POWER FROM WITHIN

GC800-SCM CONTROLLER

SMARTECH

A DIVISION OF MECC ALTE

TECHNICAL MANUAL

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Revision	Date	Notes
00	07/01/2025	First version of the manual for the version 01.00 of the device.

Table of Contents

1 Introduction

1.1 References

[1] Mecc Alte EAAM0740xx – BoardPrg4 user's manual.

[2] Mecc Alte EAAM0697xx REWIND III user's manual.

[3] Mecc Alte EAAS08376xx - GC800 SCM Modbus Registers.

[4] CAN open – Cabling and Connector Pin Assignment – CiA Draft Recommendation DR-303-1

[5] BOSCH CAN Specification – Version 2.0 – 1991, Robert Bosch Gmbh.

[6] Mecc Alte EAAM0199xx - Parallel functions manual.

[7] Mecc Alte EAAM0412xx – PLC environment description.

1.2 General information

GC800 is an automatic genset controller. It is made up by two separate devices:

- **GC800 SCM** (System Control Module or BaseBox): the main control and management unit of the system and genset. It can manage and protect both the engine and the alternator. It integrates all the functionalities needed to manage the parallel of the generator both with other generators and with the mains. It can also be used for simple standby (emergency to mains) or prime-mover (stand-alone production) applications.

  It can be mounted on a standard DIN rail.

- **GC800 HMI** (Human Machine Interface): a pre-programmed capacitive touch screen operator panel solution to be connected to the GC800 SCM device by a selectable Ethernet or serial communication resource.

  HMI offers user-friendly touch screen control, visualisation and graphical overview with a high-resolution, high-quality display that is easy to read even at very sharp angles.

  HMI can be door mounted.

In this manual, the word **GC800** refers to the combination of GC800 SCM and GC800 HMI.

This manual refers to GC800 SCM only.

1.3 Safety information

Many accidents are caused by poor knowledge and/or by 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.

Please read this manual carefully before using the device.

Safety instructions are marked with symbols in this document. These symbols express the extent of the danger:

WARNING! This symbol refers to potentially dangerous situations that, unless hazards are prevented, can lead to serious or fatal injuries. It describes the usual precautions to be taken to avoid hazard situations. Ignoring these precautions can cause serious damages to property and/or injury to persons.

WARNING! This symbol refers to risks that, unless avoided, can lead to minor or moderate injuries or damage. It may also be used for hazards that can cause damaged to property and/or injury to persons.

INFORMATION! This symbol refers to information useful for performing the current operation, or explanations or clarifications for procedures.

1.4 Safety requirements

Please read this manual carefully before using the device.

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

WARNING! Every intervention must be carried out by skilled personnel. There are dangerous voltages on the terminals of the device; before carrying out any operation on them, make sure to open the mains and genset circuit breakers or to open the related fuses.

WARNING! Do not remove or change any connection while the genset is running. Before start working on live parts of electrical systems and resources, cut the electricity, and ensure it remains off for the duration of the work.

WARNING! The device has been designed and constructed solely for the intended use described in this manual. Any unauthorized modifications or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment.

WARNING! The disconnection of the cranking battery from a control system that uses an alternator or a battery-charging device while the charging device is still connected, can cause damages to the control system. Make sure the charging device is turned off before disconnecting the battery from the system.

WARNING! Do not disconnect for any reason the terminals of the current transformers (CT) when the primary circuit is closed. Open the primary circuit first.

WARNING! The device has mechanical protection rating IK07 (2 Joule) and must be installed inside a switchboard that provides an adequate degree of protection, to protect the device against mechanical shocks.

WARNING! Damage to insulation or to specific components can pose a life-threatening hazard. Immediately switch off the power supply and have it repaired if there is damage to the insulation.

WARNING! Wrong operations on the connections can cause the disconnection of the loads from the mains or from the genset.

WARNING! All electronic equipment is sensitive to damage from electrostatic discharge, which can cause the control unit to malfunction or fail. Mecc Alte recommends handling the device with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

WARNING! Store this product in areas where temperatures are within the product's specifications. Do not restrict or block the product's ventilation slots.

INFORMATION! The device includes a lithium backup battery for real time clock. Field replacement of the battery is not allowed. In case of battery replacement please contact Mecc Alte.

INFORMATION! The SELV word refers to a generic secondary circuit that is designed to be protected from excessive voltages (≥42 Vac or ≥ 60Vdc) during normal operating conditions and single fault conditions. A reinforced isolation is required at the boundary between the primary and the secondary circuit. See proper SELV-related information along the manual.

1.5 Notes on the parameter's configuration of the device

INFORMATION! The device uses many configurable parameters, and it is therefore impossible to describe all their combinations and effects. This document describes most of them, other are described in the documents listed in chapter 1.1

WARNING! The device is supplied with a generic "default" configuration; the installer is responsible to adjust the operating parameters to the specific application.

Mecc Alte carries out a great 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 device.

Although most of the parameters and features can be accessed and configured by directly operating on GC800 HMI, **some particular features or configurations, due to their nature, can only be set or changed through the Mecc Alte BoardPrg4 PC Software**, which can be downloaded for free from the Mecc Alte website www.meccalte.com

It simplifies a lot the configuration of the device and its use is strongly suggested. It also allows you to save the current configuration of the device on a file and to reuse it on other identical devices.

The program also allows you to configure, save and load the characteristic curves of non-standard analogue sensors with resistive or live output.

BoardPrg4 can be used on all Mecc Alte devices; the connection to the PC can be done via RS232, RS845, USB, Ethernet and GPRS.

1.6 Maintenance and cleaning

The maintenance of this device must be carried out by qualified personnel, in observance of the law in force, to prevent from damages to persons or things.

1.7 Information concerning disposal.

INFORMATION! on the disposal of electrical and electronic equipment (applicable in European countries that have adopted separate waste collection systems).

Products bearing the barred wheeled waste container symbol cannot be disposed of with normal urban waste. Electrical and electronic equipment should be recycled in a facility authorized to process these items and dispose of their components. Contact your local authority for information on where and how to deliver such products to the authorized site nearest you. Proper recycle and disposal operation helps conserve resources and prevents detrimental effects for health and the environment.

1.8 Definitions

In this document, the word **ALARM** is used to indicate a fault that makes the genset operation impossible and causes the automatic and immediate stop of the engine, with emergency procedure (without cooling cycle).

The word **DEACTIVATION** is used to indicate a fault that makes the genset operation impossible and causes the automatic stop of the engine, with standard procedure (with cooling cycle). The genset controller immediately opens the GCB circuit breaker when this kind of fault arises.

The word **UNLOAD** is used to indicate a fault that makes the genset operation impossible and causes the automatic stop of the engine with standard procedure (with cooling cycle). If it is possible, the genset controller gradually reduces to zero the power supplied by the genset before opening the GCB circuit breaker.

The word **WARNING** is used to indicate a fault that requires an operator action but doesn't require the automatic stop of the genset.

1.8.1 Acronyms

AIF: It identifies a function for the configuration of the analogue inputs ("Analogue Input Function"). The number that follows the wording "AIF" is the code to set in the parameter that configures the function of the desired analogue input.

AOF: It identifies a function for the configuration of the analogue outputs ("Analogue Output Function"). The number that follows the wording "AOF" is the code to be set in the parameter that configures the function of the desired analogue output.

AVR: It identifies the "Automatic Voltage Regulator" electronic device, included in any genset.

DIF: It identifies a function for the configuration of the digital inputs ("Digital Input Function"). The number that follows the wording "DIF" is the code to set in the parameter that configures the function of the desired digital input.

DOF: It identifies a function for the configuration of the digital outputs ("Digital Output Function"). The number that follows the wording "DOF" is the code to set in the parameter that configures the function of the desired digital output.

DRIVE: It defines a particular application for the genset. See the description of the type of plant in [6].

DTC: It indicates a diagnostic code ("Diagnostic Trouble Code") received from an external device (ECU, AVR) via CAN bus or via RS485.

ECU: It indicates the ("Engine Control Unit") available in any electronic engine.

EMF: Electro Motive Force.

EVT: It identifies an event stored into the historical records. The number that follows the wording "EVT" is the numeric code of the event.

EXBUS: It identifies the Mecc Alte proprietary communication bus that allows the genset controller exchanging information to the connected Mecc Alte expansion modules.

GCB: This term identifies the circuit breaker ("Genset Circuit Breaker") that connects the genset to the loads (or to the parallel bars in case of multiple gensets applications).

MCB: This term identifies the circuit breaker ("Mains Circuit Breaker") that connects the mains to the loads.

MGCB: It indicates the circuit breaker ("Master Genset Circuit Breaker") that connects the gensets parallel bars to the loads.

MPM: It defines a particular application for the genset. See the description of the type of plant in [6].

MPtM: It defines a particular application for the genset. See the description of the type of plant in [6].

MPtM + MSB: It defines a particular application for the genset. See the description of the type of plant in [6].

MPU: Magnetic Pick Up.

MSB: It defines a particular application for the genset. See the description of the type of plant in [6].

MSB + MSTP: It defines a particular application for the genset. See the description of the type of plant in [6].

PMCB: It identifies the Mecc Alte proprietary communication bus that allows all parallel controllers exchanging information to manage the parallel functions described in the document [6].

SPM: It defines a particular application for the genset. See the description of the type of plant in [6].

SPtM: It defines a particular application for the genset. See the description of the type of plant in [6].

SPtM + SSB: It defines a particular application for the genset. See the description of the type of plant in [6].

SSB: It defines a particular application for the genset. See the description of the type of plant in [6].

SSB + SSTP: It defines a particular application for the genset. See the description of the type of plant in [6].

SELV: Safety Extra Low Voltage

1.9 Conventions

In this manual, the modifications, with respect to the previous version, are signalled by a vertical bar on the right of the paragraphs. The modifications on the fields of a table are highlighted with a grey background.

1.10 Revisions of the software

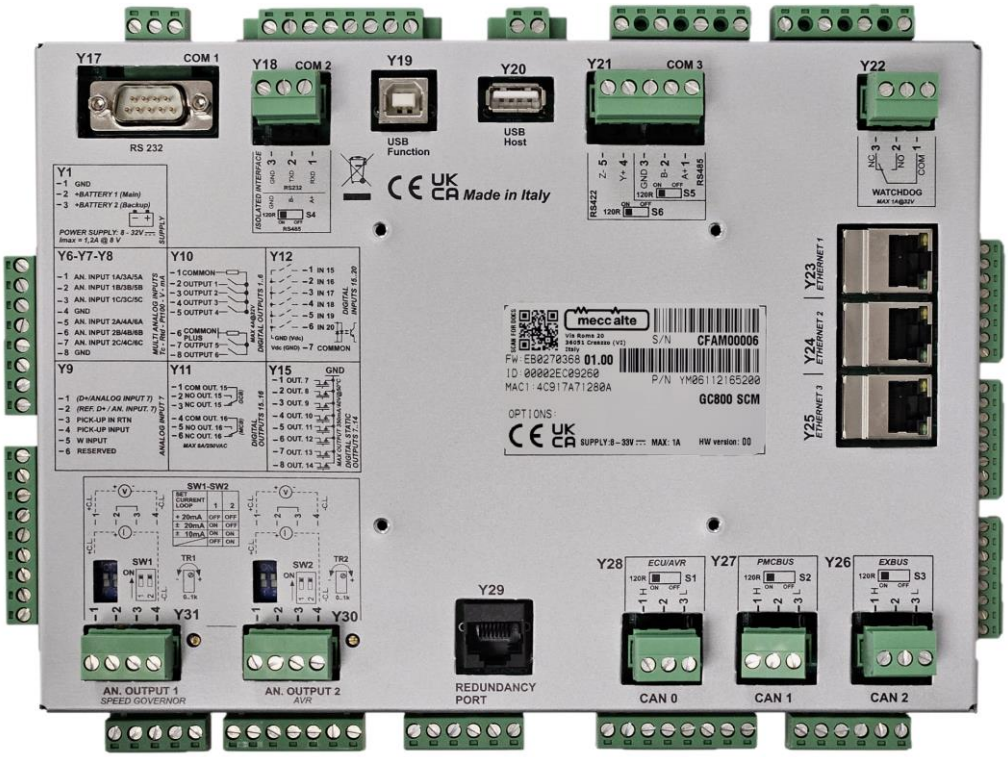
Several parts of this manual refer to the device's software revisions. These revisions are marked with the assigned Mecc Alte code (shown on the rear panel of the device). The format of the code is: EB0270368XXYY, where “XX” is the main version and “YY” is the minor version. Thus, the code EB02703680100 refers to the device software release "1.00". **GC800 HMI shows on the display the software revision of GC800 SCM too.**

GC800 SCM is a “dual processor” device and uses two different firmware:

- EB0270368XXYY: for the main processor, which deals with the operation management and the communication resources (main software version).
- EB0270362XXYY: for the secondary processor that deals with the electrical measurements and I/O resources (secondary software version).

2 Views of the device

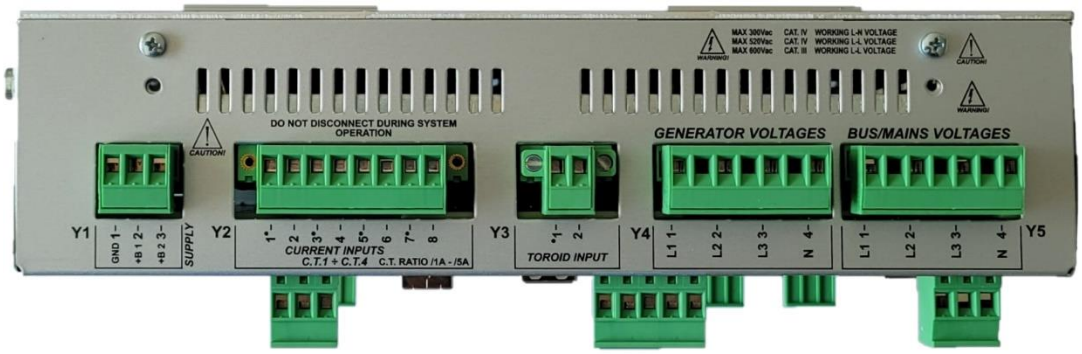
GC800 SCM front side view.



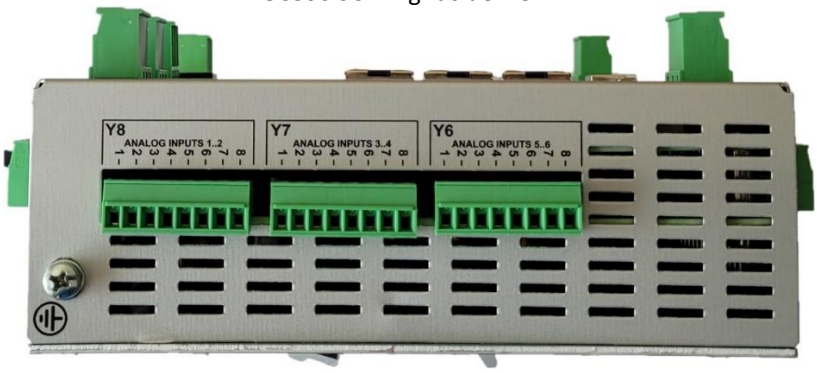
GC800 SCM rear side view.

GC800 SCM bottom side view.

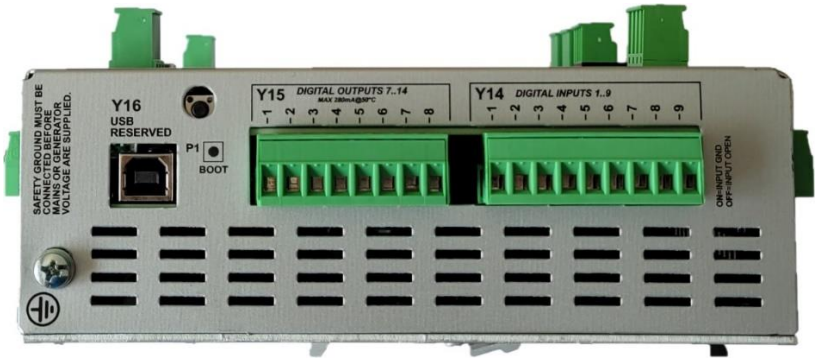
GC800 SCM top side view.



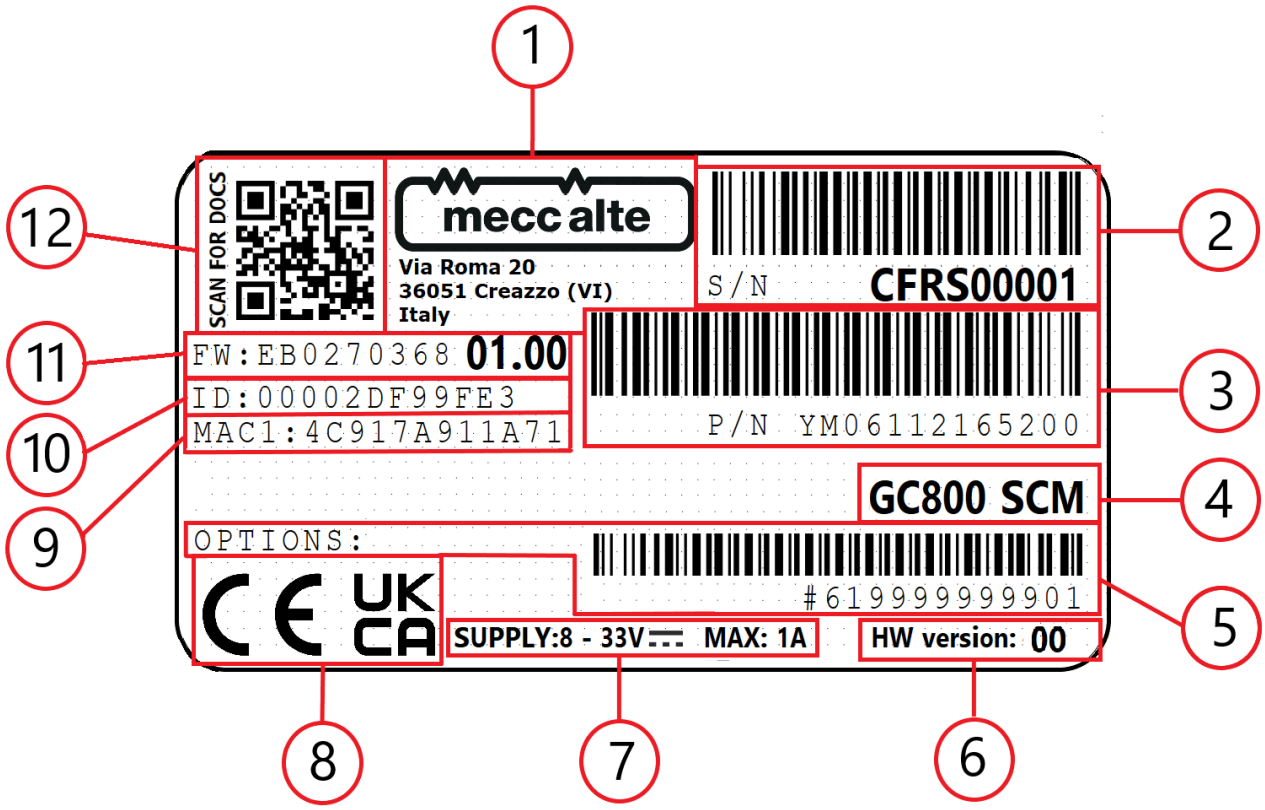
GC800 SCM right side view.



GC800 SCM left side view.



2.1 Product label



1. **Manufacturer:** address and logo.
2. **S/N:** serial number (alphanumeric and barcode).
3. **P/N**: part number (alphanumeric and barcode).
4. **Product name**: device name.
5. **Option**: option part number (alphanumeric and barcode) if available.
6. **HW version**: device revision number.
7. **Supply**: device supply range and maximum current consumption.
8. **Approvals**
9. **MAC1**: unique identifier assigned to network interface controller ETH1. The Mac-Address of the Ethernet Interface port 2(ETH2) and port 3 (ETH3) are sequential to the Mac-Address of the ETH1 port.
10. **ID**: unique identification code assigned to the device.
11. **FW**: firmware version installed on the device.
12. **SCAN FOR DOCS**: QR-code with web link to where to download the latest device documentation.

3 Technical features

INFORMATION! GND is referred to the potential of the terminal Y1-1

WARNING! Connect the unit only to a DC power source that complies with the safety extra-low voltage (SELV) requirements.

Power Supply (Y1).	
Vbat.	Two separate power supply inputs with common negative (GND): Battery1 (B1) - Main battery. Battery2 (B2) - Backup battery.
Nominal power supply (Vn).	12 Vdc or 24 Vdc.
Power supply range (Vn variation).	From 8 to 32 Vdc. The device identifies the rated DC voltage (12 Vdc or 24 Vdc) when powered up and whenever OFF mode is selected: it is used to signal over/under voltages.
Power supply drop-out immunity.	0 Vdc for minimum 40 ms from a nominal voltage of 12 Vdc (voltage drop).
Starting minimum voltage.	During the engine cranking, the operation is guaranteed up to Vbat ≥ 5 Vdc for indefinite time.
Input capacitance.	About 3800 µF.
Measurement range.	From 0 to 40 Vdc.
Sampling rate.	10 kHz.
Measurement Resolution.	14 bits.
Measurement accuracy.	± 0,5% of full-scale reading.
Measurement resolution displayed.	0.1 V.
Power consumption in stand-by.	380 mA @ 12 Vdc. 210 mA @ 24 Vdc.
Maximum power consumption during operation. Conditions: • Digital input & outputs active. • Analogue outputs @ +20 mA. • Ethernet ports in communication. • USB communication active. • USB stick inserted and powered.	900 mA @ 8 Vdc. 590 mA @ 12 Vdc. 320 mA @ 24 Vdc. 260 mA @ 32 Vdc. **INFORMATION!** The device absorbs a higher start-up current than the operating current. This is caused principally by the charging of the various capacitances in the input circuit and the EMC filters. Once the device is operating stably, the input current drops to the levels one would expect from the manual.
Protection.	Protection against polarity reversal with built-in self-resetting fuse. Circuit protection against load dump transients and voltage surge (1.2/50 µs): ±1 KV Line-Line. ±2 KV Line-Earth.

Current measurement inputs 1-4 (Y2).	
Type of input.	3-phases current measurements (L1/L2/L3). Inputs with internal CTs and common CTs ratio. 1 independent auxiliary current measurement with internal CT (can be used as for neutral, differential protection or mains power). It is required the use of external current transformers with a secondary current from 1 A to 5 A. **WARNING!** The external CTs must guarantee at least one BASIC INSULATION for the use of the device in the overvoltage CAT. III or IV.
Nominal Current (In).	-/1 Aac or -/5 Aac from current transformers.
Maximum measurement range.	Up to 6 Aac.
Scale.	1 Aac nominal (Low current range). 5 Aac nominal (High current range). Internal amplifier with automatic change of scale for currents lower than 1.2 Aac and higher than 1.5 Aac.
Input impedance.	< 0.1 Ω.
Measurement/overvoltage categories.	CAT. III.
Insulation voltage to SELV.	Basic Insulation. 2210 Vac Insulation for 5s. 1500 Vac Insulation for 60s. 2100 Vdc Insulation for 60s.
Insulation voltage to EARTH.	Basic Insulation. 2210 Vac Insulation for 5s. 1500 Vac Insulation for 60s. 2100 Vdc Insulation for 60s.
Rated surge voltage.	6 KV (1.2/50 µs).
Sampling rate.	10 kHz.
Type of measurement.	True RMS (TRMS).
Burden per phase (auto-consumption).	< 0.5 VA/phase.
Overload capacity.	+40% of the nominal current (In).
Overload peak.	Possible sinusoidal transient voltage surges up to 2.5 x In, with progressive loss of the measurement accuracy depending on the amplitude of the surge.
Sampling rate.	10 kHz.
Measurement resolution.	14 bits.
Measurement accuracy.	± 0.2% of full-scale reading (excluding external CT error).
Measurement resolution displayed.	Minimum 0.1 Aac (it depends on the CT ratio).

Toroidal transformer measurement input (Y3).	
Type of input.	1 auxiliary current with internal shunt for connecting external toroid. Adjustable toroidal ratio.
Maximum measurement range.	0.5 to 100 mAac.
Input impedance.	25-5 Ω.
Type of measurement.	True RMS (TRMS).
Burden (auto-consumption).	< 3 VA.
Overload capacity.	Maximum 280 mAac.
Short time overload peak.	Maximum 0.5 Aac for 1 second.
Sampling rate.	10 kHz.
Measurement resolution.	14 bits.
Measurement accuracy.	± 0.2% of full-scale reading (excluding toroid error).
Measurement resolution displayed.	Minimum 0.1 Aac (it depends on the toroidal ratio).

Genset and Mains/Bus voltage measurement inputs (Y4, Y5).	
Type of input.	3-phases voltage measurements (L1/L2/L3/N). Measurement of the phase to neutral and phase to phases voltages. Measurements of the neutral voltages referred to the device supply negative (GND). External fuse maximum 1 A.
Nominal range (Vn).	100 to 690 Vac phase to phase.
Measurement range.	8 to 840 Vac phase to phase.
Maximum voltages applicable. *	Maximum 398 Vac in CAT. III for measurements phase to neutral. Maximum 690 Vac in CAT. III for measurements phase to phase. Maximum 300 Vac in CAT. IV for measurements phase to neutral. Maximum 520 Vac in CAT. IV for measurements phase to phase. * Up to 2000 m (6561 ft.) **WARNING!** For CAT.III applications, the maximum voltage related to the protective earthing (PE) is 600 Vac. For CAT.IV applications, the maximum voltage related to the protective earthing (PE) is 300 Vac.
Scale.	400 Vac (HV - High Voltage range). 100 Vac (LV - Low Voltage range). User selectable.
Maximum voltages measurable with scale HV.	Maximum 487 Vac phase to neutral. Maximum 843 Vac phase to phase.
Maximum voltages measurable with scale LV.	Maximum 127 Vac phase to neutral. Maximum 152 Vac phase to phase.
Maximum tension in Common-Mode from GND with HV scale.	Maximum 100 Vac.
Maximum tension in Common-Mode from GND with LV scale.	Maximum 80 Vac.
Connection mode.	3 phases 4 wires. 3 phases 3 wires. 2 phases 3 wires. 1 phase 2 wires. Aron insertion with 2 voltage transformers.
Input impedance per path.	1.8 MΩ phase to GND. 0.6 MΩ phase to neutral.
Measurement/overvoltage categories.	CAT. III, CAT. IV.
Insulation voltage to SELV.	Reinforced Insulation – protective Impedance. 5400 Vac Insulation for 5s. 3600 Vac Insulation for 60s. 5100 Vdc Insulation for 60s.
Insulation voltage to EARTH.	Basic Insulation. 3310 Vac Insulation for 5s. 1800 Vac Insulation for 60s. 2550 Vdc Insulation for 60s.
Rated surge voltage.	9.6 KV (1.2/50 µs).

Genset and Mains/Bus voltage measurement inputs (Y4, Y5).	
Type of measurement.	True RMS (TRMS).
Sampling rate.	10 KHz.
Measurement resolution.	14 bits.
Measurement accuracy.	± 0.3% of full-scale reading.
Phase angle accuracy.	± 0.2° (within nominal voltage range and nominal frequency range).

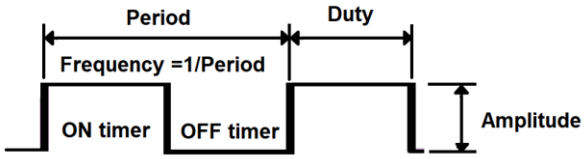
Frequency measurements.		
	Frequencies measured by L1-L2 phase voltages, for both mains/bus and genset. **For this reason, in case of single-phase systems, connect the N also on L2 terminal.**	
Nominal Frequency (Fn).	50 Hz or 60 Hz.	
Measurement range.	3 to 99 Hz.	
Measurement accuracy.	± 50 mHz	
Frequency minimum sensitivity for mains/bus voltage inputs.	Scale 100V (LV - Low Voltage range).	Scale 400 (HV - High Voltage range).
	7,5 Vac L1-N @ 50Hz. 13 Vac L1-L2 @ 50Hz.	27 Vac L1-N @ 50Hz. 47 Vac L1-L2 @ 50Hz.
	8 Vac L1-N @ 60Hz. 14 Vac L1-L2 @ 60Hz.	30 Vac L1-N @ 60Hz. 52 Vac L1-L2 @ 60Hz.
Frequency minimum sensitivity for genset voltage inputs.	Scale 100V (LV - Low Voltage range).	Scale 400 (HV - High Voltage range).
	0.5 Vac L1-N @ 10Hz. 1.0 Vac L1-N @ 10Hz.	1.6 Vac L1-N @ 10Hz. 2.7 Vac L1-N @ 10Hz.
	5 Vac L1-N @ 50Hz. 9 Vac L1-L2 @ 50Hz.	17 Vac L1-N @ 50Hz. 29 Vac L1-L2 @ 50Hz.
	6 Vac L1-N @ 60Hz. 11 Vac L1-L2 @ 60Hz.	22 Vac L1-N @ 60Hz. 38 Vac L1-L2 @ 60Hz.
	The sensitivity decreases with the increase of the frequency for the acknowledgement of the engine running and for a higher rejection of the disturbances.	
Measurement resolution.	0.1 Hz ± 50ppm, 35ppm/°C typical.	

Digital inputs 01-14 (Y14, Y13)	
Type of input.	14 opto-insulated digital inputs with common power supply. Internal power supply terminal connected to the device positive Y1. They are active when the input is connected to the supply negative GND. When they are open, the voltage of the input terminals is Vbat.
Minimum pulse length.	Digital input 13 and 14 can be associated with the 'pulse counter' function. When associated with these functions, the minimum pulse duration is 65 ms.
Input impedance.	2.2 kΩ.
Activation/deactivation threshold.	2.5 Vdc.
Voltage withstands.	± 35 Vdc.
Typical current with closed contact.	5 mA @ Vbat= 13.5 Vdc. 11 mA @ Vbat= 27 Vdc.
Open circuit voltage.	Vbat.
Input signal delay.	User adjustable.

Digital inputs 15-20 (Y12).	
Type of input.	6 opto-insulated fast digital inputs with external common power supply terminal, which can be connected to GND (active inputs to Vbat) or to Vbat (active inputs to GND).
Minimum pulse length.	These digital inputs can be associated with the 'pulse counter' function. When associated with these functions, the minimum pulse duration is 15 ms.
Input impedance.	2.2 kΩ.
Activation/deactivation threshold.	2.5 Vdc.
Voltage withstands.	± 35 Vdc.
Typical current with closed contact.	5 mA @ 13.5 Vdc. 11 mA @ 27 Vdc.
Open circuit voltage.	The voltage of common terminal Y12-7.
Input signal delay.	User adjustable.

Digital outputs 01-04 (Y10).	
Type of output.	4 relays with NO contacts. Positive or negative common input terminal (Y10-1).
Maximum switching capacity (resistive load).	4 ADC @ 32 Vdc for each output. Maximum total current of 4 ADC @ 50°C for outputs 1 & 2 activated simultaneously. Maximum total current of 4 ADC @ 50°C for outputs 3 & 4 activated simultaneously.
Minimum switching capacity.	1 mA @ 5 Vdc.
Protections.	Self-restoring fuse. Transient voltage suppressor diodes for surge and ESD protection. **INFORMATION!** With particularly inductive loads (remote control switches, electromagnets, etc.), a surge-damping diode must still be used.

Digital outputs 05-06 (Y10).	
Type of output.	2 relays with NO contacts. Positive common input terminal (Y10-6). The positive common terminal has the function of emergency stop input. The voltage measured on this terminal is displayed by GC800 HMI ("EM-Stop"). They can be used for the starter motor (START) and for the fuel solenoid valve (FUEL).
Maximum switching capacity (resistive load).	4 ADC @ 32 Vdc for each output. Maximum total current of 4 ADC @ 50°C for all outputs activated simultaneously.
Minimum switching capacity.	1 mA @ 5 Vdc.
Protections.	Self-restoring fuse. Transient voltage suppressor diodes for surge and ESD protection. **INFORMATION!** With particularly inductive loads (remote control switches, electromagnets, etc.), a surge-damping diode must still be used.

<table>
<tr><th colspan="4">Digital outputs 07-14 (Y15)</th></tr>
<tr><td>Type of output.</td><td colspan="3">8 independent static outputs, with internal common terminal connected to power supply GNS: open collector outputs.
The output current is supplied by the negative supply terminal Y1-1 (GND) of the device.
INFORMATION! The outputs 11 and 12 (Y15-5 and Y15-6) can be associated with the “PWM output” function, to generate a PWM signal with frequency and duty-cycle proportional to an analogue measure (e.g. speed control command for Caterpillar engines).</td></tr>
<tr><td>Rated supply.</td><td colspan="3">Maximum 350 mADC @ 32 Vdc for each output.
Total maximum current for all activated outputs 1.5 ADC @ 50°C.</td></tr>
<tr><td>Output resistor (status ON).</td><td colspan="3">Max 500 mΩ.</td></tr>
<tr><td>Leakage current (status OFF).</td><td colspan="3">Max 1 µA @ 32 Vdc.</td></tr>
<tr><td>Protections.</td><td colspan="3">Internal current limited to 2.2 ADC typical.
Thermal protection, short circuit, overvoltage with auto restart.
Inverted protection polarity.
INFORMATION! With particularly inductive loads (remote control switches, electromagnets, etc.), a surge-damping diode must still be used.</td></tr>
<tr><td></td><td colspan="3">Only for outputs 11 and 12 when associated with PWM output function</td></tr>
<tr><td>PWM frequency range.</td><td colspan="3">1 Hz to 2.5 kHz ± 1Hz.</td></tr>
<tr><td>PWM duty cycle resolution.</td><td colspan="3">16 bits (65536 steps).</td></tr>
<tr><td>PWM range *.</td><td colspan="3"> 

<table>
<tr><th>Frequency.</th><th>Duty (min)</th><th>Duty (max)</th></tr>
<tr><td>100 Hz.</td><td>0.6 %.</td><td>99.4 %.</td></tr>
<tr><td>500 Hz.</td><td>3.0 %.</td><td>97.0 %.</td></tr>
<tr><td>1 kHz.</td><td>6.0 %.</td><td>94.0 %.</td></tr>
<tr><td>2 kHz.</td><td>12.0 %.</td><td>88.0 %.</td></tr>
</table></td></tr>
<tr><td>Amplitude minimum/maximum.</td><td colspan="3">From 3 to 32 Vdc.</td></tr>
<tr><td>High pulse width * (ON timer).</td><td colspan="3">65 µs minimum.</td></tr>
<tr><td>Low pulse width * (OFF timer).</td><td colspan="3">65 µs minimum.</td></tr>
<tr><td></td><td colspan="3">* Declared values can vary depending on the external capacitances connected to the outputs.
INFORMATION! it is necessary to connect a pull-up resistor to a positive voltage (always referred to the negative of the device): use a resistor with a minimum value of 4,7 kΩ.
The same supply voltage of the device can be used: it depends on the output signal amplitude required.</td></tr>
</table>

Digital outputs 15 and 16 - Switch command (Y11).	
Type of output.	2 relays with dry contacts (typically for the contactors commands).
Rated voltage.	250 Vac.
Rated current.	8 Aac @ 250 V.
Maximum switching voltage *.	Maximum 398 Vac in CAT. III. * Up to 2000 m (6561 ft).
Maximum DC load breaking capacity.	5 ADC @ 32 V (resistive load).
Overvoltage category.	CAT. III.
Insulation voltage to SELV.	Reinforced Insulation. 5400 Vac Insulation for 5s. 3600 Vac Insulation for 60s. 5100 Vdc Insulation for 60s.
Insulation voltage to EARTH.	Basic Insulation. 3310 Vac Insulation for 5s. 1800 Vac Insulation for 60s. 2550 Vdc Insulation for 60s.
Contact material.	AgNi 90/10.

Output Hardware Watchdog (Y22).	
Type of output.	One relay output with dry contacts. If the device works correctly, the output is active. If the device is blocked and/or does not refresh the watchdog circuit for a time longer than 5 seconds, the output fails. If the device is turned off, the output immediately fails. The watch-dog output cannot be deactivated by the software. **INFORMATION!** Use suppression diodes on all relays and other inductive loads.
Maximum switching capacity (resistive load).	1 ADC @ 32 Vdc.
Minimum switching capacity.	10 µA, 10 mVdc.

Excitation output for recharge alternator D+ and analogue input 07 (Y9)	
Type of output.	The charging alternator D+ acts as a pre-exciting output during the engine start-up. During regular operation, it acts as an input for monitoring the charging voltage. The current output is automatically switched according to the supplied voltage Vbat (Y1). If it is not used for the excitation of the battery charger alternator, it is possible to configure the D+ terminal as analogue input to acquire voltage measurements from 0 to 40 Vdc, or as an additional digital input with Vbat activation. The input offers the possibility of differential measurement to compensate the differences of negative pole with reference to GND.
Excitation current.	200 mA @ 13.5 Vdc. 100 mA @ 27 Vdc.
Charging fail threshold.	≤ 6 Vdc.
Measurement range.	From 0 to 40 Vdc.
Sampling rate.	10 kHz.
Measurement resolution.	14 bits.
Measurement accuracy.	± 0.5% of full-scale reading.
Max common mode voltage.	± 3.5 Vdc for of full-scale reading.
Measurement resolution displayed.	0.1 V.

