considered a controller fault.**

WARNING!	**When the controller is supplied by the sole USB port, it is not to be considered operative and must not be used to manage the PTO.**

The controller implements the ModBus RTU protocol (in slave mode) on the USB port: its ModBus address is always "1".

Mecc Alte provides some PC software you can use to communicate with the controller:

- **BOARDPRG4**: for configuration.
- **REMOTEWRITER**: for firmware upgrade.
- **HISVIEW**: for reading the history logs.

When you install one of this software, they also install the driver (required by windows 7 and earlier version) for the USB port. After that, when you connect the controller to a PC using USB, the PC will "see" it as a new COM port.

Loading/replacing the firmware of the controller is a specific operation of Mecc Alte; in addition to the operating FW to be loaded, it requires a particular procedure and specific programs and normally this procedure must not be carried out by the person who performs the installation, except in specific situations previously agreed on with Mecc Alte.

6.2 CAN interface

The interface is not galvanically isolated.

Connections:

- Connect CAN_H to terminal T.20.
- Connect CAN_L to terminal T.21.

The use of specific shielded cable is required (for example, HELUKABEL 800571).

INFORMATION!	**A shield is most effective if it is grounded at both ends, but only if it does not act as an equipotential bonding conductor between two systems, resulting in current flowing in the shield. In this case, connect the shield at one end only.**

The CAN interface requires its nodes to be connected to each other in a daisy chain. In this topology, the participating drivers, receivers and transmitters are connected to the main cable via short stubs. The main cable must always be terminated with a 120 Ω resistor on both ends, and the stubs must be as short as possible to avoid signal reflections on the line.

PTO250 has an inbuilt terminator resistor inside, thus, it must be one end of the main cable: check for the proper terminator resistor on the other end.

The controller can use the CAN interface to communicate with external electronic devices:

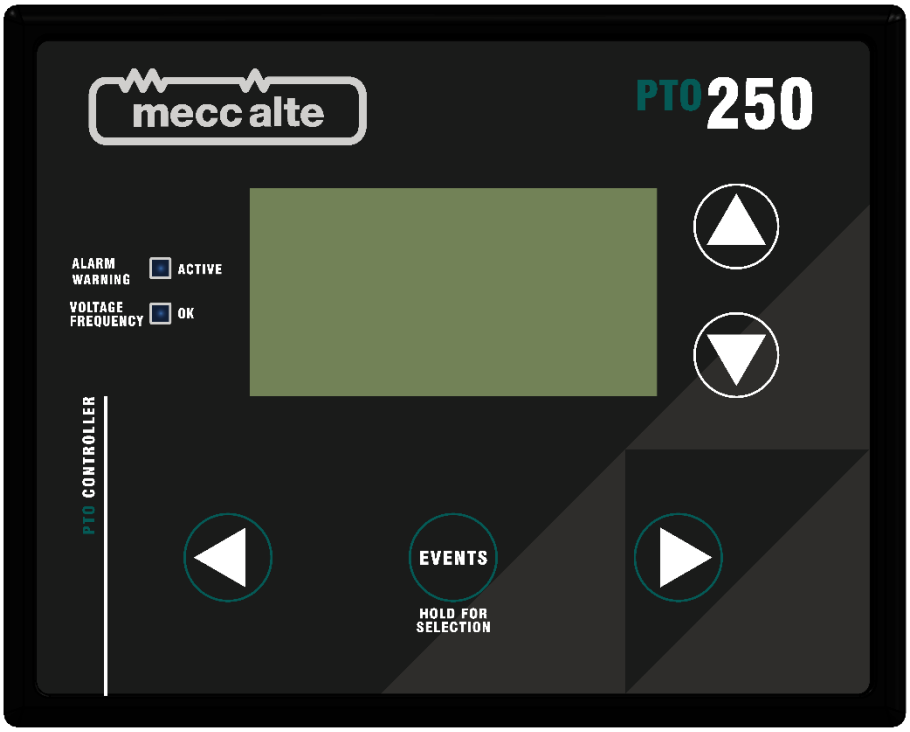
- ECU: the electronic device controlling the engine. The controller can acquire measurement (oil pressure, coolant temperature, speed …) and show them on the display. Optionally, it can manage thresholds on these measurements and send a stop command to the engine in case of alarms. Finally, the controller acquires and shows all diagnostic trouble codes activated by the ECU. See 9.5.5.
- AVR: the electronic device controlling the generator. The controller can acquire measurement (excitation voltage…) and show them on the display. It can also send the voltage setpoint to the AVR. Finally, the controller acquires and shows all diagnostic trouble codes activated by the AVR. See 9.4.7.

The controller provides the following internal states for AND/OR logics:

- ST.256 - "CAN - BUS-OFF"
- ST.257 - "CAN - ERR-PASSIVE"
- ST.258 - "CAN - ERR-ACTIVE"
- ST.259 - "No message on CAN"

7 Commands and indications

7.1 Front panel



PTO250 Front view

7.2 Pushbuttons

Pushbutton		Function
	**UP**	It allows scrolling among the display pages. And: • If pressed together with RIGHT, it increases the display contrast. • In some display pages, after pressing **EVENTS** for half a second, it allows to select one of the items shown (for example, one of the active anomalies). • In some display pages, if pressed together with DOWN for five seconds, it allows to clear the selected item (counter, history log).
	**DOWN**	It allows scrolling among the display pages. And: • If pressed together with RIGHT, it decreases the display contrast. • In some display pages, after pressing **EVENTS** for half a second, it allows to select one of the items shown (for example, one of the active anomalies). • In some display pages, if pressed together with DOWN for five seconds, it allows to clear the selected item (counter, history log).
	**LEFT**	It allows scrolling among the display pages. And: • At power on: o if pressed together with RIGHT, it allows aggressing special functions. o If the controller detects memory errors, it allows to recheck; if pressed together with **EVENTS**, it accepts the errors and allows going on. o If the controller detects a new firmware in memory, it allows to upgrade the firmware (pressed together with **EVENTS**) or going on without upgrading (alone).
	**RIGHT**	It allows scrolling among the display pages. And: • If pressed together with LEFT or RIGHT, it increases or decreases the display contrast. • At power on: if pressed together with RIGHT, it allows aggressing special functions.
	**EVENTS**	It shows/hides the history logs. And, **<u>if pressed for half a second</u>**: • In some display page, the operator can select one of the shown items. He must press **EVENTS** for half a second, then he can use the other pushbutton to select the item (press **EVENTS** again to go back to standard visualization mode). • If pressed for half a second while the display shows the history logs: It allows entering/exiting the selected archive. • In display pages S.04 and S.05, if pressed for half a second it allows to switch physical/logical visualization of digital resources. • At power on: o If the controller detects memory errors, if pressed together with LEFT, it accepts the errors and allows going on. o If the controller detects a new firmware in memory, it allows to upgrade the firmware (pressed together with LEFT).

The controller provides the following internal states for AND/OR logics:

- ST.304 – LEFT pushbutton.
- ST.305 – EVENTS pushbutton.
- ST.306 – RIGHT pushbutton.
- ST.307 – UP pushbutton.
- ST.308 – DOWN pushbutton.

7.3 Indicators

LED OFF	LED steady ON	LED flashing
☐	▣	⧈

Indicator	LED Status	Description
ALARM WARNING	▣	There is at least one alarm.
	⧈	There are no alarms, but at least one warning.
	☐	There are no anomalies.
VOLTAGE FREQUENCY	▣	The engine is running, and the generator voltages/frequency are steadily correct.
	⧈	Duty cycle 50%: transition among other states
	⧈	Duty cycle 25%: the engine is running, but the generator voltages or frequency are too low.
	⧈	Duty cycle 75%: the engine is running, and the generator voltages or frequency are too high.
	☐	The engine is stopped; no generator voltages/frequency.

At power up, the controller performs the lamp test of all the indicator lights.

7.4 Multifunctional display

7.4.1 LCD lighting

The controller provides a back light lamp to make the display more visible. It keeps the lamp always switched on, except when the controller is powered by the USB interface only (to reduce the power consumption from the USB interface of the PC).

7.4.2 Contrast adjustment

Depending on the environmental temperature conditions, you may need to adjust the contrast to view the display correctly. Press in sequence the pushbutton **RIGHT** + **DOWN** to decrease the contrast (lighten), press **RIGHT** + **UP** to increase it (darken).

7.4.3 Mode navigation

The display has different visualization modes composed by different pages:

Mode	Description	Identifier
STATUS	Status information	S
MEASURES	Electrical AC measurements	M
ENGINE	Engine measurements	E

Use the **UP/DOWN** pushbuttons to scroll among the visualization modes (in a cyclic way). Use the **LEFT/RIGHT** pushbuttons to scroll among the pages inside the current visualization mode (in a cyclic way).

The controller can automatically hide a page if it does not contain any relevant information. The **LEFT/RIGHT** pushbuttons automatically skip hidden pages. If all pages in a visualization mode are hidden, the controller skips that mode when you press **UP/DOWN**.

The controller manages an additional visualization mode, which behave differently:

Mode	Description	Identifier
HISTORY	History logs	H

Press the EVENTS pushbutton (from any other visualization mode) to enter the “H” mode: the controller will store the current display page before showing the history logs; when you’ll press EVENTS again (from within the “H” mode), the controller will move you back to the store page.

Inside the “H” mode you can:

- Use LEFT/RIGHT to select the desired archive (in a cyclic way).
- Press EVENTS for half a second to show details on the selected archive.
    - Press UP/DOWN to scroll among the records in the selected archive.
    - Press LEFT/RIGHT to scroll among the pages for the selected records in the selected archive.
    - Press EVENTS for half a second to go back to the page allowing to select an archive.

7.4.4 Structure of display areas

The first line of the display (in reverse) shows some page-independent information:

- On the left, it shows the identifier of the selected visualization mode followed by the index of the selected page. For example, “M.01” means that the display is showing the first page of the “M” visualization mode (electrical AC measurements).
- On the right, it shows the symbol “@” when it is saving data in “non-volatile memory”.
- On the right, it shows the symbol “#” when it is making the backup copy of the configuration in the external flash memory (blinking during the copy, solid if the copy is pending but not yet executing).

- On the right, it shows a “key” icon when a digital input configured with the functions DIF.2511 (“Front panel lock”) or DIF.2513 (“Front panel/remote commands lock”) is disabling the front panel commands

The other lines of the display show different information, depending on the selected page.

7.4.5 Automatic pages rotation

To help the operator, the controller periodically shows the pages containing the most relevant information. The pages involved in this function are M.01 to M.04 (see below). When the controller is powered (thus the generator is running), the controller forces the display page M.01 for a time configurable by P.2980 (“Holding time for first page at start”, seconds). After this delay, the controller switches to the next page in the list every P.2981 seconds (“Pages rotation period”). The operator can manually select a different page by using **UP/DOWN/LEFT/RIGHT**: the controller suspends this feature for P.2982 seconds (“Pause in page rotation on operator intervention”), then start again with pages rotation.

Note: some involved pages may be hidden (it depends on the generator wiring M.01): the function operates only on visible pages. For example, in case of single-phase wiring, the only available page is M.01.

7.4.6 Configurable measurement units

The controller provides three parameters allowing to customize the most common used measurement units:

- P.0191 (for temperature): it allows selecting among Celsius or Fahrenheit degrees.
- P.0192 (for pressure): it allows selecting among “bar” and “psi”.
- P.0193 (for volume): it allows selecting among litres and gallons (both US and imperial).

The controller automatically converts all acquired measurements into the selected units and shows them properly.

⚠ **ATTENTION!**	**the operator must take care of threshold and conversion curves (both must be properly set depending on the selected units). The controller never automatically converts thresholds and curves**.

Note that changing one of the previous three parameters results in clearing the history logs.

7.4.7 Status information (S.XX)

7.4.7.1 S.01 ANOMALIES

The controller hides this page if there are no anomalies; when a new anomaly arises, it forces this page.

The page uses two lines for each anomaly; thus, it can contain maximum three anomalies. If they are more, the controller shows the most recent ones. To show the older ones, the operator must:

- Press **EVENTS** for half a second: the controller will highlight the most recent one.
- Use **UP/DOWN** to navigate through the anomalies (the controller highlights the selected one).
- Press **EVENTS** to go back to normal visualization mode.

For each anomaly, the controller shows:

- A letter identifying the type (“A” for alarms, “W” for warnings).
- A three-digit numeric code that uniquely identify the anomaly. This code flashes until the anomaly is acknowledged by pressing any pushbutton.
- An icon that identifies the anomaly (see 10). The icon can be hidden using bit 11 of P.0495.
- A description in English. For the “generic” anomalies activated by digital inputs, or for the ones activated by thresholds on analogue inputs, the controller shows the customized message associated to the relevant input.

The anomalies 198 and 199 (alarms/warning from external devices connected on CAN interface) require the display of some additional information (the diagnostic codes). In this cases, the last three rows show the information related to the active diagnostic code:

- The external device that generated the code.
- The SPN code (it is a standard code defined by the SAE J1939 standard, which identifies the mechanical component that is having the problem).
- The FMI code (it is a standard code defined by the SAE J1939 standard, which identifies the type of problem).
- How many times this diagnostic code has been activated (OC).
- The alarm code specific for the external device (DTC).
- An alphanumerical description (in English) of the problem.

Depending on devices, only a subset of the previous information may be available (hidden or replaced by dashes). if more than one code is active, the controller rotates them every two seconds. The controller keeps a diagnostic code on the display until the operator acknowledges it (by pressing any pushbutton), even if the external device stops sending that code.

7.4.7.2 S.02 CONTROLLER

It shows the current date/time, the power supply voltage, the unique identification code of the controller and its firmware revision.

7.4.7.3 S.03 COMMUNICATION

It shows the communication status on the USB and on the CAN interfaces. In case of operating problems, check the information contained on this page.

The following symbols show the communication status on the USB interface:

-  Ongoing communication.
-  Stand-by (no ongoing communication).

The CAN interface may operate in three different modes:

- ERROR-ACTIVE: normal operation
- ERROR-PASSIVE: communication is working despite faults (errors).
- BUS-OFF: the controller stopped the communication due to too many errors.

The controller also shows the transmission/reception error counter, and the maximum value they reached. In case of problems, the operator can “reset” the CAN controller in the following way:

- Press **EVENTS** for half a second: the controller will highlight the CAN information.
- Hold **UP/DOWN** for five seconds: at the end, the controller will force the ERROR-ACTIVE status, clear the maximum values reached by the errors counters and inform the operator of the success of the operation.
- Press **EVENTS** to go back to normal visualization mode.

It is also possible to send this command through the communication ports (see paragraph 9.1 for protecting the controller from commands sent over the communication ports):

- “64” clears the CAN interface’s counters and forces ERROR-ACTIVE.

7.4.7.4 S.04 DIGITAL INPUTS

This page shows the status of all available digital inputs:

- “1”: if the input is active.
- “0”: if the input is not active.
- “-”: if the input is not available.

The terminals T.09…T16 can operate both as analogue/digital: when used as analogue, their value is “not available”.

The page shows the status of both physical and virtual inputs. For the physical inputs, the controller allows configuring the polarity: in case of reverse polarity, the physical status of an input is the opposite of its logical one. The operator

can press the **EVENTS** pushbutton for half a second to switch the controller from showing logical statuses to physical ones, and vice-versa (physical are shown in reverse).

7.4.7.5 S.05 DIGITAL OUTPUTS

This page shows the status of all available digital outputs:

- "1": if the output is active.
- "0": if the output is not active.

The controller allows configuring the polarity for each digital output: in case of reverse polarity, the physical status of an output is the opposite of its logical one. The operator can press the **EVENTS** pushbutton for half a second to switch the controller from showing logical statuses to physical ones, and vice-versa (physical are shown in reverse).

7.4.7.6 S.06 ANALOGUE INPUTS

This page shows the electrical measurements acquired by all analogue inputs (even if they are used as digital). It shows the DC voltage on each terminal, referred to T.01. For the resistive analogue inputs, it also shows the calculated resistance (Ohm).

Terminal T.12 is not an analogue input, but the controller uses the measured voltage on its terminal to correctly calculate the resistance of resistive inputs: that is why this page shows its value too.

7.4.8 Electrical AC measures (M.XX)

7.4.8.1M.01 AC FREQUENCY

This page shows different information depending on the wirings (P.0101). The purpose is to reduce the number of pages in case of single-phase wiring:

- Three-phases (start or delta) or two-phases:
  - The AC frequency of the generator (in reverse if "out of thresholds").
  - The phase sequence (in reverse if different from what required by P.0319): it shows "-" if unable to detect.