Analogue multi-inputs 01-06 (Y8, Y7, Y6).	
Type of input.	6 differential configurable analogue inputs. Not galvanically separated from power supply: • Current DC input. • Voltage DC input. • PT100 input (RTD). • Resistance measurement input (RMI). • Thermocouple input. • Digital input. All inputs offer the possibility of differential measurement to compensate for differences in the sensor's negative terminal from the device's GND.
Sampling rate.	25 Hz for channels 1-4. 200 Hz for channels 5-6.
Measurement resolution.	14 bits.
	Current dc input.
Current range.	0(4) to 20 mA passive.
Full scale.	20.2 mA.
Over range / fail (4 to 20mA).	Fail < 3.0 mA. Underflow < 3.8 mA. Overflow > 20.2 mA.
Over range / fail (0 to 20mA).	Overflow > 20.2 mA.
Internal shunt.	22 Ω.
Measurement accuracy.	± 0.1% of full-scale reading.
Measurement resolution displayed.	0.1 mA.
Protections.	Self-restoring fuse. Internal transient voltage suppressors.
	Voltage dc input.
Voltage range.	0 to 10 Vdc.
Full scale.	10.5 Vdc.
Over range / fail.	Overflow > 10.5 Vdc.
Input impedance.	>200 kΩ.
Measurement accuracy.	± 0.1% of full-scale reading.
Measurement resolution displayed.	0.1 Vdc.
Max common mode voltage.	± 10 Vdc for full scale reading.
Protections.	Internal transient voltage suppressors.
	PT100 input (RTD)
	Resistance calculated by measuring voltage across the sensor with a fixed current applied. The device can use RTD sensors with two or three wires. The use of three-wire sensors can compensate for reading error caused by the resistance of the connection cables. This connection gives you the precision indicated in the specifications.
Temperature range.	-200°C to 800°C.
Full scale.	400 Ω.

Analogue multi-inputs 01-06 (Y8, Y7, Y6).	
Over range / fail.	Fail > 430 Ω. Underflow < 18.5 Ω. Overflow > 400 Ω.
Injected current.	1 mA.
Measurement accuracy.	± 0.2% of full-scale reading.
Measurement resolution displayed.	0-1°C.
Protections.	Internal transient voltage suppressors.
	Resistance measurement input (RMI).
	Resistance calculated by measuring voltage across the sensor with a fixed current applied. The device can use RMI sensors with one or two wires. It is recommended to use two wire senders for best accuracy. **INFORMATION!** When using single-wire sensors, it is important that terminal "C" (sensor reference) is well connected to a ground point on the ENGINE BLOCK (**not inside the control panel**) and must provide a good electrical connection to the sensor body. This connection MUST NOT be used to provide a ground connection for other terminals or devices.
Full scale.	0 to 2100 Ω.
Over range / fail.	Fail > 2100 Ω. Underflow < 10 Ω.
Injected current.	5.3 mA.
Measurement accuracy.	± 0.2% of full-scale reading.
Measurement resolution displayed.	0.1 Ω.
Maximum common mode voltage.	-6 Vdc to +2.5 Vdc for full Scale reading (2000 Ω). ± 6 Vdc for half scale reading (1000 Ω).
Protections.	Internal transient voltage suppressors.
	Thermocouples input.
Type of input.	J, E, K and N. **INFORMATION** Since the measuring inputs are not isolated from the device power supply, it is possible that parasitic EMFs are introduced from the thermocouple to the measuring instrument, and since the thermocouple signal is in mV, it is very easy for this to be distorted or disturbed. It is therefore necessary to use thermocouples with an insulated measuring junction to obtain the accuracy indicated in the specifications. Twisted pair and shielded cable are recommended to achieve specification and optimisation of immunity-noise.
Temperature range.	Thermocouple type J: -210 to 1200 °C. Thermocouple type E: -270 to 1000 °C. Thermocouple type K: -270 to 1370 °C. Thermocouple type N: -260 to 1300 °C.
Measurement voltage range.	-10 to +80 mVdc.
Full scale.	+150 mVdc.
Over range / fail.	Fail > 120 mVdc. Underflow < -10 mVdc. Overflow > 100 mVdc.

Analogue multi-inputs 01-06 (Y8, Y7, Y6).	
Input impedance.	> 1 MΩ.
Measurement accuracy.	± 0.3 % of full-scale reading (plus tolerance of cold junction).
Measuring accuracy of the Internal sensor for cold junction compensation (CJC).	± 1.5°c in the operating temperature range: −10°C to 65°C. ± 2.0°c in the operating temperature range: −25°C to 70°C. ± 3.0°c in the full operating temperature range: −30°C to 70°C.
Measurement resolution displayed.	0.5°C.
	INFORMATION! shielded twisted-pair cable is recommended to achieve specification and optimisation of immunity-noise. Accuracy refers to the device only; error caused by the thermocouple is not included.
	Digital input.
Digital input activated.	When configured as '0 10 Vdc': input voltage > 4 Vdc. When configured as 'Resistive': input resistance < 5Ω.
Digital input not activated.	When configured as '0 10 Vdc': input voltage < 3.5 Vdc. When configured as 'Resistive': input resistance > 2 kΩ.
Input impedance.	> 200 kΩ.
Open circuit voltage.	14 Vdc typical.
Activation/deactivation threshold.	0.5 Vdc.
Protections.	Internal transient voltage suppressors.

Pick-up input for the measurement of the engine speed (Y9).	
Input type.	Filtered for DC currents blocking (capacitively isolated). If the sensor has two wires, use the Y9-4 (input) and Y9-3 (return) terminal. If the sensor has only one wire, use only the Y9-4 terminal. To use the MPU (Magnetic Pick-Up) input, the number of teeth on the flywheel (the number of pulses per revolution of the engine) must be configured.
Minimum voltage.	< 2 Vac from 20 to 5 kHz. Typical 1.6 Vac @ 3 kHz. See in detail the curve at paragraph 5.9.1.
Maximum voltage.	60 Vac.
Frequency range.	1 to 30000 Hz.
RPM range.	1 to 5000 rpm.
Frequency measurement tolerance.	± 0.2% of full-scale reading.
Flywheel teeth.	0 to 999.
Resolution.	1 rpm.

“W” inputs for the measurement of the engine speed (Y9).	
Input type.	Filtered for DC currents blocking (capacitively isolated). Use only the Y9-5 terminal. To use the W input, the RPM/W ratio must be configured.
Minimum voltage.	<2 Vac from 20 to 5kHz. Typical 2.5 Vac @ 3kHz. See in detail the curve at paragraph 5.9.2.
Maximum voltage.	60 Vac.
Frequency range.	1 to 10000 Hz.
RPM range.	1 to 5000.
Frequency measurement tolerance.	± 0,2% of full-scale reading.
RPM/W ratio.	0 to 255.
Resolution.	1 rpm.

Reserved auxiliary output (Y9).	
Output type.	Output with voltage exclusively reserved as reference for the connection of trimmers / potentiometers for analogue inputs. Example: fine adjustment of engine speed or deliverable power setpoint.
Voltage output.	5 Vdc.
Maximum current output.	30 mA DC.
Protections.	Internal current limited. Thermal protection, short circuit, overvoltage with auto-restart. **WARNING!** Only use for trimmer/potentiometer connection inside the power switchboard.

Analogue outputs 01 – 02 (Y31, Y30).	
Type of outputs.	2 current DC outputs with galvanic insulation. Active output (internal supplied) freely scalable. They can be used for the speed/voltage regulations. It is possible to convert them to DC voltage outputs by adding a simple jumper on the corresponding terminal (pin 2-3). Each output, when converted to voltage, has a built-in 1 kΩ trimming potentiometer to reduce the maximum output voltage while preserving signal resolution. Whether using current or voltage output, it is always possible to reduce the output variation by parameters.
Current range.	Configurable from switches. ±10 mADC / ±20 mADC / +20 mADC.
Voltage range.	±10 Vdc. e.g.: ±10 Vdc with built-in 1 kΩ trimming and current setting @ ±10 mADC.
Maximum load impedance in current mode.	1 kΩ @ ±10 mADC. 500 Ω @ ±20 mADC. 500 Ω @ +20 mADC.
Minimum load impedance in voltage mode (via internal trimmer).	>10 kΩ.
Built-in trimming potentiometer.	1 kΩ ± 10% 0.5 W. Actual electrical travel: 20 turns nominal.
Overvoltage categories.	CAT. III.
Insulation voltage to SELV.	Reinforced Insulation. 3510 Vac Insulation for 5s. 3000 Vac Insulation for 60s. 4200 Vdc Insulation for 60s.
Insulation voltage to EARTH.	Basic Insulation. 2210 Vac Insulation for 5s. 1500 Vac Insulation for 60s. 2100 Vdc Insulation for 60s
Maximum working voltage.	300 Vac.
Resolution.	16 bits.
Current accuracy.	± 0,2% of full-scale output.

COM1 - RS232 Communication interface (Y17).	
Type of interface.	One RS232 serial port standard TIA/EIA, not insulated on DB connector 9 poles male CANON.
Electrical signals.	TX, RX, DTR, DSR, RTS, GND.
Settings.	Baud rate selectable by parameter: 300, 600, 1200, 2400, 4800, 9600*, 19200, 38400, 57600, 115200 bps. Parity: None*, Even, Odd Stop bit: 1*, 2. * Default Setting.
Type of transmission.	Modbus RTU Slave.
Maximum distance.	The maximum cable length depends on cable capacitance, inductance, and screening. 15 m (50 ft) @ 9600 bps. 10 m (33 ft) @ 19200 bps. 7.5 m (25 ft) @ 38400 bps. 5.0 m (16 ft) @ 57600 bps. 2.5 m (8 ft) @ 115200 bps.
Protections.	Internal transient voltage suppressors.

COM2 - RS485/RS232 Communication interface (Y18).	
Type of interface.	RS232 or RS485* serial port standard TIA/EIA, with galvanic insulation. The interface type is user selectable by parameter. * Default Setting.
Electrical signals RS485.	DATA+ (A), DATA– (B).
Electrical signals RS232.	TXD, RXD, GND.
Settings.	Baud rate selectable by parameter: 300, 600, 1200, 2400, 4800, 9600*, 19200, 38400, 57600, 115200 bps. Parity: None*, Even, Odd. Stop bit: 1*, 2. * Default Setting.
Type of transmission.	Standard Modbus RTU Slave*, Modbus RTU Master. * Default Setting.
Internal line termination.	120 Ω by switch S4.
Insulation voltage.	Functional Insulation. 1000 Vdc Insulation for 60s.
Rated surge voltage.	±1 KV (1.2/50 µs)
Protections.	Internal transient voltage suppressors.
	INFORMATION! twisted pair shielded cable is recommended to achieve specification and optimisation of immunity-noise. If RS232 mode is selected, switch S4 must always be set to OFF.

COM3 - RS485/RS422 Communication interface (Y21)	
Type of interface.	1 RS485* or RS422 serial port standard TIA/EIA, not insulated. The interface type is user selectable by parameter. It can be used for serial connection to GC800 HMI. * Default Setting.
Electrical signals RS485.	DATA+ (A), DATA– (B).
Electrical signals RS422.	RX+ (A), RX– (B), TX+ (Y), TX– (Z), GND.
Settings.	Baud rate selectable by parameter: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200* bps. Parity: None*, Even, Odd. Stop bit: 1*, 2. * Default Setting.
Type of transmission.	Standard Modbus RTU Slave.
Internal line terminations.	120 Ω by switch S5 and S6.
Protections.	Internal transient voltage suppressors.
	INFORMATION! twisted pair shielded cable is recommended to achieve specification and optimisation of immunity-noise.

Redundancy Communication interface (Y29).	
Type of interface.	RS232 serial port not insulated on RJ45 9 pole connector. It's used for the serial connection between the MASTER controller and the BACKUP controller in systems requiring "Hot Redundancy".
Baud rate.	115200 bps.
Type of transmission.	Proprietary protocol.
Maximum distance.	2.5 m (8 ft).
Mandatory connection cable to use.	Ethernet shielded crossover patch cable cat. 5e.
Protections.	Internal transient voltage suppressors.

USB (reserved) (Y16).	
Type of interface.	1 USB2.0 Full-speed serial port not insulated. Connector type B.
Baud rate.	12 Mbps.
Function mode.	Service port. Modbus RTU Slave. Connection to PC by CDC driver.
Maximum distance.	3 m (9.84 ft).

USB Function interface (Y19).	
Type of interface.	1 USB2.0 Full-speed serial port not insulated. Connector type B.
Baud rate.	12 Mbps.
Function mode.	Service port. Modbus RTU Slave Connection to PC by CDC Driver
Maximum distance.	3 m (9.84 ft).

USB Host interface (Y20).	
Type of interface.	1 USB2.0 High-speed serial port not insulated. Connector type A.
Baud rate.	480 Mbps.
Host mode.	Pen drive management.
Maximum current supplied.	350 mA @ 5 Vdc with overload automatic protection.

CAN bus Communication interfaces (Y26, Y27, Y28).	
Type of interface.	3 CAN bus serial ports with galvanic insulation.
CAN bus 0.	CAN bus connection for engine control units (ECU, with SAE J1939 and MTU interface) and automatic voltage regulators (AVR with SAE J1939 interface).
CAN bus 1	CAN bus connection with proprietary protocol PMCB (Power Management Communication Bus) for the communication with other controllers.
CAN bus 2	CAN bus connection with proprietary protocol EXBUS for the communication with expansion modules.
Internal line terminations.	120 Ω by switch S1, S2, S3.
Maximum distance.	The maximum length of the communication bus wiring is dependent on the configured baud rate. Observe the maximum bus length.
Insulation voltage.	Functional Insulation. 1000 Vdc Insulation for 60s.
Rated surge voltage.	±1 KV (1.2/50 µs).
Protections.	Internal transient voltage suppressors.
Maximum distance.	The maximum length of the communication bus wiring depends on the configured baud rate, cable capacitance, inductance, and shielding. CAN bus 0: maximum 40 m (133 ft). CAN bus 1: maximum 200 m (656 ft). CAN bus 2: maximum 200 m (656 ft).

Ethernet communication interfaces (Y23, Y24, Y25).	
Type of interface.	3 Ethernet interfaces (insulated). 10/100Mbps full-duplex 10T/100Tx auto. HP Auto-MDIX support. Compliant IEE802.3/802.3u (Fast ethernet). Compliant ISO802-3/IEEE802.3 (10BASE-T). Protocol: Modbus/TCP, DNS, DHCP, SNMP, NTP, HTTP (web server).
Default LAN setting.	Port 1: IP address 192.168.0.1. Port 2: IP address 192.168.0.2. Port 3: IP address 192.168.0.3. Mask 255.255.255.0. DHCP enable.
	Use an Ethernet cable that meets or exceeds the SF/UTP CAT5e specifications.
Insulation voltage.	Functional Insulation. 1500 Vac Insulation for 60s.
Rated surge voltage.	±1 KV (1.2/50 µs).

Real-time clock	
Type RTC.	Provides year, month, day, weekday, hours, minutes, seconds and 100th seconds based on a 32.768 kHz quartz crystal.
Battery back-up.	Rechargeable.
Life span (operation without power supply).	Approximatively 6 months: depending on ambient temperature.
Battery field replacement.	Field replacement of the battery is not allowed. In case of battery replacement please contact Mecc Alte.

Environmental conditions.	
Operating temperature.	From -30°C to +70°C.
Storage temperature.	From -40°C to +80°C.
Relative humidity.	5% to 95% with no condensation.
Operating altitude.	Up to 2000 m (6561 ft).
Pollution degree.	PD2.
Impact protection.	IK07. **WARNING!** The device has mechanical protection rating IK07 (2 Joule) and must be installed inside a switchboard that provides an adequate degree of protection to protect the device against mechanical shocks.

Box.	
Material.	Aluminium.
Dimensions *.	Length: 243 mm. Height: 187 mm. Depth: 85 mm. * Dimensions including connectors and din guide support.
Weight.	1350 g.
Protection degree.	IP20.

Electromagnetic compatibility.	
EN 61326-1:2022	Electrical equipment for measurement, control, and laboratory use. Electromagnetic compatibility requirements.
EN 61000-6-2:2019	Electromagnetic compatibility (EMC) - Generic standards. Immunity for industrial environments.
EN 61000-6-4:2019	Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments.

Safety requirements	
EN 61010-1:2010. EN 61010-1:2010/A1:2019. EN 61010-1:2010/AC:2019.	Safety requirements for electrical equipment for measurement, control, and laboratory use – General requirements.

3.1 Protection elements accuracy

3.1.1 Terms and definitions

G
The measured value of the characteristic quantity.

t_d
The theorical operation time (in seconds).

k, c, α
The constants characterizing the selected curve.

G_s
Start (or pickup) value: the reference value used for the definition of the theoretical curve of time vs characteristic quantity.

Start (or pickup) time.
Duration of the time interval between the instant when the characteristic quantity of the measuring relay in reset condition is changed, under specified conditions, and the instant when the start (or pickup) signal asserts.

t_G
Operate (or trip) time: duration of the time interval between the instant when the characteristic quantity of a measuring relay in reset condition is changed, under specified conditions, and the instant when the relay operates.

Disengaging time
Duration of the time interval between the instant a specified change is made in the value of the input energizing quantity which will cause the relay to disengage and the instant it disengages.

Reset time.
Duration of the time interval between the instant when the characteristic quantity of a measuring relay in operate condition is changed, under specified conditions, and the instant when the relay resets.

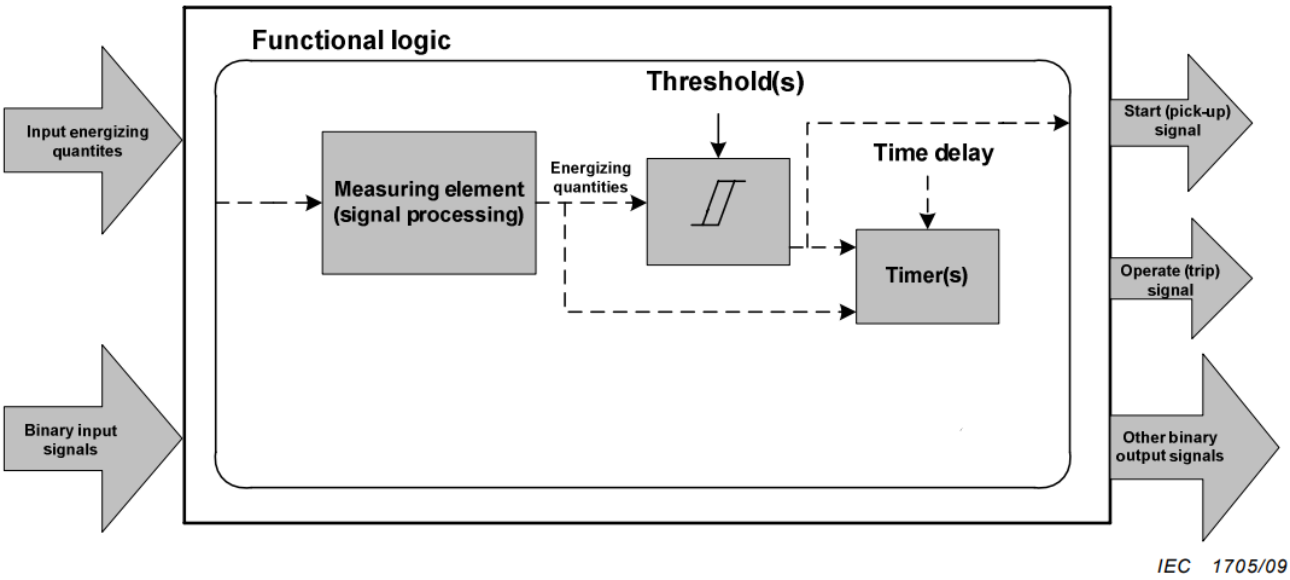
Overshoot time.
The difference between the operate time of the relay at the specified value of the input energising quantity and the maximum duration of the value of input energising quantity which, when suddenly reduced (for the overvoltage relay) or increased (for the undervoltage relay) to a specified value below (for the overvoltage relay) or above (for the undervoltage relay) the setting value, is insufficient to cause operation.

Reset ratio.
Ratio between the point where the relay just ceases to start (start signal change from ON to OFF) and the actual start value of the element.

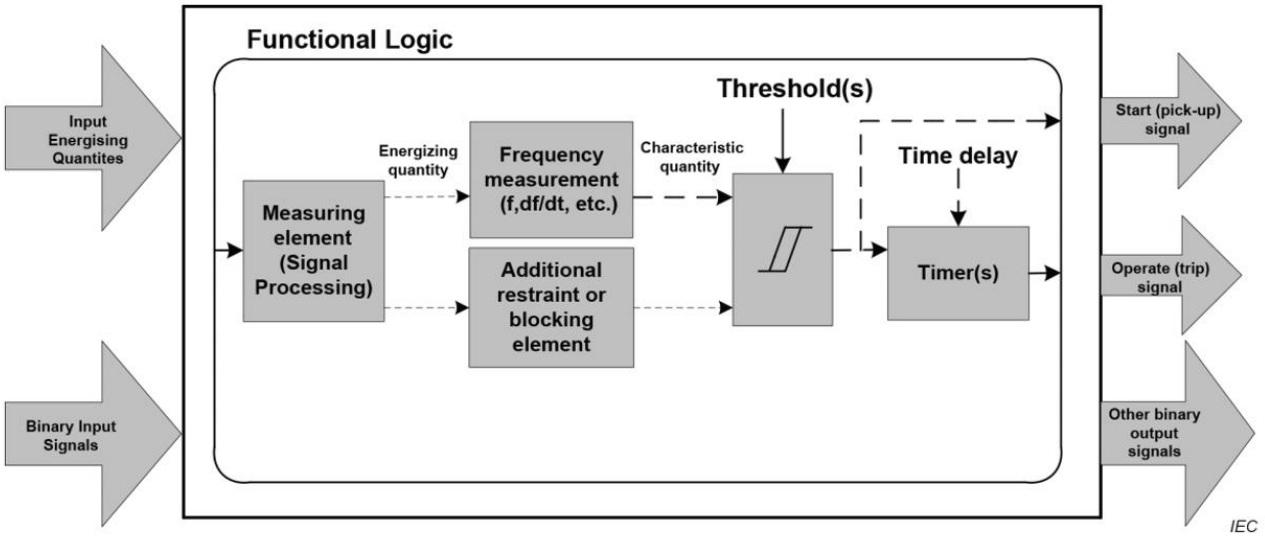
Threshold of independent time operation
The value of the characteristic quantity at which the relay operated time changes from dependent time operation to independent time operation.

3.1.2 Simplified protection functional block diagram

Voltage/current protections



Frequency protections



3.1.3 List of protections

3.1.3.1 Generator protections.

Generator – Undervoltage protection (IEEE/ANSI C37.2 - Function Number 27)				
Parameter settings		**Value (range)**		
Pickup range (G_S) (2 stages)		25% … 100% x V_n		Step 0,1
Definite time delay (t_d) (2 stages)		0,1…300 sec		Step 0,1
Characteristic		**Value**		
Pickup accuracy	Depending on the frequency of the voltage measured: F_n ±2Hz	±0,5% of the set value or ±0,002 × V_n		
Pickup time 1)	V_{Fault} = 0,8 × set Pickup value	Minimum	Average	Maximum
		22 ms	36 ms	75 ms
Reset time		< 100 ms		
Reset ratio		Depends on the set Relative hysteresis		
Trip time accuracy in definite time mode (independent time characteristic)		±1% of the delay time value or ± 65 ms 1)		
Overshoot time accuracy		±10 ms 1)		
Equation operation time		$t_G = t_d$ when $G < Gs$		
1) Includes the delay of the signal output contact				

Generator – Overvoltage protection (IEEE/ANSI C37.2 - Function Number 59)				
Parameter settings		**Value (range)**		
Pickup value (G_S) (2 stages)		100% … 200% x V_n		Step 0,1
Definite time delay (t_d) (2 stages)		0,1…300 sec		Step 0,1
Characteristic		**Value**		
Pickup accuracy	Depending on the frequency of the voltage measured: F_n ±2Hz	±0,5% of the set value or ±0,002 × V_n		
Pickup time 1)	V_{Fault} = 1,2 × set Pickup value	Minimum	Average	Maximum
		10 ms	30 ms	60 ms
Reset time		< 100 ms		
Reset ratio		Depends on the set Relative hysteresis		
Trip time accuracy in definite time mode (independent time characteristic)		±1% of the delay time value or ± 50 ms 1)		
Equation operation time		$t_G = t_d$ when $G > Gs$		
1) Includes the delay of the signal output contact				

Generator - Underfrequency / Over frequency protection (IEEE/ANSI C37.2 - Function Number 81U/81O)				
Parameter settings		**Value (range)**		
Pickup value (G_S) (2 stages)		70% … 130% x F_n		Step 0,1
Definite time delay (t_d) (2 stages)		0,1…300 sec		Step 0,1
Characteristic		**Value**		
Pickup accuracy		±50 mHz		
Pickup time 1)		Minimum	Average	Maximum
		9 ms	25 ms	55 ms
Reset time		< 160 ms		
Trip time accuracy		±0,1% of the delay time value or ±40 ms 1)		
Equation operation time underfrequency	underfrequency	$t_G = t_d$ when $G < Gs$		
	over frequency	$t_G = t_d$ when $G > Gs$		
1) Includes the delay of the signal output contact				

Generator - Instantaneous overcurrent protection (IEEE/ANSI C37.2 - Function Number 50)					
Parameter settings			**Value (range)**		
Pickup value (G_S)			5% … 500% x I_n	Step 1	
Definite time delay (t_d)			0,1…300 sec	Step 0,1	
Characteristic			**Value**		
Pickup accuracy	Depending on the frequency of the voltage measured: F_n ±2Hz	At currents in the range of 5…200% × I_n	±1,0% of the set value or ±0,002 × I_n		
		At currents in the range of 200…500% × I_n	±2,0% of the set value or ±0,004 × I_n		
Pickup time 1)			Minimum	Typical	Maximum
	Current before fault in the range 0… 25% × I_n		24 ms	73 ms	120 ms
	Current before fault in the range 25…500% × I_n		27 ms	45 ms	50 ms
Reset time			< 100 ms		
Reset ratio			Typical 0,96 %		
Disengaging time			Typical 76 ms		
Trip time accuracy in definite time mode (independent time characteristic)			±1,5% of the delay time value or ±100 ms 1)		
Equation operation time			$t_G = t_d$ when $G > Gs$		
1) Includes the delay of the signal output contact					

Generator - Time delayed overcurrent protection (IEEE/ANSI C37.2 - Function Number 51)				
Parameter settings		**Value (range)**		
Pickup value (G_S)		50% … 130% x I_n	Step 1	
Definite time delay (t_d)		1…60 sec	Step 0,1	
Characteristic		**Value**		
Pickup accuracy	Depending on the frequency of the voltage measured: F_n ±2Hz	±1,0% of the set value or ±0,002 × I_n		
Pickup time 1)		Minimum	Typical	Maximum
	Current before fault in the range 0… 25% × I_n	24 ms	73 ms	120 ms
	Current before fault in the range 25…130% × I_n	20 ms	23 ms	45 ms
Reset time		< 100 ms		
Reset ratio		Typical 0,96 %		
Disengaging time		Typical 75 ms		
Trip time accuracy in inverse time mode (dependent time characteristic)		±1,5% of the delay time value or ±80 ms 1)		
Equation operation time (SICES - Extremely inverse curve)	Definite time delay (t_d) Pickup value (G_S) c=0, k=1, α=2	$t_g = t_d \frac{k}{\left(\frac{G}{G_s}\right)^{\alpha} - 1} + c$		
1) Includes the delay of the signal output contact				

Generator - Voltage-dependent overcurrent protection (IEEE/ANSI C37.2 - Function Number 51V)					
Parameter settings			**Value (range)**		
Pickup value (G_s)			50% … 130% x I_n		Step 1
Definite time delay (t_d)			1…60 sec		Step 0,1
Characteristic			**Value**		
Pickup accuracy	Depending on the frequency of the voltage measured: F_n ±2Hz		±1,0% of the set value or ±0,002 × I_n		
Pickup time 1)			Minimum	Typical	Maximum
	Current before fault in the range 0… 25% × I_n		24 ms	73 ms	120 ms
	Current before fault in the range 25…130% × I_n		20 ms	23 ms	45 ms
Reset time			< 100 ms		
Reset ratio			Typical 0,96 %		
Disengaging time			Typical 75 ms		
Trip time accuracy in inverse time mode (dependent time characteristic)			±1,5% of the delay time value or ±80 ms 1)		
Equation operation time (SICES - Extremely inverse curve)	Definite time delay (t_d) Pickup value (G_s) c=0, k=1, α=2		$t_g = t_d \frac{k}{\left(\frac{G}{G_s}\right)^{\alpha} - 1} + c$		
Constant values for Voltage retrained characteristics			k_1=20% k_2=20% k_3=80% k_4=100%		
1) Includes the delay of the signal output contact					

Generator - Negative sequence time overcurrent protection (IEEE/ANSI C37.2 - Function Number 46)				
Parameter settings		**Value (range)**		
Pickup value (G_s)		5% … 100% x I_n		Step 0,1
Definite time delay (t_d)		1…300 sec		Step 0,1
Characteristic		**Value**		
Pickup accuracy	Depending on the frequency of the voltage measured: F_n ±2Hz	±1,5% of the set value or ±0,002 × I_n		
Pickup time 1)		Minimum	Typical	Maximum
	Current before fault in the range 0… 25% × I_n	25 ms	63 ms	115 ms
	Current before fault in the range 25…100% × I_n	25 ms	40 ms	55 ms
Reset time		< 100 ms		
Reset ratio		Typical 0,96 %		
Disengaging time		Typical 75 ms		
Trip time accuracy in definite time mode (independent time characteristic)		±1,0% of the set value or ±100 ms 1)		
Equation operation time		$t_G = t_d$ when $G > Gs$		
1) Includes the delay of the signal output contact				

Generator - Current Unbalance protection (IEEE/ANSI C37.2 - Function Number 60)				
Parameter settings		**Value (range)**		
Pickup value (G_s)		5% … 100% x I_n		Step 0,1
Definite time delay (t_d)		1…300 sec		Step 0,1
Characteristic		**Value**		
Pickup accuracy	Depending on the frequency of the voltage measured: F_n ±2Hz	±1,5% of the set value or ±0,002 × I_n		
Pickup time 1)		Minimum	Typical	Maximum
	Current before fault in the range 0… 25% × I_n	25 ms	63 ms	115 ms
	Current before fault in the range 25…100% × I_n	25 ms	40 ms	55 ms
Reset time		< 100 ms		
Reset ratio		Typical 0,96 %		
Disengaging time		Typical 75 ms		
Trip time accuracy in definite time mode (independent time characteristic)		±1,0% of the set value or ±100 ms 1)		
Equation operation time		$t_G = t_d$ when $G > Gs$		
1) Includes the delay of the signal output contact				

Generator - Voltage Unbalance protection (IEEE/ANSI C37.2 - Function Number 60)				
Parameter settings		**Value (range)**		
Pickup value (G_S)		1% … 100% x V_n		Step 0,1
Definite time delay (t_d)		1…300 sec		Step 0,1
Characteristic		**Value**		
Pickup accuracy	Depending on the frequency of the voltage measured: F_n ±2Hz	±0,5% of the set value or ±0,002 × V_n		
Pickup time 1)		Minimum	Typical	Maximum
		10 ms	30 ms	60 ms
Reset time		< 100 ms		
Reset ratio		Depends on the set Relative hysteresis		
Disengaging time		Typical 75 ms		
Trip time accuracy in definite time mode (independent time characteristic)		±1% of the delay time value ± 65 ms 1)		
Equation operation time		$t_G = t_d$ when $G > Gs$		
1) Includes the delay of the signal output contact				

3.1.3.2 Grid protections.

Mains – Undervoltage protection (IEEE/ANSI C37.2 - Function Number 27)				
Parameter settings		**Value (range)**		
Pickup value (G_S) (2 stages)		25% … 100% x V_n		Step 0,1
Definite time delay (t_d)	Stage 1	0,04…300 sec		Step 0,1
	Stage 2	0,1…300 sec		Step 0,01
Characteristic		**Value**		
Pickup accuracy		Depending on the frequency of the voltage measured: f_n ±2Hz		
		±0,5% of the set value or ±0.002 × V_n		
Pickup time [1]	V_{Fault} = 0,8 × set Pickup value	Minimum	Average	Maximum
		22 ms	36 ms	55 ms
Reset time		< 800 ms		
Reset ratio		Depends on the set Relative hysteresis		
Trip time accuracy in definite time mode (independent time characteristic)		±1% of the delay time value or± 35 ms [1]		
Overshoot time accuracy		±20 ms [1]		
Equation operation time		$t_G = t_d$ when $G < Gs$		
1) Includes the delay of the signal output contact				

Mains – Overvoltage protection (IEEE/ANSI C37.2 - Function Number 59)				
Parameter settings		**Value (range)**		
Pickup value (G_S) (2 stages)		60% … 150% x V_n		Step 0,1
Definite time delay (t_d)	Stage 1	0,04…300 sec		Step 0,01
	Stage 2	0,1…300 sec		Step 0,1
Characteristic		**Value**		
Pickup accuracy		Depending on the frequency of the voltage measured: f_n ±2Hz		
		±0,5% of the set value or ±0,002 × V_n		
Pickup time [1]	V_{Fault} = 1,2 × set Pickup value	Minimum	Average	Maximum
		10 ms	30 ms	50 ms
Reset time		< 800 ms		
Reset ratio		Depends on the set Relative hysteresis		
Trip time accuracy in definite time mode (independent time characteristic)		±1% of the delay time value or ± 30 ms [1]		
Equation operation time		$t_G = t_d$ when $G > Gs$		
1) Includes the delay of the signal output contact				

Mains - Underfrequency / Over frequency protection (IEEE/ANSI C37.2 - Function Number 81U/81O)				
Parameter settings		**Value (range)**		
Pickup value (G_S) (2 stages)		80% … 120% x F_n		Step 0,01
Definite time delay (t_d)	Stage 1	0,04…60 sec		Step 0,01
	Stage 2	0,1…60 sec		Step 0,1
Characteristic		**Value**		
Pickup accuracy		±50 mHz		
Pickup time [1]		Minimum	Average	Maximum
		10 ms	23 ms	45 ms
Reset time		< 160 ms		
Reset ratio		Depends on the set Relative hysteresis		
Trip time accuracy		±0,1% of the delay time value or ±35 ms [1]		
Equation operation time	underfrequency	$t_G = t_d$ when $G < Gs$		
	over frequency	$t_G = t_d$ when $G > Gs$		
1) Includes the delay of the signal output contact				

3.1.3.3 Verifying the protections.

The controller can help in verifying the tripping time of the protections by using some digital outputs, configured with the following functions:

- DOF.3190 (“Generator protections out of thresholds”).
- DOF.3191 (“Generator protections tripped”).
- DOF.3192 (“Grid protections out of thresholds”).
- DOF.3193 (“Grid protections tripped”).

3.2 Measurement resolution

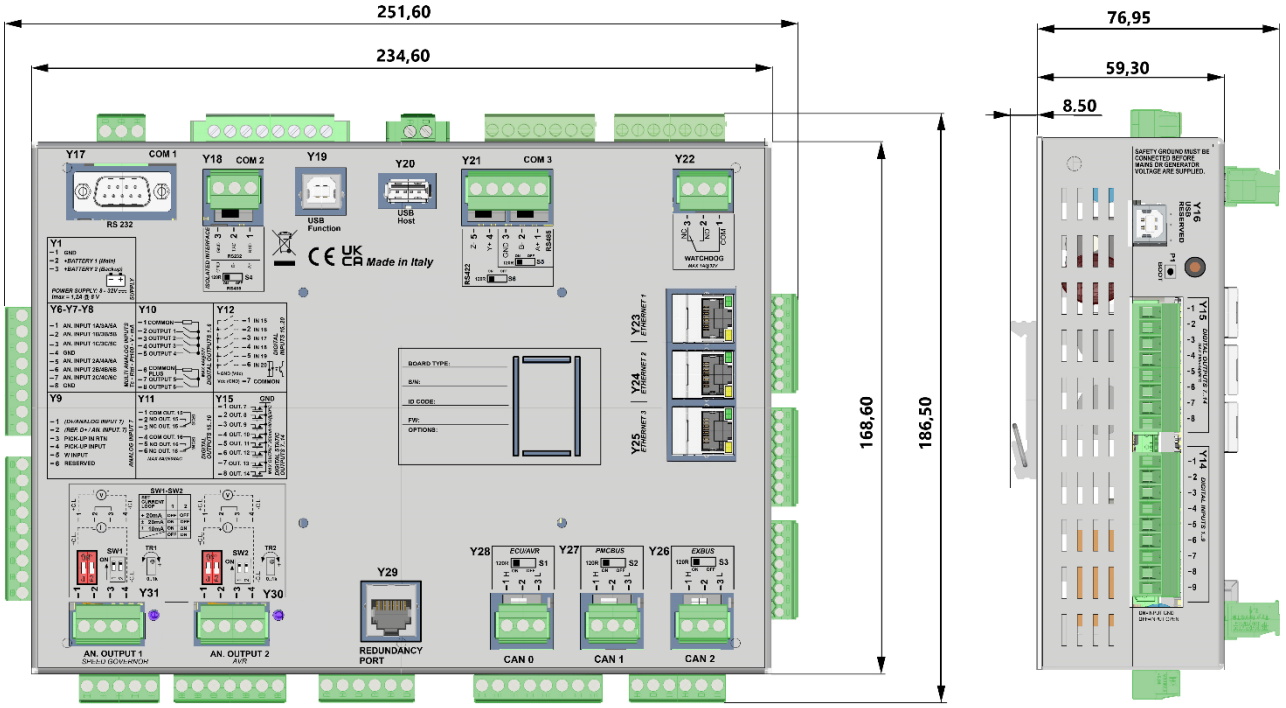
Mains and Genset voltage	1 VRMS.
Current	Minimum 0.1 Aac (it depends on the CT ratio).
Mains and Genset frequency	0,1Hz ± 50ppm, 35 ppm/°C typical.
Power	Minimum 0.1 kW/kVA/kvar (it depends on the CT ratio).
Power Factor	0.01.
Energy	1 kWh/kvarh.
Engine speed	1 rpm.
Oil pressure	0.1 bar (below 10bar).
Cooling liquid temperature	0.1 °C.
Oil temperature	0.1 °C.
Fuel level	0.1 %.

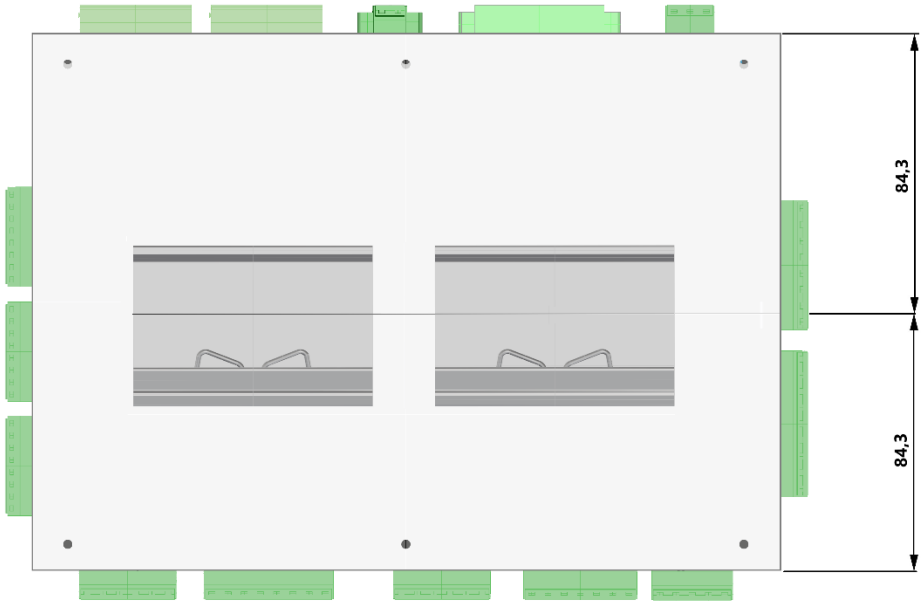
4 Installation

4.1 Mounting

The device must be mounted inside the control cabinet, or onto the backside of the control cabinet door. After installation, it should be inaccessible to unauthorised persons.

4.1.1 Dimensions



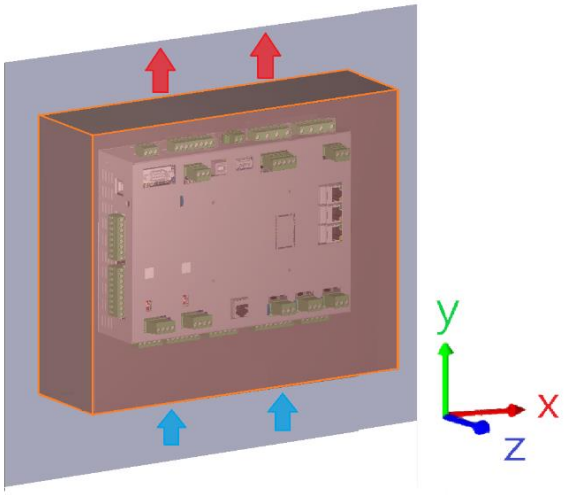


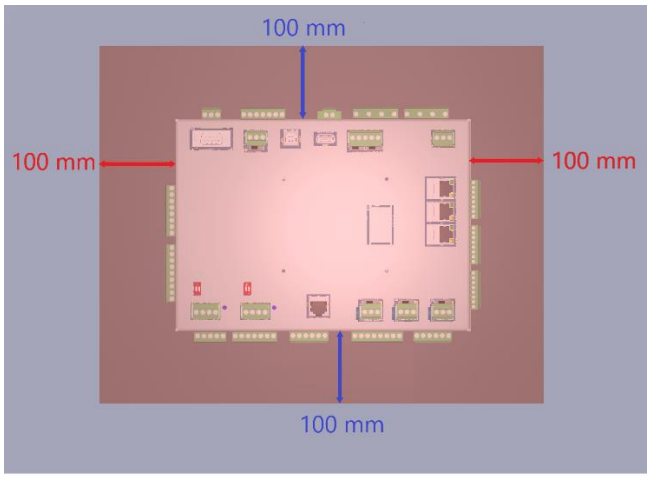
4.1.2 Checking clearances

The following clearances are required around the device to ensure sufficient self-ventilation:

- At least 100 mm to both the right and left of the mounting cutout (in **x** direction) to allow for insertion of the terminal blocks.
- At least 100 mm above and 100 mm below the mounting cutout (in the **y** direction) for ventilation and for insertion of the terminal blocks.
- At least 80 mm behind the rear panel of the device (in the **z** direction).

The following figure shows the clearances for mounting the devices and minimum free space (red color):



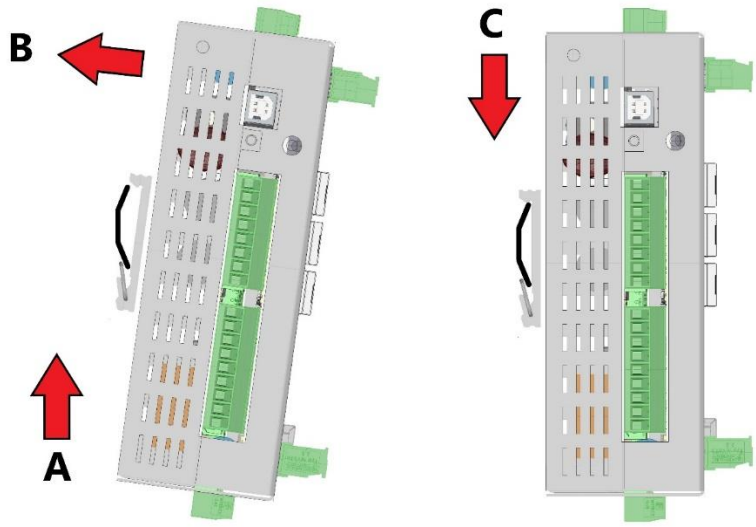


WARNING! The device has ventilation slots at the top and bottom (along the Y axis): do not restrict or block this product's ventilation slots.

4.1.3 Mounting the device

The unit can be directly mounted on a DIN rail:

- Place the bottom of the control unit against the DIN rail and push up (A).
- In the upper position, tilt the control unit horizontally by pushing it towards the DIN rail (B).
- Lower and release control unit (C).
- Ensure it is securely mounted.



4.1.4 Tightening torques.

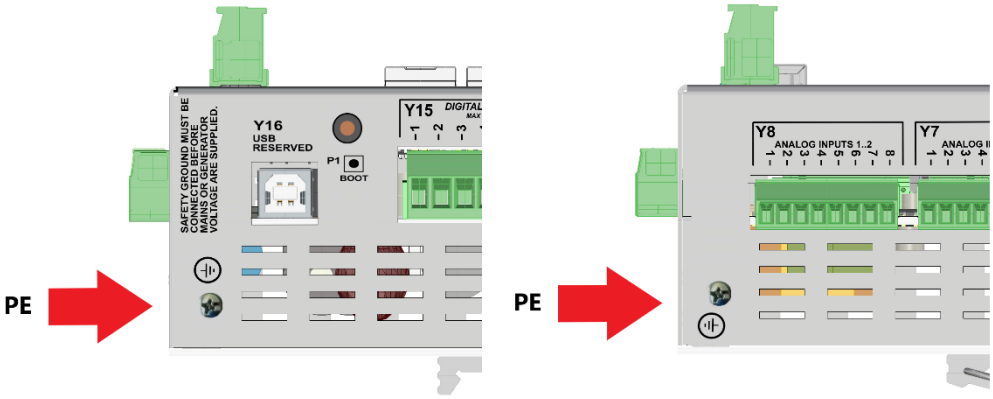
Refer to these values:

- Plug connections (terminals Pitch 5.08): 0.5 – 0.6 Nm.
- Plug connections (terminals Pitch 10): 0.5 – 0.6 Nm.
- Plug connections (terminals Pitch 3.81): 0.22 – 0.25 Nm.
- Locking screw flanges: 0.3 Nm.
- Sub-D screw: 0.2 Nm.

4.2 Wiring

WARNING! It is mandatory to permanently connect the housing of the device to earth through the suitable screws. The safety connection to earth should be implemented before any other connection.

Connect Protective Earth (PE) to the unit to avoid the risk of electric shock.



Use one of the Protective Earths (PE) screws located on the right or left side of the sheet metal housing. The conductor providing the connection must have a wire larger than or equal to 2.5 mm² (14 AWG). The cable length should be as short as possible.

WARNING! Proper use of the device requires permanent mounting in a control cabinet. Accessing device connections shall only be possible by means of specific tools or keys. Device removal shall only be possible by means of tools.

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 mains and generator voltage inputs. You can use 1A fuses.

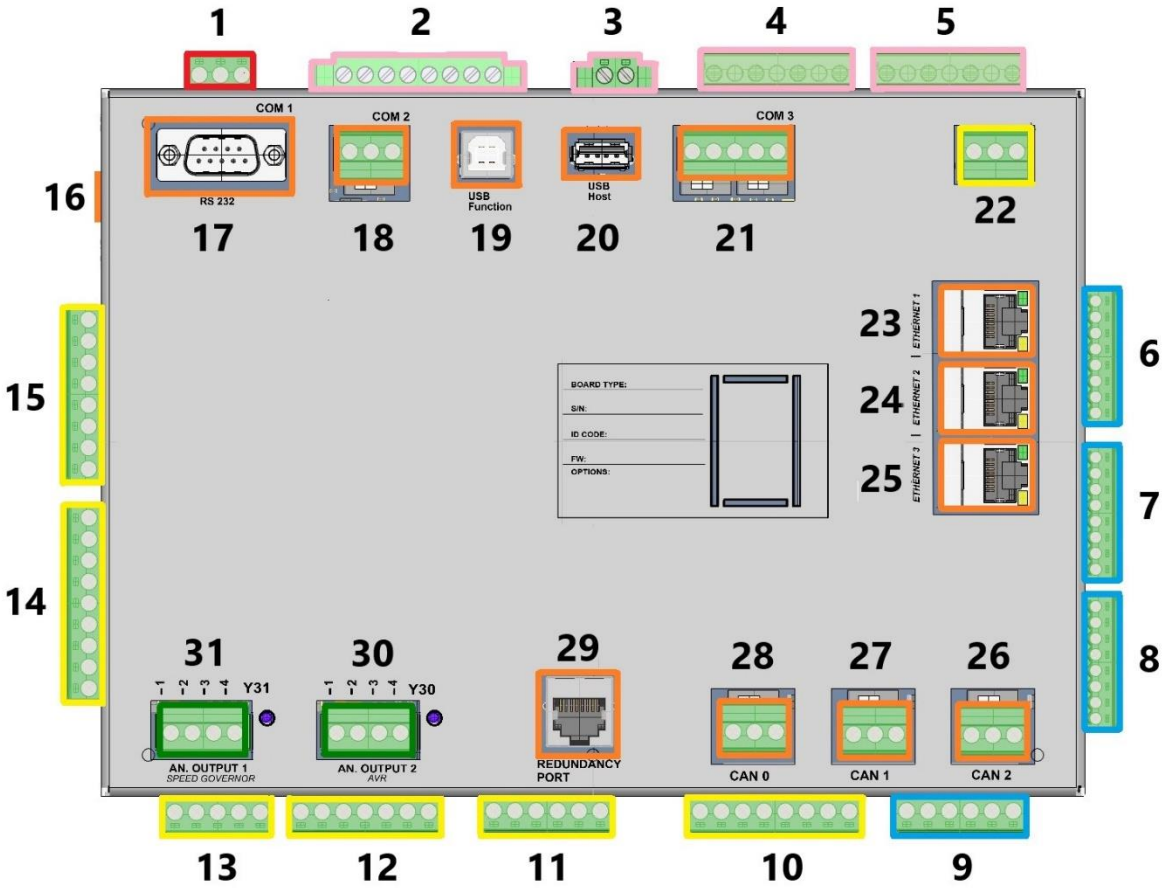
The section of the protective earthing conductor should be at least equal to the section of cables used to wire mains or generator voltage to the control panel. In addition, it must comply with the limit value of the overcurrent protection used.

For CAT.IV applications, the maximum phase-to-neutral voltage allowed is 300 Vac, while the phase-to-phase voltage is 520 Vac. The maximum voltage related to the protective earthing (PE) is 300 Vac.

For CAT.III applications, the maximum phase-to-neutral voltage allowed is 398 Vac, while the phase-to-phase voltage is 690 Vac. The maximum voltage related to the protective earthing (PE) is 600 Vac.

The device can operate in CAT.III or CAT.IV only if the supply negative terminal of the device and the neutral terminal of the genset are connected to the protective earthing.

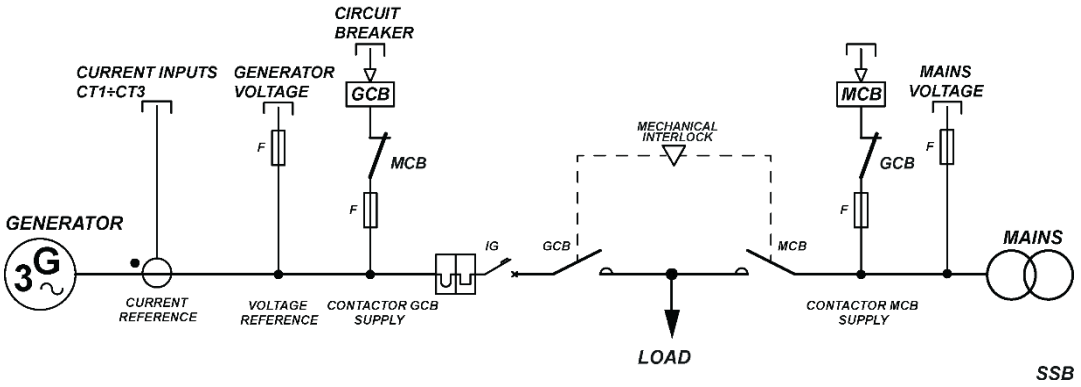
5 Connections and configuration



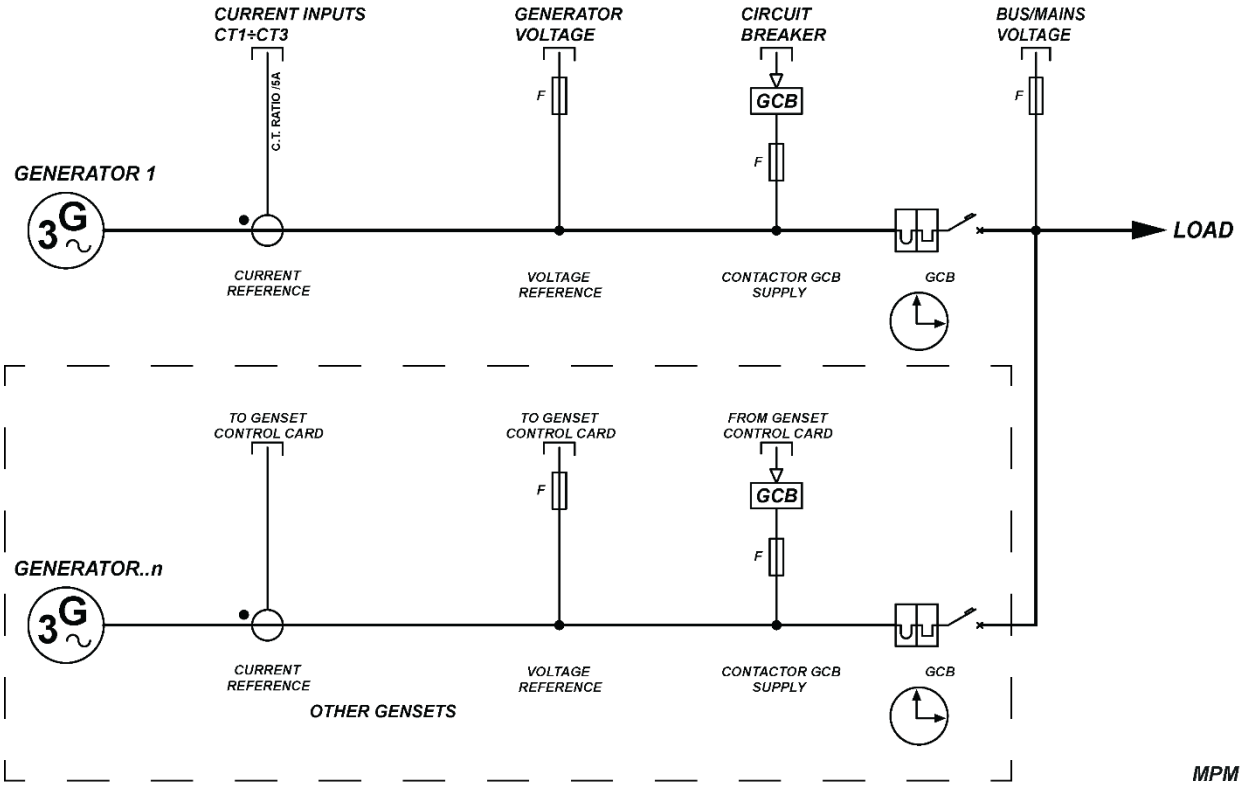
Ref.	Name	Description	Pluggable Terminal Blocks / Connector
1	Y1	Main and backup power supply.	3 poles x 2.5 mm² screw terminal, pitch 5.08.
2	Y2	Current measurement inputs 1-4.	8 poles x 2.5 mm² screw terminal with locking screw flanges, pitch 5.08.
3	Y3	Toroidal transformer measurement input.	4 poles x 2.5 mm² screw terminal, pitch 5.08.
4	Y4	Genset voltage measurement inputs.	4 poles x 2.5 mm² screw terminal, pitch 10.
5	Y5	Mains/bus voltage measurement inputs.	4 poles x 2.5 mm² screw terminal, pitch 10.
6	Y6	Analogue multi-inputs 5-6.	8 poles x 1,5 mm² screw terminal, pitch 3.81.
7	Y7	Analogue multi-inputs 4-3.	8 poles x 1,5 mm² screw terminal, pitch 3.81.
8	Y8	Analogue multi-inputs 1-2.	8 poles x 1,5 mm² screw terminal, pitch 3.81.
9	Y9	Pick-up / W input.	6 poles x 2.5 mm² screw terminal, pitch 5.08.
		D+ output, D+ input (analogue input 7).	
10	Y10	Digital outputs 1-4.	8 poles x 2.5 mm² screw terminal, pitch 5.08.
		Digital outputs 5-6, Emergency stop input.	
11	Y11	Digital outputs 15 and 16 - Engine commands.	6 poles x 2.5 mm² screw terminal, pitch 5.08.
12	Y12	Digital inputs 15-20.	7 poles x 2, mm² screw terminal, pitch 5.08.
13	Y13	Digital inputs 10-14.	5 poles x 2.5 mm² screw terminal, pitch 5.08.

Ref.	Name	Description	Pluggable Terminal Blocks / Connector
14	Y14	Digital inputs 1-9.	9 poles x 2.5 mm^2 screw terminal, pitch 5.08.
15	Y15	Digital output 7-14.	8 poles x 2.5 mm^2 screw terminal, pitch 5.08.
16	Y16	USB host interface (reserved).	Connector type B.
17	Y17	COM1 - RS232 communication interface.	Connector DB9 poles male CANON.
18	Y18	COM2 - RS485/RS232 communication interface.	3 poles x 2.5 mm^2 screw terminal, pitch 5.08.
19	Y19	USB function interface.	Connector type B.
20	Y20	USB host interface.	Connector type A.
21	Y21	COM3 - RS485/RS422 communication interface.	5 poles x 2.5 mm^2 screw terminal, pitch 5.08.
22	Y22	Watch-dog output.	3 poles x 2.5 mm^2 screw terminal, pitch 5.08.
23	Y23	Ethernet Interface - port 1.	Connector RJ45.
24	Y24	Ethernet Interface - port 2.	Connector RJ45.
25	Y25	Ethernet Interface - port 3.	Connector RJ45.
26	Y26	CAN2 – CAN bus interface for expansion modules (EXBUS).	3 poles x 2.5 mm^2 screw terminal, pitch 5.08, partially gold-plated.
27	Y27	CAN1 – CAN bus interface for parallel functions (PMCB).	3 poles x 2.5 mm^2 screw terminal, pitch 5.08, partially gold-plated.
28	Y28	CAN0 – CAN bus interface for ECU and AVR.	3 poles x 2.5 mm^2 screw terminal, pitch 5.08, partially gold-plated.
29	Y29	RS232 redundancy communication interface.	Connector RJ45 9 poles.
30	Y30	Analogue outputs 02.	4 poles x 2.5 mm^2 screw terminal, pitch 5.08.
31	Y31	Analogue outputs 01.	4 poles x 2.5 mm^2 screw terminal, pitch 5.08.

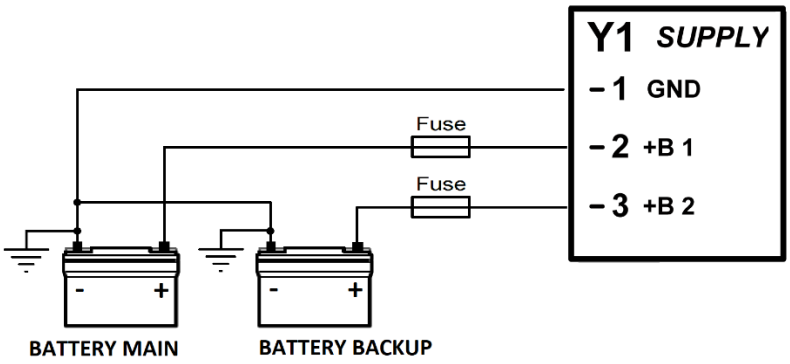
5.1 Basic diagram (SSB or SSB+SSTP plants)



5.2 Basic diagram (MPM plant)



5.3 Y1 - Power supply



Y1 is the supply connector: connect an uninterruptible power supply (usually the engine starter battery) to the “1 GND” and to the “2 +B1” terminals.

The “2 +B1” terminal is the primary power source, the “3 +B2” terminal is the backup power source. If provided, the backup battery must be connected to terminal “3 +B2”. The device will monitor both power sources.

The minus terminal “1 GND” is the reference and the common return of digital inputs, digital outputs, current and voltage measurements. It must be connected to the ground protection. Systems that require insulation between the battery negative and the ground protection can be used, but can generate operating problems and may require care, as the use of insulation voltage transformers for mains and genset.

Although the device is protected by a built-in self-resetting fuse, it is recommended to use a 4 Aac fuse for the protection of the positive lines “2 +B1” and “3 +B2”.

All the current entering the Y15 static outputs flows through "1 GND”.

The device automatically detects the rated battery voltage (12/24 Vdc) when it is powered (for managing the related logics and alarms). Also, the detection is carried out every time you switch the device to the OFF mode.

INFORMATION: when installing, connect the battery positive only after opening all fuses available in the panel.

INFORMATION: the maximum allowable current through the device’s negative terminal is 3 A (included the consumption of the independent static outputs Y15).

WARNING! Connect the unit only to a DC power source that complies with the safety extra-low voltage (SELV) requirements.

WARNING! On engines where a direct connection between battery minus and PE is not possible, it is recommended to use an isolated external power supply if the differential voltage between battery minus and PE exceeds 42 Vac.

WARNING! Take particular attention to non-isolated serial/USB connections.

Serial RS232 and USB of personal computers have the negative transmission reference usually connected to the EARTH. Voltage differences between device negative and PC negative (or EARTH) can cause damage to the communication ports of the PC or of the device. Use serial isolators if necessary.

5.4 Digital inputs

The controller is equipped with 20 opto-isolated digital inputs:

- 14 digital inputs (Y12 and Y13) with an internal common terminal connected to +Vbat.
- 6 fast digital inputs (Y14), with separated external common terminal, which can be connected to GND or to +Vbat.

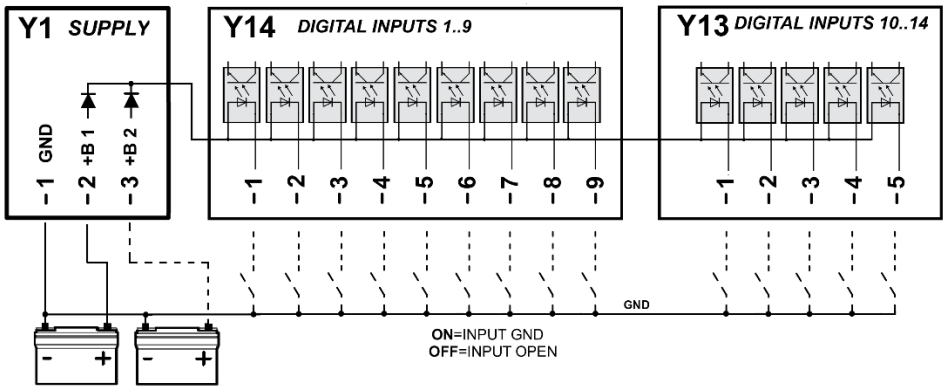
Moreover, if not required as analogue, it is possible to use each single analogue input (Y6, Y7 and Y8) as digital (see paragraph 5.6.5). With different modes, also the Y9-1 terminal (D+ signal, in combination with Y9-2) can be used as digital input (see paragraph 5.6.5).

It's possible to increase the number of digital inputs by adding up to 10 DITEL 16 IN expansion modules (connected by CAN bus), for a total of 160 additional digital inputs (see paragraph 5.8).

The controller also provides 16 "virtual" digital inputs: they are managed by the controller exactly as they were physical (without limitations), but their statuses are not acquired by the hardware but determined via software. In fact, each virtual inputs can be associated to a PLC block or to an AND/OR logic (see paragraph6.5) that determines the status.

Finally, the controller provides 256 "shared" digital inputs: they behave as "virtual", and their statuses are received from other controllers through the PMCB CAN bus.

5.4.1 Y14-Y13 Digital inputs 1-14 (DI_01 to DI_14)



The inputs are active when the terminal is connected to the supply negative GND. When the terminals are open, the voltage on the terminals is +Vbat. Avoid situations where intermediate or undefined voltage levels can occur.

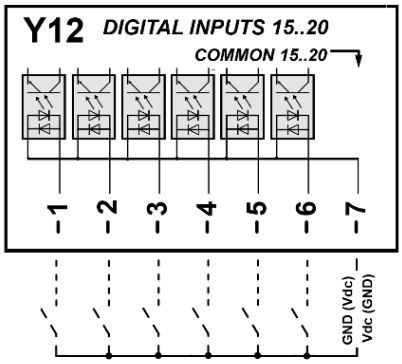
The digital inputs 13-14 can be associated with the 'pulse counter' function. When associated with these functions, the minimum pulse duration is 65 ms.

INFORMATION! It is possible to connect the same command signal in parallel to inputs of different devices (for example one signal for three GC800 SCM). It is not necessary to separate the inputs with external diodes, because each input 1-14 already has an internal diode. Built-in diodes prevent incorrect activation of the input when one of the devices is switched off.

Some of these digital inputs have a "factory" default configuration:

Terminal	Input	Default function
Y14-1	01	Status of GCB circuit breaker.
Y14-2	02	Enables the load function.
Y14-5	05	Maximum coolant temperature.
Y14-6	06	Minimum oil pressure.
Y14-7	07	Low fuel level.
Y14-8	08	Inhibition of start.

5.4.2 Y12 - Digital inputs 15-20 (DI_15 to DI_20)



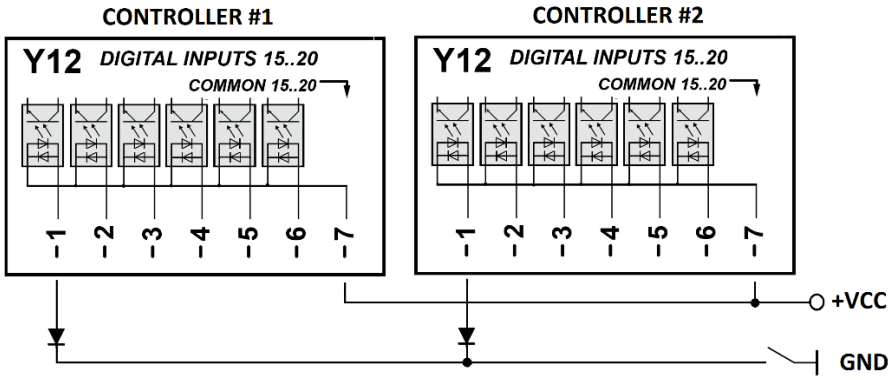
These are six fast digital inputs with an external common terminal available on Y12-7.

It's possible to activate the inputs by connecting their terminal to GND: in this way, the common terminal Y12-7 must be connected to +Vbat.

Alternatively, it's possible to activate the inputs by connecting them to +Vbat: in this case, the common terminal Y12-7 must be connected to GND.

These digital inputs can be associated with the 'pulse counter' function. When associated with these functions, the minimum pulse duration is 15 ms.

INFORMATION! These inputs do not have an internal diode in series because they need to be bi-directional; we recommend using serial diodes in case one or more devices have digital inputs connected in parallel. This expedient prevents false acquisitions of input status when a device is unsupplied.



5.4.3 Virtual digital inputs

Besides all the physical digital inputs, the controller provides 16 virtual digital inputs. They are managed by the controller exactly as they were physical inputs (without limitations), but the virtual inputs status is not acquired by the hardware but determined via software.

The purpose of the virtual digital inputs is multiple:

- To allow the activation of anomalies related to a combination of internal conditions.
- To allow the activation of commands related to a combination of internal conditions.
- To make the PLC able to provide commands to the controller.

It is possible to operate in two ways to assign a value to the virtual digital inputs:

- Using the internal PLC. In this case, it is necessary to assign a standard function to the virtual digital input. For example, we can use the PLC program to modify the “start inhibition” command for the generator based on a temperature acquired from an external sensor. It is necessary:
    - Set parameter P.2151 (“function of the virtual input #1”) to value DIF.2501 (“Inhibition of start”). The controller will therefore use the value of virtual digital input #1 as “start inhibition” command.
    - Using the internal PLC, create a logic which writes into the virtual digital input #1 the command related to the external temperature acquired.
- Associating an AND//OR to the input. The behaviour is the same od the previous point, but without using the PLC. See (6.5).

Example of the use of an AND/OR logic. Let’s suppose we would like to activate a warning if the mains/busbar exceeds the tolerance thresholds. Let us use the virtual digital input #1 (as example). Using the BoardPrg4 software we associate an AND/OR logic configured as AND to the #1 virtual digital input, with the following list of conditions:

- ST.064 (“Status of the GCB”)
- ST.017 (“Mains/Busbar out of tolerance or absent”).

Therefore, the virtual digital input will be active when the GCB is closed, and the mains/busbar is out of tolerance.

Now set the following parameters:

- P.2151 = DIF.4001 (“Generic warning”).
- P.2152 = 0.5 seconds.
- P.2153 = “Mains voltage warning”.

5.4.4 Digital inputs configuration

For “physical”, “virtual” and “analogue used as digital” inputs you can individually configure:

- The polarity: if you select “reverse polarity”, the controller will perform actions when the input is **not activated**. Reverse polarity option is not available for “virtual” inputs. Using BoardPrg4, you have a “reverse polarity” check box for each input (visible only if the input is really used). Inside the controller, these options are grouped (sixteen per group) into specific parameters: if you want to modify the “reverse polarity” option of an input directly from the GC800 HMI, you must know the related parameter:

Parameter	Inputs
P.2000	01...16
P.2050	17...20
P.2100	Analogue inputs used as digital ones
P.2200	DITEL #01
P.2250	DITEL #02
P.2300	DITEL #03
P.2350	DITEL #04
P.2400	DITEL #05
P.2450	DITEL #06
P.2500	DITEL #07
P.2550	DITEL #08
P.2600	DITEL #09
P.2650	DITEL #10

- The function: tells the controller what to do when the input activates.
- The activation delay (used only for some specific function).
- A user-defined message (for example, for user-defined faults).

The digital inputs are normally used by the controller to get information from the plant and manage the generator consequently. There are some functions, however, which makes the input “unavailable” by the controller:

- DIF.0000 (“Not used”).
- DIF.0101 (“Used by the PLC”). This function tells the controller that this input is not directly managed by it but is used by the PLC logic.

INFORMATION! Shared inputs are available only inside the PLC environment; thus, they do not have any configuration parameter.

GC800-HMI shows the status of all digital inputs on a dedicated display page.

5.5 Digital outputs

The controller has 16 digital outputs:

- 8 relay outputs (Y10, Y11)
- 8 negative static outputs (Y15).

It's also possible to increase the number of digital outputs by adding up to 20 DITEL 8 OUT relay expansion modules (connected by CAN bus), for a total of 160 additional digital outputs (see paragraph 5.8).

Finally, the controller provides 256 "shared" digital inputs: any of them can be "written" by a PLC block (behaving as an output), and its value will be transmitted to all other controllers connected on the PMCB CAN bus: they will receive it as a "shared" digital input.

5.5.1 Y10 - Digital outputs 1-6 (DO_01 to DO_06) and excitation output for recharge alternator D+

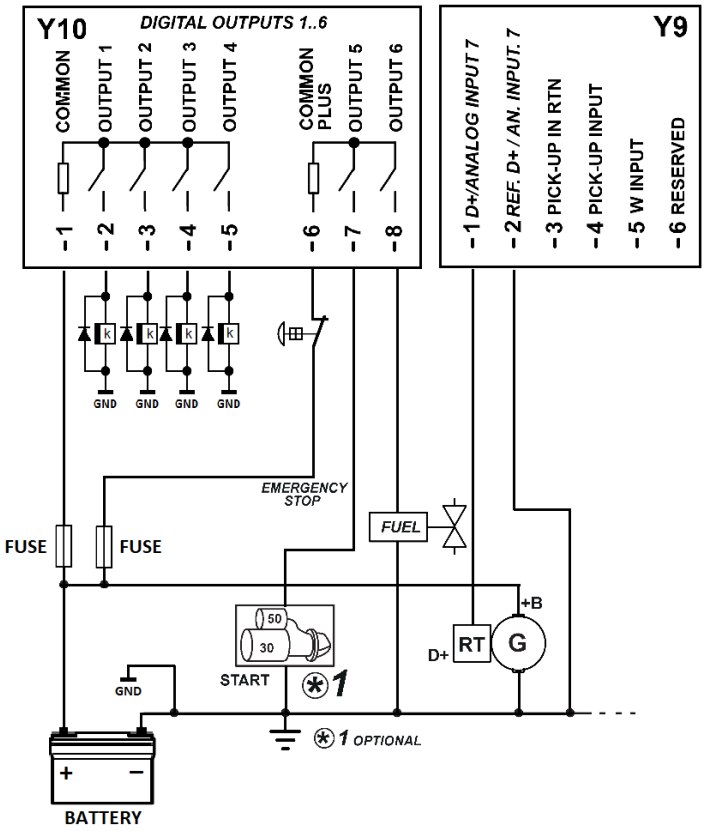


Diagram for de-energized stop system.

Y10 outputs are divided into two groups, each with its own common terminal and each internally protected by a self-resetting thermal fuse and by an opening power-surge damper transient voltage suppressor.

Y10-1 terminal is the common terminal for outputs 1…4; it can be connected to a positive voltage (0 to 32 Vdc), or it can be connected to GND.

Y10-6 terminal is the common positive for outputs 5 and 6; only a positive voltage can be connected to this terminal. These outputs can be used by default for traditional engine start/stop controls: Y10-7 terminal is factory configured for the connection of the starter motor (START) and Y10-8 for the fuel electro-valve (FUEL SOLENOID).

INFORMATION! For flowing currents above the nominal value or for inductive loads with values higher than 500 mH (for example remote control switches, electromagnets, etc) it's necessary to use an external relay. Use external opening overvoltage damping diodes.

Some of these digital outputs have a "factory" default configuration:

Terminal	Input	Default function
Y10-4	03	External horn
Y10-5	04	Stop solenoid
Y10-7	05	Command to start the engine
Y10-8	06	Fuel solenoid

5.5.1.1 Y10-6 COMMON PLUS

Positive input common terminal for outputs 5 and 6, internally protected by self-reset fuse: it is therefore suggested to protect it with a correct range external fuse. It must be connected to the positive of the starting battery by means of a NC contact of the emergency button: that is, this connection must be interrupted by keeping the emergency button pressed (**attention: this is not enough for excitation-stop systems**). Several emergency buttons may be used by series connecting them to each other.

The device activates the alarm AL.048 "A048 Emergency Stop" when no voltage is connected to this terminal (that is, pressing the emergency button): it's not possible to disable this feature.

GC800 HMI shows the voltage measured on Y10-6 on the "analogue input" display page.

5.5.1.2 Y10-7 and Y10-8

Positive relay output, with maximum capacity of 4A @ 32 Vdc. Integrated transient voltage suppressor diode for damping opening overvoltage. These terminals provide the battery voltage present on connector Y10-6; although one is already present inside, with particularly inductive loads (remote control switches, electromagnets, etc.) it is advisable to use a damper diode for opening overvoltage.