- Single-phase
  - The AC frequency of the generator (in reverse if "out of thresholds").
  - The L1-N AC voltage (in reverse if "out of thresholds").
  - The L1 AC current: the controller hides this information if the CT ratio (P.0107) is "0".

7.4.8.2M.02 L-N AC VOLTAGES

This page shows the L-N voltages of the generator; thus, the controller hides the page if the wiring is three-phases (delta). It also hides the page in case of single-phase wiring because the L-N voltage is shown on page M.01.

For two-phases wiring, it shows just the existing L-N phases. To optimize the number of the display pages, it uses the last rows to show the L-L voltage.

The voltages are shown in reverse if "out of thresholds".

7.4.8.3M.03 L-L AC VOLTAGES

This page shows the L-L voltages of the generator; thus, the controller hides the page if the wiring is single-phases. It also hides the page in case of two-phases wiring, because the L-L voltage is shown on page M.02.

The L-L voltages are shown in reverse if "out of thresholds".

7.4.8.4M.04 AC CURRENTS

This page shows the AC currents of the generator. The controller hides this page if the CT ratio (P.0107) is "0". It also hides the page in case of single-phase wiring, because the L1 current is shown on page M.01.

For two-phases wiring, it shows just the existing phases.

7.4.8.5M.05 AC POWERS (TOTAL)

This page shows the AC powers of the generator. The controller hides this page if the CT ratio (P.0107) is “0”. It contains:

- The active power (kW).
- The reactive power (kvar).
- The apparent power (kVA).
- The power factor.
- The load type:
  - “I” for inductive loads (lagging).
  - “c” for capacitive loads (leading).

7.4.8.6M.06 POWERS (per phase)

This page shows the AC powers of the generator phase by phase. The controller hides this page if the CT ratio (P.0107) is “0”. It also hides the page in case of single-phase wiring because the line powers are identical to the total ones shown in page M.05. For each phase it shows:

- The active power (kW).
- The power factor.
- The load type:
  - “I” for inductive loads (lagging).
  - “c” for capacitive loads (leading).

For two-phases wiring, it shows the powers of just the existing phases.

7.4.8.7M.07 ENERGY

This page shows the active and reactive energy counters (partial and total) managed by the controller. The controller hides this page if the CT ratio (P.0107) is “0”.

The active power is counted only if positive (it is not counted in the event of reversed power). The reactive power is counted in module (the counter goes up both with capacitive loads and with inductive loads). The operator can clear the “partial counters”, one by one:

- Press **EVENTS** for half a second: the controller will highlight one counter.
- Use **UP** or **DOWN** to select the counter to clear.
- Hold **UP/DOWN** for five seconds: at the end, the controller will clear counter and inform the operator of the success of the operation.
- Press **EVENTS** to go back to normal visualization mode.

7.4.8.8M.08 EXTERNAL MEASURES

The controller allows using its analogue inputs to acquire “generic” measurements (values that the controller does not know how to manage). The operator can configure one or more analogue inputs for this purpose, using the function AIF.2001 (“Generic sensor - page 1”). He can also add a conversion table, a measurement unit and a description.

This page shows the measurements acquired by the analogue inputs configured as AIF.2001. It shows one measurement per line, containing (from left to right):

- The configured description.
- The configured measurement unit.
- The converter value.

Ther controller hides this page if no analogue inputs are configured as AIF.2001.

7.4.8.9 M.09…M.14 AVR STANDARD

These pages contain a series of standard information (J1939-75) acquired via CAN interface from the AVR. The amount of information available depends on the connected device. Information not available is not displayed. The number of pages displayed therefore depends on the actual information transmitted by the connected device:

- SPN 1122 - Engine Alternator Bearing 1 Temperature.
- SPN 1123 - Engine Alternator Bearing 2 Temperature.
- SPN 1124 - Engine Alternator Winding 1 Temperature.
- SPN 1125 - Engine Alternator Winding 2 Temperature.
- SPN 1126 - Engine Alternator Winding 3 Temperature.
- SPN 2436 – Average frequency
- SPN 2437 - Frequency L1
- SPN 2438 - Frequency L2
- SPN 2439 - Frequency L3
- SPN 2440 - Average L-L voltage
- SPN 2441 - Voltage L1-L2
- SPN 2442 - Voltage L2-L3
- SPN 2443 - Voltage L3-L1
- SPN 2444 - Average L-N voltage
- SPN 2445 - Voltage L1-N
- SPN 2446 - Voltage L2-N
- SPN 2447 - Voltage L3-N
- SPN 2448 – Average current
- SPN 2449 - Current L1
- SPN 2450 - Current L2
- SPN 2451 - Current L3
- SPN 2452 - Total active power
- SPN 2453 - Active power L1
- SPN 2454 - Active power L2
- SPN 2455 - Active power L3
- SPN 2456 - Total reactive power
- SPN 2457 - Reactive power L1
- SPN 2458 - Reactive power L2
- SPN 2459 - Reactive power L3
- SPN 2460 - Total apparent power
- SPN 2461 - Apparent power L1
- SPN 2462 - Apparent power L2
- SPN 2463 - Apparent power L3
- SPN 2464 - Total power factor
- SPN 2465 - Power factor L1
- SPN 2466 - Power factor L2
- SPN 2467 - Power factor L3
- SPN 2518 - Load type (total) (0=leading, 1=lagging)
- SPN 2519 - Load type L1 (0=leading, 1=lagging)
- SPN 2520 - Load type L2 (0=leading, 1=lagging)
- SPN 2521 - Load type L3 (0=leading, 1=lagging)
- SPN 2468 - Exported active energy.
- SPN 2469 - Imported active energy.
- SPN 3380 - Excitation voltage
- SPN 3381 - Excitation current

7.4.8.10 M.15…M.20 AVR SPECIFIC

These pages contain a series of specific information acquired via CAN interface from the AVR. The amount of information available depends on the connected device. Information not available is not displayed. The number of pages displayed therefore depends on the actual information transmitted by the connected device.

7.4.9 Engine measurements (E.XX)

7.4.9.1 E.01 MAIN VALUES

This page contains the main engine measurements:

-  : the speed (rpm)
-  : the lubricating oil pressure (bar/psi).
-  : the coolant temperature (°C/°F).

The controller acquires these values from the ECU through the CAN interface. However, it can calculate the speed from the generator frequency, knowing the number of poles of the alternator (P.0150); set P.0150 to “0” to inhibit this calculation.

The controller hides this page if the previous values are all unavailable.

7.4.9.2E.02 COUNTERS

This page contains the running-hours counters (of the engine) managed by the controller:

 : clearable one.

 T: total one, not clearable.

The first counter is clearable:

- Press **EVENTS** for half a second: the controller will highlight the counter.
- Hold **UP/DOWN** for five seconds: at the end, the controller will clear the counter and inform the operator of the success of the operation.
- Press **EVENTS** to go back to normal visualization mode.

7.4.9.3E.03 GEARBOX

This page shows the temperature of the oil in the gearbox. The controller can acquire this measurement by one of its analogue inputs configured as AIF.1121 (“Gearbox oil temperature”). If the measurement is not available, the controller hides this page. The following icon identifies the gearbox oil temperature:

7.4.9.4E.04 DASHBOARD

This page, as indicated by the title, shows all the standard warning lights (lamps) activated by the ECU. This information is acquired via CAN interface. If none of this information is available, the page is not visible. The lamps displayed are:

-  SPN 1081 (“WAIT TO START LAMP”). The ECU is finishing the preliminary operations before starting the engine.
-  it could be used as an alternative to the last one.

-  it signals a low oil pressure condition.
-  it signals a high coolant temperature condition.
-  SPN 624 (“AMBER WARNING LAMP”). The ECU is signalling the presence of a diagnostic code (therefore of a problem) which not prevent the operation of the engine.
-  SPN 623 (“RED STOP LAMP”). The ECU is signalling the presence of a diagnostic code (therefore a problem) that prevents the operation of the engine.
-  Indicates that the regeneration of the diesel particulate filter is inhibited following explicit command. It is usually solid (not flashing). If, however, the condition remains for a long time and the soot level in the filter becomes extremely high, the ECU activates a diagnostic code with red lamp (icon with a STOP sign shape) and stops the engine: in this case the icon may blink (like red lamp). It is linked to SPN 3697 (“DIESEL PARTICULATE FILTER LAMP COMMAND”) or 6915 (“SCR SYSTEM CLEANING LAMP COMMAND”).
-  Indicates that regeneration of the diesel particulate filter is required. It is solid (not flashing) if the quantity of particulate in the filter is above the "regeneration request" threshold but below the warning threshold. It becomes flashing if it is above the warning threshold. It is related to SPN 3703 (“DIESEL PARTICULATE FILTER ACTIVE REGENERATION INHIBITED DUE TO INHIBIT SWITCH”) or 6918 (“SCR SYSTEM CLEANING INHIBITED DUE TO INHIBIT SWITCH”).
-  Indicates that regeneration of the diesel particulate filter is in progress.
-  SPN 3698 (“EXHAUST SYSTEM HIGH TEMPERATURE LAMP COMMAND”). It signals a high temperature (real or possible) in the emissions management system (HEST – High Emission System Temperature), probably because regeneration is in progress or about to start: the ECU could apply a reduction in engine performance (derating).
-  SPN 5245 (“AFTERTREATMENT DIESEL EXHAUST FLUID TANK LOW LEVEL INDICATOR”). Indicates a low level of the Diesel Exhaust Fluid (DEF) tank. It can be solid (not flashing) if the level is below normal, flashing if the low level determines a power derating.
-  Indicates that the engine emissions system has a malfunction or is working outside the standard operating conditions. It can be solid or flashing. It is related to SPN 1213 ("MALFUNCTION INDICATOR LAMP") and 3038 ("FLASH MALFUNCTION INDICATOR LAMP")

This page also shows all the diagnostic codes activated by the engine ECU.

Note: the controller forces this page to be displayed every time a lamp is activated. You can use P.0495 to modify this behaviour:

- If you set bit 09, the controller never forces this page on lamps activation.
- If you set bit 10, the controller forces this page on lamps activation, but not periodically.

7.4.9.5E.05 Emission levels exceedance

It contains a series of standard diagnostic information (J1939-DM32) concerning the exceeding of the emission levels, acquired via CAN interface from the ECU. The controller displays this page only if the ECU transmits this diagnostic information.

A maximum of eight diagnostic information is managed, each of which contains:

- The SPN code, which identifies the engine component causing or having the problem.
- The FMI code, which identifies the type of problem.
- The time (in hours) from here this diagnostic code is active.
- The time (in hours) that this diagnostic code has been active in the past.
- The remaining time (in hours) to the derating of the engine performances.

If two or more codes are active at the same time, they are alternated on the display every two seconds.

7.4.9.6E.06 DPF REGENERATION

The controller fully supports the TIER4 (US) and STAGE V (EU) directives concerning generators emissions. One PTO250, the support consists only in visualization (the commands are managed by the tractor). This page displays the fundamental states in the management of the filter regeneration. The displayed statuses are:

- SPN 3701 (“AFTERTREATMENT DIESEL PARTICULATE FILTER STATUS”): indicates whether filter regeneration is required, based on the levels of ash and/or soot.
- SPN 3700 (“AFTERTREATMENT DIESEL PARTICULATE FILTER ACTIVE REGENERATION STATUS”). Indicates the status of the active regeneration process of the filter.
- SPN 3699 (“AFTERTREATMENT DIESEL PARTICULATE FILTER PASSIVE REGENERATION STATUS”). Indicates the status of the passive filter regeneration process.
- Status of the MANUAL regeneration process of the filter.
- All the causes that prevent the regeneration of the filter:
  - SPN 3702 (“DIESEL PARTICULATE FILTER ACTIVE REGENERATION INHIBITED STATUS”)
  - SPN 3703 (“DIESEL PARTICULATE FILTER ACTIVE REGENERATION INHIBITED DUE TO INHIBIT SWITCH”)
  - SPN 3711 (“DIESEL PARTICULATE FILTER ACTIVE REGENERATION INHIBITED DUE TO LOW EXHAUST TEMPERATURE”)
  - SPN 3712 (“DIESEL PARTICULATE FILTER ACTIVE REGENERATION INHIBITED DUE TO SYSTEM FAULT ACTIVE”)
  - SPN 3713 (“DIESEL PARTICULATE FILTER ACTIVE REGENERATION INHIBITED DUE TO SYSTEM TIMEOUT”)
  - SPN 3714 (“DIESEL PARTICULATE FILTER ACTIVE REGENERATION INHIBITED DUE TO TEMPORARY SYSTEM LOCKOUT”)
  - SPN 3715 (“DIESEL PARTICULATE FILTER ACTIVE REGENERATION INHIBITED DUE TO PERMANENT SYSTEM LOCKOUT”)
  - SPN 3716 (“DIESEL PARTICULATE FILTER ACTIVE REGENERATION INHIBITED DUE TO ENGINE NOT WARMED UP”)
  - SPN 3750 (“AFTERTREATMENT 1 DIESEL PARTICULATE FILTER CONDITIONS NOT MET FOR ACTIVE REGENERATION”)

If none of the previous measurement is available, the controller hides this page. The controller makes available some information concerning the regeneration on the following internal states:

- ST.368: Active regeneration status: not active (spn3700 = 0).
- ST.369: Active regeneration status: active (spn3700 = 1).
- ST.370: Active regeneration status: it will start shortly (spn3700 = 2).
- ST.371: DPF status: regeneration not requested (spn3701 = 0).
- ST.372: DPF status: regeneration required - lowest level (spn3701 = 1).
- ST.373: DPF status: regeneration required - moderate level (spn3701 = 2).
- ST.374: DPF status: regeneration required - highest level (spn3701 = 3).

7.4.9.7E.07…E.11 EXHAUST GAS THREATMENT

These pages show a series of standard information (J1939) acquired via CAN interface from the ECU, concerning emissions management (AFTERTREATMENT). The number of information available depends on the connected ECU. Information not available is not displayed. The number of pages displayed therefore depends on the actual information transmitted by the ECU. Available information:

- SPN 4765 ("AFTERTREATMENT 1 DIESEL OXIDATION CATALYST INTAKE TEMPERATURE")
- SPN 4766 ("AFTERTREATMENT 1 DIESEL OXIDATION CATALYST OUTLET TEMPERATURE")
- SPN 4781 ("AFTERTREATMENT 1 DIESEL PARTICULATE FILTER SOOT MASS")
- SPN 3719 ("AFTERTREATMENT 1 DIESEL PARTICULATE FILTER SOOT LOAD PERCENT")
- SPN 5466 ("AFTERTREATMENT 1 DIESEL PARTICULATE FILTER SOOT LOAD REGENERATION THRESHOLD")
- SPN 3720 ("AFTERTREATMENT 1 DIESEL PARTICULATE FILTER ASH LOAD PERCENT")
- SPN 3251 ("AFTERTREATMENT 1 DIESEL PARTICULATE FILTER DIFFERENTIAL PRESSURE")
- SPN 3242 ("AFTERTREATMENT 1 DIESEL PARTICULATE FILTER INTAKE TEMPERATURE")
- SPN 81 (" AFTERTREATMENT 1 DIESEL PARTICULATE FILTER INTAKE PRESSURE")
- SPN 3246 ("AFTERTREATMENT 1 DIESEL PARTICULATE FILTER OUTLET TEMPERATURE")
- SPN 3721 ("AFTERTREATMENT 1 DIESEL PARTICULATE FILTER TIME SINCE LAST ACTIVE REGENERATION")
- SPN 1761 ("AFTERTREATMENT 1 DIESEL EXHAUST FLUID TANK VOLUME")
- SPN 3031 ("AFTERTREATMENT 1 DIESEL EXHAUST FLUID TANK TEMPERATURE 1")
- SPN 3515 ("AFTERTREATMENT 1 DIESEL EXHAUST FLUID TEMPERATURE 2")
- SPN 3516 ("AFTERTREATMENT 1 DIESEL EXHAUST FLUID CONCENTRATION")
- SPN 5963 ("AFTERTREATMENT 1 TOTAL DIESEL EXHAUST FLUID USED")
- SPN 6563 ("AFTERTREATMENT TRIP DIESEL EXHAUST FLUID")
- SPN 4360 ("AFTERTREATMENT 1 SCR INTAKE TEMPERATURE")
- SPN 4363 ("AFTERTREATMENT 1 SCR OUTLET TEMPERATURE")
- SPN 4332 ("AFTERTREATMENT 1 SCR SYSTEM 1 STATE")
- SPN 4331 ("AFTERTREATMENT 1 DIESEL EXHAUST FLUID ACTUAL DOSING QUANTITY")
- SPN 4334 ("AFTERTREATMENT 1 DIESEL EXHAUST FLUID DOSER 1 ABSOLUTE PRESSURE")
- SPN 5246 ("AFTERTREATMENT SCR OPERATOR INDUCEMENT SEVERITY")
- SPN 3241 ("AFTERTREATMENT 1 EXHAUST TEMPERATURE 1")
- SPN 3236 ("AFTERTREATMENT 1 EXHAUST GAS MASS FLOW RATE")
- SPN 3237 ("AFTERTREATMENT 1 INTAKE DEW POINT")
- SPN 3238 ("AFTERTREATMENT 1 EXHAUST DEW POINT")
- SPN 3239 ("AFTERTREATMENT 2 INTAKE DEW POINT")
- SPN 3240 ("AFTERTREATMENT 2 EXHAUST DEW POINT")
- SPN 5826 ("EMISSION CONTROL SYSTEM OPERATOR INDUCEMENT SEVERITY")