Attention: for flowing currents higher the nominal one, please use an external restart relay.

5.5.1.3 Suggested engine START/STOP wirings.

5.5.1.3.1 Starting the engine

With the "factory" configuration, the output 5 (Y10-7) is configured to manage the cranking motor. Since the emergency stop button (when pressed) cuts the terminal Y10-6, no voltage will be provided on Y10-7 terminal, thus the engine won't start.

If the crank command is not required (e.g., electronic engines with CAN bus interface), the output can be configured for other purposes. In the same way, other outputs can be configured for managing the cranking motor (but the emergency stop button won't operate on them by hardware).

The controller activates this command to crank the engine and deactivates it automatically within 200-300 ms from the instant when it recognizes the engine running state.

5.5.1.3.2 Stopping the engine with the de-excitation stop system.

With the "factory" configuration, the output 6 (Y10-8) is configured to manage the fuel solenoid. Since the emergency stop button (when pressed) cuts the terminal Y10-6, no voltage will be provided on Y10-8 terminal, thus the solenoid will automatically close the fuel pipe, and the engine will stop.

If the de-excitation stop system is not required (e.g., electronic engines with CAN bus interface), the output can be configured for other purposes. In the same way, other output can be configured for managing the fuel solenoid, but the emergency stop button won't operate on them by hardware).

The controller activates this command before starting the engine (at least 200 ms guarantee between the activation of this command and the activation of the crank command). The controller deactivates the output when the engine must be stopped.

5.5.1.3.3 Stopping the engine with the excitation stop system.

This stopping system is used when the engine requires an explicit command to stop. It is mostly used for security reasons: with the de-excitation stop system, in effect, if some wiring on the fuel solenoid accidentally disconnects, the engine stops. Instead, in case of excitation stop system, the engine does not stop until it receives the explicit stop command.

Due to its nature, thus, the standard wiring of the emergency stop button does not work properly with the excitation stop system. In case the functionality of the emergency push button has to be guaranteed, it must have a double contact: one NC connected in series to Y10-6, as already seen to cut the supply off the starter motor and one NO contact between positive of battery and stop valve/command, without intermediate fuse, which, when activated, supplies positive voltage to the stop valve bypassing the controller command.

With the “factory” configuration, the output 4 (Y10-4) is configured to manage the stop solenoid.

If the excitation stop system is not required (e.g., electronic engines with CAN bus interface), the output can be configured for other purposes. In the same way, other output can be configured for managing the stop solenoid.

The controller activates this command when the engine must be turned off. It deactivates the command when the engine is fully stopped or after e configurable maximum time (P.0213).

5.5.1.4 Y9 - Excitation output for recharge alternator D+

INFORMATION: by “factory” configuration, Y9-1 terminal **is not associated to this feature**: to use it, set parameter P.4115 to the AIF.1300 (“D+ signal”) value.

When the controller starts the engine, the terminal Y9-1 supplies the necessary current for the excitation of the engine’s battery charger. The power supplied by this terminal is drawn from the Y1 supply terminal.

When engine and generator are stopped, the D+ terminal of the engine’s battery charger is a short circuit towards the battery negative, and its voltage is close to 0 Vdc. During or immediately after the engine start, and in normal operation conditions, with the rotation of the engine’s battery charger, the D+ voltage grows to a value higher than the rated battery voltage. When the engine stops, or even if only the engine’s battery charger would stop for the break of the belt that drags it, the D+ voltage goes back to 0 Vdc. The same happens in case of malfunction of the engine’s battery charger.

The current supplied by this terminal when the engine is stopped is automatically limited to 200 mA for 12 Vdc systems and to 100 mA for 24 Vdc systems. The passage point between the two current levels happens at about +Vbat = 19 Vdc.

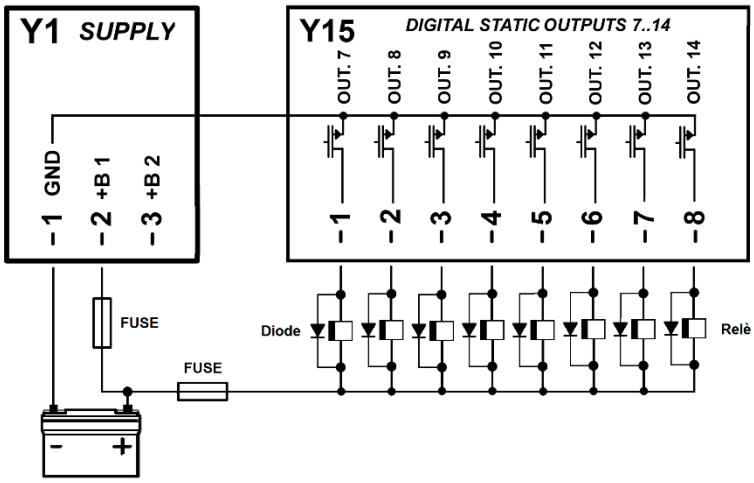
During the engine starting cycle, up to when the engine is recognised running, the D+ command is kept active for 30 continuing seconds and then it is deactivated/activated every 5 seconds (5 seconds ON followed by 5 seconds OFF) up to the end of the starting sequence. When the engine is recognised as started, the command is kept active for further 5 seconds and then released.

On the same Y9-1 terminal, referred to Y9-2, the controller measures the D+ voltage of the engine’s battery charger, both during the starting of the engine and when it is in operation. This voltage measure can be used for two purposes:

- Engine running detection.
- Usually, the recharge alternator is driven by the engine itself through a belt. Normally, the belt also drives other mechanical components of the engine, for example the cooling fan of the radiator. If during the engine operation the D+ voltage of the recharge generator falls to 0 Vdc (or does not raise after the starting), once the time P.0349 has passed, it is supposed that the belt broke or that there is a fault. The device activates the anomaly AL.005 (“Belt break”) to protect the engine from the dysfunction of the mechanic parts driven by the belt.

Using parameters P.0230 and P.0231 it is possible to enable/disable the engine running detection by signal D+; using parameter P.0349 it is possible to disable the anomaly AL.005.

5.5.2 Y15 - Digital output 7-14 (DO_07 to DO_14)



Eight digital outputs. When activated, they bring their terminals to the negative supply voltage (Y1-1 GND). All currents supplied by the active outputs flows through the Y1-1 terminal. The nominal capacity of each output is of 350 mA, while the total current with all active outputs must be maintained below 1.5 A.

All outputs are independent and individually protected from overloads, short circuits, polar inversion, and overheating. The overload protection intervenes limiting the current peak at an instantaneous value of 2.2 A. When this condition is lasting, the intervention of the thermal protection starts, which gradually reduces the current to keep the temperature of the output driver within its maximum limit.

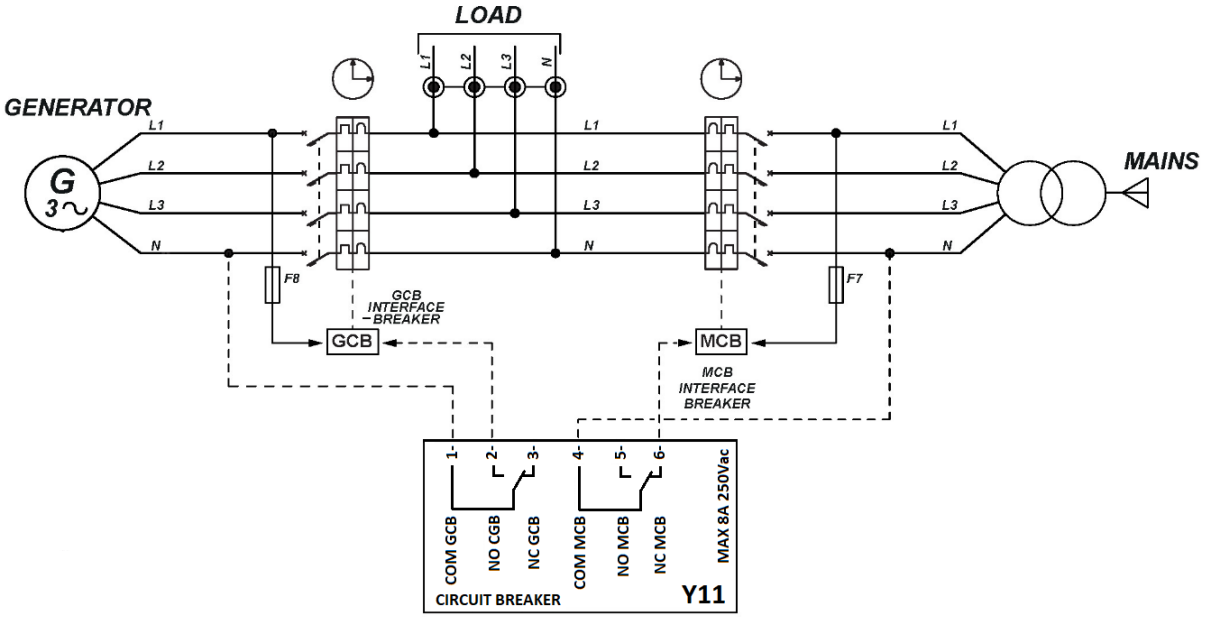
INFORMATION! With inductive loads (power relays, electro-magnetic actuators), although already internally present, it is advisable to use damping diodes of the opening over voltages.

INFORMATION! Never exceed these maximum current values.

5.5.3 Y11 - Digital outputs 15-16

The controller provides two 8 Aac @ 250 Vac relays with dry contacts. The “factory configuration” uses them for commanding the GCB and MCB circuit breakers. If the circuit breakers management is not required, the outputs can be configured for other purposes. In the same way, other outputs can be configured for managing the circuit breakers.

The following description is just a wiring example of them in a stand-by application (single genset, no parallel).



The GCB command is used to connect the loads to the generator. The MCB command is used to connect the loads to the mains. To ensure that the mains is connected to the loads in case of controller's failures:

- Use the NC contact of MCB (Y11-6) to close the MCB circuit breaker.
- Use the NO contact of GCB (Y11-2) to close the GCB circuit breaker.
- Provide an electrical and mechanical interlock among the two circuit breakers.

5.5.4 Y22 - Output (hardware watchdog)

The controller is equipped with a hardware watchdog output, implemented by a relay with dry contacts; this output is available on connector Y22.

The maximum switching capacity with resistive load is 1 A @ 32 Vdc. With inductive loads (power relays, electro-magnetic actuators), use an opening overvoltage damping diodes.

When the controller is switched ON, the output turns active after about 1 second: the NC contact will open, and the NO contact will close. If the controller works properly the output always remains active.

If the controller has a failure (if it does not refresh the watchdog circuit for more than 5 seconds), the output automatically fails. If the controller is unsupplied, the output immediately falls without waiting the 5 seconds time-out.

The watch-dog output is not controlled by the software and therefore cannot be deactivated.

5.5.5 Digital outputs configuration

For any digital output (except watchdog) you can individually configure:

- The polarity: if you select “reverse polarity”, the controller will **deactivate** the output when its own function would require its activation, and vice-versa. Using BoardPrg4, you have a “reverse polarity” check box for each output (visible only if the output is really used). Inside the controller, these options are grouped (sixteen per group) into specific parameters: if you want to modify the “reverse polarity” option of an output directly from the GC800 HMI, you must know the related parameter:

Parameter	Outputs
P.3000	01...16
P.3200	DITEL #01
P.3250	DITEL #02
P.3300	DITEL #03
P.3350	DITEL #04
P.3400	DITEL #05
P.3450	DITEL #06
P.3500	DITEL #07
P.3550	DITEL #08
P.3600	DITEL #09
P.3650	DITEL #10

- The function: tells the controller what to do with the output.

The digital outputs can be used directly as commands or as remote signals. There are some functions, however, which makes the output not directly controlled by the operating sequence of GC800 SCM:

- DOF.0000 (“Not used”). The output is always switched off.
- DOF.0100 (“Used as analogue output”). This function, available only for output 11 and 12, tells the controller to manage those outputs as analogue instead of digital, by generating a PWM signal on their own terminals (see paragraph 5.7.2). Once you selected this function, the parameters for configuring an additional analogue output are automatically added to the proper configuration menu: use this menu to manage the digital output as an analogue one.
- DOF.0101 (“Used by PLC”). This function tells the controller that the output is managed by the internal PLC, not directly by the application logic. Note: if the PLC program uses some outputs, but those are not configured with function DOF.0101, the outputs will not be commanded (but the controller signals this situation with a warning).
- DOF.0102 - “Managed by serial ports”. The controller does not command the output with its own internal logics, but with the commands received by means of the communication ports.
- DOF.0103 - “AND/OR logic”. The user, without using complex PLC programs, can create simple combinatory logics (using BoardPrg4) among digital information available in the controller, and store the result in the digital output. See 6.5.

GC800-HMI shows the status of all digital outputs on a dedicated display page.

5.6 Analogue inputs

The controller is equipped with 7 non-isolated analogue inputs:

- 4 slow multi-inputs (Y8, Y7) which can acquire voltages, currents, resistances, and temperature.
- 2 fast multi-inputs (Y6) which can acquire voltages, currents, resistances, and temperature.
- 1 voltage inputs (Y9).

INFORMATION: fast inputs (Y6) have a sampling rate of 200 Hz. They are suitable to acquire external commands (e.g. external synchronizer), setpoint or any signal which requires fast response.

INFORMATION: slow inputs (Y8, Y7) have a sampling rate of 25 Hz. They are suitable to acquire any signal which does not require fast response (e.g. temperatures).

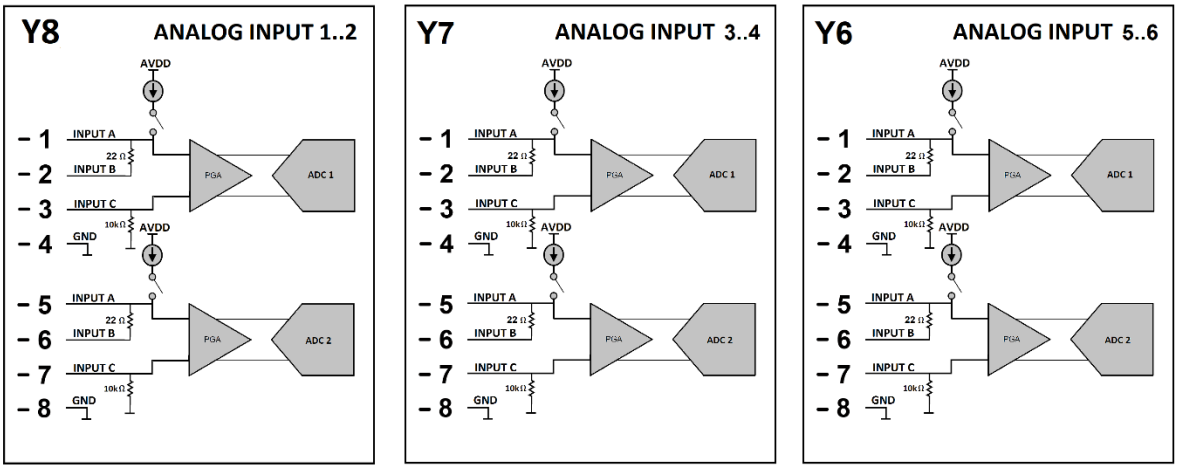
It's possible to increase the number of digital inputs by adding up to:

- 16 DIGRIN/DITHERM 3 AI expansion modules (connected by CAN bus), for a total of 48 additional temperatures (see paragraph 5.8).
- 16 DIVIT 4 AI expansion modules (connected by CAN bus), for a total of 64 additional voltage/current measurements (see paragraph 5.8).

The controller also provides 8 "virtual" analogue inputs: they are managed by the controller exactly as they were physical (without limitations), but their values are not acquired by the hardware but determined via software. In fact, each virtual inputs can be associated to a PLC block that determines its value. Otherwise, you can select among a list of special functions codes, which tells the controller to "copy" an existing measure (e.g. the generator frequency) into the virtual analogue input.

Finally, the controller provides 32 "shared" analogue inputs: they behave as "virtual", and their values are received from other controllers through the PMCB CAN bus.

5.6.1 Y8-Y7-Y6 Analogue inputs 1-6 (AI_01 to AI_06)



The controller is equipped with six multi-inputs (available on terminals Y6, Y7, Y8) which can be individually configured (by parameters P.5981…P.5986) as:

0. Voltage DC input: 0 to 10 V.

1. Current DC input: 0 to 20 mA.
2. Current DC input: 4 to 20 mA.
3. Resistance Measurement Input (RMI): 0 to 2100 Ω.
4. PT100 input (RTD): -200 °C to 800 °C.
5. Thermocouple input: Type J.
6. Thermocouple input: Type E.
7. Thermocouple input: Type N.
8. Thermocouple input: Type K.

If not required as analogue, each input can be configured as input, using the function AIF.0100 (“Used as digital input”) (see paragraph 5.6.4).

Each multiple input has 4 connection terminals that must be wired correctly according to the type of sensor to be connected:

- INPUT A: analogue measurement input.
- INPUT B: internal shunt for current measurement.
- INPUT C: compensation input.
- GND: internal controller ground.

All inputs offer the possibility of differential measurement, to compensate for differences in the sensor's negative terminal from the controller's GND.

As per “factory” default configuration, no analogue input is used:

INFORMATION: these inputs are not galvanically separated from the power supply.

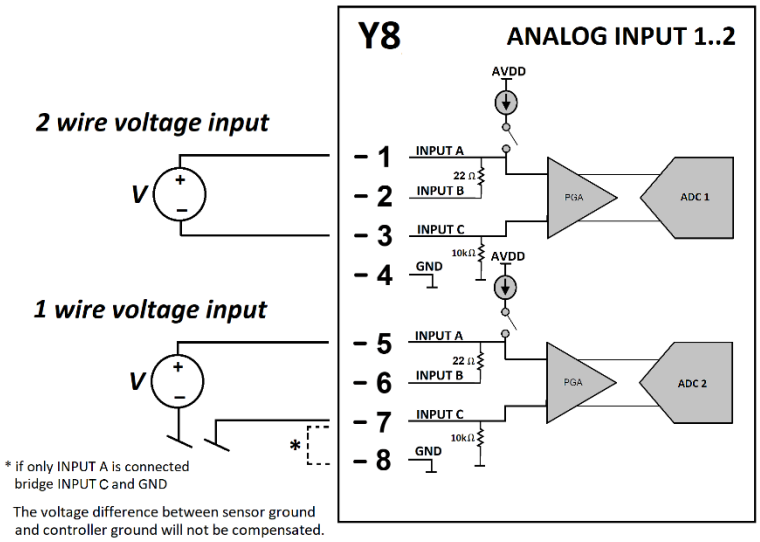
INFORMATION: It is recommended to use two-pole analogue senders for best accuracy.

The controller automatically detects some “wrong” conditions on these analogue inputs:

- Sensor disconnected.
- Overflow (the measured value is too high).
- Underflow (the measured value is too low).

The following chapters describes the recommended wiring for each hardware option, and for each lists the “wrong” conditions really detected.

5.6.1.1 0…10 V DC voltage

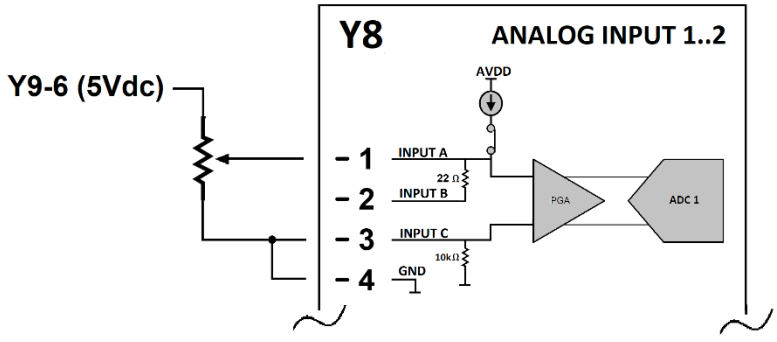


Each analogue inputs (Y6, Y7, Y8) can be configured as a DC voltage input by setting parameter P.598X ("Hardware for analogue input x") to the value "0 - 0…10 Vdc".

When using a two-wire sensor, the positive of the sensor must be connected to INPUT A (Y8-1 in the picture) and the negative to INPUT C (Y8-3). The circuit is designed to compensate the voltage differences between the negative of the controller and the negative of the sensor up to a maximum of ± 12 Vdc.

When using a one-wire sensor, connect the sensor signal to INPUT A (Y8-5 in the picture). Usually the negative of one-wire sensors is provided by the mechanical structure of the sensors themselves, which in turn are connected to the motor frame. Connect INPUT C (Y8-7) with one wire to the motor chassis to allow the circuit to compensate for voltage differences between sensor negative (motor chassis) and controller negative. If this is not possible, bridge INPUT C (Y8-7) to GND (Y8-8): in this case the voltage difference will not be compensated. The INPUT C inputs are internally connected to GND by means of 10 kΩ resistors.

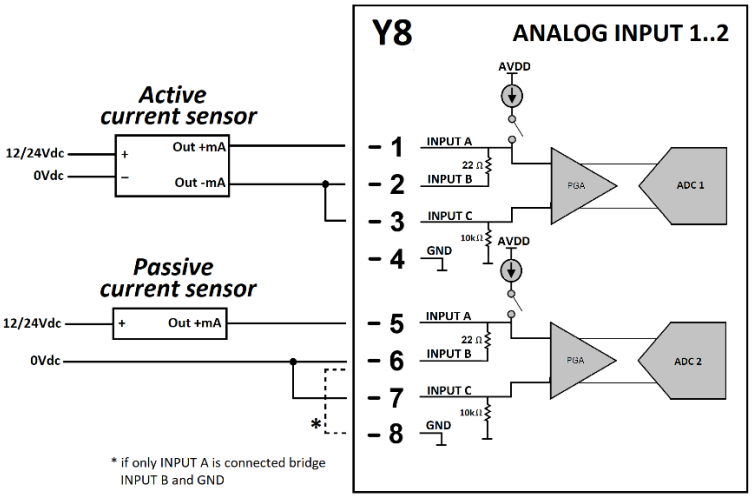
A voltage above 10.5 Vdc is interpreted as "Overflow".



If the input signal is to be provided by a potentiometer, the 5 Vdc output, available on connector Y9-6, can be used as a power source. This voltage is specific for the use of potentiometers only. We recommend using 10 kΩ potentiometers.

If configured as digital (function AIF.0100 in parameter P.4001 or equivalent), the input is considered active when the measured voltage is higher than 4.0 Vdc; it is considered not active when the measured voltage is lower than 3.5 Vdc. It cannot therefore be activated like the other inputs by connecting it to the battery negative.

5.6.1.2 0…20 / 4…20 mA DC current



Each analogue inputs (Y6, Y7, Y8) can be configured as a DC voltage input by setting parameter P.598X (“Hardware for analogue input x”) to the values:

1. 0…20mA
2. 4…20mA

The circuit measures the current injected by the sensor via the shunt resistor between INPUT A and INPUT C: the positive of the sensor must be connected to INPUT A and the negative to INPUT B; it is necessary to bridge INPUT B with INPUT C to provide a correct measurement.

If only INPUT A is available from the sender, a bridge must be made between INPUT B (Y8-6) and GND (Y8-8) to close the current loop through the controller's power supply terminal (Y1-1) This is only possible if the sensor is powered from the same power source of the controller.

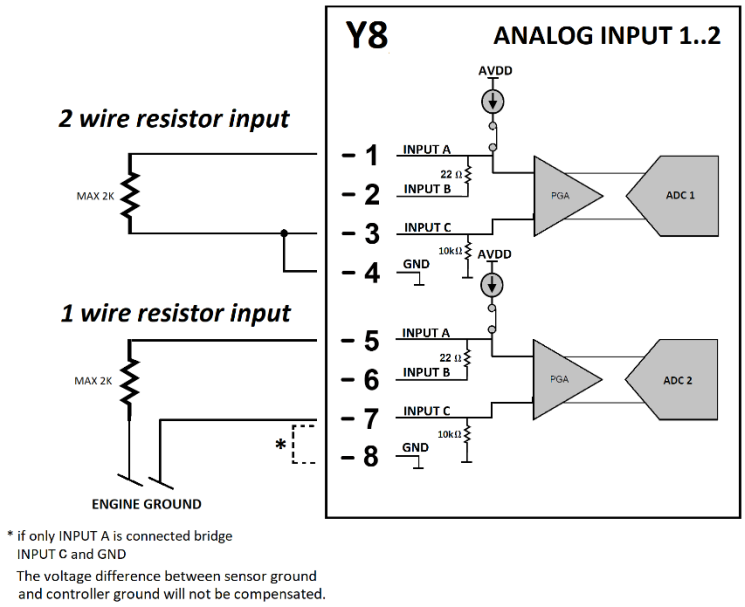
A current above 20.2 mA is interpreted as “Overflow”.

When using 4-20mA senders:

- A current below 3.0 mA is interpreted as “Sensor disconnected”.
- A current below 3.8 mA is interpreted as “Underflow”.

INFORMATION: The controller is unable to supply the current loop. The passive sensor must be powered by an external source with a negative in common with the controller. The same power supply of the controller can be used with the appropriate protection for the sensor.

5.6.1.3 0…2000 Ω (RMI)



* if only INPUT A is connected bridge INPUT C and GND
The voltage difference between sensor ground and controller ground will not be compensated.

Each analogue inputs (Y6, Y7, Y8) can be configured as a DC voltage input by setting parameter P.598X ("Hardware for analogue input x") to the value "3 - Resistive".

The controller allies a fixed current (about 5.3 mA) and measures the voltage across the sensor. The useful resistance range is 0 to 2000 Ω.

Two-wires sensors.

The positive of the sensor must be connected to INPUT A and the negative to INPUT C.

One-wire sensors

Connect the sensor signal to INPUT A. The negative of one-wire sensors is provided by the mechanical structure of the sensors themselves, which in turn are connected to the engine frame. Connect INPUT C with a **dedicated wire** to the engine frame (don't use it for any other purpose, any current flowing on it may invalidate the measurement). Its purpose is to compensate the voltage difference between electric earthing of the device (GND terminal) and electric earthing of the sender (engine frame). This voltage difference is usually generated by the voltage drop on the connection cables; particularly, this happens when the connections between electric panel and engine are long and when there is a power flow in the battery minus and earthing connections, for example due to the presence of the battery recharge device inside the electric panel. The circuit is designed to compensate voltage differences between the negative of the controller and the negative of the sensor up to:

- ± 6 Vdc for half scale reading (1000 Ω)
- -6 Vdc to +2.5 Vdc for full scale reading (2000 Ω)

The input measures the potential of the common ground point (negative) of the resistive sensors, which for the sensors mounted on the engine is represented directly by the engine itself or the chassis of the gen-set; INPUT C (Y8-7) can therefore be connected to a grounding system or to a bolt on the engine.

If the negative of one or several sensors is isolated from the engine frame (for example fuel level sensors mounted on the plastic tanks), you need to connect the INPUT C (Y8-7) to the return of the sensor and to the engine frame, or to the negative pole of the starting battery.

If it is not possible to bring the engine frame reference to the controller, bridge INPUT C (Y8-7) to GND (Y8-8): in this case the voltage difference will not be compensated, and the measurement will have lower accuracy.

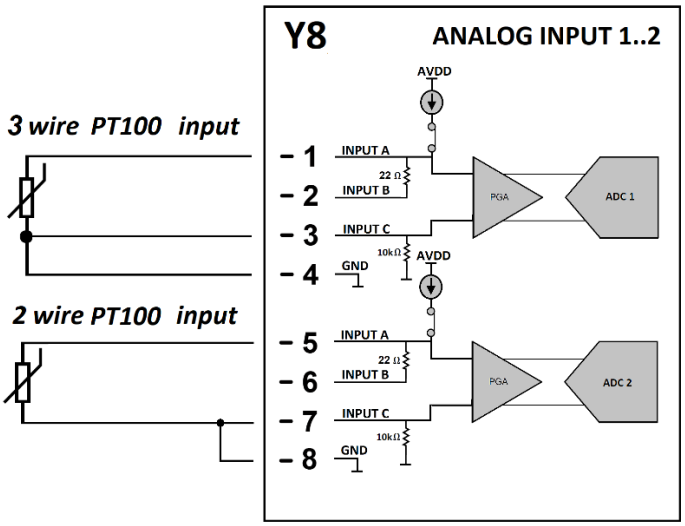
A resistance above 2100 Ω is interpreted as “sensor disconnected”.

A resistance bellow 10 Ω is interpreted as “underflow”.

INFORMATION: It is recommended to use two-pole analogue senders for best accuracy.

INFORMATION! When using single-wire sensors, it is important that terminal “C” (sensor reference) is well connected to a ground point on the engine frame, **not inside the control panel**, and must provide a good electrical connection to the sensor body. This connection **MUST NOT** be used to provide a ground connection for other terminals or devices.

5.6.1.4 PT100



Each analogue inputs (Y6, Y7, Y8) can be configured as a DC voltage input by setting parameter P.598X ("Hardware for analogue input x") to the value "4 – PT100".

The positive of the sensor must be connected to INPUT A and the negative to INPUT C.

Three-wires connection.

The idea of the three-wires connection is to compensate the voltage drop over the wires leading to the sender. The principle assumes that the three wires have the same length and diameter. The controller calculates the voltage drop over the wiring with the INPUT C.

Two-wires connection.

It is used when the voltage drops over the wiring does not have much impact on the measurement signal. A bridge is executed directly on terminals INPUT C and GND.

A resistance above 430 Ω is interpreted as "Sensor disconnected".

A resistance above 400 Ω is interpreted as "Overflow".

A resistance bellow 18,5 Ω is interpreted as "Underflow".

INFORMATION: It is recommended to use three-wire sensor for best accuracy. The use of three-wire sensors can compensate for reading error caused by the resistance of the connection cables. This connection gives you the precision indicated in the specifications (see paragraph 3).

5.6.1.5 Thermocouples

5.6.1.5.1 Thermocouple overview.

Thermocouples are temperature measurement sensors that generate a voltage proportional to temperature. Thermocouples are constructed from two wire leads made of different metals. The wire leads are welded together to create a junction. As the temperature changes from the junction to the ends of the wire leads, a voltage grows across the junction.

Combinations of different metals create a variety of voltage responses. This leads to different types of thermocouples, used for different temperature ranges and accuracies. Choosing a thermocouple often is a function of the measurement temperature range required in the application. Other considerations include the temperature accuracy, durability, conditions of use, and the expected service life.

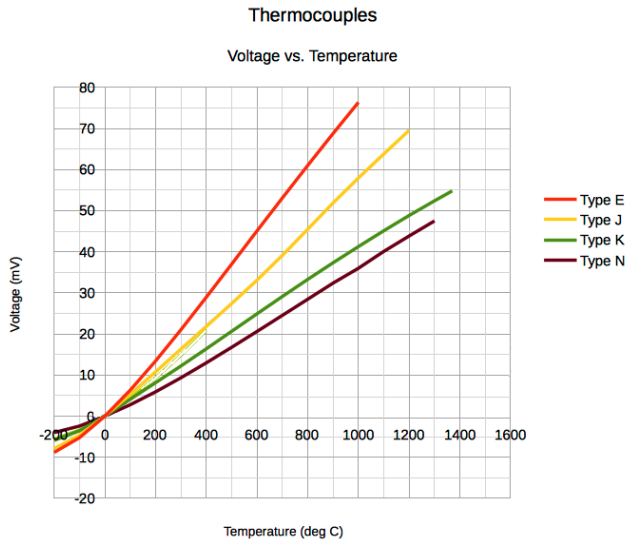
Regardless of metal lead, each thermocouple type is designated by a single letter to indicate the two metals used. For example, a J-type thermocouple is constructed from iron and constantan. With each type, the thermoelectric properties are standardized so that temperature measurements are repeatable. Thermocouple leads and connectors are standardized with colour plugs and jacks, indicating the type of thermocouple. Different colours for insulation and lead wires also indicate the thermocouple grade and extension grade.

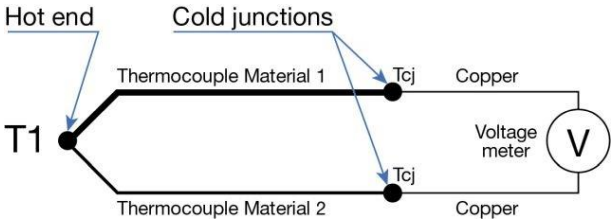
This lists several common thermocouple types and their characteristics.

Type	Lead metal A (+)	Lead metal B (–)	Temperature range (°C)	EMF over temperature range (mV)	Seebeck coefficient (µV / °C at 0 °C)
J	Iron	Constantan	–210 to 1200	–8.095 to 69.553	50.37
K	Chromel	Alumel	–270 to 1370	–6.458 to 54.886	39.48
T	Copper	Constantan	–200 to 400	–6.258 to 20.872	38.74
E	Chromel	Constantan	–270 to 1000	–9.385 to 76.373	58.70
N	Nicrosil	Nisil	–270 to 1300	–4.345 to 47.513	25.92

- **Constantan**: 55% copper and 45% nickel.
- **Chromel**: 90% nickel and 10% chromium.
- **Alumel**: 95% nickel, 2% aluminium, 2% manganese, and 1% silicon.
- **Nicrosil**: nickel containing about 14.4% chromium, 1.4% silicon, and (in some sources) 0.1% magnesium.
- **Nisil**: 95.5% nickel, 4.4% silicon, 0.1% magnesium.

Figure bellow illustrates the typical responses for these same thermocouple types:



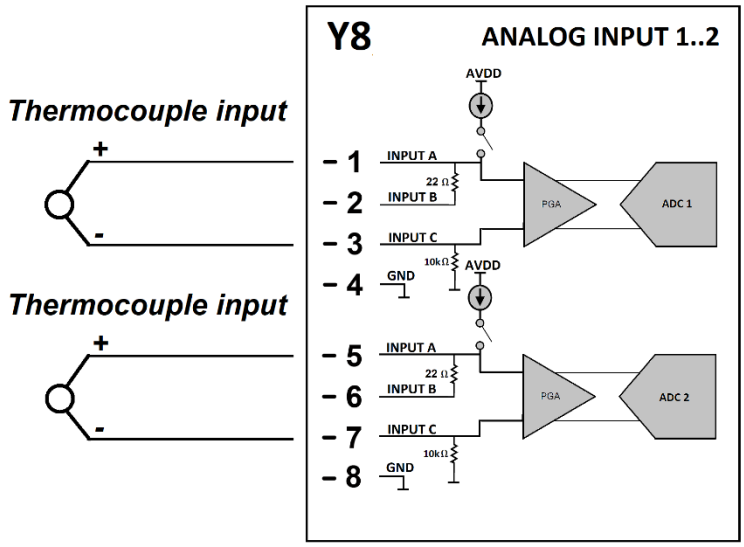


In the above picture: the “Thermocouple material 1 and 2” represent the two different materials the thermocouple is made of. “T1” is the hot end of the thermocouple, i.e. the point that is used to measure temperature. The two “Tcj” points are the temperatures of the cold junctions.

The voltage created from the thermocouple is non-linear depending on the temperature of the cold junction. Cold-junction compensation is required to accurately determine the thermocouple junction temperature based on the cold junction temperature. An accurate measurement of the cold junction block acts as the reference temperature of the cold junction. This reference measurement is often made through a diode, thermistor, or RTD. If the reference temperature at TCJ is known, then the thermocouple temperature at T1 is computed based on the thermocouple voltage.

All connections between thermocouples and measuring instruments must be made with suitable compensated cables, in fact there are compensated cables for each type of thermocouple, the choice of insulation type and size depends solely on the conditions of use. All compensating and/or extension cables for thermocouples are coloured to identify both the type of thermocouple and its polarity, so it is important to take care to avoid reversing polarities in any connections.

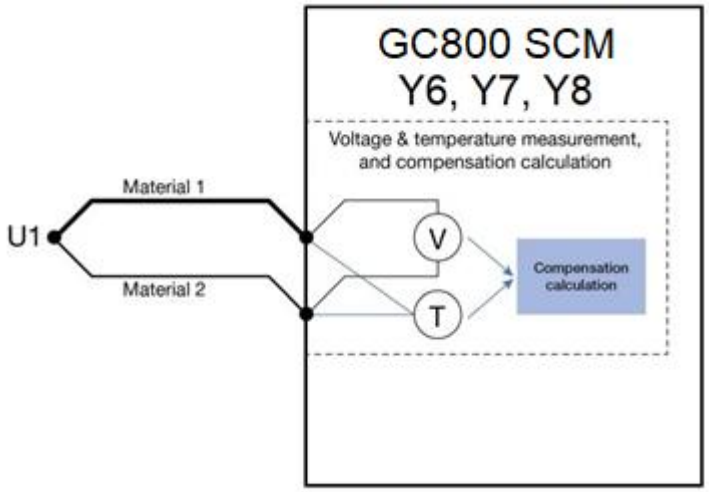
5.6.1.5.2 Connections with Thermocouples sensors



Each analogue inputs (Y6, Y7, Y8) can be configured as a DC voltage input by setting parameter P.598X (“Hardware for analogue input x”) to the value “4 – PT100”.

4. Type J thermocouple.
5. Type E thermocouple.
6. Type N thermocouple.
7. Type K thermocouple.

The positive of the thermocouple must be connected to INPUT A and the negative to INPUT C.



The controller compensates the temperature of the cold junction Tcj (the junction between the thermocouple wire and the device terminal) by means of an internal thermometer that measures the temperature at terminals Y6, Y7, Y8.

Each channel has an open thermocouple detection circuit, which consists of a current source between the INPUT A and INPUT B terminals. If an open thermocouple is connected to the channel, the current source forces a full-scale voltage across the terminals.

A voltage above 120 mV is interpreted as “Sensor disconnected”.

A voltage above 100 mV is interpreted as “Overflow”.

A voltage bellow -10 mV is interpreted as “Underflow”.

INFORMATION Since the measuring inputs are not isolated from the controller power supply, it is possible that parasitic EMFs are introduced from the thermocouple to the measuring instrument, and since the thermocouple signal is in mV, it is very easy for this to be distorted or disturbed. It is therefore necessary to use thermocouples with an insulated measuring junction.

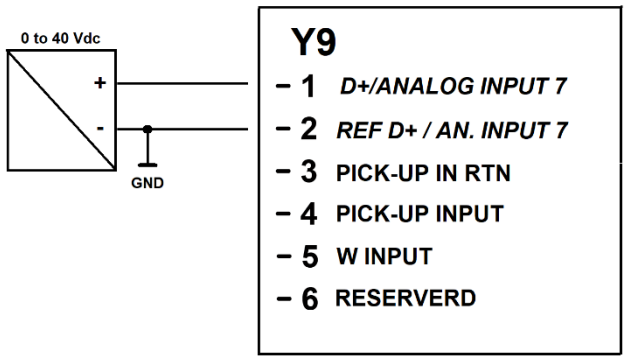
INFORMATION: All connections between thermocouples and measuring instruments must be made with suitable compensated cables. Any connection between two different metals creates a thermocouple junction.

INFORMATION Accuracy refers to the device only; error caused by the thermocouple is not included.

INFORMATION Twisted pair and shielded cable is recommended to achieve specification and optimisation of immunity-noise.

5.6.2 Y9 - Analogue input 7 (AI_07)

voltage input



If the engine's battery charger does not require the excitation connection, it is possible to configure the terminal Y9-1 as a standard DC voltage analogue input (AI_07), with measurement range from 0 to 40 Vdc compared to the terminal Y9-2 (Reference D+). Note: the terminal is used as "analogue input" whenever parameter P.4115 is set to a value different from AIF.1300 ("D+ signal"), which is the "factory" default.

The circuit is designed to compensate the voltage differences between the negative of the controller and the negative of the sensor up to a maximum of ± 3.5 Vdc.

5.6.3 Virtual analogue inputs

The controller, besides the physical analogue inputs, also manages 8 virtual analogue inputs. They are managed by the controller exactly as they were physical inputs (without limitations), but the virtual inputs status is not acquired by the hardware but determined via software.

The purpose of the virtual analogue inputs is multiple:

- To allow the activation of anomalies related to the internal available measurements.
- To activate digital outputs based on the value of the internal available measurements.
- To make the PLC able to provide setpoints to the controller.

It is possible to operate in two ways to assign a value to the virtual analogue inputs:

- Using the internal PLC. In this case, it is necessary to assign a standard function to the virtual analogue input (function lower than AIF.4001). For example, we can use the PLC program to modify the "active power setpoint" for the generator based on a temperature acquired from an external sensor. It is necessary:
    - Set parameter P.4051 (function for virtual analogue input #1) to value AIF.2301 ("Setpoint local BASE LOAD"). The controller will therefore use the value of virtual analogue input #1 as power setpoint for the parallel with the mains.
    - Using the internal PLC, create a logic which writes into the virtual analogue input #1 the power setpoint corresponding to the external temperature acquired.
- Configuring the "function" parameter with a value greater than or equal to AIF.4001. In this case, the controller copies the value identified by the previous function code in the virtual analogue input: it is then possible to manage the thresholds to activate digital outputs and anomalies.

5.6.4 Analogue inputs configuration

The analogue inputs can be used for the acquisition of several predefined values, or to acquire generic sensors (therefore user-configurable). Some values can only be acquired by some specific inputs. They can also be used to acquire setpoints for the genset (speed, power etc.), typically by adding external potentiometers.

Most of these values are engine-related measurements. When operating with electronic engines (equipped with an ECU able to communicate over CAN bus or RS485), most of these values are acquired directly from the ECU over the communication link. If you still want to use the controllers' inputs to acquire these values, simply configure the inputs: the controller's inputs always have higher priority than ECU's values.

For the most standard measurements (coolant temperature, oil pressure etc.) the controller internally implements the characteristic curve for the most common VDO sender suitable for such measurement. You can select this sender directly from GC800 HMI. If you have a different sender, you must use BoardPrg4: it has a database allowing you to choose among the most common commercial senders. If your sender is not in the database, you can create your own (and, if you'll share it with Mecc Alte, it will be added to the database).

The standard senders inbuilt in the controller are:

VDO Oil temperature sensor (AIF.1100)	
0 °C.	3240 Ohm.
50 °C.	322 Ohm.
100 °C.	62 Ohm.
150 °C.	19 Ohm.

VDO Coolant temperature sensor (AIF.1110)	
0 °C.	1800 Ohm.
50 °C.	195 Ohm.
100 °C.	38 Ohm.
120 °C.	22 Ohm.

VDO Oil pressure sensor (AIF.1000)	
0 bar.	10 Ohm.
4 bar.	86 Ohm.
10 bar.	180 Ohm.

Level sensor VDO (AIF.1200, AIF.1210, AIF.1220)	
0 %.	180 Ohm.
100 %.	10 Ohm.

Once the proper sender has been selected, the controller will convert (by the sensor curve) the measured value (voltage, current, resistance) into the required measurement (°C, bar etc.).

INFORMATION: virtual analogue input does not allow to select any "sender type", since their value is set by the PLC or copied from another existing measurement).

INFORMATION: in the same way, temperature inputs (PT100, thermocouples, or DIGRIN/DITHERM inputs) does not allow to select a sender because the acquired value is a temperature and does not need any conversion.

For "physical" and "virtual" inputs you can individually configure:

- Only for analogue input AI_01…AI_06: a parameter allowing to select the hardware type (P.5981 or equivalent).
- The function (P.4001 or equivalent): tells the controller what to do when the acquired measure.
- A message (P.4002 or equivalent): for user defined measurements or for fault activations.
- Two configurable thresholds, made up of three parameters each):
    - Threshold value (P.4003 and P.4006, or equivalent).

- Threshold delay (P.4004 and P.4007, or equivalent). The transition between “out of threshold” and “in threshold” (and vice versa) happens only after this delay.
- Threshold options (P.4005 and P.4008, or equivalent).

The two thresholds are completely independent on each other. The third parameter of each threshold is a “bit mapped” parameter that allows you to associate to each threshold the following options:

- Bit 00. It selects the “out of threshold” condition:
  - OFF (“greater than”): measurement > threshold.
  - ON (“lower than”): measurement < threshold.
- Bit 01. You normally don’t need to set this bit. This “tricky” bit is important only when two thresholds must be used together to SET/RESET an “internal status” (with hysteresis). In this case, you will have an “out of threshold condition” in both thresholds (typically one “greater than” and one “lower than”). You must decide which condition (and thus which threshold) must set the “internal status”, and which one must reset it:
  - ON: on the condition which must set the “internal status”.
  - OFF: on the condition which must reset the “internal status”.
- Bit 04. If this bit is ON, the controller activates a WARNING if case of “out of threshold”.
- Bit 05. If this bit is ON, the controller activates an UNLOAD if case of “out of threshold”.
- Bit 05. If this bit is ON, the controller activates a DEACTIVATION if case of “out of threshold”.
- Bit 07. If this bit is ON, the controller activates a SHOTDOWN if case of “out of threshold”.
- Bit 08. If this bit is “ON”, the controller activates an anomaly only if the engine is running.
- Bit 09. If this bit is “ON”, the controller activates an anomaly only if "oil mask time" is elapsed.
- Bit 10. If this bit is “ON”, the controller activates an anomaly only if the GCB circuit breaker is closed.
- Bit 11. If this bit is “ON”, the controller activates an anomaly only if the fuel valve is active.
- Bit 12. If this bit is “ON”, the controller activates an anomaly only if the gas valve is active.
- Bit 13. If this bit is “ON”, to activate an anomaly, the controller checks the status of an eventual digital inputs configured with function DIF.2705 (“Disables protections on analogue measures”). The anomaly will be activated if no digital input is configured like that, or if they are all OFF.
- Bit 14. If this bit is “ON”, the anomaly causes the stop of the fuel pump.
- Bit 16. If this bit is “ON”, the anomaly is subject to override of the engine’s protections (see paragraph 8.5).

It is possible to set any combination of these bits.

INFORMATION: the thresholds here defined are independent from those eventually set on the “Protections” menus: it is possible, for example, to set a threshold of high temperature for the coolant temperature by means of parameter P.0337 to stop the engine, and a couple of independent temperature thresholds through the above-described parameters, useable to create other alarms, signalling or different logics.

INFORMATION! Shared inputs are available only inside the PLC environment; thus, they do not have any configuration parameter.

The analogue inputs are normally used by the controller to get information from the plant and manage the generator consequently. There are some functions, however, which makes the input “unavailable” by the controller:

- AIF.0000 (“Not used”).
- AIF.0100 (“Used as digital input”). This function, available only for input 1…7, tells the controller to manage those inputs as digital instead of analogue (see next chapter). Once you selected this function, the parameters for configuring an additional digital input are automatically added to the proper configuration menu: use this menu to manage the analogue input as a digital one.
- AIF.2001 (“Generic sensor (page 1)”).
- AIF.2003 (“Generic sensor (page 2)”).
- AIF.2005 (“Generic sensor (page 3)”).
- AIF.2007 (“Generic sensor (page 4)”).
- AIF.2009 (“Generic sensor (page 5)”).
- AIF.2011 (“Generic sensor (page 6)”).
- AIF.2013 (“Generic sensor (page 7)”).
- AIF.2015 (“Generic sensor (page 8)”).
  These functions tell **GC800 HMI** that the converted value acquired by these inputs must be shown on eight dedicated display pages, together with the description configured for each input).
- AIF.2051 (“Generic sensor”). This function, available only for input 1…7, tells the controller that the measurement acquired by this input will be managed by something else (typically by the PLC). The controller, thus, will ignore this value.
- Function greater than AIF.4000. This functions, available only for virtual input, tells the controller which information must be “copied” into the virtual analogue input: the thresholds will then operate on such value.

If one or both thresholds activate an anomaly, **GC800-HMI** will show the alarm code, and the configured message of the analogue input.

GC800-HMI shows the electrical measurement of all analogue inputs on a dedicated display page. In case of “wrong” values (see previous chapters), it will show:

- “OPEN”: in case of “sensor disconnected”.
- “+OVER”: in case of “Overflow”.
- “-OVER”: in case of “Underflow”.

The same for the analogue input on external modules.

5.6.5 Analogue inputs used as digital.

Analogue inputs AI_01 to AI_07 (Y6, Y7, Y8 and Y9) can individually be set configured “digital” by setting their “function” parameter to AIF.0100 (“Used as digital”). When done, they will be available in the digital inputs’ configuration menu as DI_21 to DI_27.

For analogue inputs AI_01 to AI_06, it’s also mandatory to configure (and wire) the input as:

0. “0…10 Vdc”.
3. “Resistive”.

The input AI_07 is implicitly configured as “0…10 Vdc”.

When the hardware is set as “0…10 Vdc”, the input is considered active when the measured voltage is above 4.0 Vdc, while it is considered inactive when it is below 3.5 Vdc. It cannot therefore be activated like the other inputs by connecting it to ground.

When the hardware is set as “resistive”, the input is considered active when the measured resistance is below 5 Ω, while it is considered inactive when it is above 2 kΩ. It can therefore be activated like the other inputs by connecting it to ground.

GC800 HMI shows the status of analogue inputs “used as digital” together with the other inputs (DI_21…27). Their value is “-” for analogue input not used as digital.

5.7 Analogue outputs

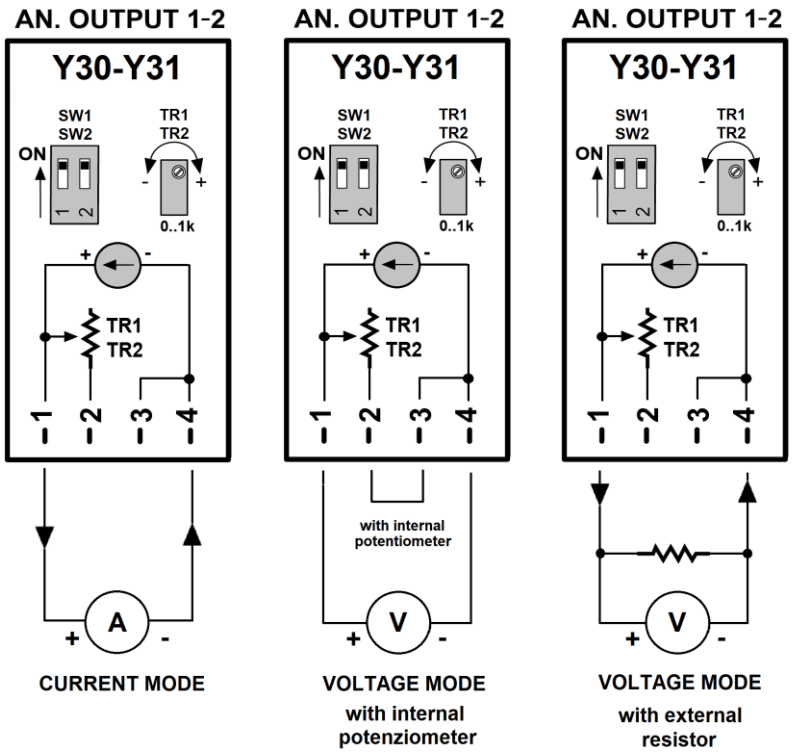
The controller has 2 insulated analogue outputs (Y30, Y31).

The digital inputs 11 and 12 can individually be configured as analogue outputs (not insulated, they operate as PWM). When used as analogue output, their name becomes AO_03 and AO_04.

It's also possible to increase the number of analogue outputs by adding up to 8 DANOUT 4 AO expansion modules (connected by CAN bus), for a total of 32 additional analogue outputs (see paragraph 5.8).

Finally, the controller provides 32 "shared" analogue inputs: any of them can be "written" by a PLC block (behaving as an output), and its value will be transmitted to all other controllers connected on the PMCB CAN bus: they will receive it as a "shared" analogue input.

5.7.1 Y31 – Y30 Analogue outputs 1-2 (AO_01, AO_02)



The controller provides two isolated analogue outputs, to allow the connection to external devices accepting current/voltage input signals. For example, they can be used for controlling the engine speed (toward speed regulator) and the generator voltage (toward voltage regulator).

The two outputs are isolated from each other, from the controller power supply and from the protective earth. They do normally operate as "DC current output". The DC current range can be selected by two switches (SW1.x for output AO_1, SW2.x):

Range	SWx.1	SWx.2
±10 mADC.	ON	ON
±20 mADC	ON	OFF
+20 mADC	OFF	OFF

As you can see, the output can be symmetrical (both positive and negative) or asymmetrical (only positive).

It's possible to convert the output in a "DC voltage output". In this case, the maximum voltage that can be output is ±10 Vdc. To use the output as "DC voltage":

- Apply an external resistor on the two wires connected to terminals 1 & 4. Connect the resistor as close as possible to the device that needs the voltage signal. This increases immunity to signal noise and compensates any voltage drops occurring from cables.
- Using the internal potentiometer (TR1 and TR2) by placing a simple jumper between terminals 2 and 3. The internal potentiometer (1 kΩ) allows to reduce the output voltage range while preserving the resolution of the control signal.

When the output operates as “DC voltage”, you must pay attention to the value of the connected load impedance. Electrically the output is a current loop, thus the resulting voltage is the product of the current and the connected resistance: you should not exceed the ±10 Vdc limit:

- Maximum 500 Ω (total) for 20 mA configurations.
- Maximum 1000 Ω (total) for 10 mA configurations.

For example, configuring the output as ±10 mA by SWX, and using the internal trimmer set to 500 Ω, we should obtain an output voltage of ±10 mA x 500 Ω= ±5V; this is without the applied load. If we consider a load resistor with a value of 10 KΩ, the impedance effectively connected to the output is the parallel between 500 Ω ohms and 10 KΩ: 476 Ω. This means that the voltage obtained is not ±5V but ±4,76V (10 mA x 476 Ω). By turning the potentiometer adjustment screw to increase the resistance, it is possible to compensate for this effect and obtain the desired output voltage value.

Both in “current” or “voltage” mode, it is always possible to reduce the output range via software using the appropriate parameters of the controller, losing resolution on the electrical output signal. For finer adjustments, the best is using these parameters.

INFORMATION! The outputs provide REINFORCED insulation to SELV (GND of the controller) and BASIC insulation to protective earth (PE). Insulation voltages and maximum working voltages are specified in the technical characteristics in chapter 3

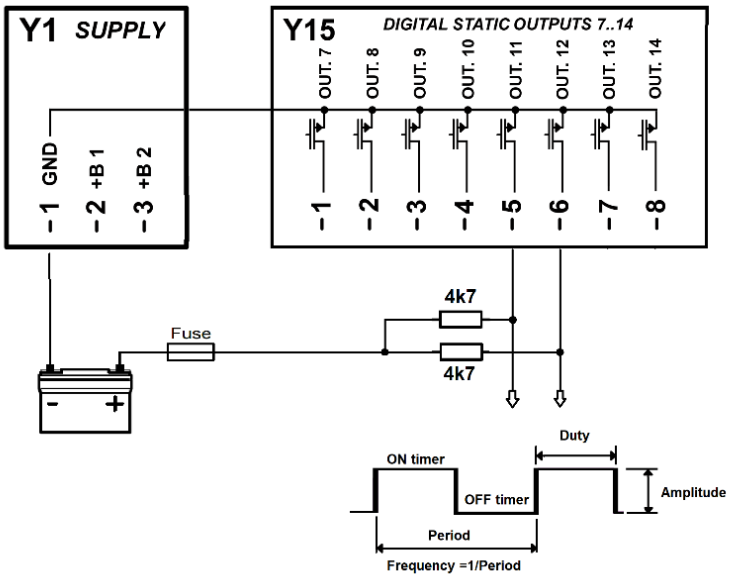
INFORMATION! When using an external trimmer or resistor, terminals 2 and 3 of connectors Y30 / Y31 shall be left unconnected.

WARNING! Take all required precautions to avoid contact danger on the current loop. For example, depending on the characteristics of the external device, the external resistor or trimmer may be above earth potential e reach high operation voltages.

These analogue outputs have a “factory” default configuration:

Connector	Input	Default function
Y31	01	Speed regulator.
Y30	02	Voltage regulator.

5.7.2 PWM output (AO_03, AO_04)



The digital outputs 11 and 12 (Y15-5 and Y15-6) can be associated with the “PWM output” function, to generate a PWM signals with configurable frequency, and with the duty-cycle proportional to an analogue measure. The PWM frequency can be selected via parameter P.6000 between a minimum of 1 Hz and a maximum of 2500 Hz and is common to both outputs. The duty cycles, instead, are fully independent.

To use these digital output as “analogue”, set the function DOF.0100 (“Used as analogue output (PWM)”) into:

- Parameter P.3011 for digital output 11 → AO_03.
- Parameter P.3012 for digital output 12 → AO_04.

Once you set the function DOF.0100, additional analogue outputs will appear on the proper configuration menu (AO_03, AO_04): see the next chapter for the configuration of the analogue output.

Since the outputs are open collector, it is necessary to connect a pull-up resistor to a positive voltage (always referred to the negative of the controller). The same supply voltage as the controller can be used: it depends on the output signal amplitude required. Use a resistor with a minimum value of 4,7 kΩ.

INFORMATION! the on/off time of the output signal varies depending on the externally connected capacitance. The higher the connected capacity, the more difficult it will be to have a correct PWM signal. See paragraph 3.

Just an example. Suppose you want to control the speed of a Caterpillar engine, which requires a PWM command with fixed frequency (500 Hz) and a duty cycle proportional to the required speed (0 to 100%). Suppose the ECU is programmed with a speed range of 240 rpm (1380-1620), and you want only to regulate from 1460 to 1540 rpm: these two values correspond to a percent regulation from 33.3% to 66.7%. The settings on GC800 SCM will be:

- P.3011 (“Function of the output 11”) = DOF.0100 (“Used as analogue output (PWM)”). This tells the controller to manage DO_11 as AO_03.
- P.6000 (“Frequency for PWM outputs”) = 500. The frequency is valid for both outputs 11/12.
- P.6003 (“Function of the analogue output #3”) = AOF.1000 (“Speed regulator”). This tells the controller to “map” the speed regulation command on this analogue output.
- P.0856 (“Minimum value for speed regulator”) = 33.3.

- P.0857 (“Maximum value for speed regulator”) = 66.7.

5.7.3 Analogue outputs configuration

The controller provides one parameter for each analogue output:

- The function (P.6001 or equivalent): tells the controller hoe to manage the output.

Moreover, it is possible to apply a conversion curve to all analogue outputs (its availability depends on the programmed function).

The analogue outputs can be used directly as commands or as remote signals. There are some functions, however, which makes the output not directly controlled by the operating sequence of GC800 SCM:

- AOF.0000 (“Not used”).
- AOF.0101 (“Used by PLC”). This function tells the controller that the output is managed by the internal PLC, not directly by the application logic. Note: if the PLC program uses some outputs, but those are not configured with function AOF.0101, the outputs will not be commanded (but the controller signals this situation with a warning).
- AOF.0102 - “Managed by serial ports”. The controller does not command the output with its own internal logics, but with the commands received by means of the communication ports.
- AOF.3001 and following: these functions are used to echoes a selected measurement (depending on the function itself): the proportion between the source measurement and the % value must be defined through the conversion curves.

GC800-HMI shows the command percentage of all analogue outputs on a dedicated display page.

5.8 Optional additional modules

Using the CAN bus connection (CAN2 - EXBUS) it is possible to connect the following optional additional modules to the controller:

- 16 DITHERM/DIGRIN modules:
    - DITHERM: 3 galvanically insulated thermocouple inputs.
    - DIGRIN: 3 galvanically insulated PT100 inputs.
- 16 DIVIT modules: 4 galvanically insulated analogue inputs 0...5 Vdc / 0...10 Vdc / 0...10 mA / 0...20mA.
- 8 DANOUT modules: 4 galvanically insulated analogue outputs 0...5 Vdc / 0...10 Vdc / 0...10 mA / 0...20 mA.
- 10 DITEL 16IN modules:
    - 16 opto-insulated digital inputs.
    - 0/8/16 relays (0/1/2 DITEL 8OUT modules).
- 2 D-PRO: multifunction protection relay device.
- 2 PC22: pulse counter device.

You must tell GC800 SCM which expansion modules are connected to the EXBUS line (this configuration can be done only using BoardPrg4). The modules can be added in any order and does not need to be consequent (you can add DITEL#2 and #4 without the others): we strongly recommend (for simplicity) to install and configure consequent modules.

Once configured, additional programming menus will be automatically added (both on BoardPrg4 and on GC800 HMI), allowing to proper configure additional digital/analogue inputs/outputs.

GC800 SCM will perform some checks on the configured modules:

- It checks for the real presence of each configured module and inform the operator if some is missing (AL.252 - “W252 – EXBUS: some module is missing”).
- It checks for any existing configured and used analogue inputs and inform the operator if:
    - Some measure is missing (AL.253 - “W253 – EXBUS: some measure is missing”). This typically happens when the module itself is not properly configured.
    - Some sensor is disconnected (AL.255 - “W255 – EXBUS: sensor disconnected”).
- It informs the operator in case of CAN bus link failure (AL.251 - “W251 – EXBUS: BUS OFF”)
- It informs the operator in case two or more expansion modules shares the same address (AL.254 - “W254 – EXBUS: duplicated address”)

GC800 SCM, when activates the previous warnings, provides additional information allowing the operator to fix the problem (address of the related module, index of the related measurement, etc.).

The modules may need some specific configuration (to be done directly on them using BoardPrg4. Refer to the technical manuals of the modules. Some hints:

- DITHERM module: as “factory” default, the three measurement inputs are disabled. You must enable each of them by selecting the proper type of thermocouple connected to them. Once enabled, the module will send over the CAN bus directly the measured temperatures (no conversions required on the module itself or on GC800 SCM).

- DIGRIN module: as “factory” default, all three measurement inputs are enabled. No configuration is required. The module will send over the CAN bus directly the measured temperatures (no conversions required on the module itself or on GC800 SCM).

- DIVIT module: as “factory” default, the four measurement inputs are disabled. You must enable each of them by selecting the proper input type (0…10 mA, 0…20 mA, 0…5 Vdc, 0…10 Vdc).

  Then you **must** also specify the conversion to be applied to the electrical measurement before sending it over the CAN bus. We strongly suggest converting the measured value into a percentage, whatever is the input type.

  Then, you can add conversion curves in GC800 SCM, to convert the acquired percentages into real values.

  In the following example, we configure DIVIT to convert a 0…10 mA signal into 0…100% before sending it over the CAN:

ID	Description	U.M.	In the controller	In the PC
P.0101	Sensor 1 - Input Type	-		1-0/10 mA
I1_SO1	Input 1 - Input value 1 (mA/V)	mA/V		0,000
I1_DE1	Input 1 - Correspondent transmitted value 1	-		0,0
I1_SO2	Input 1 - Input value 2 (mA/V)	mA/V		10,000
I1_DE2	Input 1 - Correspondent transmitted value 2	-		100,0
I1_LDN	Input 1 - Lower threshold for sensor fault (0-10(	%		-1
I1_LUP	Input 1 - Upper threshold for sensor fault (20-12	%		-1

- DITEL module: no configurations required.

- DANOUT module: as “factory” default, the four measurement outputs are configured as 0…10 mA. If required, you may need to modify the configuration. DANOUT expects to receive the output values in percentage: you may need to add conversion curves on GC800 SCM (for these inputs) to adjust the format.

- D-PRO module. It is a stand-alone protection relay, which simply shares data and alarms over the CAN bus. It requires a full configuration, to be done directly on it using BoardPrg4. No configuration is required on GC800 SCM to use it.

- PC22 module. It is a stand-alone module, which simply shares counters over the CAN bus. It requires a full configuration, to be done directly on it using BoardPrg4. No configuration is required on GC800 SCM to use it.

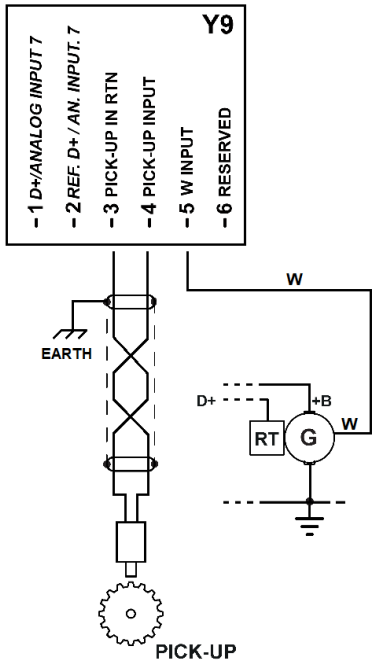
5.9 Engine rotational speed measurement

To measure the engine rotational speed, the controller can use:

- A magnetic pick-up (MPU) placed on the flywheel.
- The W signal generated by the engine’s battery charge alternator.
- Use the information coming from the ECU through CAN bus.
- Calculate it from the generator frequency.

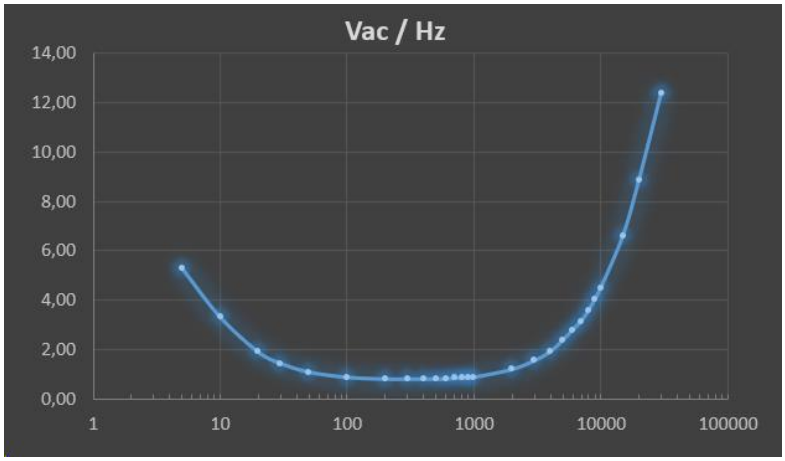
The priority is given by the order in the previous list: MPU has higher priority, the calculation “from generator frequency” has the lower. The highest priority measurement available is used.

5.9.1 Magnetic pick-up (MPU)



The connection must be made with a shielded cable, with grounded shield. You can use either a ground insulated two-wires MPU, or a single-wire MPU with the thread screwed onto the grounded engine (GND), which is the return connection for the signal; the two-wire isolated MPU is however recommended.

The signal is sine wave; the frequency depends on the engine rotation speed and on the numbers of teeth of the flywheel. The minimum input voltage with the engine at full speed must be at least 3 Vac; in case the voltage is lower, the signal can be increased screwing the MPU to get it closer to the cogged wheel, paying much attention not to hit the wheel during the rotation. See the graph below for the minimum characteristics of the input signal as a function of frequency:



Two-wires connections:

- Y9-4 MPU signal positive input.
- Y9-3 MPU signal negative input (return)-

Single-wire connections:

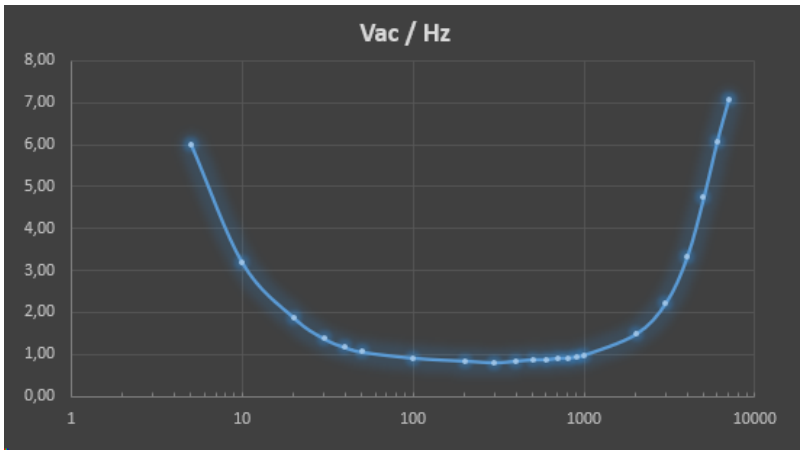
- Y9-4 MPU signal positive input.

It is normally possible to use a single MPU connected both to the controller and to another device, e.g. a speed governor, paying therefore attention to observe the polarity of the connections. Check also that the signal amplitude is sufficient.

The number of teeth of the flywheel must be set in the P.0110 parameters (“Number of teeth of the pick-up wheel”); by entering 0 (factory default), the speed measurement from MPU is disabled.

5.9.2 W signal

Some engine’s battery charger alternators make available a “W” terminal providing (when the charger is rotating) an alternating voltage with a frequency proportional to the rotation speed of the charger itself. The W signal is a squared wave, with amplitude between 0 and +Vbat. See the graph below for the minimum characteristics of the input signal as a function of frequency:



Usually, the battery charger is driven by the engine through a belt. Thus, the rotation speed of the charger is proportional to the rotation speed on the engine (the ratio depends on the diameters of the pulleys of the belt). This results in a direct ratio between the engine speed and the W frequency.

Connect the W signal of the engine’s battery charger alternator to the terminal Y9-5 (see picture in MPU chapter).

To enable the speed measurement from the W signal, set the parameter P.0111 (“Rpm/W ratio”) to a value different from 0 (its factory default is 0, meaning that this measurement is disabled). This ratio depends on different factors, and it is not easily obtainable. The following procedure shows a way to calculate the right value for P.0111. It is however required to have an alternative speed (or frequency) measurement during the procedure.

- Set a random value for P.0111 (e.g., 15).
- Start the engine and, when at operating speed, read the rpm value shown by the controller.
- Calculate the ratio between the displayed speed and the real engine speed (obtained from the alternative measurement). The ratio must be calculated as displayed/actual.
- Multiply the value previously set in P.0111 for such ratio and set the new value.
- Restarting the engine, the speed measure should be close to the real speed. It is then possible to proceed by manually adapting the P.0111 value up to obtain the correct reading, keeping in mind that at constant real speed, the more P.001 increases, the more the values displayed by the controller decreases.

5.9.3 Notes on MPU and W

You can use both measurement systems together. The priority is given to the MPU measurement; in case of MPU failures, the controller will use the W measurement.

INFORMATION: GC800 HMI shows both measurements (when available).

If one or both measurement systems are enabled, GC800 performs a check on the senders and activates an anomaly if there’s something wrong. The anomaly is configurable with parameters P.0387 (“Delay for magnetic pickup failure”) and P.0388 (“Action for magnetic pickup failure”). Set P.0387 to “0.0” to disable this protection. If the protection is

enabled, the controller checks for the enabled measurements **while the engine is running**: if one of them is "0", it activates the anomaly AL.096 ("X096 Magnetic pickup failure"). The kind of the anomaly (warning, alarm etc.) is configurable with P.0388.

Obviously, to activate the protection, the controller must be able to detect the "engine running" condition by a different source (generator frequency, CAN bus, D+ voltage, oil pressure etc.). Using both MPU and W allows to protect each other: if one of them is missing, the controller can still measure the speed (and detecting the engine running condition) from the other, and thus can activate the protection.

5.9.4 Acquiring the speed from an ECU via CAN bus

If P.0110 and P.0111 are both set to "0", if an electronic ECU is connected over the CAN0 interface (Y28) and it sends the engine speed, the controller uses this measurement.

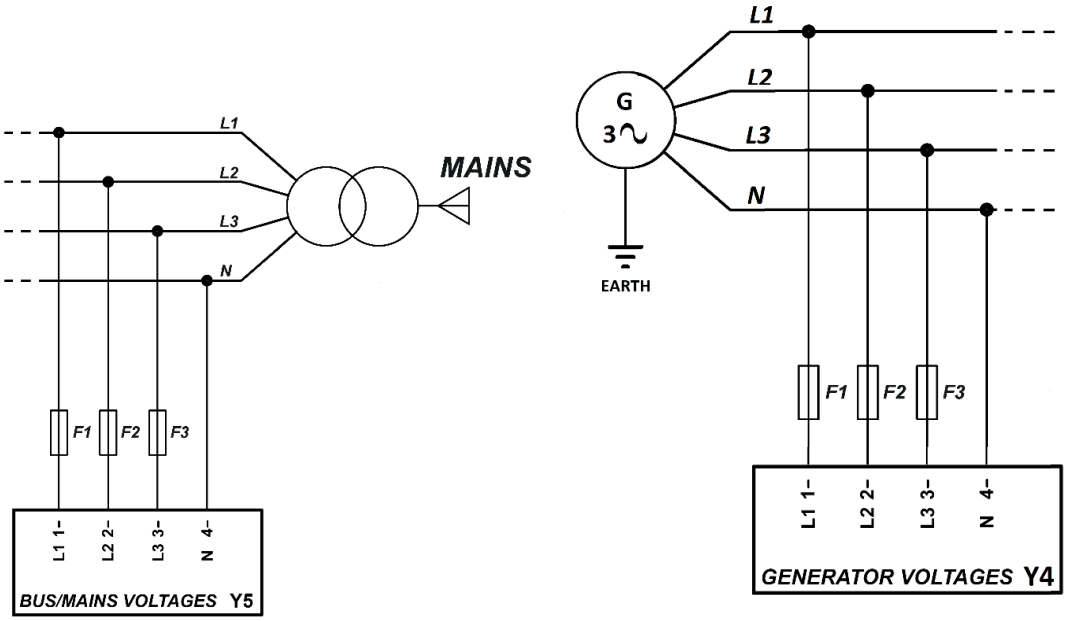
To enable the controller receiving data from an ECU over the CAN bus, you must deal with some parameters (at least P.0700 and F.0700, which tells the controller which kind of ECU is connected to the CAN bus). In any case, the speed measurement is quite standard on J1939 ECU's, thus probably you'll get the right measure simply selecting any ECU).

5.9.5 Calculating the speed from the generator frequency

If none of the previous systems is available, the controller can still calculate the engine speed from the frequency of the generator. The speed and the frequency, in fact, are related by a fixed ratio, depending only by the number of poles of the alternator. Thus, once you properly P.0150 ("Number of poles of the generator"), the controller automatically calculates the engine speed from the generator frequency.

INFORMATION: P.0150 indicates the number of poles per phase; the standard value "4" indicates two couple of two poles per phase.

5.10 Y4 - Y5 – Generator & Mains/Bus AC voltage measure input



The connector Y4 allows connecting the generator AC voltages to the controller.

The connector Y5 allows connecting the public mains AC voltages (typical for single-genset applications) or the parallel bars AC voltages (bus, typical for multiple-genset applications) to the controller. Anyway, it is possible to use parameter P.0126 (“Usage of mains/bus bars sensor”) to tell the controller what has been connected to Y5:

0. Bus bars.
1. Mains.
3. Loads.
4. None.

Different wirings are allowed, selectable by P.0101 for Y4 (“Generator AC wiring”) and by P.0119 for Y5 (“Mains/busbars AC wiring”):

- Single phase, two wires (1P2W).
  - Connect phase L1 (or R) to terminal 1.
  - Connect neutral (N) to terminal 4 **and** 2 *.
- Two phases, three wires (2P3W).
  - Connect phase L1 (or R) to terminal 1.
  - Connect phase L2 (or S) to terminal 2.
  - Connect neutral (N) to terminal 4.
- Three phases, four wires (3P4W).
  - Connect phase L1 (or R) to terminal 1.
  - Connect phase L2 (or S) to terminal 2.
  - Connect phase L3 (or T) to terminal 3.
  - Connect neutral (N) to terminal 4.
- Three phases, three wires (3P3W).
  - Connect phase L1 (or R) to terminal 1.
  - Connect phase L2 (or S) to terminal 2.
  - Connect phase L3 (or T) to terminal 3.