7.4.9.8E.12…E.22 ECU STANDARD

They contain a series of standard information (J1939) acquired via CAN interface from the ECU. The number of information available depends on the connected ECU. Information not available is not displayed. The number of pages displayed therefore depends on the actual information transmitted by the ECU. Available information:

- SPN 22: Engine Extended Crankcase Blow-by Pressure

- SPN 51: Engine Throttle Position.
- SPN 52: Engine Intercooler Temperature.
- SPN 81: Aftertreatment 1 Diesel Particulate Filter Intake Pressure
- SPN 91: Accelerator Pedal Position 1.
- SPN 92: Engine Percent Load At Current Speed.
- SPN 94: Engine Fuel Delivery Pressure.
- SPN 96: Fuel Level 1
- SPN 98: Engine Oil Level.
- SPN 100: Engine Oil Pressure.
- SPN 101: Engine Crankcase Pressure.
- SPN 102: Engine Intake Manifold #1 Pressure.
- SPN 105: Engine Intake Manifold #1 Temperature.
- SPN 106: Engine Intake Air Pressure
- SPN 106: Engine Intake Air Pressure
- SPN 107: Engine Air Filter 1 Differential Pressure
- SPN 108: Barometric Pressure.
- SPN 109: Engine Coolant Pressure.
- SPN 110: Engine Coolant Temperature.
- SPN 111: Engine Coolant Level.
- SPN 132: Engine Intake Air Mass Flow Rate
- SPN 156: Engine Injector Timing Rail 1 Pressure.
- SPN 157: Engine Injector Metering Rail 1 Pressure.
- SPN 158: Key switch Battery Potential.
- SPN 166: Engine Rated Power.
- SPN 168: Battery Potential / Power Input 1
- SPN 171: Ambient Air Temperature.
- SPN 172: Engine Intake 1 Air Temperature
- SPN 173: Engine Exhaust Gas Temperature
- SPN 174: Engine Fuel Temperature 1.
- SPN 175: Engine Oil Temperature 1.
- SPN 182: Engine Trip Fuel.
- SPN 183: Engine Fuel Rate.
- SPN 189: Engine Rated Speed.
- SPN 190: Engine Speed.
- SPN 247: Engine Total Hours of Operation.
- SPN 249: Engine Total Revolutions
- SPN 250: Engine Total Fuel Used.
- SPN 411: Engine Exhaust Gas Recirculation 1 Differential Pressure
- SPN 412: Engine Exhaust Gas Recirculation 1 Temperature
- SPN 441: auxiliary temperature 1
- SPN 442: auxiliary temperature 2
- SPN 512: Driver's Demand Engine - Percent Torque.
- SPN 513: Actual Engine - Percent Torque.
- SPN 514: Nominal Friction - Percent Torque.
- SPN 515: Engine's Desired Operating Speed.
- SPN 544: Engine Reference Torque
- SPN 977: Fan Drive State
- SPN 1108: Engine Protection System Timer Override
- SPN 1029: Trip Average Fuel Rate.
- SPN 1127: Engine Turbocharger 1 Boost Pressure
- SPN 1135: Engine Oil Temperature 2.
- SPN 1136: Engine ECU Temperature.
- SPN 1172: Engine Turbocharger 1 Compressor Intake Temperature

- SPN 1180: Engine Turbocharger 1 Turbine Intake Temperature
- SPN 1181: Engine Turbocharger 2 Turbine Intake Temperature
- SPN 1182: Engine Turbocharger 3 Turbine Intake Temperature
- SPN 1183: Engine Turbocharger 4 Turbine Intake Temperature
- SPN 1241: Engine Fuel System 1 Gas Mass Flow Rate
- SPN 1636: Engine Intake Manifold 1 Temperature (High Resolution)
- SPN 1637: Engine Coolant Temperature (High Resolution)
- SPN 1639: Fan Speed
- SPN 2432: Engine Demand – Percent Torque

It is possible to reset SPN 182 and 1029 (if displayed) directly in the engine control unit (if the ECU supports the command) by holding down the **UP** and **DOWN** pushbuttons for five seconds. It is also possible to send this command through the communication ports (see paragraph 9.1 for protecting the controller from commands sent over the communication ports):

- "67" clears SPN 182 and 1029.

7.4.9.9E.23…E.28 ECU SPECIFIC

These pages contain a series of specific information acquired via CAN interface from the ECU. The amount of information available depends on the connected device. Information not available is not displayed. The number of pages displayed therefore depends on the actual information transmitted by the connected device.

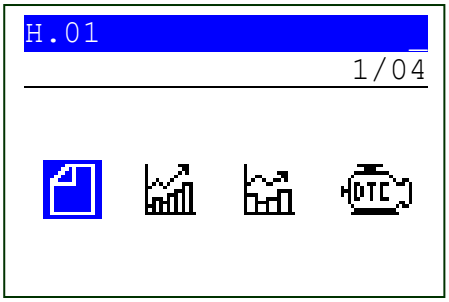
7.4.10History logs (H.XX)

The controller performs periodical or on-event recordings that can be partially configured with programming parameters. The history logs are downloadable via PC through USB connection. The controller manages four types of archives:

Item	Description	Icon	Max
1	Events		64
2	Fast Analogues		42
3	Slow Analogues		64
4	DTC-ECU-AVR		16

Press the **EVENTS** pushbutton for less than half a second (from any other visualization mode) to enter the “H” mode: the controller will store the current display page before showing the history logs. Then it will show the list of available archives (see below).

7.4.10.1 Log selection



Use **LEFT** and **RIGHT** pushbuttons to select the desired archive.

Press **EVENTS** for half a second to show the selected archive.

Press **EVENTS** for less than half a second: the controller will exit “H” mode, move you back to the stored page (see above).

7.4.10.2 Events

When e preconfigured event happens, the controller adds a record in this archive. The capacity is of 64 records. If the archive is full and a new event occurs, the controller overwrites the older one (so always the last 64 events are stored). For each event, the controller records:

- The numeric code.
- One/two icons that describe the event (see the table below).
- The date/time.
- The engine status (stopped/running)
- The status of AC quantities (in thresholds, out of thresholds, off)
- The status of the GCB circuit breaker.

If the event is an anomaly, it also records the measurements described for the analogue archives below.

The controller always records the anomalies. The parameter P.0441 allows selecting the other events to be recorded:

Bit	Description
2	Generator statuses.
3	Engine statuses.
4	Circuit breaker statuses.
5	Circuit breaker commands.

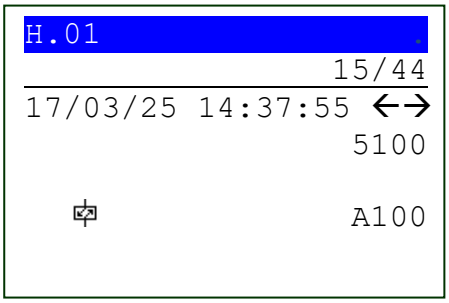
The following table lists all event codes, with the icons used to describe it.

Code	Icon	Event Description
EVT.1020		No AC quantities
EVT.1021		AC quantities present but out of thresholds
EVT.1022		AC quantities present and in thresholds
EVT.1030		GCB close command
EVT.1031		GCB open command
EVT.1032		GCB closed
EVT.1033		GCB open
EVT.1040		Engine stopped
EVT.1042		Engine running
EVT.1074		Reset
EVT.1075		Clock/calendar not valid
EVT.1076		Clock/calendar update
EVT.1077		New power-on
EVT.1078		Default values of the parameters recharged
EVT.1080		GCB closure inhibited.
EVT.1081		GCB closure not inhibited.

Anomalies are themselves saved as events. They are registered with their own code added to:

- EVT.2000: if they are warnings.
- EVT.5000: if they are alarms.

To display every event, the controller uses at least three pages of the display: if the event displayed is one of the 21 most recent anomalies, it uses seven pages. The main page has the following format:



The second line of each event page shows which event is currently displayed (15) and the total number of stored events (44). The example in the previous picture shows the event 15 of 44 stored (out of 64 available).

The fourth line of each event page shows the date/time of the record; on the right it may displays one/two arrows indicating the availability of further pages to the right or to the left of the current page for the current event.

The lines from the fifth to the eighth show different information, depending on the selected page.

- The first page shows the numerical code of the event (”5100” in the given example) and one or more icons which identify the event (see table above). If the event is an anomaly, the controller shows the icon related to the anomaly and its code (A100 in the example).

- The second page shows:
  - The status of the engine:
    - : engine idle (stand-by).
    - : engine running.
  - The status of the AC quantities.
    - : no voltages.
    - : voltages present, but “out of tolerance”.
    - : voltages present and “within tolerance”.
- The third page shows the status of the GCB.
  - : open.
  - : closing.
  - : closed.
  - : opening.

Pages from the fourth to the seventh (available only in the event is an anomaly) are the same of the periodical logs (described below).

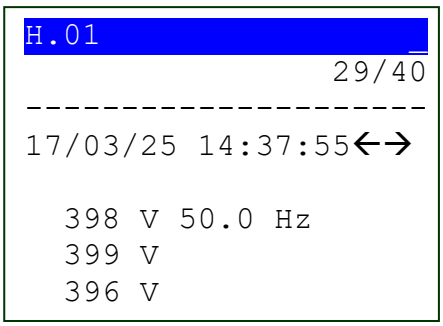
The most recent event is associated to the highest number. Use the **UP** and **DOWN** pushbuttons to scroll among all the records. Use **LEFT** and **RIGHT** pushbuttons to scroll among the pages of the selected record.

7.4.10.3 Periodical recording

The controller performs periodical recordings on two different archives, with two different rhythms, configurable through parameters P.0442 (fast, interval in seconds) and P.0443 (slow, interval in minutes). The controller stores the same information on both archives:

- AC frequency.
- AC L-L voltages.
- AC L-N voltages.
- AC currents.
- AC powers (active, reactive, apparent, power factor, and the type of load).
- Power supply voltage.
- Engine values: engine speed, coolant temperature, oil pressure
- Gearbox oil temperature.

Each record is associated with its date/time. The controller shows dashes for not-available measurements. The controller uses four pages for each record. The first page has the following format:



The second line of each page shows which record is currently displayed (29) and the total number of stored records (40). The example in the previous picture shows the record 29 of 40 stored (out of 42 available).

The fourth line of each page shows the date/time of the record; on the right it may displays one/two arrows indicating the availability of further pages to the right or to the left of the current page for the current record.

The lines from the fifth to the eighth show different information, depending on the selected page:

- The first page shows the AC frequency and the AC L-L voltages.
- The second page shows the AC L-N voltages.
- The second page shows the AC currents, powers, power factor and load type.
- The fourth page displays the power supply voltage, the gearbox oil temperature and the engine related measurements (speed, oil pressure, coolant temperature).

The most recent record is associated to the highest number. Use the **UP** and **DOWN** pushbuttons to scroll among all the records. Use **LEFT** and **RIGHT** pushbuttons to scroll among the pages of the selected record.

7.4.10.4 Fast periodical recordings

The controller adds records with the rhythm configured by P.0442 (interval in seconds, default value is 60). This archive can store up to 42 records. Every following record overwrites the older one.

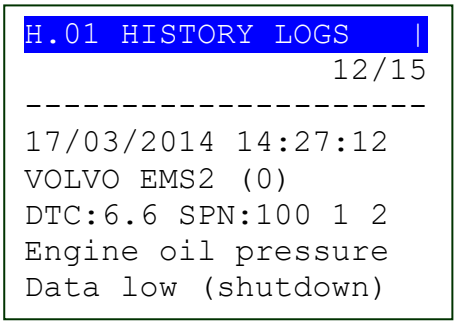
7.4.10.5 Slow periodical recordings

The controller adds records with the rhythm configured by P.0443 (interval in minutes, default value is 30). This archive can store up to 64 records. Every following record overwrites the older one.

7.4.10.6 Diagnostics pages for external devices connected by CAN interfaces (DTC)

The controller records the diagnostic codes received from external devices connected to the CAN interface. Basically, depending on the connected external devices, the diagnostic message consists of the DTC, SPN and fault description. This archive can store up to 16 records. Every following code record overwrites the older one.

To controller uses just one page for each record:



The second line shows which record is currently displayed (16) and the total number of stored records (16). The example in the previous picture shows the record 12 of 15 stored (out of 16 available).

The fourth line shows the date/time of the record.

The fifth line identifies the external controller that triggered the diagnostic code.

The sixth line shows the diagnostic code. It contains:

- DTC (Diagnostic Trouble Code): it is a non-standard diagnostic code, specific to the connected external controller, which can be found in the technical manual of the external controller (in the example, the code "6.6" in the engine technical manual will describe the low oil pressure problem).
- SPN (Suspect Parameter Number): is a numeric code showing the engine part/component that generated the diagnostic code (in the example, “100” identifies oil pressure measure).

- FMI (Fault Mode Identifier): is a numeric code between 0 and 31 that identifies the kind of problem (in the example, “1” indicates an excessively low value of the measure, thus requiring engine stop).
- OC (Occurrence Count): indicates how many times this diagnostic code has already been activated (example “2”).

In addition, if the controller knows the combination of the SPN and FMI codes (or the DTC code), it shows a textual description of the problem (on the last row).

The most recent record is associated to the highest number. Use the **UP** and **DOWN** pushbuttons to scroll among all the records.

7.4.10.7 Locked recordings

The controller stops recording in the archives in case of alarms (to keep the recorded situation until the operator takes care of the alarm itself). When the records are blocked the controller shows a lock icon on the second line:

7.4.10.8 Exit from archives visualization.

Hold the **EVENTS** pushbutton for half a second to go back to the archive selection page; press it for less than half a second to exit the “H” visualization mode.

7.4.10.9 Clearing archives

To clear an archive, the operator must first show one of its records; then he must hold UP and DOWN pushbuttons for five seconds: the controller will clear the archive and inform the operator of the success of the operation. It is also possible to send commands through the communication ports (see paragraph 9.1 for protecting the controller from commands sent over the communication ports):

- “61” to clear the DTC log.
- “62” to clear the event log.
- “63” to clear the periodical logs (both).

8 Configuration

⚠ **WARNING!**	**Assigning an incorrect value to one or more parameters can cause malfunctions, damage to things or injury to people. Only qualified personnel should change the parameters. Parameters can be password protected (refer to par. 8.4).**

ⓘ **INFORMATION!**	

The controller does not allow to modify parameters directly from the front panel. It is required to use the BOARDPRG4 software, connected through USB. This chapter, anyway, provide some general hints.

8.1 Digital outputs configuration

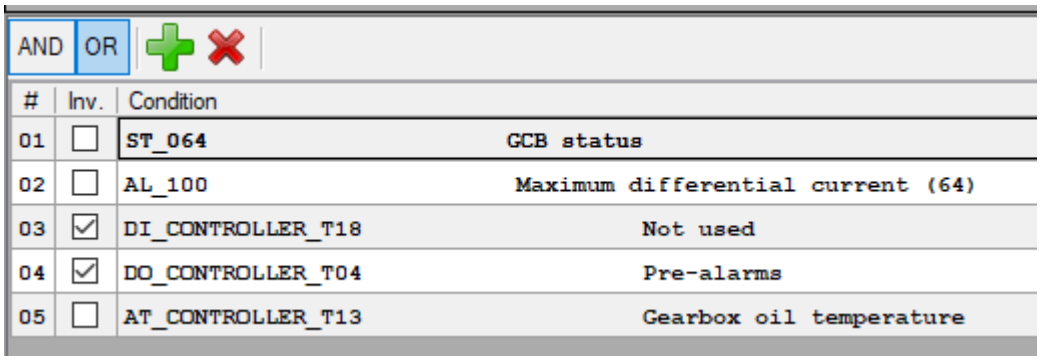
For each digital output, the controller allows to configure:

- A function (DOF.XXXX, Parameter P.3001 for the output T.03).
- The “reverse” polarity (not for virtual digital inputs)

BOARDPRG4 allows to select the “polarity” only if the selected function is different from DOF.0000 (“Not used”). This document describes all the functions in the relevant chapters; the function DOF.0103 (“AND/OR logic”) is not related to any specific function, so it is described here.