INFORMATION: * The controller measures the frequency over terminals 1 and 2: that's why, in single phase connection, you must wire the neutral on terminal 2 too.

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

WARNING! For CAT.III applications, the maximum allowed phase-to-neutral voltage is 398 Vac, while the phase-to-phase voltage is 690 Vac. The maximum voltage related to the protection earth is 600 Vac.

WARNING! For CAT.IV applications, the maximum allowed phase-to-neutral voltage is 300 Vac, while the phase-to-phase voltage is 520 Vac. The maximum voltage related to the protection earth is 300 Vac.

If working voltages are greater than these values, step-down voltage transformers (VTs) must be used to respect the specified limits. The rated voltages on the primary and secondary side of the VTs are configurable with parameters:

- P.0103 and P.0104 for Y4 (generator).
- P.0117 and P.0118 for Y5 (mains/bus).

It is suggested to use VTs having a rated voltage of 400 Vac on the secondary side (this solution preserves the controller accuracy). In alternative, it is possible to use VTs with 100 Vac rated voltage on the secondary side. For operating at 100 Vac, it is necessary to configure parameter:

- P.0151 ("Input type for generator voltages") for Y4.
- P.0152 ("Input type for mains/bus voltages") for Y5.

The controller will adapt the internal gain to optimize the voltage measurement on the nominal value set in parameters P.0151 / P.0152.

It is also possible to use the Aron insertion of the VTs, which uses only two transformers, instead of three (see paragraph 5.10.1).

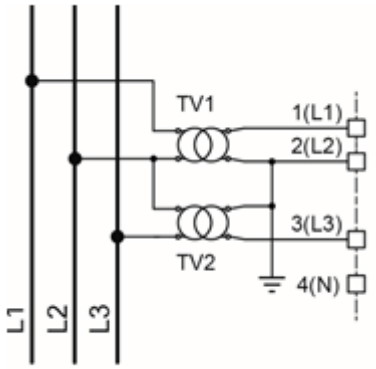
WARNING! Do not connect 400 Vac (secondary side of VTs or directly the mains/bus/generator voltages) when the device is configured to read at 100 Vac (parameter P.0151 / P.0152 set to 1). The device could be damaged.

WARNING! Apart from the previous safety notes, the measuring circuit works correctly with maximum 1000 Vac (HV) or 1000 Vac (LV) between each terminal and GND (Y1). 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 GND. The insulating VTs can be 400/400, 100/100 or 400/100.

5.10.1 Aron insertion of voltage transformers

This wiring mode is available independently for genset voltages (Y4) and for mains/bus voltages (Y5). It allows to manage a 3P3W wiring (three phases, three wires) using only two voltage transformers (instead of three). This wiring mode is available both at 400 Vac (HV) and at 100 Vac (LV), see previous chapters.

The wiring diagram is:



Set P.0101 (for Y4) or P.0119 (for Y5) to “4-Three-phase without neutral” when using this feature.

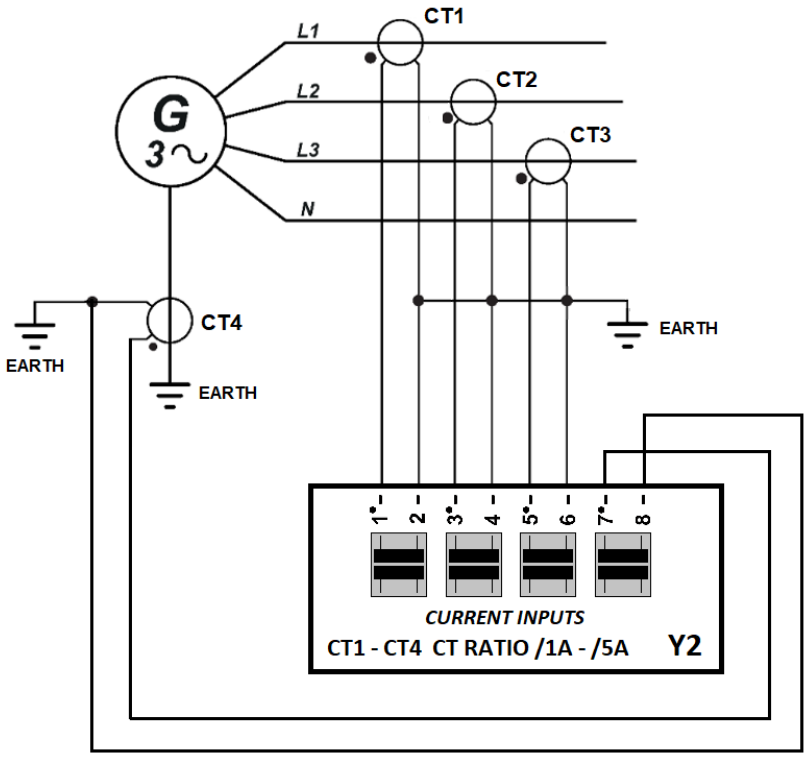
5.10.2 Available measurements

Measurement	1P2W	2P3W	3P4W	3P3W
Frequency	X	X	X	X
N-GND	X	X	X	
L1-N	X	X	X	
L2-N		X	X	
L3-N			X	
L1-L2		X	X	X
L2-L3			X	X
L3-L1			X	X
Phases’ sequence		X	X	X
Sequence components (0/+/-, module & angle)			X	

GC800 HMI shows all the previous measurements.

5.11 Y2 – Y3 Currents measurement inputs.

5.11.1 Y2 - Currents measurement inputs 1-3



WARNING! You **must** connect external currents transformers (CTs) to these terminals. Do not directly connect generator conductors to Y2. The controller uses additional internal CTs for measuring currents.

The rated current on secondary side of the external CTs must be 5 Aac or 1 Aac: internally, the controller guarantees the same measurement precision with both types of external transformers. Each current measurement requires a power of about 0.5 VA: however, 5 VA CTs are suggested to compensate the losses along the connection cables. The three external CTs must be identical to each other.

The maximum current measurable directly from the controller is 6 Aac. Over this threshold, the measuring circuit saturates. The controller can measure (with progressively decreasing precision) up to 15 Aac though, e.g., to measure over currents or short circuit currents on the plant, using an algorithm of compensation of saturation of the circuits.

The really used terminals of this connector depends on the selected generator voltage wirings (P.0101):

- Single phase, two wires (1P2W).
  - Y2-1: the hot pole of the CT connected on phase L1.
  - Y2-2: the cold pole of the CT connected on phase L1.
- Two phases, three wires (2P3W).
  - Y2-1: the hot pole of the CT connected on phase L1.
  - Y2-2: the cold pole of the CT connected on phase L1.
  - Y2-3: the hot pole of the CT connected on phase L2.
  - Y2-4: the cold pole of the CT connected on phase L2.
- Three phases (3P3W, 3P4W).
  - Y2-1: the hot pole of the CT connected on phase L1.
  - Y2-2: the cold pole of the CT connected on phase L1.

- Y2-3: the hot pole of the CT connected on phase L2.
- Y2-4: the cold pole of the CT connected on phase L2.
- Y2-5: the hot pole of the CT connected on phase L3.
- Y2-6: the cold pole of the CT connected on phase L3.

Parameters P.0107 and P.0139 allows to configure the rated current respectively on the primary/secondary side of the CTs. For example, if you use 50/5 CTs, set P.0107=50 and P.0139=5.

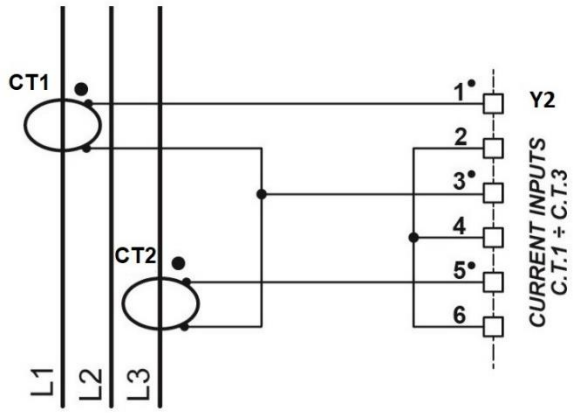
Normally, the external CTs must be located on the generator lines. Only for simple AMF ("Auto Mains Failure") single-genset applications, however, it is possible to locate the external CTs on the loads' lines: in this way the controller can calculate the power absorbed by the loads from the mains when the generator is stopped. Parameter P.0124 ("C.T. connection") allows specifying the CTs location:

0. On the generator.
1. On the loads.

5.11.1.1 Aron insertion of current transformer

This wiring mode is available for generator currents independently from the voltage wirings. It allows to manage three phases wiring using only two current transformers (instead of three).

The wiring diagram is:



5.11.2 Y2 - Currents measurement input 4

The device allows to acquire a fourth current measurement, usable e.g. for a "neutral current protection". By default, the fourth measure is not used.

WARNING! You **must** connect an external current transformer (CT) to Y2-7 and Y2-8 terminals. Do not directly connect generator/mains/bus conductors to Y2. The controller uses an additional internal CT for measuring the current.

The rated current on secondary side of the external CT must be 5 Aac or 1 Aac: internally, the controller guarantees the same measurement precision with both types of external transformers. The current measurement requires a power of about 0.5 VA: however, a 5 VA CT is suggested to compensate the losses along the connection cables.

The maximum current measurable directly from the controller is 6 Aac. Over this threshold, the measuring circuit saturates. The controller can measure (with progressively decreasing precision) up to 15 Aac though, e.g., to measure over currents or short circuit currents on the plant, using an algorithm of compensation of saturation of the circuits.

Wiring instruction:

- Y2-7: the hot pole of the CT.
- Y2-8: the cold pole of the CT.

Parameters P.0108 and P.0135 allows to configure the rated current respectively on the primary/secondary side of the CT. For example, if you use 50/5 CTs, set P.0108=50 and P.0135=5.

Parameter P.0130 (“Connection for the fourth current”) allows specifying the CT location (and to enable the measurement):

0. On the generator
1. On the loads.
2. On the mains.
3. On the busbars.
4. Not used.

When the measurement is enabled, the following parameters allow to set a protection (AL.045) on it:

- P.1260: allow to select the curve for the protection.
  - 0: immediate
  - 1: immediate (voltage-restrained)
  - 2: extremely inverse.
  - 3: extremely inverse (voltage-restrained)

  The “voltage-restrained” option has effect only if the related voltage (P.0130) is available.

- P.0367: threshold (Aac).
- P.0368: delay (seconds). Set this parameter to “0” to disable the protection.
- P.1264: type (warning, alarm etc.).

It is possible to configure a digital input with function DIF.2704 - “Disable the protections on the 4th current”. If the input is active, the previous protections are disabled.

If the related voltage source (P.0130) is available, the controller also calculates the active power on the 4th current. It assumes the related voltage phase is L1, unless P.0131 specifies a different phase:

- P.0131 = 5 → phase L2 (see below).
- P.0131 = 6 → phase L3 (see below).

GC800 HMI shows this active power measurement on the proper power source display page.

Parameter P.0131, instead, allows to select what to do with the measured current:

- “1-Normal”. The acquired current has no predefined purpose. GC800 HMI shows it as “L4”.

- “2 - Neutral current”. The acquired current is considered the “neutral current” of the selected source (P.0130). GC800 HMI shows it as “LN”. If the three main CTs are located (P.0124) on the same power source of this current (P.0130), the controller calculates the differential current by making the real time sum of the 4 current waveforms: GC800 HMI shows the differential current as “LD”. The following parameters allow to set a protection (AL.100) on this differential current:
  - P.0377: threshold (Aac).
  - P.0378: delay (seconds). Set this parameter to “0” to disable the protection.

- “3/4/5 -Power measurement on the phase L1/L2/L3”. The controller manages the measurement as the current circulating on Lx phase of the selected source (P.130). GC800 HMI shows this current as “L4”. The controller calculates the active power flowing on that phase (if the related voltage measurement is available). If the wiring configured for the selected source (P.0130) is multi-phases, the controller multiplies the calculated active power by the number of phases, assuming that the loads are uniformly distributed on the phases. If not, it is possible to apply a correction factor (P.0132), which allows to increase the calculated power (if P.0132 > 1) or

to decrease it (if P.0132 < 1), to make it as close as possible to the real one. The typical usage of this feature is to calculate the power on the mains, allowing to implement “single-genset in parallel to mains applications” without other external devices, with “IMPORT/EXPORT” feature.

5.11.3 Y3 - Currents measurement from TOROID input

WARNING! You **must** connect an external toroid to Y3 terminals. Do not directly connect generator/mains/bus conductors to Y3.

The maximum current measurable directly from the device is 0.1 Aac. Over this threshold the measure circuit saturates. Use a toroid with a transformation ratio which guarantees currents lower than this threshold on the secondary side.

Wiring instruction:

- Y3-1: the hot pole of the toroid.
- Y3-2: the cold pole of the toroid.

INFORMATION! The cold pole of the Toroid (JI-2) must also be connected to the supply negative of the controller (Y1).

Parameters P.8108 and P.8135 allows to configure the rated current respectively on the primary/secondary side of the toroid. For example, if you use a toroid with a ratio 500/1, set P.8108 = 500 and P.8135 = 1.

Parameter P.8130 (“Connection for the fourth current”) allows specifying the toroid location (and to enable the measurement):

0. On the generator
1. On the loads.
2. On the mains.
3. On the busbars.
4. Not used.

When the measurement is enabled, the following parameters allow to set a protection (AL.010) on it:

- P.1265: allow to select the curve for the protection.
  - 0: immediate
  - 1: immediate (voltage-restrained)
  - 2: extremely inverse.
  - 3: extremely inverse (voltage-restrained)

  The “voltage-restrained” option has effect only if the related voltage (P.0130) is available.
- P.1266: threshold (Aac).
- P.1267: delay (seconds). Set this parameter to “0” to disable the protection.
- P.1268: type (warning, alarm etc.).

Parameter P.8131, instead, allows to select what to do with the measured current:

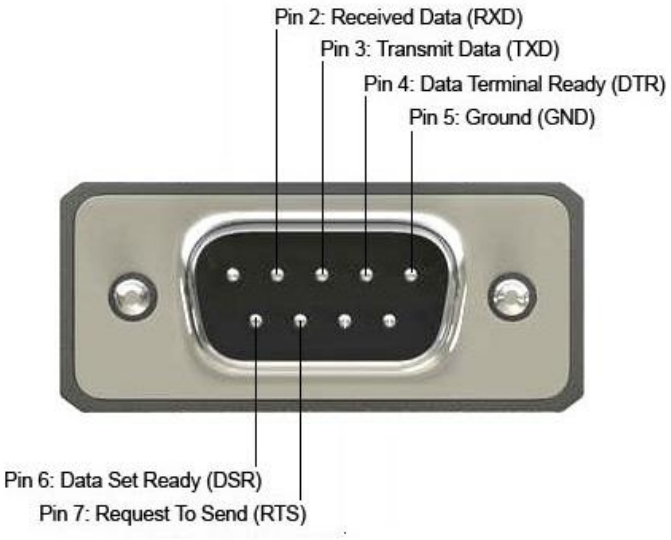
- “1-Normal”. The acquired current has no predefined purpose. GC800 HMI shows it as “LT”.
- “3-Differential current”. Valid only if P.8130 is set to “0 – On the generator”. The toroid is placed around all the genset currents, included the neutral. The measurement is already a differential current. This measurement has highest priority than the differential current calculated using the four CTs. The following parameters allow to set a protection (AL.100) on this differential current:
  - P.0377: threshold (Aac).
  - P.0378: delay (seconds). Set this parameter to “0” to disable the protection.

5.12 Communication ports

The controller is equipped with many communication ports, allowing remote monitoring and control:

- Two USB 2.0 full-speed serial ports not insulated, operating in “function mode” (Y19, Y16).
- One USB 2.0 full-speed serial ports not insulated, operating in “host mode” (Y20, pen drive).
- One RS232 serial port (not insulated) (Y17).
- One RS232 or RS485 serial port (with galvanic insulation) (Y18).
- One RS485 or RS422 serial port (not insulated) (Y21).
- One RS232 serial port (not insulated) with RJ45 connector, for “hot swap redundancy” (Y29).
- Three CAN bus ports (with galvanic insulation) for the communication with:
    - Y28: external devices like ECUs, AVRs.
    - Y27: expansion modules.
    - Y26: other Mecc Alte controllers.
- Three Ethernet ports with RJ45 (Y25, Y24, Y23).

5.12.1 Y17 - Serial port 1 RS232 (COM1)



RS232 port (not insulated) with DB9 male connector. Signals TXD, DTR and RTS are outputs for the controller. Signals RXD and DSR are inputs for the controller.

RS232 has no specific distance limitation. Instead, the RS232 standard defines a capacitance limitation of 2500 pF per transmitter. Since capacitance is accumulative with length, longer cables mean more capacitance. See paragraph 3 for the maximum cable length and other electrical characteristics. The specified 15 m (50 ft) distance limitation is from an appendix of the RS232 specification that explains “this distance is a good rule of thumb when you do not know the specification of your cable.”

INFORMATION! Shielding is critical for RS232: never use unshielded cables for anything but bench-top trial runs.

Supported protocols:

- Modbus RTU, in “slave mode” only.

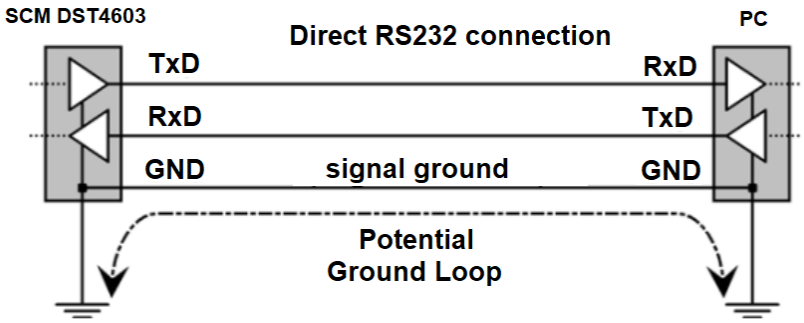
The connection can be used for:

- Firmware upgrade (RemoteWrite software): delicate operation to be performed by qualified personnel.
- Parameters setting (BoardPrg4 software).
- Monitoring (SS3 software or customer specific SCADA system).
- Connecting a REWIND device for adding GPRS capability.

Available configuration parameters:

- P.0452: Modbus address.
- P.0453: Baud rate.
- P.0454: Setting (parity, stop bits).
- P.0470: Order for Modbus registers (defines how multiple-register information is divided into the registers).

5.12.1.1 RS232 and grounding



Y17 RS232 port is not insulated. Thus, its GND pin is internally connected to the module's earth/supply negative terminal. Similarly, the RS232 ports of PCs, laptops and other peripherals that can be connected to Y17 have an internal connection from the GND pin to the power earthing. The RS232 cable interconnects the two GND pins.

Although in principle the presence of this wire should force the two common points to be at the same voltage, the resistance and the inductance of the wire prevent it from acting as an ideal short circuit. RS232 requires this common ground connection to work properly.

Note that this would not be a problem with a computer and controller sharing a common power source, but this can cause a problem if earth loop is created.

The consequence is that in the real-world voltage differences can occur between RS232 data transmitters and receivers which can compromise data transmission and result in serious hardware damages. If the potential difference begins to rise, current flows between the RS232 port reference wire (signal ground). This can cause damage to one or both devices, from RS232 port failure to, in some cases, complete failure of the PC or controller. Thus, it is critical for EIA/RS232 that one of the following two situations be true:

- Both devices must share a common ground with no ground potential difference.
- One device must isolate its RS232 port to break any path to local ground.

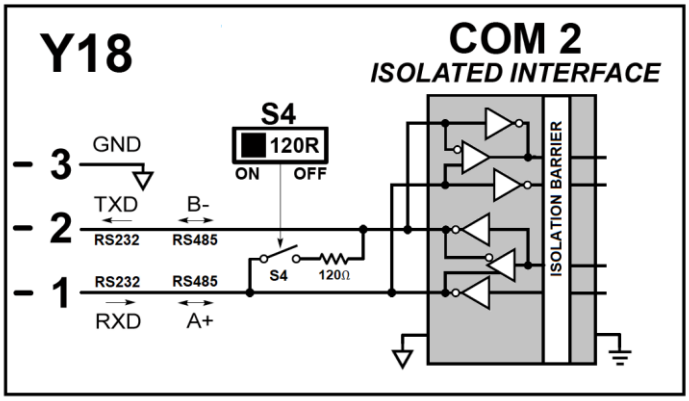
WARNING: Voltage differences between controller negative and PC negative (or earth) can cause damage to the communication ports of the PC or controller. Use serial isolators if necessary.

INFORMATION! Many PCs are not equipped with an internal RS232 serial port. Mecc Alte does not recommend the use of USB to RS232 converters if a permanent connection is required: an additional RS232 port should be added to the computer.

INFORMATION! Low-cost USB converters do not support baud rates above 19600 and are very sensitive to electrical noise.

INFORMATION! The signal ground (Y17-5) is connected directly with the negative controller power supply (Y1-1).

5.12.2 Y18 - Serial port 2 RS232/RS485 (COM2)



The device is equipped with a RS232 or RS485 serial port standard TIA/EIA, with galvanic insulation. The galvanic insulation guarantees the operation security also among distant devices and with different ground potentials. The serial port is equipped with Internal transient voltage suppressors.

The interface type is selectable via software by a controller parameter (P.0480):

- 0 – RS232.

Terminal	Signal	Signal name	Signal direction
Y18-1	RXD	Received data	In
Y18-2	TXD	Transmit data	Out
Y18-3	GND	Signal ground	

- 1 – RS485.

Terminal	Signal	Signal name	Signal direction
Y18-1	A+	Noninverting receiver input / driver output	In/out
Y18-2	B-	Inverting receiver input / driver output	In/Out
Y18-3	GND	Signal ground	

See paragraph 3 for the maximum cable length and other electrical characteristics.

Supported protocols:

- Modbus RTU, in “slave mode”.
- Modbus RTU, in “master mode”.

The connection can be used for:

- Parameters setting (BoardPrg4 software).
- Monitoring (SS3 software or customer specific SCADA system).
- Connecting a REWIND device for adding GPRS capability.
- Exchanging information with external ECUs (Modbus master).

Available configuration parameters:

- P.0480: Type of serial interface (RS232 / RS485).
- P.0471: usage of the serial port (Modbus sleave / master).
- P.0472: Modbus address.
- P.0473: Baud rate.
- P.0474: Setting (parity, stop bits).
- P.0475: Order for Modbus registers (defines how multiple-register information is divided into the registers).

To interface a CUMIINS RS485 ECU directly to this port, configure the following parameters:

- P.0480= 1-RS485
- P.0471 = 2-Master Modbus
- P.0472 = 1
- P.0473 = 9600
- P.0474 = 3-8 bit, no parity, 2 stops
- P.0475 = 0-LSWF
- P.0700:
    - 184: for CUMMINS QSX15
    - 185: for CUMMINS QSK2323/45/60/78
    - 186: for CUMMINS QST30

Use the traditional commands for the starting and stopping the engine, ant for controlling speed.

5.12.2.1 RS232 mode

To configure the serial port in RS232 mode, set parameter P.0480 to “0”. Ensure that the S4 selector is in OFF position, to remove the 120 Ohm resistor (used by RS485 only)

RS232 has no specific distance limitation. Instead, the RS232 standard defines a capacitance limitation of 2500 pF per transmitter. Since capacitance is accumulative with length, longer cables mean more capacitance. See paragraph 3 for the maximum cable length and other electrical characteristics. The specified 15 m (50 ft) distance limitation is from an appendix of the RS232 specification that explains “this distance is a good rule of thumb when you do not know the specification of your cable.”

Otherwise, using a quality low-capacitance cable with 42 pF/m (such as the Belden 1421A), you can professionally run RS232 over 55 m (180 ft). Note that the thinner the overall RS232 cable is, the higher its capacitive rating is, due to cross coupling between wires. So, expect a low-capacitance cable to appear fatter than the standard cables.

INFORMATION! Shielding is critical for RS232: never use unshielded cables for anything but bench-top trial runs.

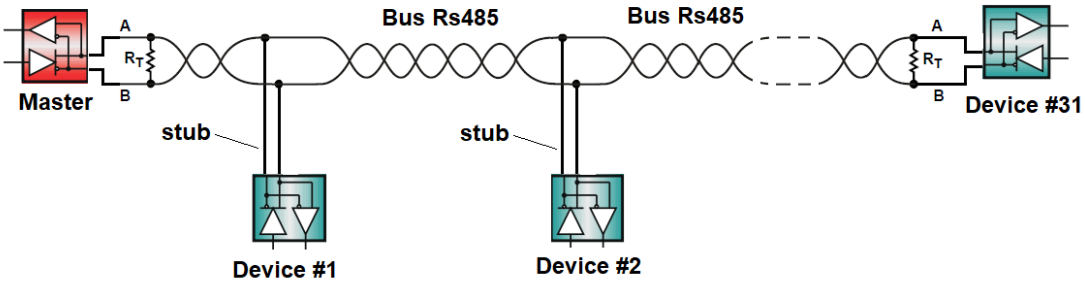
5.12.2.2 RS485 mode

To configure the serial port in RS485 mode, set parameter P.0480 to “1”.

The RS485 connection requires a 120 Ohm termination resistor on both ends of the cable. The device has integrated resistor; to insert it, it is necessary to act on selector S4.

The maximum permissible length between a RS485 driver and receiver is 4000 ft (or 1200 m). However, both cable quality and data rates impact this distance. As data rates increase, the signal is increasingly attenuated by the parasitic RC-filter created by the cable. When high data rates are used, the application is limited to a shorter cable. It is possible to use longer cables when low data rates are used. See paragraph 3 for the maximum cable length and other electrical characteristics.

RS485 applications benefit from differential signalling over twisted-pair cable because noises from external sources couple equally into both signal lines (as common-mode noises), which is rejected by the differential receiver input. Industrial RS485 cables are of the sheathed, shielded, twisted-pair type, (STP), with a characteristic impedance of 120 Ohm and 22–24 AWG (e.g., BELDEN 3105A Multi-conductor-EIA Industrial RS485PLT/CM).



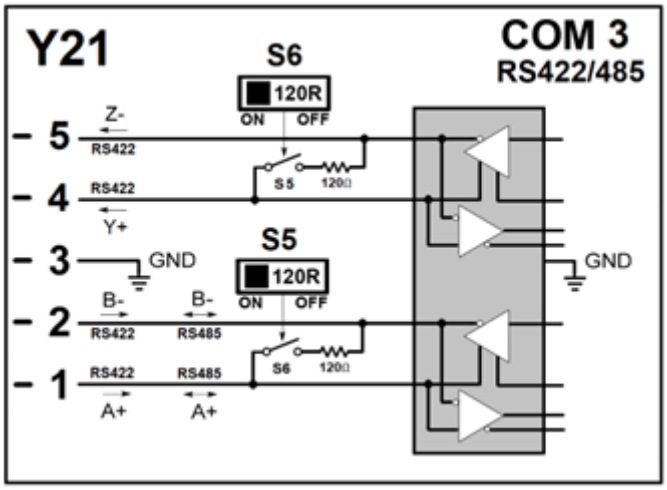
The RS485 standards suggests that its nodes be networked in a daisy-chain, also known as party line or bus topology (see image above). In this topology, the participating drivers, receivers, and transceivers connect to a main cable trunk via short network stubs. Data transmission lines should always be terminated, and stubs should be as short as possible to avoid signal reflections on the line.

Up to 32 load units can be connected on the RS485 bus: 1 master device and 31 slave devices.

INFORMATION: A shield is most effective if it's earthed at both ends, but only if it does not act as an equipotential bonding conductor between two systems, resulting in the circulation of current in the shield. In that case, connect the shielding at one end only.

INFORMATION! For more information about RS485, refer to the TIE/EIA-422-B guideline.

5.12.3 Y21 - Serial port 3 RS422/RS485 (COM3)



The device is equipped with a RS485 or RS422 serial port standard TIA/EIA, not insulated. The serial port is equipped with internal transient voltage suppressors.

The interface type is selectable via software by a controller parameter (P.0651):

- 1 – RS485.

Terminal	Signal	Signal name	Signal direction
Y21-1	A+	Noninverting receiver input / driver output	In/out
Y21-2	B-	Inverting receiver input / driver output	In/Out
Y21-3	GND	Signal ground	

- 2 – RS422.

Terminal	Signal	Signal name	Signal direction
Y21-1	A+	Noninverting receiver input	In
Y21-2	B-	Inverting receiver input	In
Y21-3	GND	Signal ground	
Y21-4	Y+	Noninverting driver output	Out
Y21-5	Z-	Inverting driver output	Out

See paragraph 3 for the maximum cable length and other electrical characteristics.

Supported protocols:

- Modbus RTU, in “slave mode”.

The connection can be used for:

- Connection to GC800 HMI. Recommended baud rate 115200, to reduce the display response time.
- Parameters setting (BoardPrg4 software).
- Monitoring (SS3 software or customer specific SCADA system).
- Connecting a REWIND device for adding GPRS capability.

Available configuration parameters:

- P.0651: Type of serial interface (RS485 / RS422).
- P.0652: Modbus address.
- P.0654: Baud rate.
- P.0654: Setting (parity, stop bits).
- P.0655: Order for Modbus registers (defines how multiple-register information is divided into the registers).

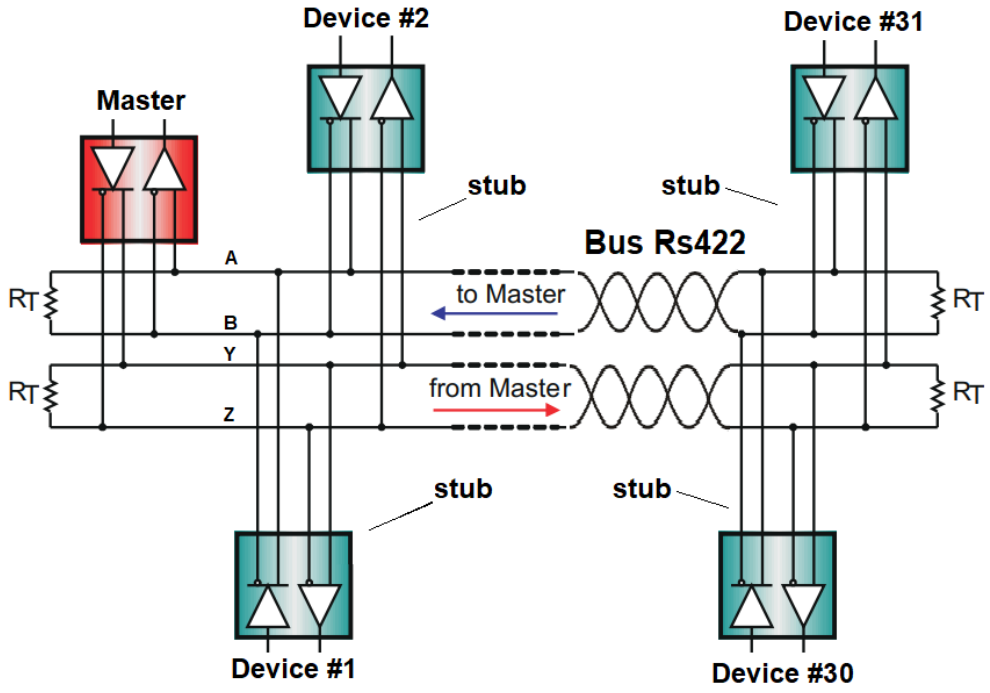
5.12.3.1 RS422 mode

To configure the serial port in RS422 mode, set parameter P.0651 to “2”.

The RS422 (full duplex) implementation requires two signal pairs (four wires), and full duplex transceivers with separate bus access lines for transmitter and receiver. Full duplex mode, if the protocol supports it, allows a node to simultaneously transmit data on one pair while receiving data on the other pair.

The RS422 connection requires 120 Ohm terminating resistors at both ends of both signal pairs. The device has two integrated resistors; to insert the resistor, the S5 and S6 switches must be used.

RS422 applications benefit from differential signalling over twisted-pairs cable because noises from external sources couple equally into both signal lines of each pair (as common-mode noises), which is rejected by the differential receiver input. Industrial RS422 cables are of the sheathed, shielded, twisted-pair type, (STP), with a characteristic impedance of 120 Ohm and 22–24 AWG (e.g., BELDEN 3105A Multi-conductor-EIA Industrial RS485PLT/CM). See paragraph 3 for the maximum cable length and other electrical characteristics.



5.12.3.2 RS485 mode

To configure the serial port in RS485 mode, set parameter P.0651 to “1”.

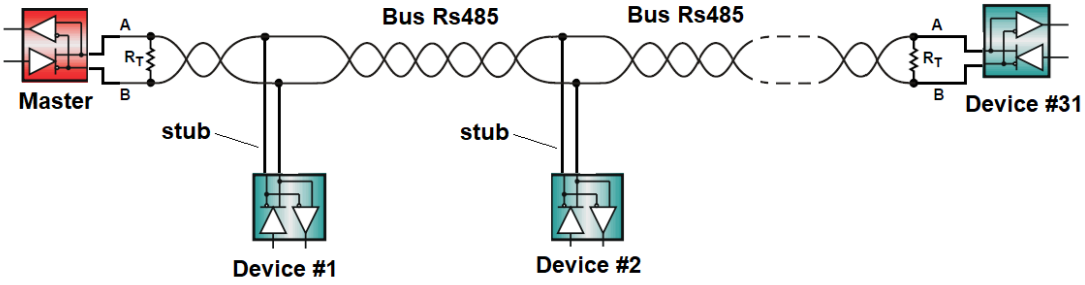
In RS485 (half duplex), only one signal pair is used. A single node cannot transmit and receive at the same time.

The RS485 connection requires a 120 Ohm termination resistor on both ends of the cable. The device has integrated resistor; to insert it, it is necessary to act on selector S5.

The maximum permissible length between a RS485 driver and receiver is 4000 ft (or 1200 m). However, both cable quality and data rates impact this distance. As data rates increase, the signal is increasingly attenuated by the parasitic RC-filter created by the cable. When high data rates are used, the application is limited to a shorter cable. It is possible to use longer cables when low data rates are used. See paragraph 3 for the maximum cable length and other electrical characteristics.

RS485 applications benefit from differential signalling over twisted-pair cable because noises from external sources couple equally into both signal lines (as common-mode noises), which is rejected by the differential receiver input.

Industrial RS485 cables are of the sheathed, shielded, twisted-pair type, (STP), with a characteristic impedance of 120 Ohm and 22–24 AWG (e.g., BELDEN 3105A Multi-conductor-EIA Industrial RS485PLT/CM).



The RS485 standards suggests that its nodes be networked in a daisy-chain, also known as party line or bus topology (see image above). In this topology, the participating drivers, receivers, and transceivers connect to a main cable trunk via short network stubs. Data transmission lines should always be terminated, and stubs should be as short as possible to avoid signal reflections on the line.

Up to 32 load units can be connected on the RS485 bus: 1 master device and 31 slave devices.

INFORMATION: A shield is most effective if it's earthed at both ends, but only if it does not act as an equipotential bonding conductor between two systems, resulting in the circulation of current in the shield. In that case, connect the shielding at one end only.

INFORMATION! For more information about RS485, refer to the TIE/EIA-422-B guideline.

5.12.4 Y29 - Serial port RS232 for "Hot swap redundancy"

RS232 port (not insulated) with RJ45 male connector.

Supported protocols: Mecc Alte proprietary.

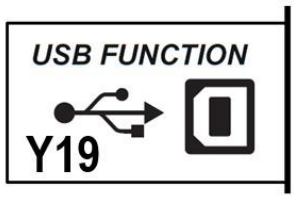
The connection can be used only for the "Hot swap redundancy" function, to allow MASTER and BACKUP controller to exchange information.

No configuration parameters are available for this port.

See paragraph 3 for cable details and other electrical characteristics.

WARNING! Even if the connector is RJ45, this is not an Ethernet interface. Do not connect it to other Ethernet interfaces.

5.12.5 Y19 - USB Function mode (Type B)



USB2.0 full-speed serial port not insulated (type-B).

Supported protocols:

- Modbus RTU, in “slave mode”.

The connection can be used for:

- Firmware upgrade (RemoteWrite software): delicate operation to be performed by qualified personnel.
- Parameters setting (BoardPrg4 software).
- Monitoring (SS3 software or customer specific SCADA system).

No configuration parameters are available for this port.

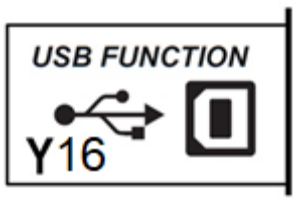
When connecting this port to a PC, it appears as an additional COM port of the PC itself. Application software can access the USB device as it would a standard COM port. Usually, Windows automatically recognize them when plugged into a USB port of the PC. If it doesn't, you will need to download and install the appropriate driver.

INFORMATION: In industrial environments, the use of the USB port for permanent connections is **strongly not recommended** because the cable length is limited, and the PC is highly sensitive to electrical noise. For this reason, the USB cable must be connected only when required, and should be removed as soon as the operation finishes.