8.1.1 AND/OR logics

AND/OR logics are a list of Boolean conditions (true/false, on/off, 1/0) configurable by the operator; the controller evaluates the list and assigns the result to a digital output (or to a virtual digital input, see next chapters). To use AND/OR logics with a digital output, use the DOF.0103 function.



The operator must first decide whether the list of conditions must be evaluated as AND (they must all be verified) or as OR (at least one condition must be verified). It is not possible to have mixed AND/OR logic (it is possible to do so using virtual digital inputs, see later).

Up to 30 conditions can be added. Each condition can be individually negated: in the previous figure, for example, the controller will verify that digital input T.18 and digital output T.04 are both inactive.

The following conditions can be added:

- DI.XXX: logic states of all digital inputs (physical and virtual).
- DO.XXX: logic states of all digital outputs.
- AL.XXX: presence of pre-alarms/blocks.
- ST.XXX: internal states of the controller.
- AT.XXX: statuses connected to the thresholds on analogue measures (see next chapters).

Using virtual digital inputs, you can create mixed AND/OR logics (composed of AND/OR together). Suppose we want to activate the digital output T.03 when the digital inputs T.16 and T.17 are both active, or when the digital input T.18 is active.

We must first associate virtual digital input #1 (for example) with an AND/OR logic configured as AND, which verifies that the digital inputs T.16 and T.17 are both active. Then we must associate digital output T.03 with an AND/OR logic configured as OR that verifies that virtual digital input #1 or digital input T.18 is active. In practice, virtual digital input #1 is used as a “support” for the AND condition. In this case, it is not necessary to associate any function with the virtual digital input.

8.2 Digital inputs configuration

For each digital input, the controller allows to configure:

- A function (DIF.XXXX, P.2001 for input T.16).
- The “reverse” polarity (not for virtual digital inputs)
- An activation delay (P.2002 for input T.16).
- A message (P.2003 for input T.16).

BOARDPRG4 allows to select the “polarity” and the delay only if the selected function is different from DIF.0000 (“Not used”).

The controller uses the “activation delay” only if the input is configured with the following functions:

- DIF.3001 (“Status of GCB circuit breaker”): it is the maximum acceptable delay between the opening/closure command for the circuit breaker and its feedback (if longer times happen, the controller activates a warning).

- DIF.4XXX: all functions greater than 4000 are used to activate alarms/warnings: the controller activates the alarm if the input is logically activated consecutively for this time.

The controller uses the “message” only if the input is configured to activate a generic anomaly:

- DIF.4001 (“Generic warning”).
- DIF.4004 (“Generic alarm”).
- DIF.4011 (“Generic warning (after oil mask delay)”).
- DIF.4014 (“Generic alarm (after oil mask delay)”).
- DIF.4021 (“Generic warning (when GCB is closed)”).
- DIF.4024 (“Generic alarm (when GCB is closed)”).

For using virtual digital inputs, the operator must create an AND/OR logic (see 8.1.1) used by the controller to set the status of the input itself. Then you can assign a function and a delay to the virtual input: the controller will use it as a physical one.

8.3 Analogue inputs configuration

The analogue inputs can be used to acquire predefined quantities (for example the oil temperature of the gearbox), or to acquire generic sensors (and therefore customizable).

Each specific sensor requires a conversion between the electrical measurement (Vdc, Ω) and the final unit of the acquired quantity (for example a pressure). For this purpose, the controller provides the "conversion curves" (see

par.8.3.1). BOARDPRG4 provides a library of the most used sensors in Mecc Alte applications: if the desired sensor is not present in the library, the operator can create his own.

Each analogue input is associated with a set of eight parameters, to define its function, a message (if it is not a “known” measurement to the controller) and two thresholds that can be used to activate anomalies and/or digital outputs. The parameters relating to the T.14 input are shown below as an example. For the parameters relating to other inputs, refer to the BOARDPRG4 configuration page.

NOTE: BOARDPRG4 shows by default for each input only the parameter that configures the function. After selecting a function, you can also change the other parameters.

- P.4017: configures the input function.
- P.4018: configures a message (shown on the display or as the text of an anomaly).
- Two thresholds composed of three parameters each:
  - P.4019 and P.4022: threshold value.
  - P.4020 and P.4023: delay to manage the “out of threshold”.
  - P.4021 and P.4024: configures the check options and the actions in case of “out of threshold”.

The two thresholds are completely independent of each other. The third parameter of each threshold is a “bit” parameter that allows the following options to be associated with each threshold:

- Bit 0
  - OFF: the controller considers the measurement “out of threshold” if it is greater than the threshold.
  - ON: the controller considers the measurement “out of threshold” if it is less than the threshold.
- Bit 1: acts only if the measurement is “out of threshold”:
  - OFF: the controller sets the internal state linked to this analogue input (AT.XXX) to OFF if the measurement is “out of threshold”.
  - ON: the controller sets the internal state linked to this analogue input (AT.XXX) to ON if the measurement is “out of threshold”.
- Bit 4: the controller activates a warning if the measurement is “out of threshold”.
- Bit 7: the controller activates an alarm if the measurement is “out of threshold”.
- Bit 8: the controller masks the anomaly configured with bits 4…7 if the engine is stopped.
- Bit 9: the controller masks the anomaly configured with bits 4…7 if the engine is running by less than P.0216 seconds.
- Bit 10: the controller masks the anomaly configured with bits 4…7 if the GCB circuit breaker is open.

Any combination of these bits can be set.

Note: If you configure an analogue input with the AIF.2051 function (generic sensor), the controller does not display the converted measurement on any display page, but still manages the thresholds described above.

Using the two thresholds and the AND/OR logic together, it is possible to activate a digital output with respect to the value of an analogue measurement, with hysteresis. Suppose we want to activate a digital output if the gearbox oil temperature exceeds 100 °C. We must first manage a minimum hysteresis on the threshold, otherwise when the temperature is close to the threshold, the output would continue to activate and deactivate for minimal variations in the temperature itself. So, let us suppose we want to activate the output if the temperature exceeds 100 °C, and turn it off if the temperature is lower than 95 °C. To do this, for example, we use analogue input T.13. We set the parameters as follows:

- P.4009 (function #1): 1121 (AIF.1121).
- P.4010 (message #1): “”.
- P.4011 (threshold #1): 100.00 °C
- P.4012 (delay #1): 0.5 sec
- P.4013 (configuration #1): 0002 (bit 0 OFF, bit 1 ON)
- P.4014 (threshold #2): 95.00 °C
- P.4015 (delay #2): 0.5 sec
- P.4016 (configuration #2): 0001 (bit 0 ON, bit 1 OFF)

The first threshold is used to activate the internal state associated with the analogue input. Looking at the configuration parameter, you can see that:

- Bit 0 OFF (out of threshold condition if measurement greater than the threshold).
- Bit 1 ON (activates the internal state in the “out of threshold” condition).

The second threshold is used to deactivate the internal state associated with the analogue input. Looking at the configuration parameter, you can see that:

- Bit 0 ON (out of threshold condition if measurement less than the threshold).
- Bit 1 OFF (deactivates the internal state in the “out of threshold” condition).

With the previous programming, therefore, the controller will activate the internal state associated with the analogue input (AT.XXX) when the measurement is greater than 100 °C for 0.5 seconds; it will deactivate the internal state when the measurement is less than 95 °C for 0.5 seconds.

Using the AND/OR logics (see par. 8.1.1), it is possible to “copy” the internal AT.XXX state to a physical output.

NOTE: the thresholds defined here are independent of those set in the “Protections” menus.

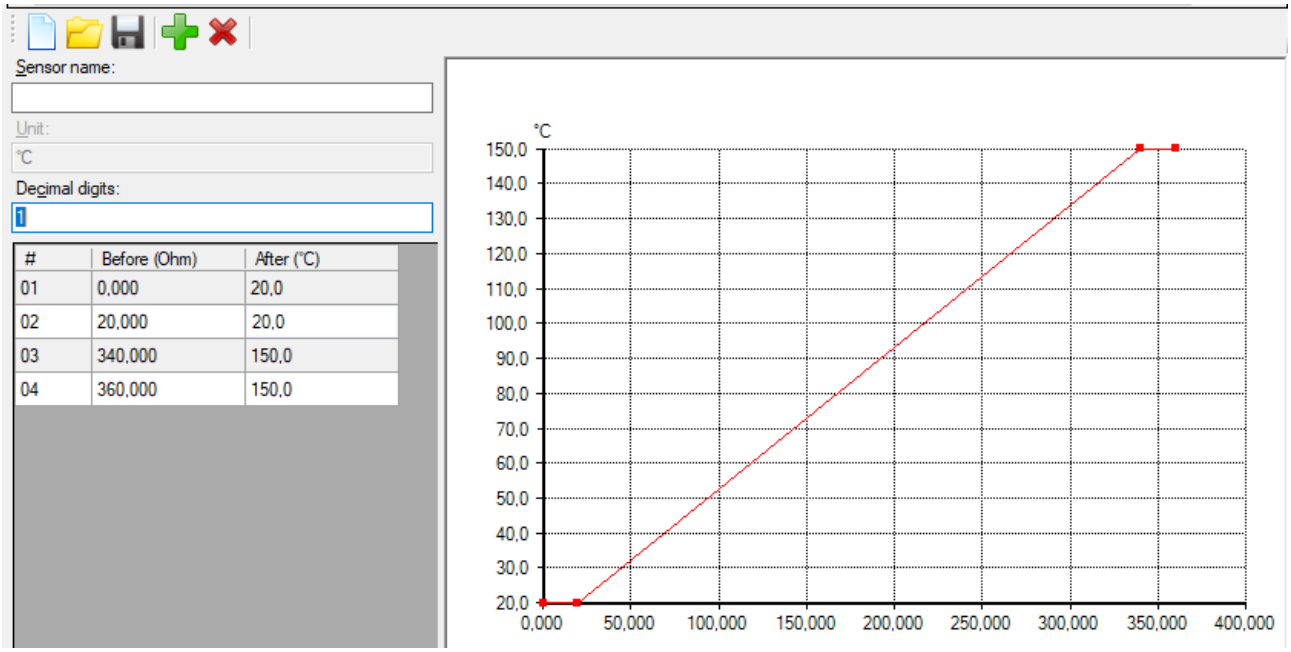
Below is a brief description of some functions:

- AIF.0000 – “Not used”. The analogue input is not used.
- AIF.0100 – “Used as digital input”.

8.3.1 Conversion curves

Conversion curves are a tool that allows you to convert a numeric value into another numeric value. They can be used to convert the electrical measurement acquired from an analogue input into the real measurement of the quantity.

The curves, once created, can be saved to a file for subsequent reuse (even on other controllers).



The previous figure shows a conversion curve associated with an analogue input. The analogue input has been configured with the AIF.1121 function ("Gearbox oil temperature"). With this configuration, the controller will acquire:

- A temperature of 20 °C for a measured resistance lower than 20 Ohms
- A temperature of 150 °C for a measured resistance higher than 340 Ohms
- For measured resistances between 20 and 340 Ohms, the temperature will assume a value between 20 and 150 °C.

Up to 32 points can be added to the graph, thus also creating non-linear curves. Note in the example that the configured curve has two horizontal segments at the beginning and end, obtained by placing two equal values in the "After" column corresponding to two different values in the "Before" column. This is not mandatory, but it allows you to impose a saturation limit on one end or both ends of the curve. In fact, the controller extends the first and last segment of the curve to infinity. Since they are horizontal, whatever value the measurement "to be converted" takes, the same value will be obtained as the "converted" measurement. In the previous example, for any measured resistance lower than 20 Ohms, the temperature will be 20 °C. If the first point (0 Ohm 20 °C) were removed from the previous example, there would be no horizontal segment at the beginning of the curve: in this case, if the resistance dropped below 20 Ohm, the temperature would drop below 20 °C.

BOARDPRG4 allows (via the first buttons at the top left) to save the curve to a file, so that it can then be reused in other applications. It is therefore possible to create an archive of the conversions associated with the sensors used.

8.4 Alternative configurations for parameters.

The controller allows configuring up to two different values for a specific set of parameters: you can then recall any "configuration" using the digital inputs of the controller. This function is usually used with multi-voltage and/or multi-frequency panel.

INFORMATION!	**the controller "copies" the values of a "configuration" into the working parameters, losing their previous values. This means that one of the four available "configurations" must contain the "base" values, to be able to restore them. This also means that, when using this function, you must configure at least two "configurations".**

You can customize the following parameters:

- P.0101 ("Generator voltage wiring").
- P.0102 ("Nominal voltage of the generator").
- P.0105 ("Nominal frequency").
- P.0106 ("Nominal power of the generator").
- P.0107 ("C.T. primary").
- P.0125 ("Nominal power of the engine").
- P.0713 ("Speed at 0% command").
- P.0714 ("Speed at 100% command").
- P.1703 ("Voltage corresponding to 0%").
- P.1704 ("Voltage corresponding to 100%").
- P.1708 ("Rated voltage for AVR").

To select a "configuration, use a digital input configured as DIF.2151, DIF.2152.

INFORMATION!	**The controller accepts the input command only in the first five seconds after power on.**

8.5 Protection password

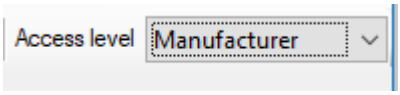
The controller manages three access levels, listed according to their priority:

- MANUFACTURER.
- INSTALLER.
- USER.

Each parameter of the controller is associated to a protection level.

A parameter associated to the MANUFACTURER level can be modified only by the MANUFACTURER himself. A parameter associated to the INSTALLER level can be modified by the MANUFACTURER and the INSTALLER. A parameter associated to the USER lever can be modified by the MANUFACTURER, the INSTALLER, and the USER.

The operator who wants to modify a parameter, must first let the controller recognise him as MANUFACTURER, INSTALLER or USER. On the top-right of the window, BOARDPRG4 shows (and allows modify) the current access level of the operator:



If the operator needs higher access level, should select the desired access level from the dropdown list. BOARDPRG4 will ask for a password: if the typed password is correct, BOARDPRG4 will show the new access level and enable the modification of the relevant parameters.

It is possible to customise the password through parameters P.0001 (MANUFACTURER), P.0002 (INSTALLER) and P.0003 (USER).

If a password gets lost, it is possible to reconfigure it by logging in with the higher-level password. For this reason, we advise against not setting at least the MANUFACTURER password (P.0001): is, in effect, someone else sets it or another lower password (even only for distraction) without communicate it, it will no longer be possible to modify any parameter. By knowing the MANUFACTURER password, it will be possible to nullify or modify the other passwords. Contact our service centre if the MANUFACTURER password is lost.

The following examples show all combinations of password assignment.

Example 1: P.0001 = 0 P.0002 = 0 P.0003 = 0

Any operator is considered MANUFACTURER without setting anything in P.0000. Therefore, all parameters, except for the special ones, can be changed by anyone (this is the default mode).

Example 2: P.0001 = 0 P.0002 = 0 P.0003 = UUU

No parameter is modifiable. When the operator enters the UUU code in P.0000, he would be considered USER, but as no password is associated to the INSTALLER and the MANUFACTURER, the controller considers him as MANUFACTURER. After entering this code, all parameters, except for the special ones, can be modified.

Example 3: P.0001 = 0 P.0002 = III P.0003 = UUU

No parameter is modifiable. When the operator enters UUU in P.0000, he is considered USER and can modify only the parameters associated to USER. If the operator enters III, the controller considers it MANUFACTURER because there is no password for MANUFACTURER. After entering this code, all parameters, except for the special ones, can be modified.

Example 4: P.0001 = CCC P.0002 = III P.0003 = UUU

No parameter is modifiable. When the operator enters UUU in P.0000, he is considered USER and can modify only the parameters associated to USER. If the operator enters III, he can modify all parameters associated to INSTALLER and USER. When entering CCC, the operator is identified as MANUFACTURER and can modify all parameters, excluding the critical ones of the controller.

Example 5: P.0001 = CCC P.0002 = 0 P.0003 = 0

No passwords are associated to the USER and the INSTALLER. The parameters associated to USER and INSTALLER are free programmable, without entering any code in P.0000. To modify MANUFACTURER associated parameters you have to enter CCC in P.0000.

Example 6: P.0001 = 0 P.0002 = III P.0003 = 0

As no password is associated to the USER, the parameters associated are freely programmable, without entering any code in P.0000. When the operator enters III in P.0000, he can modify all parameters because there is no password for MANUFACTURER. After entering this code, all parameters, except for the special ones, can be modified.

Example 7: P.0001 = CCC P.0002 = III P.0003 = 0

As no password is associated to the USER, the parameters associated are freely programmable, without entering any code in P.0000. When the operator enters III in P.0000, he can modify all parameters associated to INSTALLER and USER. When entering III in P.0000, the operator is identified as MANUFACTURER and can modify all parameters, excluding critical ones.

Example 8: P.0001 = CCC P.0002 = 0 P.0003 = UUU

No parameter is modifiable. When the operator enters the UUU code in P.0000, the controller considers him USER, but as no password is associated to INSTALLER, it considers him INSTALLER. He can modify all parameters associated to the USER and the INSTALLER. When entering CCC in P.0000, the operator is identified as MANUFACTURER and can modify all parameters, excluding critical ones.

9 Operation sequence

In PTO application, the generator is usually dragged by the engine of a tractor. The operator takes care of starting and stopping the engine, through tractor's commands: PTO250 does not manage the engine at all (expect for some protections) and focuses on the generator only. Moreover, usually the controller is powered by the voltage of the generator itself; so, it powers up when the engine is already running. The only real command available on PTO250 is the circuit breaker (GCB) connecting the generator's voltages to the loads: when PTO250 powers up, it keeps GCB open until it detects proper generator voltages/frequency. Once closed, PTO250 monitors the engine and the generator and can open the GCB when protections (alarms) trip.

Since PTO250 can communicate with the ECU and the AVR through the CAN interface, it may be able to:

- Send stop command to the ECU (it depends on the ECU itself).
- Control the voltage of the generator, by sending commands to the AVR.

9.1 Operator's commands.

The operator can interact with the PTO250 in many ways, sending commands for opening/closing the circuit breakers, for silencing the horn, for resetting the alarms and so on.

Typically, the operator interacts with the front panel of PTO250 (circuit breaker commands are not available). It is possible to disable quite all the commands activated from the front panel, using a digital input configured with the functions DIF.2511 ("Front panel lock") or DIF.2513 ("Front panel/remote commands lock"): the commands are enabled if the input is not active or if it does not exist.

It is also possible to use the USB port for sending commands. In this case, it is possible to disable the commands received through the communication ports, using a digital input configured with the functions DIF.2512 ("Remote commands lock") or DIF.2513 ("Front panel/remote commands lock")

Each command has a specific numeric code: to execute a command, the ModBus master writes this code into HOLDING REGISTER 102. This Modbus register is write-only.

HOLDING REGISTER 102 is password protected. The password can be configured into parameter P.0004, the value "0" means "no password" (the factory default is "123"). If configured, the password must be written into HOLDING REGISTER 101 maximum five seconds before writing HOLDING REGISTER 102 (preferrable to use the Modbus Function 16 which allows writing both registers in the same command). HOLDING REGISTER 101 is also write-only.

9.2 Power on

When the controller is powered, it performs some operations:

- It records the code EVT.1077 (new power on) in the events log.
- If may also record the code EVT.1074 (reset) in the events log (if the unpowered phase lasted not more than 19 seconds.
- It performs a check of the non-volatile memory (see 11.4).
- It detects the rated power supply voltage (see 5.2).

9.3 Operating mode

If you are familiar with other Mecc Alte controllers, you may expect to deal with OFF, MAN and AUTO operating modes on PTO250. **This is not the case: PTO250 is always in AUTO mode**.

9.4 Generator

Using the connector JD, the controller measures the generator voltages and frequency, to protect the loads and the generator itself from operating outside valid ranges. See paragraph 5 for wirings diagrams and notes.

Before using the sensor, you must properly configure it. Unless the sensor is four-poles, the controller allows different wirings, selectable by parameter P.0101 (“Generator voltages wiring”):

1. Single phase (1P2W, 1 phase, two wires).
2. Two phases with neutral (2P3W, 2 phases, three wires).
3. Three phases with neutral (star connection, 3P4W,3 phases, 4 wires)
4. Three phases without neutral (delta connection, 3P3W,3 phases, 3 wires)

Different measurements will be available depending on the selected wiring mode (see paragraph 5.7).

9.4.1 Rated values.

The operator must properly set the rated quantities (important because thresholds are usually percentages of them):

- P.0106 (“Nominal power of the generator”).
- P.0150 (“Number of poles of the generator”).
- P.0102 (“Nominal voltage of the generator”).
- P.0105 (“Nominal frequency”).
- P.0319 (“Phases sequence for generator”).

INFORMATION!	**Do not set the rated voltage to “0”: the controller will anyway perform measurements, but for the application logic, the power source will be considered “not present”.**

For single-phase wiring (P.0101 = 1) set P.0102 with the rated L-N voltage. For multi-phases wirings, set the L-L rated voltage; the controller calculates the equivalent rated L-N voltage as:

$$VLN_{nom} = \left(P.0102 / \sqrt{3} \right)$$

Moreover, the controller calculates the rated current of the alternator (per phase):

Single-phase wiring: $$I_{nom} = \frac{P.0106 * 1000}{P.0102}$$

Multi-phases wiring: $$I_{nom} = \frac{\left((P.0106 * 1000) / 3 \right)}{\left(P.0102 / \sqrt{3} \right)}$$

Parameter P.0150 is used to calculate the engine speed from the generator frequency, both for thresholds and measurement (in case no other speed measurement systems are available).

The controller must check the status of the “generator” for allowing GCB closure (and for protections too). First, the controller must assign a “level” to the “generator” among:

- Absent.
- Low.
- Ok.
- High.

To assess the generator level, the controller can perform different checks described (with examples) below.

9.4.2 Frequency

Parameter	Description	Default value	Frequency (Hz)
P.0105	Nominal frequency	50 Hz	50
P.0228	Threshold for engine stopped (Hz)	10.0 %	5
P.0229	Threshold for engine started (Hz)	20.0 %	10
P.0305	Threshold for minimum frequency (81<<)	90.0 %	45
P.0307	Threshold for maximum frequency (81>>)	110.0 %	55
P.0202	Hysteresis for generator's measures	2.5 %	1.25

The hysteresis applies to:

- P.0305 (with the default values, between 45 Hz and 46.25 Hz).
- P.0307 (with the default values, between 53.75 Hz and 55 Hz).

These values define the following bands:

Frequency (Hz)	Band
0 – 5	A: absent
5 – 10	B: hysteresis
10 – 45	C: low
45 – 46.25	D: hysteresis
46.25 – 53.75	E: ok
53.75 – 55	F: hysteresis
55 – x	F: high

If the frequency is in "B", "D" or "F" bands, it keeps the level it had before (hysteresis). For example, if the frequency was in "E" band and now is in "D" band, it is still considered "Ok". On the contrary, if it was in the “C” band and now is in “D” band, it is considered “Low”.

The controller uses the thresholds P.0305 and P.0307 also to manage the protections on generator frequency. These protections can be individually disabled setting to zero the relevant delay (respectively P.0306 and P.0308). Even if the protections are disabled, the controller still use the thresholds to define the frequency level: this avoid GCB closure if frequency is not “Ok”.

9.4.3 Voltages

Parameter	Description	Default value	Voltage (Vac)
P.0102	Nominal voltage of the generator	400 V	400
P.0226	Threshold for engine stopped (V)	17.5 %	70
P.0227	Threshold for engine started (V)	20.0 %	80
P.0301	Threshold for minimum voltage (27<<)	75.0 %	300
P.0303	Threshold for maximum voltage (59>>)	112.5 %	450
P.0202	Hysteresis for generator's measures	2.5 %	10

The hysteresis applies to:

- P.0301 (with the default values, between 300 Vac and 310 Vac).
- P.0303 (with the default values, between 440 Vac and 450 Vac).

These values define the following bands:

Voltage (Vac)	Band
0 – 70	A: absent
70 – 80	B: hysteresis

80 - 300	C: low
300 – 310	D: hysteresis
310 – 440	E: ok
440 – 450	F: hysteresis
450 - x	F: high

If the voltage is in "B", "D" or "F" bands, it keeps the level it had before (hysteresis). For example, if the voltage was in "E" band and now is in "D" band, it is still considered "Ok". On the contrary, if it was in the “C” band and now is in “D” band, it is considered “Low”.

The voltages affected are:

- P.0101 = 1 (1P2W): L1-N
- P.0101 = 2 (2P3W): L1-N, L2-N, L1-L2.
- P.0101 = 3 (3P4W): L1-N, L2-N, L3-N, L1-L2, L2-L3, L3-L1.
- P.0101 = 4 (3P3W): L1-L2, L2-L3, L3-L1.

The controller uses the thresholds P.0301 and P.0303 also to manage the protections on generator voltages. These protections can be individually disabled setting to zero the relevant delay (respectively P.0302 and P.0304). Even if the protections are disabled, the controller still use the thresholds to define the voltages levels: this avoid GCB closure if voltages are not “Ok”.

9.4.4 Global level

The controller evaluates the following conditions (in the presented order) to calculate the “global” level of the “generator”:

- If all voltages and frequency are “Absent ", also the global level is "Absent".
- If all voltages and frequency are "Ok", also the global level should be "Ok".
- If at least one voltage or the frequency is “High”, also the global level is “High”.
- If none of the previous conditions is true, the global level is “Low".

9.4.5 Generator status.

For general management purposes, generator can assume three statuses:

- **Out of tolerance**: the level of at least one voltage or frequency of the generator is not "Ok" consecutively for two seconds.
- **In tolerance**: synchronous generator’s voltages and frequency status are “Ok” for at least 0.5 seconds.
- **Transitory**: during the transition between the two previous statuses.

9.4.6 Events and signalling

The controller records the following events related to generator status (if enabled with bit 2 of P.0441 parameter):

- EVT.1020: Genset voltage absent
- EVT.1021: Genset voltage present, but “out of tolerance”.
- EVT.1022: Genset voltage present, and “within tolerance”.

The following functions allows mapping the generator status to digital outputs:

- DOF.3032 - “Generator in tolerance”. The controller activates this output when the generator status is “in tolerance”, but also during the two seconds delay before declaring it “out of tolerance”.

The following internal statuses are available for AND/OR logics and PLC:

- ST.024 - “Generator present (voltages/frequency)”.
- ST.025 - “Generator absent or out of thresholds”.
- ST.026 - “Delay for generator in thresholds”.
- ST.027 - “Delay for generator in thresholds”.
- ST.028 - “Delay for generator absent or out of thresholds”.

9.4.7 AVR

PTO250 allows interfacing with automatic voltage regulators (AVR) through the CAN interface. To activate the connection, you must first download an external file that describes the CAN communication. BOARDPRG4 allows you to select (parameter F.1700) the AVR model from a list.

P.1701 allows to define whether to receive only information from the AVR or to also send commands:

- 0: the controller does not transmit anything on the CAN bus.
- 1: the controller only sends requests for information that is not "automatically" transmitted by the AVR; it does not transmit any command.
- 91…99: the controller transmits all the commands supported by the AVR, included the voltage setpoint.

Other available parameters:

- P.1702 ("Transmission address for voltage regulator"). The controller uses this address to send messages to the AVR. For some AVRs it is not used (because it is already statically defined in the file that describes the regulator). For others, however, it must be set as required by the AVR manufacturer.
- P.1705 (“Voltage fine tuning”). This is a percentage value (default 50 %) allowing the operator to manually change the required generator voltage.
- P.1703 and P.1704 ("Voltage corresponding to 0% or 100% of the internal command"). The controller internally uses a percentage voltage command (P.1705). Some AVRs accept instead a “Vac” command: the controller converts the percentage into a “Vac” request using the range defined by P.1703 and P.1704.
- P.1708, instead, configures the nominal voltage for the AVR, which may differ from the controller’s one due to any transformers or due to the wiring. If the AVR supports it, the controller automatically transfers this set-point to it, thus automating management in multi-voltage applications.
- P.1706 allows selecting a maximum communication timeout: if the AVR is supplied (engine running) and the controller does not receive messages from the AVR for the configured time, it activates an anomaly: it can be warning or alarm, depending on P.1707.

Some AVRs require the operator to configure additional specific setpoints: the controller makes them available through parameters P.1721…P.1728 (visible only when really used).

9.5 Engine

The controller does not provide any command for the engine (except the stop command for some ECUs, see 9). In any case, PTO250 can detect the engine running/stopped status, and can manage protections on the most relevant engine's quantities.

9.5.1 Rated values.

The operator must properly set the rated quantities (important because thresholds are usually percentages of them):

- P.0125 ("Nominal power of the engine") (kW).

9.5.2 Engine running/stopped detection.

INFORMATION!	**The controller is usually powered by the generator voltages. They are present only when the engine is running, so usually the controller always detects the engine running conditions.**

The controller detects the engine-running conditions in the following ways.

- **From generator voltage**. The controller provides the thresholds P.0226 and P.0227; they are percentages of the rated generator voltage (P.0102, see 9.4.1). If both are set to zero, PTO250 ignores the generator voltages for engine-running detection. The engine is running if **at least one** L-N or L-L voltage is higher than the P.0227 threshold; the engine is stopped if **all** available L-N and L-L voltages are lower than the P.0226 threshold.
- **From generator frequency**. The controller provides the thresholds P.0228 and P.0229; they are percentages of the rated generator frequency (P.0105, see 9.4.1). If both are set to zero, PTO250 ignores the generator frequency for engine-running detection. The engine is running if the frequency is higher than the P.0229 threshold; the engine is stopped if the frequency is lower than the P.0228 threshold.
- **From ECU (CAN interface)**. Some ECU transmits their "engine-running" conditions over the CAN interface. If this information is available, the controller always uses it.

The engine is globally considered:

- Running if **at least** one of the previous tests detects the "running" condition consecutively for at least 0,2 seconds.
- Stopped if all previous enabled tests detect the "stopped" condition consecutively for five seconds.

9.5.3 Masking of oil protections

If no pre-lubrication system is available, the controller must allow the mechanical pump of the engine to pressurize the lube oil before checking for "low oil pressure" conditions. Parameter P.0216 ("Time mask for engine protections") allows to configure the delay required by the mechanical pump to pressurize the lube oil.

INFORMATION!	The controller masks also the coolant temperature protections during this delay. In case of shutdowns, in fact, the engine's temperature tends to grow. Since protections are masked for P.0216 seconds, the operator can manually start the engine, allowing the in-built cooling system to operate**.**

9.5.4 Events and signalling

The controller records any change of the engine's status in the events log, if it is enabled with bit 3 of the P.0441 parameter:

- EVT.1040: Engine stopped.
- EVT.1042: Engine running.

The following functions allows mapping the engine status to digital outputs:

- DOF.3061 - “Engine running”.

In addition, the controller makes available the following engine statuses for the AND/OR logics:

- ST.032 - "Engine running”.
- ST.033 - "Oil protections enabled”.

9.5.5 ECU

PTO250 allows interfacing with Engine Control Units (ECU) through the CAN interface. To activate the connection, you must first download an external file (or select an embedded one); the file describes the CAN communication. BOARDPRG4 allows you to select (parameter F.1700) the AVR model from a list. Parameter P.0700 allows to select the connected ECU among a list of models. If the required model is not in the list, please set the value 300 in P.0700: you can now select your ECU model (parameter F.0700) among a list of external files (Mecc Alte continuously implements new files for new ECUs or for new versions of existing ECUs).

P.0703 allows to define whether to receive only information from the ECU or to also send commands:

- 0: the controller does not transmit anything on the CAN bus.
- 1: the controller only sends requests for information that is not "automatically" transmitted by the ECU; it does not transmit any command.
- 2…90: the controller transmits all the commands supported by the ECU, except the speed request.
- 91…99: the controller transmits all the commands supported by the ECU. NOTE: for some ECUs, the value "98" activates special functions, see specific documentation.