INFORMATION: all the USB ports of the controller have an internal connection to the module’s earth/supply negative terminal. Similarly, the USB ports of PCs, laptops and other peripherals that can be connected to the controller usually have an internal connection to the power earthing. This can cause a problem when connecting two such devices, as an earth loop can be created. If a voltage difference close to 0 V is present between the ground connections of both USB ports, no current flows between the connected devices, and both can operate correctly.

WARNING! If the voltage difference grows, a current start flowing across the USB port reference wire. This can cause damages to one or both devices, from a simple USB port failure to, in some cases, complete failure of the PC or of the controller. Use a USB insulator to ensure this does not occur.

5.12.6 Y16 - USB Function mode (Type B)



USB2.0 full-speed serial port not insulated (type-B).

INFORMATION: reserved to Mecc Alte, do not use it.

5.12.7 Y20 - USB Host mode (Type A)

USB 2.0 high-speed serial port not insulated (type A), operating in Host mode. The port provides 350 mA continuous current.

The controller immediately activates the USB port at power-up. A green LED near the USB type-A connector indicates the status of the USB port:

- Green LED on: port powered.
- Green LED off: port unpowered or in protection.

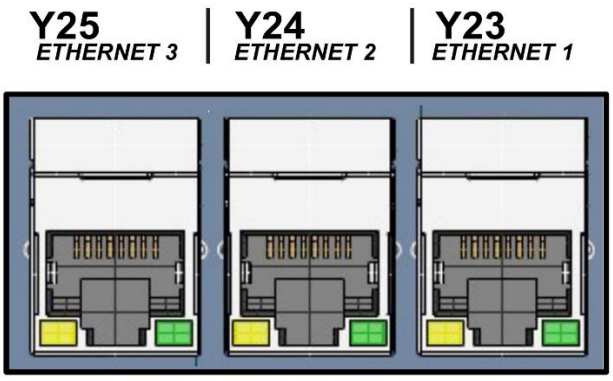
The port allows the connection of a USB pen drive with the following characteristics:

- 1 GB minimum capacity.
- USB 2.0 specification or less.
- Formatted in FAT16 or FAT32.
- A volume label must be set.
- Single partition only.

INFORMATION: due to the lack of detailed specifications and the variety of typically purchased USB pen drives, even if a particular pen drive appears to conform to these characteristics, it may still be unrecognized by the controller. Therefore, you should first test any given USB pen drive to assure that it can be recognized by the controller before investing in large quantities of that pen drives.

The pen drive can be used for upgrading the firmware of the controller. Just plug the pen drive with the desired firmware in the root directory. GC800 HMI will notify the presence of the new firmware to the operator, and the operator can manually decide when to upgrade it. The firmware will only be updated if the controller is in the OFF mode.

5.12.8 Y23-Y24-Y25 - Ethernet interface 10/100 Mbps (ETH1, ETH2, ETH2)



Device is equipped with three full-duplex Ethernet 10/100Mbps LAN interfaces compliant with IEE802.3/802.3u (Fast ethernet) and ISO802-3/IEEE802.3 (10BASE-T) standards.

The interfaces can automatically detect network speed and negotiate between 100BASE-TX and 10BASE-T, as well as full and half-duplex. It also supports HP Auto-MDIX feature, which means that automatically applies an internal cross, when needed, allowing to use both direct (EIA/TIA-568A or EIA/TIA-568B) and crossover cables.

Two integrated LEDs built-in in RJ45 connector allow to physically check the connection (as well known by the standard):

- Green led (Link/Act). It shows the physical connection status:
  - Led off: interface not connected (link is down, no activity).
  - Led on: interface connected to an external device (link is up, no activity).
  - Led blinking: interface connected to an external device with data exchange (link is up, with activity).

- Yellow led (10/100). It shows the connection speed of the interface:
  - Led off = 10 Mbps connection.
  - Led on = 100 Mbps connection.

Interfaces are independent of each other and can be configured on three separate networks with different Ip addresses and different masks. It is possible to connect the device to a hub/switch/router or directly to a PC (point to point connection).

Supported protocols:

- **IP:** we support it on IPv4 version only.
- **TCP/UDP.**
- **DHCP**: automatic IP assignment by a LAN server.
- **DNS**: allows to use “names” instead of IP addresses.
- **NTP**: Using this protocol, the controller can synchronize its own real time clock with a public server (managing both the time zine where the controller is located and the eventual “Daylight Saving Time”).
- **Modbus-TCP**: for remote monitoring/configuration.
- **SNMP**: a quite standard monitoring protocol.
- **HTTP** (Web Server).

The connection can be used for:

- Firmware upgrade (RemoteWrite software): delicate operation to be performed by qualified personnel.
- Parameters setting (BoardPrg4 software).
- Monitoring (SS3 software or customer specific SCADA system).

Available configuration parameters (dedicated to each interface):

Description	Y23	Y24	Y25	Default
IP address	P.0500	P.7500	P.7550	192.168.0.1/2/3
Subnet mask	P.0501	P.7501	P.7551	255.255.255.0
Network gateway	P.0502	P.7502	P.7552	0.0.0.0
Primary DNS server	P.0510	P.7510	P.7560	0.0.0.0
Enable DHCP protocol	P.0513	P.7513	P.7563	1 - Yes
Modbus-TCP port	P.0503	P.7503	P.7553	502
Enable SNMP protocol	P.0524	P.7524	P.7574	0 - No
SNMP manager address	P.0525	P.7525	P.7575	0.0.0.0
SNMP notification port (TRAP)	P.0526	P.7526	P.7576	162
SNMP notification events (TRAP)	P.0527	P.7527	P.7577	-

Available configuration parameters (Common):

Description	Parameter	Default
Web server port	P.0504	80
Interfaces enabled for NTP	P.0507	-
NTP server address	P.0509	
NTP server port	P.0508	123

5.12.8.1 DHCP protocol.

The three mandatory parameters required for connecting an Ethernet interface to a LAN are the "**IP address**", the "**Subnet mask**" and, optionally, the "**Network gateway**". There are two standard ways to get their value:

- Using DHCP protocol. This feature can be enabled/disabled independently (for each interface), using the "**Enable DHCP protocol**" parameters. It is enabled for all interfaces as per factory default configuration. **It requires a DHCP server in the LAN.**

  Once enabled, the controller sends proper queries on each Ethernet interface to any available DHCP server on the LAN, providing the unique MAC address of that interface.

  The MAC addresses are unique in the word, and uniquely identifies any device connected to any Ethernet (included Internet). They are assigned in factory by Mecc Alte to any Ethernet interface of each controller. You can check them on a label directly on GC800 SCM; GC800 HMI shows on a proper display page the MAC addresses of both GC800 SCM and HMI.

  If any DHCP server is available in the LAN, it answers providing at least the three mandatory parameters to be used for that interface ("**IP address**", "**Subnet mask**", "**Network gateway"**). Usually, it also provides the IP

address of the available DNS server of that LAN. The controller stores all the received data and use them. GC800 HMI shows, for each interface, the data currently in use.

- Not using DHCP protocol. If the DHCP protocol is not enabled for an interface, the customer has to proper set the "**IP address**", the "**Subnet mask**" and, optionally, the "**Network gateway**", to match the ones in use on the connected LAN (usually a network administrator can provide these information). Some notes:
    - The "**subnet mask**" must be identical for all devices connected on the LAN.
    - The "I**P address**" (and the "**Network gateway**" address too), must follow two rules:
        - The part of the IP address corresponding to a "1" in the "subnet mask" must be identical for all devices connected on the LAN.
        - The part of the IP address corresponding to a "0" in the "subnet mask" must be unique for any device connected on the LAN.

      Both the IP address and "subnet mask" are 32 bits numbers, which are really composed by a sequence of 32 0/1 digits. The check between addresses and "subnet mask" is done by bits.

  So, you must ask the network administrator for the right "**subnet mask**" (no way to autodetect it) and for an available "**IP address**" (two identical IP addresses on the same LAN are not allowed). The "**network gateway**" is required only if the controller must contact any other device outside the LAN (for example a NTP server).

5.12.8.2 DNS protocol.

Once the basic parameters are set, it's possible to use the DNS protocol. DNS is a standard protocol that allows to use "names" instead of "IP addresses" for contacting devices over Ethernet. **It requires a DNS server in the LAN**.

DNS is quite useful in combination with DHCP (where the IP address of a specific device is not fixed but can be changed dynamically over the time by the DHCP server). If we assign a "name" to a device, we can use this "name" to ask the DNS server for the current IP address of that device and use it to contact the device itself.

DNS protocol is always enabled on GC800 SCM. To work, however, it requires the IP address of the DNS server. This address is usually provided by the DHCP server: if not provided (or if the DHCP protocol is disabled for that interface), you can type it (for each interface) using the parameter "**Primary DNS server**".

Once the DNS address is available for an interface, GC800 SCM register on it the name to be used for that Ethernet interface. The "names" of the three interfaces are configurable by parameter P.0456, automatically followed by "_1" for interface Y23, "_2" for Y24 and "_3" for Y25. Note that, as per factory default, P.0456 contains the unique ID of the controller, making the "names" unique in the Ethernet.

Once the "name" for an interface is registered on a DNS server, any device on the LAN can ask the DNS server for the IP address linked to the "name" and use it for connecting to the controller. This avoid providing the "IP address" (which can change over the time) to any device requiring it.

Moreover, the controller itself can require the IP address of an external servers providing the server's "name" and use it for connecting to the server. For example, if we you need the NTP protocol, you must identify a NTP server: you can tell the controller the URL (name) of that server (easy to get information) instead of its IP address.

5.12.8.3 NTP protocol.

This protocol allows any device on a LAN to synchronize its internal real time clock with an Ethernet/Internet server.

GC800 SCM has three Ethernet interfaces, and enabling DNS on all of them may result in a multiple RTC synchronizations. You can decide on which interface (or interfaces) you want to enable NTP using parameter P.0507 ("Interfaces enabled for NTP protocol"): it is a "bit-mapped" parameter, allowing you to individually enable/disable any of the three interfaces.

Once NTP is enabled for an interface, GC800 SCM periodically sends proper queries to the NTP server: you must first tell the controller which server to contact. This configuration is available with the following parameters (common for all interfaces):

- P.0509 (“NTP server address”). You can type here the URL (“name”) of the server (DNS server must be available and configured) or its IP address.
- P.0508 (“NTP server port”): allows to specify the TCP port where the NTP server is listening for external queries. As default, any NTP server listen on port 123, and this is also the factory default for this parameter. So, you normally don’t need to deal with it.

The NTP server replies with real time clock information expressed in UTC (Universal Time Coordinates) format. The controller must translate them into local format. It must deal with two things:

- The local time zone. Depending where physically the controller is located around the word, a time offset must be applied to the UTC information to get correct localized information. GC800 SCM allows to set the proper time zone using parameter P.0410 (“Time Zone”). It’s a number expressed in quarters of hours. Its range is -47...+48, corresponding to -12…+12 hours. For example, Italy is UTC+1: set P.0410 to “4”.
- Some countries use the DST (“daylight saving time”) feature. In a specific period of the year (typically during the summer) a specific time offset (usually one hour) is added/subtracted to the local time, to have more lighting hours available over the day. GC800 SCM allows to configure the DST feature with parameters P.0409 and P.0410: the information received by the NTP server are automatically corrected using the DST configurations.

5.12.8.4 Modbus-TCP protocol.

This is a quite common monitoring protocol. It’s the Ethernet version of the Modbus-RTU protocol available on USB and serial ports. It is implemented in slave mode only. It can be used for:

- Firmware upgrade (RemoteWrite software): delicate operation to be performed by qualified personnel.
- Parameters setting (BoardPrg4 software).
- Monitoring (SS3 software or customer specific SCADA system).

GC800 SCM supports multiple simultaneous Modbus-TCP connection: it allows minimum 2 connections per interface, with a total maximum of 12 connections over all interfaces (the maximum on a single interface is 8 connections, but this limits the other interfaces to 2 connections).

The standard listening port for Modbus-TCP protocol is “502”, and this is also the factory default for the three parameters “Modbus/TCP Port”. So, you normally don’t need to deal with it. If required, you can change it for each single port: set it to “0” if you want to disable the Modbus-TCP protocol for that interface.

5.12.8.5 SNMP protocol.

The SNMP protocol (Simple Network Management Protocol) is an international standard protocol for managing devices on IP networks. It uses the UDP protocol on ports 161 and 162; it allows to simplify the configuration, management, and monitoring of devices connected in a network.

The SNMP protocol has three fundamental components:

- **Manager**: is the management system (e.g. SCADA system).
- **Agent**: is the device that responds to SNMP queries (e.g., Mecc Alte controller).
- **MIB** (Management Information Base): is a fixed file used to provide the manager with instructions on how to collect information from the agent. The MIB file is available on Mecc Alte Web site.

It is a request-response protocol. The manager queries the agent by sending requests and the agent will reply. Furthermore, when an "event" occurs, the agent sends spontaneous information (TRAPs) to a specified manager.

The protocol provides the definition of the "Community String" to regulate the access to the data of the agent in reading and writing. Those currently used in the controller are:

- Read Community String: "public"
- Write Community String: "private".

Currently the controller supports the versions v1 and V2c of the SNMP protocol.

As per factory default, the SNMP protocol is disabled on all Ethernet interfaces. To enable it, set the parameters “Enable SNMP protocol” to “1 – Yes”. That’s enough to operate as slave (answering the queries coming from any external manager). GC800 SCM supports maximum two simultaneous SNMP connections per interface.

If you also want the controller to send TRAP in case of events, please configure the following parameters (for the desired interfaces):

- “SNMP manager address”. The controller will send the TRAPs to that IP address (at the moment DNS is not supported here).
- “SNMP notification port”. It’s the port where the manager is listening for TRAPS. The standard listening port for SNMP managers is “162”, and this is also the factory default for these parameters. So, you normally don’t need to deal with it.
- “SNMP Notification events”. It’s a bit-mapped parameters, allowing you to choose which event should send a TRAP.

5.12.8.6 HTTP protocol (web server)

The controller implements a simplified internal web server, allowing monitoring and some basic command. The web server operates through HTTP standard protocol: it is intended for use in private networks. It is not recommended to expose the web interface to the public Internet.

The controller listens for HTTP requests on the standard TCP port 80 (on all Ethernet interfaces): parameter P.0504 (“Web server Port”) allows you to change the listening port. Set P.0504 to “0” to disable the Web server on all ethernet interfaces.

The Web Server is designed to monitor the main measures, the states, and the alarms of the controller through a Web browser. It is enough to set the IP address of the controller in the address bar of the browser (ex: http://192.168.1.220) to view the main web page of the controller. You will be asked for eventual required passwords.

GC800 SCM supports multiple simultaneous HTTP connection: it allows minimum 2 connections per interface, with a total maximum of 10 connections over all interfaces (the maximum on a single interface is 6 connections, but this limits the other interfaces to 2 connections).

5.12.9 Y28 – Y27 – Y26 - CAN bus interfaces.

The controller provides three independent galvanically insulated CAN bus interfaces.

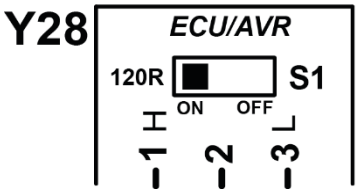
The CAN bus connection requires a 120 Ohm termination resistor on both ends of the cable. The terminal resistors are integrated in the controller; to insert them, operate on selectors S1 (for Y28), S2 (for Y27) and S3 (for Y26).

INFORMATION: the termination resistor must always be inserted unless the connection carries on towards other devices and the controller is not one of the two extremes.

The specific use of the shielded cable is required (e.g., HELUKABEL 800571). See paragraph 3 for wiring and electrical notes.

INFORMATION: A shield is most effective if it's earthed at both ends, but only if it does not act as an equipotential bonding conductor between two systems, resulting in the circulation of current in the shield. In that case, connect the shielding at one end only.

5.12.9.1 Y28 CAN0 interface



The controller uses this interface to exchange information with external devices like:

- ECUs: electronic engine control units.
- AVRs: automatic voltage regulators.
- …

The standard protocol used by this CAN interface is the standard J1939. Specific protocols (like MTU MDEC proprietary protocol) are also supported.

When possible, the use of this interface allows simplifying the wiring from the controller to the engine/alternator. With a unique connection, the controller can read a lot of data (diagnostic trouble codes, temperatures, pressures, speed, voltages, currents etc) avoiding the installation of additional senders. It may also control the start/stop of the engine and its speed; finally, it may control the voltage of the generator.

The real capability of the controller depends on the connected ECU/AVR (depends on what they allow us to do).

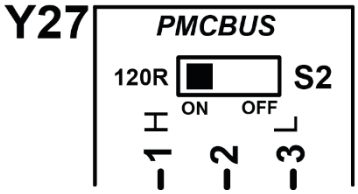
The configuration menu 7 allows to select the connected device:

- Menu 7.1 for the ECU. The most relevant parameters are:
    - P.0700: allows to select the ECU model among the ones directly embedded in the firmware. If your ECU model is not in the list, select the option "300 – File".
    - F.0700: when P.0700 is set to "300", this parameter (available only through BoardPrg4) allows to select among a list of external files, which describes the available ECUs. The list grows continuously, if your ECU model is still not in the list, please contact Mecc Alte.
    - P.0703: set it to "99" to enable the controller sending all available commands to the selected ECU. Different values are required only for specific ECUs.
- Menu 7.1 for the AVR. The most relevant parameters are:

- F.1700: this parameter (available only through BoardPrg4) allows to select among a list of external files, which describes the available AVRs. The list grows continuously, if your AVR model is not in the list, please contact Mecc Alte.
- P.1701: set it to “99” to enable the controller sending all available commands to the selected ECU. Different values are required only for specific ECUs.

- Menu 7.2 for external gas mixers. The most relevant parameters are:
  - P.0730: allows to select the gas mixer model among the ones directly embedded in the firmware.

5.12.9.2 Y27 CAN1 interface



Use this CAN interface to connect the controller to other Mecc Alte parallel controllers like:

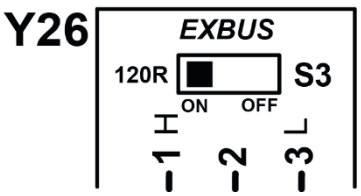
- Genset controllers (GC400, GC600, GC800, DST4602).
- Mains controller (MC200, MC400).
- Bus tie breaker controllers (BTB200).
- Renewable controllers (RN200).

The controllers use this interface to exchange the information required for complex parallel application management. Parameter P.0800 (“PMCB bus mode”) allows to disable this interface (0-Disabled) or to specify the communication speed:

- 250 kbit/s (“1”). It allows the connection of up to 32 devices; the bus length is limited to 125 m.
- 50 kbit/s (“3”). It allows the connection of up to 8 devices; the bus length is extended to 800 m.

INFORMATION: the same communication speed must be selected on all controller connected to this interface.

5.12.9.3 Y26 CAN2 interface



Use this CAN interface to connect Mecc Alte expansion modules to the controller. See paragraph 5.8.

6 Configuration

The controller manages a relevant number of parameters, which allows different type of users to configure the application based on the plant specific requirements. This chapter does not contain a list of all parameters (even if many of them are mentioned along the document). This chapter describes the general structure of the configuration and the basic knowledge required to deal with it.

WARNING: assigning an incorrect value to one or more parameters can cause malfunctions, damage to things or injury to people. The parameters must only be changed by qualified personnel. To avoid unintended modification, you can protect the configuration be passwords.

Mecc Alte identified four kinds of users:

- Mecc Alte (super-user).
- The panel builder (manufacturer).
- The installer.
- The final user.

The configuration can be completely read by each user: however, each kind of user can only modify a specific subset of the configuration, and it is possible to protect the access to that part by adding a password.

The “super-user” part of the configuration **is always password protected**. This part includes few parameters but very relevant to the application: unintended modification of the application type may result in damages (for example, changing from a “Drive” application to a “parallel” application). The “super-user” password is unique for each controller and is provided by Mecc Alte together with the controller itself. If you lose this password, you can get a copy by contacting Mecc Alte providing the ID number of the controller (reported on the back side and visible on GC800 HMI).

On demand, Mecc Alte can provide a secondary “super-user” password, only valid for 2 hours operation: you can provide this password to trusted people, allowing them to fully operate on the controller, but for limited time. To get this password, contact Mecc Alte providing both the ID number of the controller and the “internal code” (shown by GC800 HMI): this “internal code” will permanently change after two hours, making the password inefficient.

As “factory” default, there are no password for the other kind of users: thus, anyone can fully modify the configuration (except the “super-user” part). The controller provides three parameters for configuring passwords (their value “0” means no password):

- P.0001: for the manufacturer level.
- P.0002: for the installer level.
- P.0003: for the user level.

The controller provides an additional parameter (P.0000) acting as login. Once configured the password, if you want to modify the configuration, type your password in P.0000: the controller will compare it with the configured ones and will assign you a level among “super-user”, “manufacturer”, “installer”, “user” or “none”. Then, the controller grants you the access only to the relevant part of the configuration, depending on your level.

INFORMATION: the set access code remains in P.0000 memory for about 10 minutes after the last modification. After this period, it will be automatically reset, and you’ll have to set it again if need additional modifications.

Protection rules:

- A parameter associated to the “super-user” level can be modified by “super-users” only.
- A parameter associated to the “manufacturer” level can be modified by “manufacturers”, “super-users”.
- A parameter associated to the “installer” level can be modified by “installers”, “manufacturers”, “super-users”.
- A parameter associated to the “user” level can be modified by “users”, “installers”, “manufacturers”, “super-users”.

Obviously, it's not possible to read back the password (once set) of a level higher than yours.

If a configured 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): if, in effect, someone else sets P.0001 or another lower-level password (even only for distraction) without communicate it, it will be no longer 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.

INFORMATION: to modify the configuration, you can use the Mecc Alte tool (BoardPrg4), or you can operate directly on GC800 HMI (with some restriction). Both automatically disable (and shows in grey background) the part of configuration you are not allowed to modify. You will find security-related parameters in menu 1.1.

The following table describe your granted level in different password scenarios, assuming P.0000 (login) is not set:

P.0001 (manufacturer)	P.0002 (installer)	P.0003 (user)	Your level if P.0000 = "0"
0	0	0	Manufacturer
Set	0	0	Installer
X	Set	0	User
X	X	Set	None

6.1 Menu organization

Parameters are organized in a menu tree. The main menus are:

1) **SYSTEM**: it allows defining the application type, the type of engine and alternator, the electrical wirings and all the rated values. It is most important to correctly set these parameters, because quite all protection thresholds are expressed in percentages.

2) **SEQUENCE**: it allows to better define the operating sequence, by adding thresholds and delays. The "factory" default is suitable for most applications.

3) **PROTECTIONS**: it allows defining all protections in detail (threshold, delay, action). As general rule, you may disable a protection by simply setting its delay to zero, leaving the threshold unchanged (there are some exceptions). The chapter enumerating the anomalies (see 8) describes, for each protection, also how to disable it.

4) **AUXILIARY FUNCTIONS**: it contains secondary features (schedulers, history logs, controller features…).

5) **COMMUNICATION**: it allows you to deeply configure each controller's communication resource (except CAN bus).

7) **CAN bus**: it allows you to deeply configure the CAN0 (Y28) controller 's interface, used for communicating with ECUs and AVRs.

8) **PARALLEL**: it allows configuring all functions related to the parallel with the mains or with other gensets.

6.2 Type of parameters

The controller manages the following types of parameters:

- Numeric: it allows to set values (with or without decimal part) between two limits.
- Numeric with selection among a predefined list of value (e.g., the genset baud rate for the serial ports).
- Numeric with selection among a predefined list of "number-description" couples (e.g., "generator AC wiring").
- Time: it allows to select hours and minutes in the day (from 00:00 to 23:59). The controller does not allow to operate with AM/PM, always in 24 hours mode.
- String. It allows to type a description (for example the message for a user-defined alarm). Each string parameter has a predefined length (capacity).

- Bit-mapped: a single parameter including a group of Boolean options (on/off, usually sixteen options per parameter).
- Power factor: it allows to select:
  - Lagging: between 0.70 and 1.00.
  - Leading: between 0.80 and 1.00.
- IP addresses: allows to specify an IPv4 address.
- External file: it allows selecting an external file to be downloaded to the controller (for example for ECUs management). **This requires BoardPrg4.**

6.3 Set up limits.

The operator does not have to worry about verifying that the set value is acceptable for the controller since **it is not possible to set not acceptable values**. This is valid for each single parameter; it is possible, though, to set two or more parameters in contradictory or incompatible way. The operator oversees verifying that this does not happens.

6.4 Thresholds on analogue inputs

The controller provides two thresholds for each physical/virtual analogue inputs (not for shared ones, see paragraph 5.6.4). Using together the two thresholds and the "AND/OR logics", it is possible to activate a digital output related to the value of an analogue measurement, with hysteresis. Let's assume to activate a digital output if the mains frequency goes over 50.5 Hz. It is first necessary to manage a minimum hysteresis on the threshold. Otherwise, when the mains frequency is close to the threshold, the output would keep on activating and deactivating for minimum variation of the frequency itself. Let's assume to activate the output if the frequency goes over 50.5 Hz and turn off the output if the frequency is lower than 50.3 Hz. To do so, we use for example the virtual analogue input #1 which has been configured to contain the mains frequency.

Let's set the parameters as follows:

- P.4051 ("Function of the virtual analogue input 1"): AIF.4001 ("Generator frequency").
- P.4052 ("Message for the virtual analogue input 1"): "".
- P.4053 ("Threshold #1 for the virtual analogue input 1"): 50.5 Hz
- P.4054 ("Delay #1 for the virtual analogue input 1"): 0.5 sec
- P.4055 ("Configuration #1 for the virtual analogue input 1"): 0002 (bit 0 OFF, bit 1 ON)
- P.4056 ("Threshold #2 for the virtual analogue input 1"): 50.3 Hz
- P.4057 ("Delay #2 for the virtual analogue input 1"): 0.5 sec
- P.4058 ("Configuration #2 for the virtual analogue input 1"): 0001 (bit 0 ON, bit 1 OFF)

The first threshold is used to activate the "internal status" associated to the analogue input. Having a look to the configuration parameter, we can see that:

- Bit 0 OFF ("greater than").
- Bit 1 ON (sets the internal status when "out of Threshold").

The second threshold is used to deactivate the internal status associated to the analogue input. Having a look to the configuration parameter, we can see that:

- Bit 0 ON ("lower than").
- Bit 1 OFF (resets the internal status when "out of Threshold").

With the previous program, therefore, the controller will activate the "internal status" related to the analogue input when the measurement is higher than 50.5 Hz per 0,5 seconds; it will deactivate the internal status when the measurement is lower than 50.5 Hz per 0,5 seconds.

Using "AND/OR logics" (see paragraph 6.5), it is possible to "copy" the internal status on a physical output.

6.5 AND/OR logics

INFORMATION: this feature requires BoardPrg4.

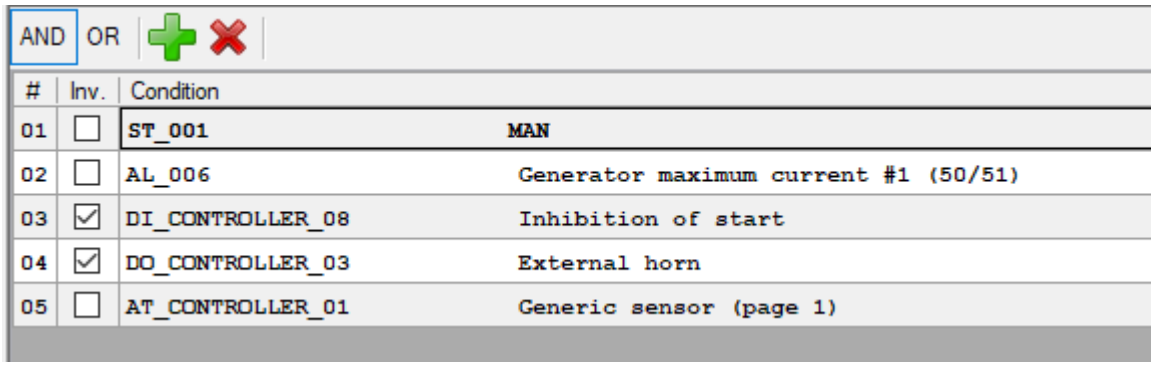
The “AND/OR logics” feature allows the operator to add combinatory logics (but also sequential ones, see below) to the controller, without having to deal with the controller’s PLC environment (which is much more powerful, but also much more complex).

An “AND/OR logic” is basically a list of digital conditions (true/false - on/off - 1/0), configurable by the operator (programming) and evaluated by the controller: the result of this logic can be assigned to a digital output or to a virtual digital input. Note that both digital outputs and virtual digital inputs are available as basic conditions for the “AND/OR logics”, allowing you to create multi-level logics.

To assign and AND/OR logic to a digital output, set its “function” parameter (P.3001 for example) to DOF.0103 (“AND/OR logic”).

“AND/OR logics” are, instead, always available for the “virtual digital inputs”: take care, however, not to set the value of a “virtual digital input” both from PLC and from an “AND/OR logic” (the controller activate the warning W900 in this case).

The following is an “AND/OR logic” example (BoardPrg4 screenshot).



First, the operator must decide whether the conditions list must be evaluated as AND (they must be all checked) or as OR (at least one condition checked). It is not possible to have mixed AND/OR logics (it is possible using nested logics, see below). The operator can add up to 30 conditions and can reverse each of them: in the previous picture, for example, the controller will verify that both digital input 8 and digital output 3 are not active.

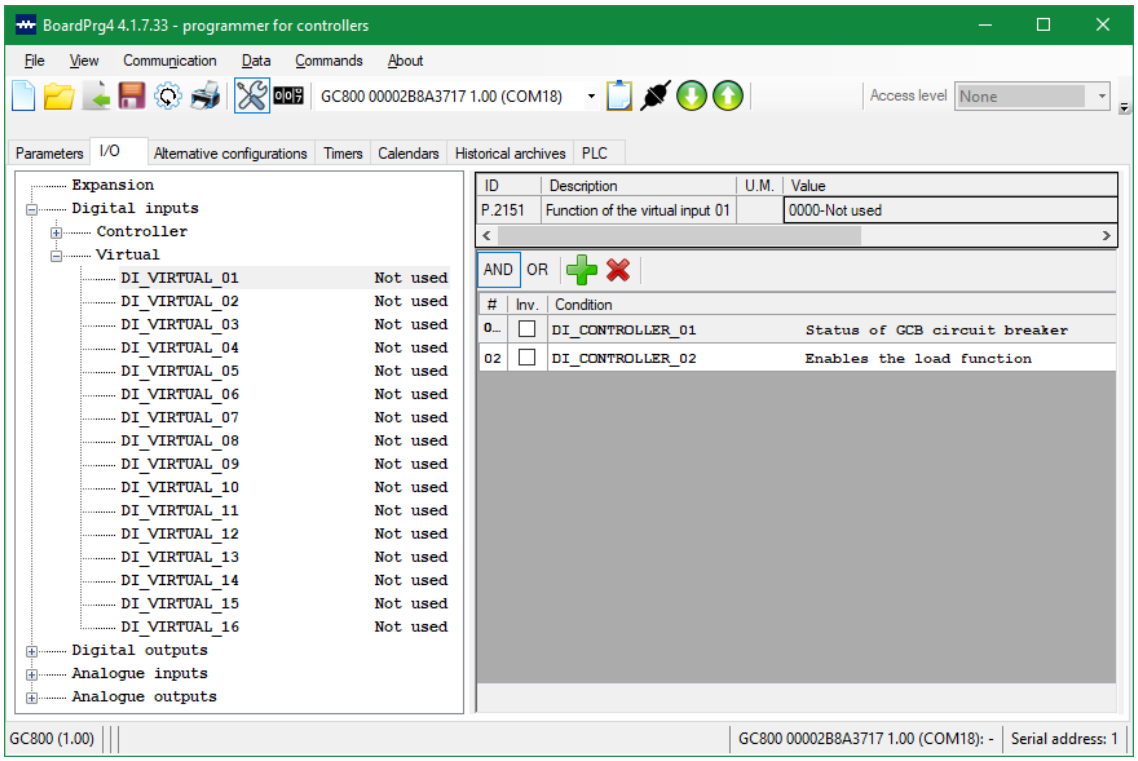
The operator can add the following conditions to the list:

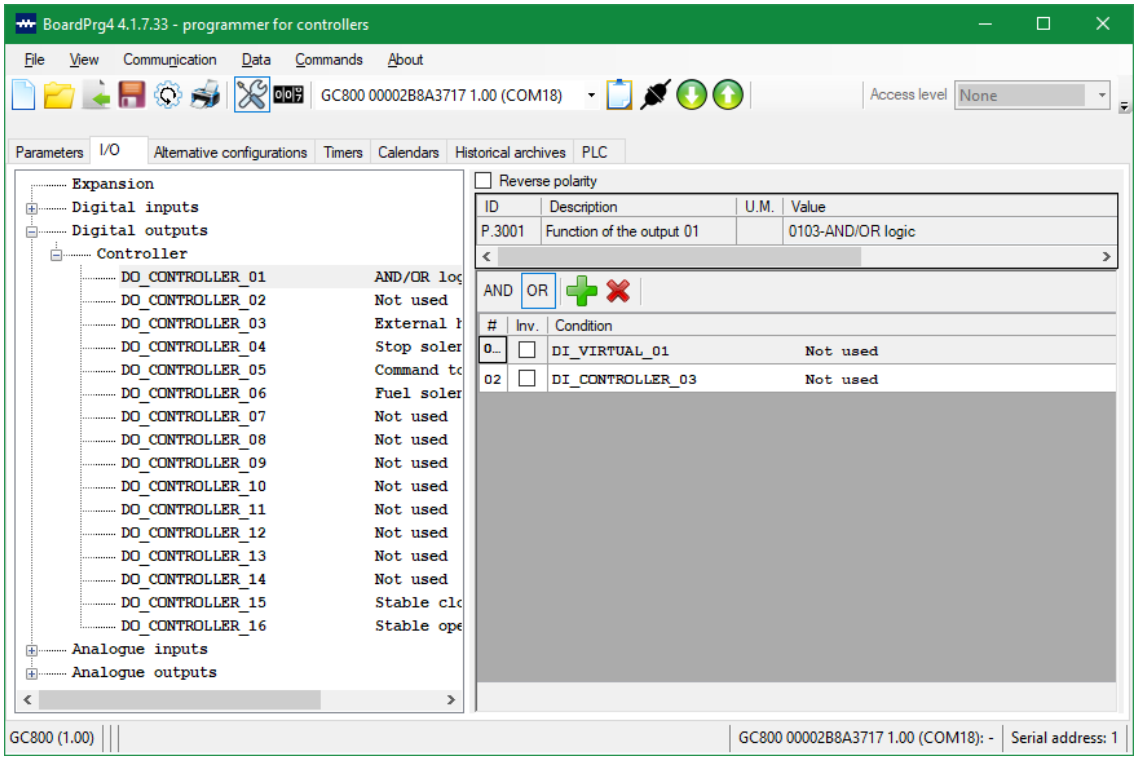
- DI_XXX: logic statuses of all digital inputs (physical, virtual, shared).
- DO_XXX: logic statuses of all digital outputs.
- AL_XXX: presence of an anomaly.
- ST_XXX: internal statuses of the controller.
- AT_XXX: internal status associated with thresholds on analogue inputs (see paragraph 6.4).

INFORMATION: the logical state of a digital input/output differs from the physical one when “reverse polarity” is selected for that input/output.

Using internal statuses (ST_XXX), the operator can access a wide set of the internal digital conditions of the controllers. For example, available conditions are the operating modes (OFF, MAN, AUTO), the engine running state, the “generator voltage in threshold” and so on. Among the available conditions, the operator can find the “active status” of the controller’s general purpose “calendars” and “timers”. The general-purpose timers are particularly significant in this context: using them in an “AND/OR logic”, the operator can create sequential logics (time dependant) instead of simply combinatory ones.

Using the virtual digital inputs, it is possible to create nested logics: nested logics allows creating logics with both AND conditions and OR conditions. Let's suppose we want to activate the digital output #1 when the digital inputs #1 and #2 are active, or if the digital input #3 is active:





The first picture describes an "AND" logic among the first two digital inputs and stores the result into "virtual digital input 1". The second picture describes an "OR" logic among "virtual digital input 1" and the third input and stores the result into the digital output 1. Note that the function of "virtual digital input 1" (P.2151) is left "not used": in fact, it has no real purpose itself, it is just a temporary storing to allow nested "AND/OR logic".

The following internal generic statuses are available for AND/OR logics and PLC (all the others are described along the manual):

- ST.112 - “Sync per second”.
- ST.113 - “Sync per minute”
- ST.114 - “Sync per hour”.

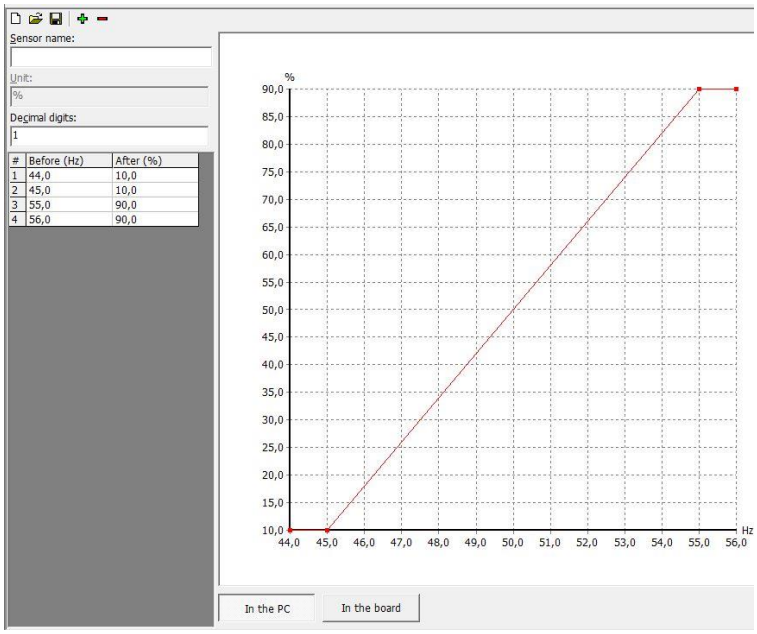
6.6 Conversion curves

INFORMATION: this feature requires BoardPrg4.