Other available parameters:

- P.0716 ("ID for transmission on Can-Bus"). The controller uses this address to send messages to the ECU. For some ECUs it is not used (because it is already statically defined in the file that describes the ECU). For others, however, it must be set as required by the ECU manufacturer.
- P.0702 (“Speed fine tuning”). This is a percentage value (default 50 %) allowing the operator to manually change the required engine speed.
- P.0713 and P.0714 ("Speed corresponding to 0% or 100% of the internal command"). The controller internally uses a percentage speed command (P.0702). Some ECUs accept instead a “rpm” command: the controller converts the percentage into a “rpm” request using the range defined by P.0713 and P.0714.

INFORMATION!	1380…1620 is a special range. It represents a variation of +/- 8% on the rated rotation speed (1500) @ 50Hz. The controller forces the same percent range at 60 Hz; thus, when the rated frequency is 60 Hz, the controller uses the range 1656…1944 even if the configured one is 1380…1620. The controller makes this range adjustment only if P.0713 = 1380 and P.0714 = 1620.

- P.0711 allows selecting a maximum communication timeout: if the controller does not receive messages from the ECU for the configured time, it activates an anomaly: it can be warning or alarm, depending on P.0797.
- If the ECU signals specific anomalies (therefore not through the cumulative yellow and red lamps), the controller manages them with direct warnings/alarms (codes from 105 to 160). Using parameter P.0704 it is possible to mask these alarms on the controller (attention: the ECU can still stop the engine).
- Specific options for each ECU can be activated with parameter P.0715.

Some ECUs require the operator to configure additional specific setpoints: the controller makes them available through parameters P.0721…P.0728 (visible only when really used).

Some ECU definition file makes some ECU statuses available for the AND/OR logics:

- ST.320 - "Status #01 from engine management by file”
- …
- ST.335 - "Status #16 from engine management by file”

9.6 Gearbox

The controller implements some protection on the gearbox oil temperature. To acquire this quantity, use an analogue input configured as AIF.1121 (“Gearbox oil temperature”) and use a proper conversion curve.

9.7 Circuit breaker management

9.7.1 Command.

The controller can use up to four commands to control the GCB breakers:

- DOF.2031 - “Minimum voltage coil for GCB”. This feature can be used to supply the minimum voltage coil (if any) of the GCB. The controller activates this output to supply the coil (allowing to close the GCB): it ensures minimum 0,5 seconds delay before issuing the real closure command.
- DOF.2032 - “Coil for opening of GCB”. The controller activates this output when it wants to open the GCB: it deactivates the output when the GCB opens (or when the opening time-out expires).
- DOF.2033 - “Coil for closure of GCB”. The controller activates this output when it wants to close the GCB (ensuring that the minimum voltage coil was supplied by at least 0.5 seconds): it deactivates the output when the GCB closes (or when the closing time-out expires).
- DOF.2034 - “Stable closing command for GCB”. **Do not use this command with motorized circuit breakers, use it only with contactors**. The controller activates this output to close the breaker (ensuring that the minimum voltage coil was supplied by at least 0.5 seconds) and deactivates the output to open the breaker.

9.7.2 Acquiring CBs status.

The controller provides the function DIF.3001 (“Status of GCB circuit breaker”) to acquire the feedback of the GCB. It is not mandatory to connect the feedback of the GCB; if not available, PTO250 assumes that the GCB always follow the controller’s command (it is closed when commanded closed and vice-versa). If available, the controller uses the feedback for:

- For issuing “fail to open” or “fail to close” warnings.
- For its own operating sequence.
- To show the proper status.

The controller uses the delay configured for the input configured as DIF.3001 (P.2002 or equivalent) as maximum time for opening or closing.

9.7.3 Management logic

Before issuing a closure command, the controller must evaluate the following conditions (in the presented order):

- No alarms present.
- The engine must be “running”.
- The generator voltages and frequency should enter the “tolerance” thresholds within P.0217 seconds (“Maximum time for operating conditions”) from the “engine-running” detection (otherwise PTO250 activates the alarm AL.008).
- The controller waits for P.0218 seconds (“Warming time before GCB closure”).

After that, the controller issues a GCB closing command; it opens (or keeps the GCB open) only in the following conditions:

- Alarms present.
- A “GCB closure inhibition request” is pending (see the next paragraph).

9.7.4 GCB closure inhibition.

The controller normally tries to close the GCB. Using “GCB closure inhibition” feature, the operator can force the controller to open or keep the GCB opened, overriding the application’s logic. Different “GCB closure inhibition” requests are available.

- **Request from digital input**. The controller uses any digital input configured as DIF.2502 (“Inhibition of supply”): it requires the “GCB closure inhibition” if at least one of these inputs is active.

- **Request from communication ports.** See paragraph 9.1 for protecting the controller from commands sent over the communication ports. The ModBus muster must send proper Modbus commands:
  - “31” or “32” to activate the request.
  - “33” to de-activate the request.

  The controllers discard the command after 30 seconds from last reception: so, any external monitoring system must periodically send the proper command (within 30 seconds) to keep the “GCB closure inhibition” request activated.

9.7.5 Events and signalling related to the breakers.

The controller records any change of the GCB breaker status/command in the events log, if enabled with bit 4 and 5 respectively, of the P.0441 parameter:

- EVT.1030: GCB close command
- EVT.1031: GCB open command
- EVT.1032: GCB closed.
- EVT.1033: GCB open.
- EVT.1080: GCB closure inhibition activated.
- EVT.1081: GCB closure inhibition deactivated.

The controller makes the following statuses (related to GCB) available for AND/OR logics:

- ST.064 – "GCB status"
- ST.068 – “Stable close command for GCB”.
- ST.070 – “Minimum voltage coil command for GCB"
- ST.071 – "Impulse open command for GCB”
- ST.072 – "Impulse close command for GCB”
- ST.088 – “GCB closure inhibited by digital input”.
- ST.090 – “GCB closure inhibited by communication interface”.
- ST.096 - "Ready to supply"
- ST.104 - "Supplying"

10 Anomalies

This chapter describes all the anomalies managed by the controller. Some of these act as protections for the loads, for the generator or for the engine. There is also signalling of specific events in the plant management. Before describing them in detail, some definitions are required.

We define three typologies of anomaly:

- **Warnings**: these anomalies do not require disconnecting the loads from the generator. They point out to situations that are not dangerous now, but the operator must take some action because, if ignored, they could degenerate in alarms.
- **Alarms**: these anomalies require disconnecting the loads from the generator. They are dangerous for the loads and/or for the engine and the generator. For this reason, the controller opens immediately the GCB breaker; if possible, it also sends a stop command to the ECU through the CAN interface.

Anomalies can be activated if no alarms are already active (there are some exceptions, which will be listed below); warnings can be present, though.

When the controller needs to activate an anomaly, it performs the following actions:

- It activates all digital output configured for managing an external horn (function DOF.3152 – “external horn”).
- It forces the display showing the page S.01. This page shows both the icons, and the code related to the anomaly. The numeric code flashes to indicate that the anomaly has not been recognized by the operator yet.
- It activates the “ALARM/WARNING” indicator, flashing in case there are only warnings, fixed If there are alarms.
- If the anomaly is an alarm, the controller disconnects the generator from the load (and, if possible, it also sends a stop command to the ECU through the CAN interface.

Three operations can be carried out on an anomaly:

- **Silence** the horn.
- **Acknowledge**: this means informing the controller that the operator has taken note of it.
- **Reset**: this tells the controller to act as if the anomaly was never active.

10.1Silence the horn

The controller manages the horn depending on parameter P.0491 (“Horn duration”):

- 0: the horn will never be activated.
- 999: only the operator can silent the horn.
- Any other values: the controller deactivates the horn P.0491 seconds after the last activation: the operator can manually silent them before P.0491.

The operator can silent the horn in different ways:

- By pressing any pushbuttons while the horn is active.
- By sending proper Modbus command (“51”) over the communication ports (see paragraph 9.1):

INFORMATION!	**The “silence” command does not “acknowledge” the anomalies.**

10.2Acknowledge the anomalies.

The operator can acknowledge the anomalies in different ways:

- By pressing any pushbuttons while the horn is not active.
- By sending proper Modbus command (“52”) over the communication ports (see paragraph 9.1):

INFORMATION!	**The “acknowledge” command also “silences” the horn.**

Once acknowledged, the anomaly’s code stops blinking on display page S.01. The controller automatically resets “acknowledged warnings” when their activation causes are no more present. On the contrary, the controller never automatically resets any “not acknowledged warning”.

10.3Reset the anomalies.

An anomaly can be reset only if the related cause is no more present. The operator can reset the anomalies in different ways:

- By holding the EVENTS pushbuttons for one second.
- By sending proper Modbus command (“53”) over the communication ports (see paragraph 9.1):
- With a digital input configured as DIF.2001 (“Command for resetting alarms”): the controller executes the command on the input activation (not when it is active).

INFORMATION!	**The “reset” command also “acknowledges” all anomalies and “silences” the horn.**

10.4Events and signalling

The controller automatically adds a record to the event log when activates a new anomaly. The event code is the anomaly code itself.

The following functions allows mapping the operating mode to digital outputs:

- DOF.3151 (“Reset of the anomalies”). The controller activates this output for one second when it executes a “reset” command (external devices may need this command).
- DOF.3152 (“External horn”). This output is activated and deactivated along with the internal hooter. It can be used to control a more powerful hooter and/or a lamp.
- DOF.4001 (“Warnings”): at least one “warning” is active.
- DOF.4004 (“Alarms”): at least one “alarm” is active.
- DOF.4031 (“Anomalies of the generator”): at least one of the following anomalies is active:
  - AL.008 - “Operating conditions not reached”.
  - AL.003 - “Minimum generator's frequency (81<<)”.
  - AL.058 - “Low generator's frequency (81<)”.
  - AL.060 - “High generator's frequency (81>)”.
  - AL.004 - “Maximum generator's frequency (81>>).
  - AL.001 - “Minimum generator's voltage (27<<)”.
  - AL.056 - “Low generator's voltage (27<)”.
  - AL.059 - “High generator's voltage (59>)”.
  - AL.002 - “Maximum generator's voltage (59>>)”.

  - AL.052 - “Generator's voltages unbalance (47)”.
  - AL.055 - “Wrong phases sequence (47)”.
  - AL.053 - “Currents unbalance (46)”.
  - AL.006 - “Generator maximum current”.
  - AL.016 - “Generator short circuit”.

- DOF.4032 (“Anomalies of the engine”): at least one of the following anomalies is active:
  - AL.118 - “Maximum speed (from CANBUS) (12)”.
  - AL.065 - “Low coolant temperature (from measure)”.
  - AL.031 - “High coolant temperature (from contact)”.
  - AL.032 - “High coolant temperature (from measure)”.
  - AL.132 - “High coolant temperature (from CANBUS)”.
  - AL.033 - “Maximum coolant temperature (from contact)”.
  - AL.034 - “Maximum coolant temperature (from measure)”.
  - AL.134 - “Maximum coolant temperature (from CANBUS)”.
  - AL.135 - “Minimum coolant level (from CANBUS)”.
  - AL.136 - “Low coolant level (from CANBUS)”.
  - AL.160 - “Water in fuel (from CANBUS)”.
  - AL.043 - “Low oil pressure (from contact)”.
  - AL.044 - “Low oil pressure (from measure)”.
  - AL.144 - “Low oil pressure (from CANBUS)”.
  - AL.041 - “Minimum oil pressure (from contact)”.
  - AL.042 - “Minimum oil pressure (from measure)”.
  - AL.142 - “Minimum oil pressure (from CANBUS)”.
  - AL.054 - “High oil temperature (from measure)”.
  - AL.158 - “High oil temperature (from CANBUS)”.
  - AL.035 - “Maximum oil temperature (from measure)”.
  - AL.159 - “Maximum oil temperature (from CANBUS)”.
  - AL.105 - “Engine's battery charger failure (from CANBUS)”.
  - AL.137 - “Low battery voltage (from CANBUS)”.
  - AL.049 - “Maximum power (32)”.
  - AL.198 - “Warnings - Yellow lamp (from CANBUS)”.
  - AL.199 - “Alarms - Red lamp (from CANBUS)”.
  - AL.062 - “CANBUS 0 (engine): BUS-OFF”.
  - AL.098 - “Communication failure with the ECU”.

- DOF.4035 (“4035-Anomalies of circuit breakers”): at least one of the following anomalies is active:
  - AL.014 - “GCB not closed”.
  - AL.024 - “GCB not opened”.

The following internal statuses are available for AND/OR logics and PLC:

- Each single anomaly.
- ST.006 – “Acknowledgment of anomalies in progress”.
- ST.007 – “Reset of anomalies in progress”.
- ST.008 - “Warnings”.
- ST.011 - “Alarms”.
- ST.012 - “Not recognized warnings”.
- ST.015 - “Not recognized alarms”.

10.5Anomalies related to digital inputs.

The controller manages many digital inputs. You can use any of them to activate anomalies. We can divide these anomalies in two groups, “specific” and “generic”, described below. For both groups, the controller uses the input-related “delay” parameter as an “activation delay” for the anomaly.

INFORMATION!	**if you set the delay to "0", you disable the anomaly.**

10.5.1Specific.

They are configured with functions DIF.4201 and following. The controller knows how to manage these anomalies and provides specific alarm codes and proper icons. The following chapters will describe each of them.

10.5.2Generic.

They are configured through functions DIF.4001 to DIF.4024. The selected function gives the controller information about how to manage the anomaly (kind of anomaly, masked by some conditions etc.). The controller shows the following icon on page S.01:

The controller assigns numeric codes 701 through 742 to generic anomalies related to digital inputs:

Input	Alarms code
T.16	AL.701
T.17	AL.702
T.18	AL.703
T.19	AL.704
T.09	AL.723
T.13	AL.724
T.14	AL.725
T.15	AL.726
Virtual digital inputs 1…16	AL.727 to AL.742

The function code identifies the kind of anomaly; you can focus on the last digit of the function (1=warning, 4= alarm):

Warnings	Alarms
DIF.4001	DIF.4004
DIF.4011	DIF.4014
DIF.4021	DIF.4024

The function code also defines the "activation conditions" of the anomaly; you can focus on the second-last digit of the function:

- DIF.4001, DIF.4004. Required conditions: none.
- DIF.4011, DIF.4014. Required conditions: engine running at least from P.0216 seconds.
- DIF.4021, DIF.4022, DIF.4023, DIF.4024. Required conditions: GCB closed.

10.6Anomalies related to analogue inputs.

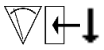
The controller manages some analogue inputs. You can add two thresholds for each of them (on the acquired measurements), and each threshold can activate an anomaly. These are "generic" anomalies because the controller does not know how to manage them.

The controller assigns numeric codes 301 through 310 to generic anomalies related to analogue inputs (always using two consecutive codes for the two thresholds of a single input):

- Even codes refer to the first threshold.
- Odd codes refer to the second threshold.

Input	Alarms code
T.09	AL.301…302
T.13	AL.303…304
T.14	AL.305…306
T.15	AL.307…308
T.16	AL.309…310

First, the operator should configure the alarm message, using the input-related “message” parameter (for example P.4002 for analogue input 1). The message is common for the two thresholds. The controller will show a generic symbol, followed by an arrow to indicate:

-  : “High value:” if the anomaly is activated when the measure is higher than the threshold.
-  : “Low value:” if the anomaly is activated when the measure is lower than the threshold.

The controller provides two sets of three parameters each for configuring the thresholds (in the following description we’ll refer to parameters related to analogue input T.09, P.4003, P.4004 and P.4005 for the first threshold and P.4006, P.4007 and P.4008 for the second one):

- P.4003 and P.4006: allows to configure the thresholds for the acquired measurement.
- P.4004 and P.4007: allows to configure the activation delay for the anomaly (the controller activates the anomaly only if the “out of threshold” condition persists for this time).
- P.4005 and P.4008: they allow to deeper configure the anomaly (see 8.3).

INFORMATION!	**if you set the delay to “0”, you disable the anomaly.**

10.7Fault list

INFORMATION!	**For input-related anomalies, the following chapters always refer to the parameters related to the 1st input (both for digital and analogue): the symbol (*) or the indication “or equivalent for the other inputs” indicates that that the real parameter number changes according to the used input.**

10.7.1AL.001 – Minimum generator's voltage (27<<).

Type:	Alarm
Icons:	
Related parameters:	P.0101 (“Generator AC wiring”). P.0102 (“Nominal voltage of the generator”). P.0202 (“Hysteresis for generator's measures”). P.0301 (“Threshold for minimum voltage (27<<)”). P.0302 (“Delay for minimum voltage (27<<)”).
To disable:	P.0302 = 0

Disabled when:

- Engine stopped.
- After starting the engine, until firstly the generator voltages/frequency become “ok”.

The controller activates the protection if the lowest generator voltage (both L-L and L-N or, depends on P.0101) is lower than the configured threshold for the configured delay.

10.7.2AL.002 – Maximum generator's voltage (59>>).

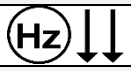
Type:	Alarm
Icons:	
Related parameters:	P.0101 (“Generator AC wiring”). P.0102 (“Nominal voltage of the generator”). P.0202 (“Hysteresis for generator's measures”). P.0303 (“Threshold for maximum voltage (59>>)”). P.0304 (“Delay for maximum voltage (59>>)”).
To disable:	P.0304 = 0

Disabled when:

- Engine stopped.

The controller activates the protection if the highest generator voltage (both L-L and L-N or, depends on P.0101) is higher than the configured threshold for the configured delay.

10.7.3AL.003 – Minimum generator's frequency (81<<).

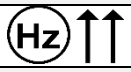
Type:	Alarm
Icons:	
Related parameters:	P.0105 (“Nominal frequency”). P.0202 (“Hysteresis for generator's measures”). P.0305 (“Threshold for minimum frequency (81<<)”). P.0306 (“Delay for minimum frequency (81<<)”).
To disable:	P.0306 = 0

Disabled when:

- Engine stopped.
- After starting the engine, until firstly the generator voltages/frequency become “ok”.

The controller activates the protection if the generator frequency is lower than the configured threshold for the configured delay.

10.7.4AL.004 – Maximum generator's frequency (81>>).

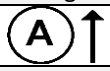
Type:	Alarm
Icons:	
Related parameters:	P.0105 (“Nominal frequency”). P.0202 (“Hysteresis for generator's measures”). P.0307 (“Threshold for maximum frequency (81>>)”). P.0308 (“Delay for maximum frequency (81>>)”).
To disable:	P.0308 = 0

Disabled when:

- Engine stopped.

The controller activates the protection if the generator frequency is higher than the configured threshold for the configured delay.

10.7.5AL.006 – Maximum generator current (51).

Type:	Configurable by P.0323 (shared with anomaly AL.016)
Icons:	
Related parameters:	P.0107 (“C.T. primary”). P.0106 (“Nominal power of the generator”). P.0102 (“Nominal voltage of the generator”). P.0101 (“Generator AC wiring”). P.0309 (“Shutdown level for high current”). P.0310 (“Delay for high current shutdown”). P.0323 (“Action on maximum current (50/51)”)
To disable:	P.0310 = 0

Disabled when:

- Engine stopped.

Use parameter P.0323 to select if the protection must operate as warning or as alarm (P.0323 is shared with anomaly AL.016).

The protection operates on all available generator currents. The trip time of this protection is not fixed but depends on how higher the current is, respect to the configured threshold (the higher the current, the shorter the trip time). The controller uses an internal curve named EXTREMELY INVERSE and implements an I2t function. This behaves as generator protection because it limits the thermal accumulation of the generator.

Using the parameters P.0309 and P.0310, the operator defines the maximum current threshold and the maximum time the generator can supply this current. If the current is lower than the threshold, the controller never activates the protection. If the current rises above the threshold, the controller activates the protection with a time inversely proportional to the overcurrent. To correctly set the thresholds, perform the following steps:

- Set the maximum current threshold with the parameter P.0309, as a percentage of the rated current (see 9.4.1).
- Set the action time in the parameter P.0310: the protection will trip with this time if the current is constantly equal to the threshold P.0309 multiplied by $\sqrt{2}$.

To calculate the trip time for a preferred current, please use the following formula (according to EN60255-151):

$$t_1 = P.0310 \frac{k}{\left(\frac{I}{P.0309}\right)^{a} - 1} + c$$

With the constants “k” = 1, “c” = 0 and “a” = 2 the equation changes to the following:

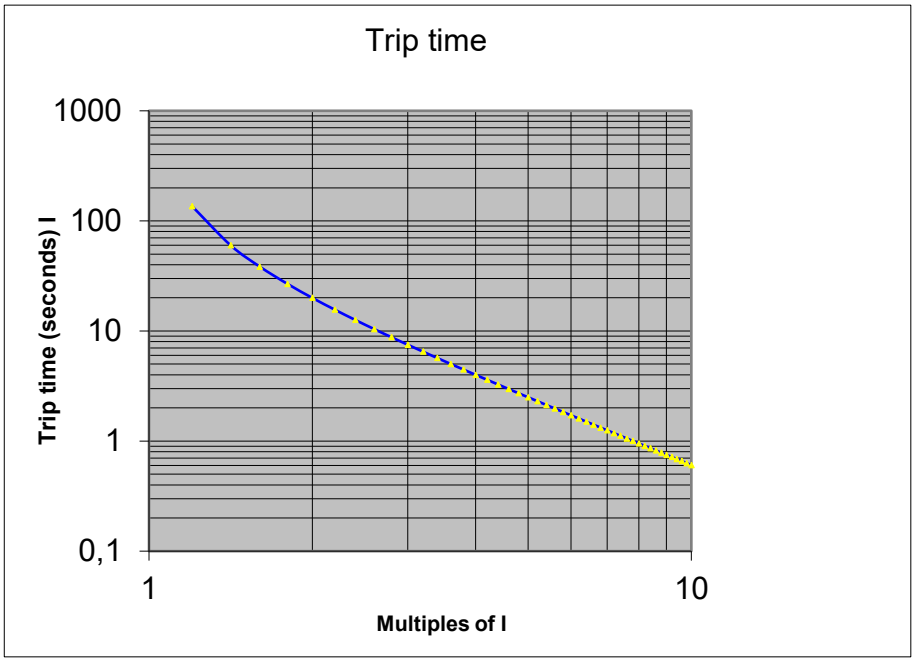
$$t_1 = \frac{P.0310}{\left(\frac{I}{P.0309}\right)^{2} - 1}$$

Where “I” is the current in the circuit.

Please remember that the controller calculates the integral of the current during the time; therefore, every single sample of current above the rated threshold concur to define the intervention time, with their instant weight resulting

from the above formula. Thus, the only way to experimentally verify this formula is to switch instantaneously from a normal load situation to an overload situation.

The following graph shows the curve used for enabling protection, with a value of P.0310 set to 60 seconds ("I" is the maximum current):



10.7.6AL.008 – Operating conditions not reached.

Type:	Warning
Icons:	G ↓
Related parameters:	P.0217 ("Maximum time for operating conditions").
To disable:	P.0217 = 0

Disabled when:

- Engine stopped.
- For the first P.0217 seconds after starting the engine.

The controller activates this protection if generator voltages and frequency do not reach their "ok" values within the configured delay from the "engine running" detection.

10.7.7AL.014 – GCB not closed.

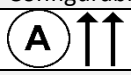
Type:	Warning
Icons:	G
Related parameters:	P.2001 ("Function of the input T.16") or equivalent for the other inputs. P.2002 ("Delay for the input T.16") or equivalent for the other inputs.
To disable:	P.2002 = 0

Disabled when:

- The controller does not acquire the real status of the CB (DIF.3001).
- The "delay" parameter of the input acquiring the status is set to zero.

The controller activates this protection if, after three closure attempts, the GCB is still opened (P.2002 configures the duration of each attempt).

10.7.8AL.016 – Short circuit on the generator (50).

Type:	Configurable by P.0323 (shared with anomaly AL.006)
Icons:	
Related parameters:	P.0107 (“C.T. primary”). P.0106 (“Nominal power of the generator”). P.0102 (“Nominal voltage of the generator”). P.0101 (“Generator AC wiring”). P.0311 (“Shutdown level for short circuit”). P.0312 (“Delay for short circuit shutdown”). P.0323 (“Action on maximum current (50/51)”)
To disable:	P.0312 = 0

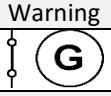
Disabled when:

- Engine stopped.

Use parameter P.0323 to select if the protection must operate as warning or as alarm (P.0323 is shared with anomaly AL.016).

The protection operates on all available generator currents. The controller activates the protection when at least one current is higher than the configured threshold for the configured delay.

10.7.9AL.024 – GCB not opened.

Type:	Warning
Icons:	
Related parameters:	P.2001 (“Function of the input T.16”) or equivalent for the other inputs. P.2002 (“Delay for the input T.16”) or equivalent for the other inputs.
To disable:	P.2002 = 0

Disabled when:

- The controller does not acquire the real status of the CB (DIF.3001).
- The “delay” parameter of the input acquiring the status is set to zero.

The controller activates this protection if, after three opening attempts, the GCB is still closed (P.2002 configures the duration of each attempt).

10.7.10 AL.031 – High coolant temperature (from contact).

Type:	Warning
Icons:	
Related parameters:	P.2001 (“Function of the input T.16”) or equivalent for the other inputs. P.2002 (“Delay for the input T.16”) or equivalent for the other inputs. P.0216 (“Time mask for engine protections”).
To disable:	P.2002 = 0

Disabled when:

- Engine stopped.
- After starting the engine, within the first P.0216 seconds.

The controller activates the protection if the input (function DIF.4231 - “High coolant temperature”) is active for the configured delay.

10.7.11 AL.032 – High coolant temperature (from measure).

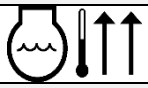
Type:	Warning
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0216 (“Time mask for engine protections”). P.0335 (“Threshold for high coolant temperature”). P.0336 (“Delay for high coolant temperature”).
To disable:	P.0336 = 0

Disabled when:

- The controller does not acquire the coolant temperature from the ECU through the CAN interface.
- Engine stopped.
- After starting the engine, within the first P.0216 seconds.

The controller activates the protection if the acquired temperature stays above the configured threshold for the configured delay.

10.7.12 AL.033 – Maximum coolant temperature (from contact).

Type:	Alarm
Icons:	
Related parameters:	P.2001 (“Function of the input T.16”) or equivalent for the other inputs. P.2002 (“Delay for the input T.16”) or equivalent for the other inputs. P.0216 (“Time mask for engine protections”).
To disable:	P.2002 = 0

Disabled when:

- Engine stopped.
- After starting the engine, within the first P.0216 seconds.

The controller activates the protection if the input (function DIF.4232 - “Maximum coolant temperature”) is active for the configured delay.

10.7.13 AL.034 – Maximum coolant temperature (from measure).

Type:	Alarm
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0216 (“Time mask for engine protections”). P.0337 (“Threshold for maximum coolant temperature”). P.0338 (“Delay for maximum coolant temperature”).
To disable:	P.0338 = 0

Disabled when:

- The controller does not acquire the coolant temperature from the ECU through the CAN interface.
- Engine stopped.
- After starting the engine, within the first P.0216 seconds.

The controller activates the protection if the acquired temperature stays above the configured threshold for the configured delay.

10.7.14 AL.035 – Maximum oil temperature (from measure).

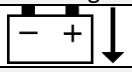
Type:	Alarm
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0216 (“Time mask for engine protections”). P.0375 (“Threshold for maximum coolant temperature”). P.0376 (“Delay for maximum coolant temperature”).
To disable:	P.0376 = 0

Disabled when:

- The controller does not acquire the oil temperature from the ECU through the CAN interface.
- Engine stopped.
- After starting the engine, within the first P.0216 seconds.

The controller activates the protection if the acquired temperature stays above the configured threshold for the configured delay.

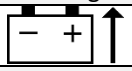
10.7.15 AL.037 – Low power supply voltage.

Type:	Warning
Icons:	
Related parameters:	P.0362 (“Threshold for low power supply voltage”). P.0363 (“Delay for low power supply voltage”).
To disable:	P.0363 = 0

Always enabled.

The controller activates the protection if the power supply voltage is lower than the configured threshold for the configured delay. The threshold is expressed as a percentage of the rated power supply voltage (see 5.2).

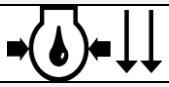
10.7.16 AL.038 – High power supply voltage.

Type:	Warning
Icons:	
Related parameters:	P.0364 (“Threshold for high power supply voltage”). P.0365 (“Delay for high power supply voltage”).
To disable:	P.0365 = 0

Always enabled.

The controller activates the protection if the power supply voltage is higher than the configured threshold for the configured delay. The threshold is expressed as a percentage of the rated power supply voltage (see 5.2).

10.7.17 AL.041 – Minimum oil pressure (from contact).

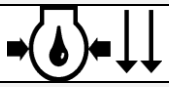
Type:	Alarm
Icons:	
Related parameters:	P.2001 (“Function of the input T.16”) or equivalent for the other inputs. P.2002 (“Delay for the input T.16”) or equivalent for the other inputs. P.0216 (“Time mask for engine protections”).
To disable:	P.2002 = 0

Disabled when:

- Engine stopped.
- After starting the engine, within the first P.0216 seconds.

The controller activates the protection if the input (function DIF.4221 - “Minimum oil pressure”) is active for the configured delay.

10.7.18 AL.042 – Minimum oil pressure (from measure).

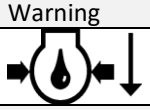
Type:	Alarm
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0216 (“Time mask for engine protections”). P.0341 (“Threshold for minimum oil pressure”). P.0342 (“Delay for minimum oil pressure”).
To disable:	P.0342 = 0

Disabled when:

- The controller does not acquire the oil pressure from the ECU through the CAN interface.
- Engine stopped, stopping, starting.
- After starting the engine, within the first P.0216 seconds.

The controller activates the protection if the acquired pressure stays below the configured threshold for the configured delay.

10.7.19 AL.043 – Low oil pressure (from contact).

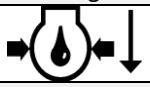
Type:	Warning
Icons:	
Related parameters:	P.2001 (“Function of the input T.16”) or equivalent for the other inputs. P.2002 (“Delay for the input T.16”) or equivalent for the other inputs. P.0216 (“Time mask for engine protections”).
To disable:	P.2002 = 0

Disabled when:

- Engine stopped.
- After starting the engine, within the first P.0216 seconds.

The controller activates the protection if the input (function DIF.4222 - “Low oil pressure”) is active for the configured delay.

10.7.20 AL.044 – Low oil pressure (from measure).

Type:	Warning
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0216 (“Time mask for engine protections”). P.0339 (“Threshold for low oil pressure”). P.0340 (“Delay for low oil pressure”).
To disable:	P.0340 = 0

Disabled when:

- The controller does not acquire the oil pressure from the ECU through the CAN interface.
- Engine stopped, stopping, starting.
- After starting the engine, within the first P.0216 seconds.

The controller activates the protection if the acquired pressure stays below the configured threshold for the configured delay.

10.7.21 AL.048 – Emergency stop.

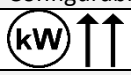
Type:	Alarm
Icons:	
Related parameters:	P.2001 (“Function of the input T.16”) or equivalent for the other inputs. P.2002 (“Delay for the input T.16”) or equivalent for the other inputs.
To disable:	P.2002 = 0

Always enabled. The controller activates the protection if the input (function DIF.4201 - “Emergency stop”) is active for the configured delay.

It is also possible to activate this anomaly by a command through the communication interfaces (see paragraph 9.1 for protecting the controller from commands sent over the communication ports). The ModBus muster must send proper Modbus commands:

- “99” to activate the anomaly.

10.7.22 AL.049 – Maximum power.

Type:	Configurable by P.0352
Icons:	
Related parameters:	P.0107 (“C.T. primary”). P.0350 (“Threshold for maximum power (32)”). P.0351 (“Delay for maximum power (32)”). P.0352 (“Action for maximum power (32)”). P.0125 (“Nominal power of the engine”)
To disable:	P.0351 = 0

Disabled when:

- The controller does not acquire the generator’s current (CTs ratio not set).
- Engine stopped.

The controller activates this protection if the active power is positive and above the configured threshold for the configured delay.

10.7.23 AL.052 – Generator's voltages unbalance (47).

Type:	Alarm
Icons:	
Related parameters:	P.0101 (“Generator AC wiring”). P.0102 (“Nominal voltage of the generator”). P.0202 (“Hysteresis for generator's measures”). P.0315 (“Threshold for voltage unbalance (47)”). P.0316 (“Delay for voltage unbalance (47)”).
To disable:	P.0316 = 0

Disabled when:

- Single-phase generator.
- Engine stopped.
- Generator voltages and frequency are not “ok”.

The controller activates the protection if the highest voltage difference (L-L or L-N or both, depends on P.0101) is higher than the configured threshold for the configured delay.

10.7.24 AL.053 – Currents unbalance (46).

Type:	Alarm
Icons:	
Related parameters:	P.0107 (“C.T. primary”). P.0106 (“Nominal power of the generator”). P.0102 (“Nominal voltage of the generator”). P.0101 (“Generator AC wiring”). P.0317 (“Threshold for current unbalance (46)”). P.0318 (“Delay for current unbalance (46)”).
To disable:	P.0318 = 0

Disabled when:

- The controller does not acquire the generator’s current (CTs ratio not set).
- Engine stopped.
- Single-phase generator.

The threshold is a percentage of the rated current (see 9.4.1 for the determination of the rated current from P.0101, P.0102 and P.0106 parameters).

The controller activates the protection if the highest current difference is higher than the configured threshold for the configured delay.

10.7.25 AL.054 – High oil temperature (from measure).

Type:	Warning
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0216 (“Time mask for engine protections”). P.0373 (“Threshold for high oil temperature”). P.0374 (“Delay for high oil temperature”).
To disable:	P.0374 = 0

Disabled when:

- The controller does not acquire the oil temperature from the ECU through the CAN interface.
- Engine stopped.
- After starting the engine, within the first P.0216 seconds.

The controller activates the protection if the acquired temperature stays above the configured threshold for the configured delay.

10.7.26 AL.055 – Wrong phases sequence (47).

Type:	Configurable by P.0320
Icons:	
Related parameters:	P.0101 (“Generator AC wiring”). P.0319 (“Phases sequence for generator”). P.0320 (“Wrong genset phases sequence action (47)”).
To disable:	P.0319 = 0

Disabled when:

- Single-phase generator.
- Engine stopped.
- GCB closed.
- Generator voltages and frequency not “ok”

The controller activates the protection if the real phases sequence of the generator does not match the configured one, with a 0.5 second filter time.

10.7.27 AL.056 – Low generator's voltage (27<).

Type:	Warning
Icons:	
Related parameters:	P.0101 (“Generator AC wiring”). P.0102 (“Nominal voltage of the generator”). P.0202 (“Hysteresis for generator's measures”). P.0391 (“Threshold for low voltage (27<)”). P.0392 (“Delay for low voltage (27<)”).
To disable:	P.0302 = 0

Disabled when:

- Engine stopped.
- After starting the engine, until firstly the generator voltages/frequency become “ok”.

The controller activates the protection if the lowest generator voltage (both L-L and L-N or, depends on P.0101) is lower than the configured threshold for the configured delay.

10.7.28 AL.058 – Low generator's frequency (81<).

Type:	Warning
Icons:	
Related parameters:	P.0105 (“Nominal frequency”). P.0202 (“Hysteresis for generator's measures”). P.0395 (“Threshold for low frequency (81<)”). P.0396 (“Delay for low frequency (81<)”).
To disable:	P.0396 = 0

Disabled when:

- Engine stopped.
- After starting the engine, until firstly the generator voltages/frequency become “ok”.

The controller activates the protection if the generator frequency is lower than the configured threshold for the configured delay.

10.7.29 AL.059 – High generator's voltage (59>).

Type:	Warning
Icons:	
Related parameters:	P.0101 (“Generator AC wiring”). P.0102 (“Nominal voltage of the generator”). P.0202 (“Hysteresis for generator's measures”). P.0393 (“Threshold for high voltage (59>)”). P.0394 (“Delay for high voltage (59>)”).
To disable:	P.0394 = 0

Disabled when:

- Engine stopped.

The controller activates the protection if the lowest generator voltage (both L-L and L-N or, depends on P.0101) is lower than the configured threshold for the configured delay.

10.7.30 AL.060 – High generator's frequency (81>).

Type:	Warning
Icons:	
Related parameters:	P.0105 (“Nominal frequency”). P.0202 (“Hysteresis for generator's measures”). P.0397 (“Threshold for high frequency (81>)”). P.0398 (“Delay for high frequency (81>)”).
To disable:	P.0398 = 0

Disabled when:

- Engine stopped.

The controller activates the protection if the generator frequency is higher than the configured threshold for the configured delay.

10.7.31 AL.062 – CAN interface: BUS-OFF.

Type:	Configurable by P.0709
Icons:	
Related parameters:	P.0700 (“Engine type”). F.1700 (“Voltage regulator (AVR) type”). P.0709 (“Action on Can-Bus fault”).
To disable:	-

Disabled when:

- P.0700 and F.1700 are both set to zero.

The controller activates this protection if the can controller (hardware) detects a “BUS-OFF” condition on the CAN interface.

10.7.32 AL.065 – Low coolant temperature (from measure).

Type:	Warning
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0353 (“Threshold for low coolant temperature”). P.0354 (“Delay for low coolant temperature”).
To disable:	P.0354 = 0

Disabled when:

- The controller does not acquire the coolant temperature from the ECU through the CAN interface.

The controller activates the protection if the acquired temperature stays below the configured threshold for the configured delay.

10.7.33 AL.088 – High gearbox oil temperature (from measure).

Type:	Warning
Icons:	
Related parameters:	P.4001 (“Function of the analogue input T.09”) or equivalent for the other inputs. P.9881 (“Pre-alarm level for high gearbox oil temperature”). P.9882 (“Delay for high gearbox oil temperature pre-alarm”).
To disable:	P.9882 = 0

Disabled when:

- The controller does not acquire the gearbox oil temperature from any analogue input configured as AIF.1121.

The controller activates the protection if the acquired temperature stays above the configured threshold for the configured delay.

10.7.34 AL.089 – Maximum gearbox oil temperature (from measure).

Type:	Alarm
Icons:	
Related parameters:	P.4001 (“Function of the analogue input T.09”) or equivalent for the other inputs. P.9883 (“Pre-alarm level for high gearbox oil temperature”). P.9884 (“Delay for high gearbox oil temperature pre-alarm”).
To disable:	P.9884 = 0

Disabled when:

- The controller does not acquire the gearbox oil temperature from any analogue input configured as AIF.1121.

The controller activates the protection if the acquired temperature stays above the configured threshold for the configured delay.

10.7.35 AL.097 – Communication failure with the AVR.

Type:	Configurable by P.1707
Icons:	
Related parameters:	F.1700 (“Voltage regulator (AVR) type”). P.1706 (“Communication timeout with AVR (s)”). P.1707 (“Action for communication failure with AVR”).
To disable:	P.1707 = 0

Disabled when:

- F.1700 is set to zero.

The controller activates this protection if does not receive any message from the configured AVR for the configured delay.

10.7.36 AL.098 – Communication failure with the ECU.

Type:	Configurable by P.0797
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0797 (“Action for communication failure with the ECU”). P.0711 (“Maximum time without messages from engine”).
To disable:	P. 0797 = 0

Disabled when:

- P.0700 is set to zero.

The controller activates this protection if does not receive any message from the configured ECU for the configured delay.

10.7.37 AL.100 – Differential protection (from contact).

Type:	Alarm
Icons:	
Related parameters:	P.2001 (“Function of the input T.16”) or equivalent for the other inputs. P.2002 (“Delay for the input T.16”) or equivalent for the other inputs.
To disable:	P.2002 = 0

Always enabled. The controller activates the protection if the input (function DIF.4262 - “Differential protection”) is active for the configured delay.

10.7.38 AL.105 - Engine's battery charger failure (from CAN interface).

Type:	Warning
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can interface alarms disable mask”).
To disable:	Set bit 11 of P.0704 = 0

Disabled when:

- Engine stopped, stopping, starting.
- After starting the engine, within the first P.0216 seconds.

The controller activates the protection when reported by the ECU.

10.7.39 AL.118 Maximum speed (from CAN interface) (12).

Type:	Alarm
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can interface alarms disable mask”).
To disable:	Set bit 4 of P.0704 = 0

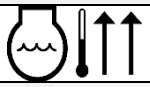
Always enabled. The controller activates the protection when reported by the ECU.

10.7.40 AL.132 - High coolant temperature (CAN interface).

Type:	Warning
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can interface alarms disable mask”).
To disable:	Set bit 7 of P.0704 = 0

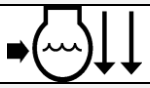
Always enabled. The controller activates the protection when reported by the ECU.

10.7.41 AL.134 - Maximum coolant temperature (CAN interface).

Type:	Alarm
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can interface alarms disable mask”).
To disable:	Set bit 5 of P.0704 = 0

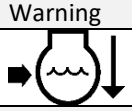
Always enabled. The controller activates the protection when reported by the ECU.

10.7.42 AL.135 – Minimum coolant level (CAN interface).

Type:	Alarm
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can interface alarms disable mask”).
To disable:	Set bit 7 of P.0704 = 0

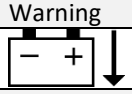
Always enabled. The controller activates the protection when reported by the ECU.

10.7.43 AL.136 – Low coolant level (CAN interface).

Type:	Warning
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can interface alarms disable mask”).
To disable:	Set bit 6 of P.0704 = 0

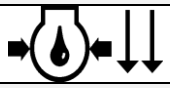
Always enabled. The controller activates the protection when reported by the ECU.

10.7.44 AL.137 – Low battery voltage (CAN interface).

Type:	Warning
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can interface alarms disable mask”).
To disable:	Set bit 9 of P.0704 = 0

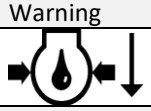
Always enabled. The controller activates the protection when reported by the ECU.

10.7.45 AL.142 – Minimum oil pressure (CAN interface).

Type:	Alarm
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can interface alarms disable mask”).
To disable:	Set bit 1 of P.0704 = 0

Always enabled. The controller activates the protection when reported by the ECU.

10.7.46 AL.144 – Low oil pressure (CAN interface).

Type:	Warning
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can interface alarms disable mask”).
To disable:	Set bit 0 of P.0704 = 0

Always enabled. The controller activates the protection when reported by the ECU.

10.7.47 AL.158 – High oil temperature (CAN interface).

Type:	Warning
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can interface alarms disable mask”).
To disable:	Set bit 2 of P.0704 = 0

Always enabled. The controller activates the protection when reported by the ECU.

10.7.48 AL.159 – Maximum oil temperature (CAN interface).

Type:	Alarm
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can interface alarms disable mask”).
To disable:	Set bit 3 of P.0704 = 0

Always enabled. The controller activates the protection when reported by the ECU.

10.7.49 AL.160 – Water in fuel (CAN interface).

Type:	Warning
Icons:	
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can interface alarms disable mask”).
To disable:	Set bit 8 of P.0704 = 0

Always enabled. The controller activates the protection when reported by the ECU.

10.7.50 AL.198 - Warnings - Yellow lamp (CAN interface).

Type:	Warning
Icons:	
Related parameters:	P.0700 (“Engine type”). F.1700 (“Engine type”). P.0704 (“Can-Bus alarms disable mask”).
To disable:	Set bit 14 of P.0704 = 0

Always enabled. The controller activates the protection when reported by the ECU or by the AVR.

10.7.51 AL.199 – Alarms - Red lamp (CAN interface).

Type:	Configurable but bit 13 of P.0704
Icons:	
Related parameters:	P.0700 (“Engine type”). F.1700 (“Engine type”). P.0704 (“Can-Bus alarms disable mask”).
To disable:	Set bit 15 of P.0704 = 0

Always enabled. The controller activates the protection when reported by the ECU or by the AVR.

11 Other functions

11.1Thresholds on loads.

The controller allows monitoring the active power supplied by the generator. You can choose among two monitoring modes, by acting on P.0481 (“Load thresholds mode”):

- “0-Low power”.
- “1-High power”.

You can “map” the result of the monitoring to a digital output, configured as DOF.3121 (“Load thresholds”).

You can dynamically enable this function using a digital input configured as DIF.2703 (“Enables the power thresholds”): if the input exists, the controller enables the function when the input is activated (when disabled, the controller deactivates the output).

Use the following parameters to configure this function:

- P.0482 (“Initial delay”): if the enabling input exists (DIF.2703), the controller keeps the output DOF.3121 deactivated for P.0482 seconds from the input’s activation. This allows system stabilization before starting monitoring.
- P.0483 (“Low power threshold”).
- P.0484 (“Low power delay”).
- P.0485 (“High power threshold”).
- P.0486 (“High power delay”).

The two thresholds P.0483 and P.0485 are percentages of P.0125; if both are set to zero (or not congruent), the function is disabled (ant the output deactivated).

Low power

The controller activates an output to signal that the generator is underloaded: the output could be used to connect an external dummy load to the generator, avoiding keeping it running underloaded for a long time. You must properly set the two thresholds: the power increase produced by the dummy load should not exceed P.0485, otherwise the controller will continuously connect/disconnect the dummy load itself.

High power

The controller activates an output to signal that the generator is underloaded: the output could be used to disconnect non-essential loads from the generator (avoiding degenerating into an overload protection). Again, you must properly set the two thresholds: the power decrease produced by the “load shedding” should not exceed P.0483, otherwise the controller will continuously connect/disconnect the non-essential loads.

11.2Counters

The controller manages internally the following counters:

- Controllers powered hours counter.
- Engine running hours counter (clearable and total).
- Engine running hours counter with GCB closed (clearable).
- Active energy counter (clearable and total). The counter is incremented only when the active power is positive.

- Reactive energy counter (clearable and total). The counter is incremented both when the reactive power is positive and negative.

The controller shows all these counters (except the “Engine running hours counter with GCB closed” and the “Controllers powered hours counter”) on the display; all of them can be read via the communication port (Modbus protocol). Some of these counters can be reset by the operator following a proper procedure, or via the communication port (they are marked in the list with “clearable”). All these counters are saved in a non-volatile memory; therefore, they store their values also when the controller is powered off. Since non-volatile memories “consume” themselves writing in them, it is necessary to reduce at the minimum the number of writings. For this reason, a counter is not immediately saved as its value changes, and it is then important to know when values are saved and how to be sure that they are saved before removing supply from the board.

Counters are saved (all together and at the same time) in the following conditions:

- When the controller detects a change in the “engine-running” condition.
- When the hours counters changes.
- Every five minutes.

Furthermore, counters are saved when they are reset to zero (individually or globally) via front panel or communication port.

For information on how to clear a counter, see 7.4.8.7 and 7.4.9.2

11.3Clock/calendar

The controller is provided with a hardware clock/calendar. The controller shows the date/time in the page S.02. The operator can use BOARDPRG4 to synchronize the clock with the PC. The date/time is used for recording in historical logs.

The controller records the following events related to the clock/calendar:

- EVT.1075: Clock/calendar not valid
- EVT.1076: Clock/calendar updates

The following states (related to the clock) are available for PLCs and AND/OR logics:

- ST.112: one pulse every second.
- ST.113: one pulse every minute.
- ST.114: one pulse every hour.

11.4Non-volatile memory

The controller has a non-volatile memory inside (which does not need power supply), used to store various information such as parameters, counters etc. The memory is divided into different zones. When the controller is powered, it performs a check on the data stored in each area: if even just one area is incorrect, it displays an error message. This message contains a numerical code (in hexadecimal form); each bit of the code corresponds to an area of the memory that is not valid. Here is a table listing the areas and their bit.

Area	Version	Bit	Value	Description
1	1.00	0	1 (0001)	Coefficients for the calibration of the measuring inputs of the controller.
2	1.00	1	2 (0002)	Different information (lcd display contrast …).
3	1.00	2	4 (0004)	Counters.
4	1.00	3	8 (0008)	Diagnostic trouble codes acquired via CAN interface from external devices.
5	1.00	4	16 (0010)	Alternative configurations of parameters.
6	1.00	5	32 (0020)	Parameter.

If, for example, the value between brackets is “0004”, it means that only the counters area is not valid. If the value is “0021”, it means that the parameters areas (0020) and the LCD contrast areas (0001) are not valid.

If any zone is not valid, the normal operation sequences are not performed until when the operator presses buttons "**LEFT** + **EVENTS**": it is in effect necessary that the situation has been acknowledged as it can cause dysfunctions (for example if the not valid area is the one of the parameters). Only when the operator presses "**LEFT** + **EVENTS**", the controller reloads the defaults for the data saved in the not valid areas: this means that if the controller is shut down without pressing "**LEFT** + **EVENTS**", when you turn it on next you will get again the signalling of not valid memory.

In case the controller detects an error in the "parameters" zone, after reloading the default values, it records the code EVT.1078 in the events log.

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