A “conversion curve” allows to convert a numeric value into another numeric value. They can be associated to for analogue inputs and outputs, for two main purposes:

- To convert the value acquired by an analogue input (physical) from the electric value to the real unit of measurement of the sensor.
- To convert an internal measurement of the controller to a percentage value before writing it on an analogue output.

The curves, once created, can be saved on a file to use them later, even on different controllers.



The figure above shows a conversion curve associated to an analogue output. The analogue output has been configured with the function AOF.3101 (“Frequency of the generator”). With this configuration, the controller sets the output:

- At 10% for a generator frequency lower than or equal to 45 Hz.
- At 90% for a frequency higher than or equal to 55 Hz.
- For frequency values included between 45 Hz and 55 Hz, the output will take a value between 10% and 90%.

You can add up to 32 points in the graph, thus creating also non-linear curves.

In the example, the configured curve has two horizontal segments at the beginning and at the end, obtained inserting two equal values in column “after”, corresponding to two different values in column “before”. This is not mandatory but allows you to set a saturation limit on one or both ends of the curve. In fact, the controller extends to infinity the first and the last segments of the curve. Being horizontal, whatever value the measure “to convert” assumes, you will obtain the same value of the “converted” measure. In the previous example, for any frequency lower than 45 Hz, the analogue output will be set at 10%. If from the example above you removed the first point (44 Hz 10%), the horizontal

segment would not be at the beginning of the curve: in this case, if the frequency should drop below 45 Hz, the analogue output would drop below the 10%.

BoardPrg4 allows you to save the curve on file, to use it again in other applications. Thus, you can create your own archive for your commonly used senders.

Note that, using conversion curves, you can also select the number of decimal digits of the result and its unit of measurements. GC800 HMI uses this information to show the converted value on display pages.

6.7 Alternative configurations for parameters.

The controller allows configuring up to four 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”.

Alternative configurations can be configured only using the BoardPrg4.

You can customize the following parameters:

- P.0105 (“Nominal frequency”).
- P.0125 (“Nominal power of the engine”).
- P.0106 (“Nominal power of the generator”).
- P.0101 (“Generator AC wiring”).
- P.0102 (“Nominal voltage of the generator”).
- P.0103 (“Voltage transformers for the generator (primary side)”).
- P.0104 (“Voltage transformers for the generator (secondary side)”).
- P.0151 (“Input type for generator voltages”).
- P.0119 (“Mains/busbars AC wiring”).
- P.0116 (“Nominal voltage of the mains/bus”).
- P.0117 (“Voltage transformers for the mains/bus (primary side)”).
- P.0118 (“Voltage transformers for the mains/bus (secondary side)”).
- P.0152 (“Input type for mains/bus voltages”).
- P.1604 (“Setpoint for the frequency”).
- P.0713 (“Speed at 0% command”).
- P.0714 (“Speed at 100% command”).
- P.1708 (“Rated voltage for AVR”).
- P.1654 (“Setpoint for the voltage”).
- P.1703 (“Voltage corresponding to 0%”).
- P.1704 (“Voltage corresponding to 100%”).

To select a “configuration, use a digital input configured as DIF.2151, DIF.2152, DIF.2153, DIF.2154.

INFORMATION! the controller accepts the input command only with the engine stopped and in OFF mode.

7 Operating sequence.

7.1 Operator's commands.

The operator can interact with the GC800 SCM in many ways, sending commands for starting/stopping the engine, for opening/closing the circuit breakers, for silencing the horn, for resetting the alarms and so on.

Typically, the operator interacts with the touch screen of GC800 HMI (the most common commands are available in all display pages). GC800 HMI uses a communication port to connect with GC800 SCM: thus, any operator command on the touch screen is translated into a Modbus command, sent over the communication port. Any external monitoring system can operate in the same way, sending commands to GC800 SCM over a communication port.

Each command has a specific numeric code: to execute a command, GC800 HMI (or any external monitoring system) 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 (menu 1.1.2), the value "0" (factory default) means "no password". 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 write-only too.

You can also hardware-protect the controller from receiving commands over the communication ports, by using a digital input configured with the function DIF.2706 ("Enables the commands by the communication ports"). If configured, GC800 SCM accepts commands written into HOLDING REGISTER 102 only when this input is active.

Other two protocols can be used for sending commands over the Ethernet interfaces: SNMP and HTTP (WEB server). Both protect their command by function DIF.2706 and by P.0004.

7.2 Operating mode

The controller can operate in three main modes:

- **OFF**: the controller stops the engine, opens the GCB circuit breaker (to insulate the genset from the loads), and closes the MCB circuit breaker (if included, to connect the loads to the mains). The operator cannot influence this behaviour.
- **MAN**: the operator can manually start/stop the engine and open/close the available circuit breakers: since the protections are activated, the controller can automatically open the circuit breakers and stop the engine, if required.
- **AUTO**: the controller can automatically start/stop the engine and operate on the available circuit breakers, as required by the application logic (opening and closing them in any sequence, with or without synchronization). The operator cannot interact with the controller's logic.

INFORMATION: the relevant protections are enabled in all operating modes.

GC800 HMI shows the currently selected operating mode in the bottom bar, present on all pages.

At power on, the controller forces the operating mode configured in parameter P.0490 (men 4.7.2, factory default "OFF").

The operator can change the operation mode in different ways:

- By using one or more digital inputs configured with the following functions:
  - DIF.2271 "Remote OFF".
  - DIF.2272 "Remote MAN".
  - DIF.2273 "Remote AUTO".

When one of these inputs is active, the controller forces the operating mode and the operator cannot modify it (GC800 HMI notify this situation by showing a padlock next to the operating mode, and by disabling the selection command).

INFORMATION: you can configure virtual inputs with the previous function codes. This means that you can change the operating mode of the controller by the PLC.

If there are more than one inputs active at the same time, the priority is given to “OFF”, followed by “MAN”, and then “AUTO”.

It is not mandatory to use all three inputs. For example, you can use only one input to force the AUTO mode; while the input is active, the controller forces the AUTO mode; when the input becomes not active, the controller remains in AUTO, but the operator can change to OFF or MAN.

If you configure just the “Remote OFF” input, the controller acts differently:

- When the input becomes active, the controller “saves” the currently selected mode, then forces OFF mode.
- When the input becomes not active, the controller switches back to the previously “saved” operating mode.

- By using GC800 HMI.
  The operator can click on the touch screen of GC800 HMI, over the label showing the currently selected operating mode: GC800 HMI will open a popup allowing the operator to select a different mode.
  INFORMATION: GC800 HMI is connected to GC800 SCM through a communication port. Thus, the previous operation will result in sending a proper Modbus command over the communication port (see next point).

- By sending proper Modbus commands over the communication ports (see paragraph 7.1):
  - “1” to require the OFF mode.
  - “2” to require the MAN mode.
  - “3” to require the AUTO mode.

- By sending proper SNMP commands over the Ethernet (see paragraph 7.1)

- By sending proper HTTP commands over the Ethernet (see paragraph 7.1)

7.2.1 Secondary AUTO operating modes

When the controller is in AUTO mode, it starts the engine only when the application’s logic requires it (for example, in case of mains failure for AMF applications). The operator may require starting the engine even if the application logic doesn’t (for example, to periodically check for the efficiency of the engine and/or the alternator). The controller provides two sub-operating modes of the AUTO (remember however that the main mode is still AUTO, and thus the operator cannot interact with the automatic logics of the controller).

INFORMATION: the following sub-modes override any active “start inhibition” request.

INFORMATION: the following sub-modes cannot be activated if unloads, deactivations or alarms are present.

7.2.1.1 TEST

its purpose is to test the efficiency of the genset, assuring it will be fully operative when required by the application’s logic. If, during the TEST, the application logic will require the genset (for example, in case of mains failure for AMF applications), the controller immediately ends the TEST forcing the AUTO mode: any pending TEST requests are ignored.

In TEST mode, the controller always starts the engine (overriding any “start inhibition” request). Once running, it operates on the circuit breakers depending on the active TEST request and on its configuration. The TEST may be:

- Without loading the genset (GCB circuit breaker open).
- Loading the genset in island mode (MCB circuit breaker open). In this case, if parallel operations are enabled, the controller first closes GCB with synchronization, and then opens the MCB.
- Loading the genset in parallel to another source.

When no more TEST requests are active, the controller switches back from TEST to AUTO mode (operating on the engine and on the circuit-breakers as required by the application’s logic).

The operator can require the TEST in different ways:

- Using a digital input configured with function DIF.2029 (“TEST without load (pulse)”). The TEST starts when the input becomes active; it ends after P.0420 (“Test duration”) minutes. If P.0420 is set to “0”, the TEST never starts. The operator can terminate the TEST before P.0420 minutes with a second activation of the input.

- Using a digital input configured with function DIF.2030 (“TEST with load (pulse)”). The TEST starts when the input becomes active; it ends after P.0420 (“Test duration”) minutes. If P.0420 is set to “0”, the TEST never starts. The operator can terminate the TEST before P.0420 minutes with a second activation of the input.

- Using a digital input configured with function DIF.2031 (“Request for TEST mode”). The controller forces the TEST mode while the input is active. Parameter P.0222 (“Enable generator supply on TEST?”) selects whether to load the genset or not.

- Using the provided weekly scheduler. The scheduler allows to select one or more days of the week (P.0418), a starting time (P.0419) and a duration (P.0420). The controller will force the TEST mode in the selected days and in the selected time interval. Since real time clock is required for this feature, if the current date/time is not reliable the controller activates the anomaly AL.057 (“Clock not valid”). Parameter P.0222 (“Enable generator supply on TEST?”) selects whether to load the genset or not.

- Using GC800 HMI. By clicking on the label showing the current operating mode, GC800 HMI shows a popup allowing to change the mode itself: TEST is a possible option. GC800 HMI translates this operator action in a Modbus command sent over the communication port (see next points).

- By sending proper Modbus commands over the communication ports (see paragraph 7.1):
  - “12”: to require the TEST without loading the genset.
  - “14”: to require the TEST with loading the genset.
  - “15”: the controller uses parameter P.0222 (“Enable generator supply on TEST?”) to decide about loading the genset.

- By sending proper SNMP commands over the Ethernet (see paragraph 7.1)

- By sending proper HTTP commands over the Ethernet (see paragraph 7.1)

- By sending a proper SMS message to the REWIND module connected to a serial port of the controller (when available).

7.2.1.2 REMOTE START

its purpose is to temporarily override the application’s logic, forcing the starting of the generator. Typically, the controller tries to load the genset in REMOTE START mode; however, it correctly manages the “load inhibition” requests, thus the operator can force the engine running without loads.

REMOTE START mode has higher priority than TEST (it interrupts any pending TEST).

The REMOTE START mode can optionally be enabled by a digital input, configured with the function DIF.2701 (“Enables remote start requests”): The REMOTE START mode is enable when the input is activated (or if not configured).

The operator can require the REMOTE START mode in different ways:

- Through a command sent by MC100 controllers over the CAN bus PMCB. MC200 & MC400 controllers can use this command too, when configured to “emulate MC100”.
- Using a digital input configured with the function DIF.2032 (“Request for REMOTE START mode”). In this case, the activation delay configured for that input is relevant: the controller forces the REMOTE START mode after the configured delay from the input activation; it forces back the AUTO mode immediately when the input becomes not active.
- Using the provided weekly scheduler. The scheduler allows to select one or more days of the week (P.0426), a starting time (P.0427) and an ending time (P.0428). The controller will force the REMOTE START mode in the selected days and in the selected time interval. Since real time clock is required for this feature, if the current date/time is not reliable the controller activates the anomaly AL.057 (“Clock not valid”). Note: setting P.0427 and P.0428 to the same value, you define a full day range.
- By sending proper Modbus commands over the communication ports (see paragraph 7.1):
  - “13”: to require the REMOTE START mode.
- By sending proper SNMP commands over the Ethernet (see paragraph 7.1)
- By sending proper HTTP commands over the Ethernet (see paragraph 7.1)
- By sending a proper SMS message to the REWIND module connected to a serial port of the controller (when available).

7.2.2 Events and signalling

The controller records the following events if the working mode changes (if enabled with bit 0 of P.0441 parameter):

- EVT.1001: the new mode is “OFF”.
- EVT.1002: the new mode is “MAN”.
- EVT.1003: the new mode is “AUTO”.
- EVT.1004: the new mode is “TEST”.
- EVT.1005: the new mode is “REMOTE START”.

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

- DOF.3001 - “OFF”. The controller activates this output when in OFF mode.
- DOF.3002 - “Manual”. The controller activates this output when in MAN mode.
- DOF.3003 - “Automatic”. The controller activates this output when in AUTO mode.
- DOF.3004 - “Test”. The controller activates this output when in TEST mode.
- DOF.3005 - “Remote start”. The controller activates this output when in REMOTE START mode.
- DOF.3011 - “Not in OFF”. The controller activates this output when not in OFF mode.
- DOF.3012 - “One of the automatic modes”. The controller activates this output when in AUTO, TEST, or REMOTE START.

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

- ST.000 - “OFF”.
- ST.001 - “MAN”
- ST.002 - “AUTO”.
- ST.003 - “TEST”.
- ST.004 - “REMOTE START”.

7.3 Application types.

The controller can manage eleven different applications:

- **0-SPM** and **5-MPM** (**Prime Mover**): public grid is not present. The controller starts the genset following an operator request (local or remote), to supply the loads. **SPM** refers to single-genset applications, **MPM** to multiple-gensets applications (the controller provides all the required functions for the parallel between gensets, included, with some limitation, the MGCB circuit breaker).

- **1-SSB** and **6-MSB** (**Stand By**, often referred also as **AMF** – Automatic Mains Failure): these applications work as emergency to the public grid. The controller automatically starts the genset in case of anomalies on the grid and stops it when the anomalies cease. Parallel with the grid is not allowed. **SSB** refers to single-genset applications (where the controller directly manages the grid and its circuit breaker), **MSB** to multiple-gensets applications (an MC controller is required for managing grid, MCB and MGCB, GC800 SCM provides all the required functions for parallel between gensets).

- **2-SSB+SSTP** and **7-MSB+MSTP** (**Stand By + Short Time Parallel**): these applications are very similar to the previous ones, where the controller automatically starts the genset in case of anomalies on the public grid and stops it when the anomalies cease. Transient parallel with the grid is allowed. **SSB+SSTP** refers to single-genset applications (where the controller directly manages the grid and its circuit breaker), **MSB+MSTP** to multiple-gensets applications (an MC controller is required for managing grid, MCB and MGCB, GC800 SCM provides all the required functions for parallel between gensets and/or to the grid).

- **3-SPtM** and **8-MPtM** (**Parallel to Mains**): applications for pure production in parallel to the public grid. The controller normally starts the genset only if the grid is permanently present and in tolerance; in case of anomalies on the grid, it disconnects the generator from the grid (and from the loads), and eventually stops it. **SPtM** refers to single-genset applications (where the controller directly manages the grid and its circuit breaker). **MPtM** refers to multiple-gensets applications (an MC controller is required for managing grid, MCB and MGCB, GC800 SCM provides all the required functions for parallel between gensets and/or to the grid).

- **4-SPtM+SSB** and **9-MPtM+MSB** (**Parallel to Mains + Stand By**): the most complete applications. The controller always starts the genset. If the public grid is present and in tolerance, the genset will produce energy in parallel to it; otherwise, it will supply the local loads. **SPtM+SSB** refers to single-genset applications ((where the controller directly manages the grid and its circuit breaker). **MPtM+MSB** refers to multiple-gensets applications (an MC controller is required for managing grid, MCB and MGCB, GC800 SCM provides all the required functions for parallel between gensets and/or to the grid).

- **11-DRIVE**: public grid, generator and circuit breakers are not managed. The controller manages only the engine; it also can manage a circuit breaker (you can consider it the clutch). There are no electrical AC measurements.

The selection is normally made using parameter P.0802 (with the previously described codes).

For the maximum flexibility on rental gensets, the controller allows selecting the application using digital inputs: the manufacturer can foresee different operating modes (all preconfigured) and select them using a selector on the electrical panel (better if protected with a key). The final operator cannot change the selection made by the manufacturer. To use this possibility:

- Set parameter P.0802 with the value "10-Selected by digital input".
- Configure one or more digital inputs with the following functions:
  - DIF.2161 - Selects the application SPM.
  - DIF.2162 - Selects the application SSB.
  - DIF.2163 - Selects the application SSB+SSTP.
  - DIF.2164 - Selects the application SPTM.
  - DIF.2165 - Selects the application SPTM+SSB.
  - DIF.2166 - Selects the application MPM.
  - DIF.2167 - Selects the application MSB.
  - DIF.2168 - Selects the application MSB+MSTP.

- DIF.2169 - Selects the application MPTM.
- DIF.2170 - Selects the application MPTM+MSB.
- DIF.2171 - Selects the application DRIVE.

When parameter P.0802 is set to "10", one of the previously described inputs **must always be active**. if not (for five seconds), the controller activates the anomaly AL_273 ("incoherent parameters"):

- It activates a warning if there is at least one configured input, and previously it has been activated (so a valid application was selected, the controller continues to use it).
- It activates an alarm if, when the controller is switched on, no input is active or configured (no valid previous selected application, the controller does not know what to do).

If several inputs are active at the same time, the controller uses the one with the smaller "DIF" function.

To select a different plant, the operator must:

- Stop the engine and wait for stopping.
- Set the controller in OFF mode.
- Activate the digital input related to the new application and deactivate the one related to the old one.
- The new plant is selected when, in the previous conditions, the statuses of the digital inputs are stable for one second.

If you want to combine the selection of an application with the loading of a specific alternative configuration, you can use the virtual digital inputs: set them with the functions DIF.2151…DIF.2154 and activate them with the proper AND/OR logic, using the internal states listed below.

7.3.1 Events and signalling

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

- ST.336 - Application type: SPM.
- ST.337 - Application type: SSB.
- ST.338 - Application type: SSB+SSTP.
- ST.339 - Application type: SPTM.
- ST.340 - Application type: SPTM+SSB.
- ST.341 - Application type: MPM.
- ST.342 - Application type: MSB.
- ST.343 - Application type: MSB+MSTP.
- ST.344 - Application type: MPTM.
- ST.345 - Application type: MPTM+MSB.
- ST.347 - Application type: DRIVE.

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

- ST.108 – “Emergency plant”.
- ST.109 – “Parallel to grid plant”.
- ST.110 – “Parallel to other genset plant”.

7.4 Mains/bus AC voltage sensor

The controller provides a three-phases four-poles AC voltage sensor (Y5) that can be used to acquire any AC power source (expect generator, which has its own dedicated sensor). See paragraph 3 for wirings diagrams and notes.

This sensor should be used for the mains in single-genset applications, and for the bus in multiple-gensets applications. But it's not mandatory: use parameter P.0126 ("Usage of mains/bus bars sensor") to select the measured power source:

0. Bus (parallel bars).
1. Mains.
3. Loads
4. None (not used).

Before using the sensor, you must properly configure it, using the following parameters.

Unless the sensor is four-poles, the controller allows different wirings, selectable by parameter P.0119 ("Mains/busbars AC 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 5.10.2).

When external voltage transformers (VTs) are used, properly set:

- P.0117 ("Voltage transformers for the mains/bus (primary side)").
- P.0118 ("Voltage transformers for the mains/bus (secondary side)").
- P.0152 ("Input type for mains/bus voltages").

Paragraph 3 describes how and when the VTs are required. Parameters P.0117 and P.0118 allows selecting the VTs ratio. Use P.0152 to select the voltage scaling to be used in the controller (it refers to the L-L voltage):

0. 400.
1. 100.

WARNING! you can select "0 – 400V" even if the rated voltage on the secondary side of the VTs is 100Vac (you are just going to lose accuracy); but don't select "1 – 100V" if the rated voltage is 400V, because you may damage the controller.

Finally, set the rated quantities (important because thresholds are usually percentages of them):

- P.0116 ("Nominal voltage of the mains/bus"). Set the L-N rated voltage only for single-phase wirings, otherwise set the L-L rated voltage.
- P.0105 ("Nominal frequency").
- P.0239 ("Phases sequence for mains/bus").

INFORMATION! if you set the rated voltage to "0", the controller will anyway perform measurements, but for the application logic, the power source is considered as not present.

7.4.1 Using the sensor for the parallel bars (bus)

Definition: considering the generator connected on one side of the GCB circuit breaker, the terms “bus” or “parallel bars” identify what is connected on the other side.

The parallel bars make real sense only in multiple-gensets applications. In such applications, they are usually (but not always) separated from the “loads” by the MGCB circuit breaker. In single-genset applications, the “loads” are directly connected on the other side of GCB, thus the “parallel bars” make no real sense.

The controller must verify the “voltage free” status of the “parallel bars”, to allow the closure of the GCB circuit breaker without synchronization. Moreover, controller uses this status to enable the features configured as “powered by the parallel bars” (see P.0406 for the fuel pump as example).

The controller can use the “Y5 sensor” for this purpose, if:

- P.0116 is different from 0 (“rated voltage”, see previous chapter).
- P.0126 is set as “0-Bus bars”.
- P.0126 is set as “3-Loads” (see note 1)
- P.0126 is set as “1-Mains” (see note 2)

Note 1: using the “loads” status for “parallel bars”.

The controller can use its “loads” voltages as “parallel bars” voltages only when just one “load” and one “parallel bars” are present in the plant (for sure connected to Y5), and the MGCB circuit breaker is closed (or not present).

INFORMATION! Mecc Alte controllers support just one “parallel bars” in the plant.

In single-genset applications, there are no MC controllers, so only one “loads” can exist.

Multiple-genset applications, instead, support multiple MC controllers, each of them having their own “loads”. GC800 SCM must first determinate how many “loads” are present in the plant:

- No MC controllers: just one “loads”.
- One MC controllers: just one “loads”.
- Two or more MC controllers, but all of them without MGCB: just one “loads”.
- Two or more MC controllers, with at least one MGCB: more than one “load” (**cannot use Y5**).

Note 2: using the “mains” status for “parallel bars”.

The controller can use its “mains” voltages as “parallel bars” voltages only when just one “mains” and one “parallel bars” are present in the plant (for sure connected to Y5), the MCB circuit breaker is closed, and the MGCB circuit breaker is closed (or not present).

INFORMATION! Mecc Alte controllers support just one “parallel bars” in the plant.

In single-genset applications, there are no MC controllers, so only one “mains” can exist.

Multiple-genset applications, instead, support multiple MC controllers, each of them having their own “mains”. GC800 SCM must first determinate how many “mains” are present in the plant:

- No MC controllers: just one “mains”.
- One MC controllers: just one “mains”.
- Two or more MC controllers: more than one “mains” (**cannot use Y5**).

If the controller can use the Y5 sensor, it applies a fixed threshold corresponding to 9% of the rated voltage (with a 2% hysteresis): if **all** available voltages (both L-L and L-N) are below this threshold, the “parallel bars” are "voltage free".

You can also provide this information to the controller using a digital input configured as DIF.3102 ("No voltages on parallel bars"): when the input is **active**, the “parallel bars” are "voltage free". Note: the implicit reverse polarity of this signal ensures that, in case of wire disconnection, the controller will detect “voltage presence” and won’t allow GCB closure without synchronization (safe condition).

If Y5 and DIF.3102 are both used, the controller applies an OR condition: the “parallel bars” are “voltage free” only if both systems detect the “voltage free” condition.

If the controller cannot use Y5 nor DIF.3102, it never closes GCB without synchronization. DRIVE and SPM application are an exception since there are no other power sources (other than the generator).

7.4.1.1 Signalling

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

- DOF.3031 - “Voltage on bus bars”. The controller activates this output when voltages are present.

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

- ST.048 - “Busbars live (voltages)”.

The following internal measurements (related to the mains) are available for the PLC:

- AM.076 - “Active power on the parallel bus bars”.
- AM.077 - “Nominal power on the parallel bus bars”.

7.4.2 Using the sensor for the loads

The controller verifies the “voltage presence” on the “loads” to enable features configured as “powered by loads” (see P.0406 for the fuel pump as example).

The controller can use the “Y5 sensor” for this purpose, if:

- P.0116 is different from 0 (“rated voltage”, see previous chapter).
- P.0126 is set as “3-Loads”.
- P.0126 is set as “0-Bus” (see note 1)
- P.0126 is set as “1-Mains” (see note 2)

Note 1: using the “parallel bars” status for “loads”.

The controller can use its “parallel bars” voltages as “loads” voltages only when just one “load” and one “parallel bars” are present in the plant (for sure connected to Y5), and the MGCB circuit breaker is closed (or not present).

INFORMATION! Mecc Alte controllers support just one “parallel bars” in the plant.

In single-genset applications, there are no MC controllers, so only one “loads” can exist.

Multiple-genset applications, instead, support multiple MC controllers, each of them having their own “loads”. GC800 SCM must first determinate how many “loads” are present in the plant:

- No MC controllers: just one “loads”.
- One MC controllers: just one “loads”.
- Two or more MC controllers, but all of them without MGCB: just one “loads”.
- Two or more MC controllers, with at least one MGCB: more than one “load” (**cannot use Y5**).

Note 2: using the “mains” status for “loads”.

The controller can use its “mains” voltages as “loads” voltages only when just one “mains” and one “loads” are present in the plant (for sure connected to Y5) and the MCB circuit breaker is closed.

In single-genset applications, there are no MC controllers, so only one “mains” and one “loads” can exist.

Multiple-genset applications, instead, support multiple MC controllers, each of them having their own “mains” and “loads”. GC800 SCM must first determinate how many “mains” are present in the plant:

- No MC controllers: just one “mains” and one “loads”.
- One MC controllers: just one “mains” and one “loads”.
- Two or more MC controllers: more “mains” and more “loads” (**cannot use Y5**).

If the controller can use the Y5 sensor, it applies a fixed threshold corresponding to 9% of the rated voltage (with a 2% hysteresis): if **all** available voltages (both L-L and L-N) are below this threshold, the “parallel bars” are "voltage free".

If the controller cannot use the Y5 sensor, the loads are considered “supplied” if at least one MC controller signals “mains present” and MCB closed.

7.4.2.1 Signalling

The following internal measurements (related to the mains) are available for the PLC:

- AM.075 - “Active power on the loads”.

7.4.3 Using the sensor for the mains (AMF)

The controller must check the status of the “mains” for starting the generator in in the case of anomalies. Moreover, the controller uses this status to enable the features configured as “powered by the mains” (see P.0406 for the fuel pump as example).

First, the controller must assign a “level” to the “mains” among:

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

The controller can assign such level to each available voltage and to the frequency; at the end it must generate a global level to be used in further managements.

GC800 SCM can evaluate the global level in different ways.

7.4.3.1 Level acquired by a MC device.

INFORMATION! MC devices are managed for multiple-gensets applications only. On such applications, usually the GC800 SCM does not directly measure the “mains” voltages (it usually acquires the “parallel bars” voltages).

INFORMATION! Mecc Alte controllers support just one “parallel bars” in the plant. So, all MC controllers are suitable for the “mains” level determination.

If one or more MC controllers are connected to the CAN bus (Y27 PMCB), they transmit the level of their “mains” over the CAN. GC800 SCM uses such levels as its own “mains” level. If different levels are sent, GC800 SCM creates a “global” level with the following logics (assessed in the order in which they are described):

- If at least one MC indicates “high”, the “mains” is “high”.
- If at least one MC indicates “low”, the “mains” is “low”.
- If at least one MC indicates “absent”, the “mains” is “absent”.
- The “mains” is "ok".

In this situation:

- The delays for “mains within tolerance” and “mains out of tolerance” are managed by the selected MC controller, then P.0205 and P.0206 parameters are ignored.
- The controller ignores its internal sensor and any external sensors connected to its digital inputs.

7.4.3.2 Level acquired by the internal sensor.

The controller can use the “Y5 sensor” for this purpose, if:

- P.0116 is different from 0 (“rated voltage”, see previous chapter).
- P.0126 is set as “1-Mains”.

To assess the mains level, the controller can perform up to four different checks that can be individually disabled. These checks are described (with examples) below: please, remember that disabling both voltages and frequency checks is not possible (in this case, “mains” is always considered “absent”).

7.4.3.2.1 Frequency check

Parameter	Description	Default value	Frequency (Hz)
P.0105	Nominal frequency	50 Hz	50.00
P.0236	Threshold for low mains frequency (81<)	90.0 %	45.00
P.0237	Threshold for high mains frequency (81>)	110.0 %	55.00
P.0201	Hysteresis for mains measures	2.5 %	1.25

To disable this check, one of the following conditions shall be true:

- P.0236 = 0%.
- P.0237 = 0%.
- P.0237 = 200%.
- P.0236 >= P.0237

The hysteresis on the various thresholds is calculated as half the difference between P.0237 and P.0236. However, it is limited by the maximum value set with parameter P.0201. The hysteresis applies to:

- P.0236 (with the default values, between 45.00 Hz and 46.25 Hz).
- P.0237 (with the default values, between 53.75 Hz and 55.00 Hz).

These values define the following bands:

Frequency range (Hz)	Band
0.00	A: absent
0.01 - 45.00	B: low
45.00 - 46.25	C: hysteresis
46.25 - 53.75	D: ok
53.75 - 55.00	E: hysteresis
55.00 – x	F: high

If the frequency is within the bands “C” o “E”, previous level is maintained (hysteresis). For example, in case the voltage was within the “D” band and is now within the “E” band, it is anyway considered “ok”. On the other hand, in case the frequency was within the “B” band, and now is within “C” band, it is considered “Low”.

7.4.3.2.2 Voltage’s check.

Parameter	Description	Default value	Voltage (Vac)
P.0119	Mains/busbars AC wiring	3-Three-phase with neutral	-
P.0116	Nominal voltage of the mains/bus	400 Vac	400
-	Mains presence threshold	20.0 %	80
P.0203	Threshold for low mains voltage (27)	80.0 %	320
P.0204	Threshold for high mains voltage (59)	110.0 %	440
P.0201	Hysteresis for mains measures	2.5 %	10
P.0244	Apply thresholds for the voltages also to measurements phase-neutral?	1-Yes	-

To disable this check, one of the following conditions shall be true:

- P.0203 = 0%.
- P.0204 = 0%.
- P.0204 = 200%.
- P.0203 >= P.0204

The hysteresis on the various thresholds is calculated as half the difference between P.0204 and P.0203. However, it is limited by the maximum value set with parameter P.0201. The hysteresis applies to:

- Mains presence threshold (with the default values, between 70 Vac and 80 Vac).
- P.0203 (with the default values, between 320 Vac and 330 Vac).

- P.0204 (with the default values, between 430 Vac and 440 Vac).

These values define the following bands:

Voltage range (Vac)	Band
0 – 70	A: absent
70 – 80	B: hysteresis
80 – 320	C: low
320 – 330	D: hysteresis
330 - 430	E: ok
430 - 440	F: hysteresis
440 - x	G: high

If the voltage is in the “B”, “D” or “F” bands, previous level is maintained (hysteresis). For example, if the voltage was in the “E” band and now it is in “D” band, it is considered however “ok”. On the contrary, if voltage was in the “C” band and now is in “D” band, it is considered “Low”.

The voltages affected are:

- P.0119 = 1 (1P2W): L1-N
- P.0119 = 2 (2P3W): L1-L2. If enabled by P.0244 also L1-N and L2-N
- P.0119 = 3 (3P4W): L1-L2, L2-L3, L3-L1. If enabled by P.0244 also L1-N, L2-N and L3-N.
- P.0119 = 4 (3P3W): L1-L2, L2-L3, L3-L1.

7.4.3.2.3 Unbalance check.

Parameter	Description	Default value	Voltage (Vac)
P.0116	Nominal voltage of the mains/bus	400 Vac	400
P.0238	Threshold for mains voltages unbalance (47)	10.0 %	40
P.0201	Hysteresis for mains measures	2.5 %	10
P.0244	Apply thresholds for the voltages also to measurements phase-neutral?	1-Yes	-

This check verifies the absolute difference among measured voltages (vector modules). It doesn’t take care of vector angles.

To disable this check, one of the following conditions shall be true:

- P.0238 = 0%.

The compared voltages depend on the selected wiring of the sensor:

- P.0119 = 1 (1P2W): **disabled**
- P.0119 = 2 (2P3W): L1-N, L2-N.
- P.0119 = 3 (3P4W): L1-L2, L2-L3, L3-L1. If enabled by P.0244 also L1-N, L2-N and L3-N.
- P.0119 = 4 (3P3W): L1-L2, L2-L3, L3-L1.

The controller calculates the maximum difference (absolute value) among all available voltages and compare it with the threshold. With the default parameters’ values:

- The “mains” is “low” if the maximum L-L voltage difference is higher than 40 Vac.
- The “mains” is “ok” if the maximum L-L voltage difference is lower than 30 Vac.

For L-N voltages, the thresholds are calculated respect to the rated L-N voltage.

7.4.3.2.4 Phase's sequence check

Parameter	Description	Default value
P.0239	Phases sequence for mains/bus	0-None

This check is available only for multi-phases system: the "mains" is "low" when the real rotation direction of the voltage vectors differs from the one specified by parameter P.0239 ("1-Clockwise (CW)" or "2-Counterclockwise (CCW)").

To disable this check, simply set parameter P.0239 to "0-None".

7.4.3.2.5 Global level detected by the internal sensor.

The controller evaluates the following conditions (in the presented order) to calculate the "global" level of the "mains":

- 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". In this case, if there's something wrong on the rotation direction or on the unbalance checks, the global level is "Low".
- 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".

7.4.3.3 Level acquired by a digital input.

It is possible to configure a digital input with DIF.3101 function ("External sensor for mains"): the "mains" level is "Ok" when the input is active.

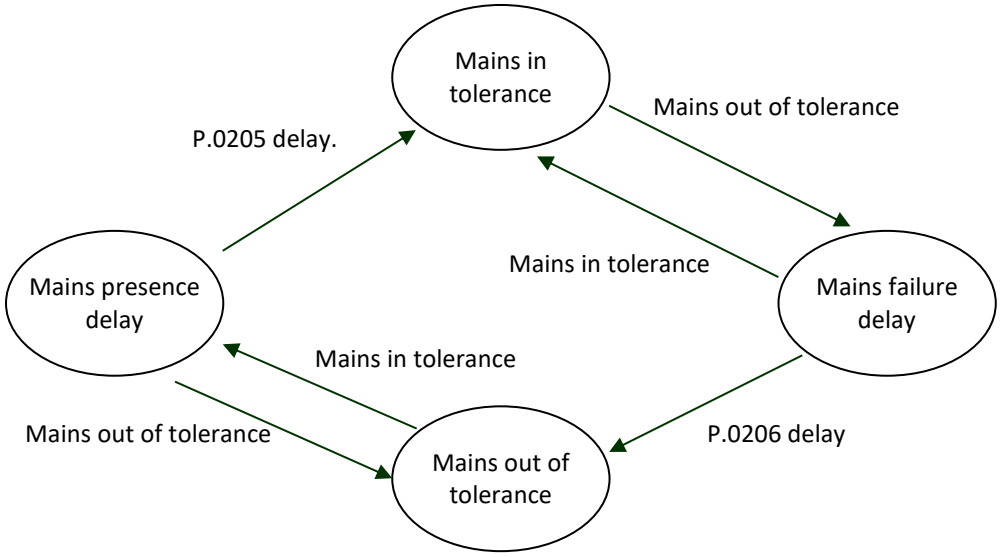
The controller allows to use both the internal sensor and the external one (digital input). In this case:

- If the digital input is active, the mains level is "Ok" (no matter the internal sensor).
- If the digital input is not active, the mains level is determined by the internal sensor.

As an alternative to the function DIF.3101, the controller can detect the mains level from a digital input configured as DIF.3103 ("External protections for parallel to mains") **but only if no input is configured as DIF.3101 and only if it cannot use the internal sensor:** the mains level is "Ok" when the input is active.

7.4.3.4 Mains global status

Whichever the method used to acquire the mains instant status, to the extent of the plant operation logics, the mains global status is described in four steps:



The controller can optionally not use the P.0205 and P.0206 delays, depending on plant conditions and on P.0250 (“Mains options”). P.0205 (“Delay for mains presence”) is **not used** when:

- The mains level is acquired from MC devices.
- The controller is in OFF mode, and bit 0 of P.0250 is not set.
- The controller is in AUTO mode, but the genset cannot start because of “start inhibitions”, and bit 1 of P.0250 is not set.

P.0206 (“Delay for mains fault”) is **not used** when:

- GCB is closed.
- GCB is open, and generator is “in threshold” (can immediately supply): in this case the controller uses a two second fixed delay.

7.4.3.5 Events and signalling

The controller records the following events if the working mode changes (if enabled with bit 1 of P.0441 parameter):

- EVT.1010: Mains voltage absent.
- EVT.1011: Mains voltage present, but “out of tolerance”.
- EVT.1012: Mains voltage present, and “in tolerance”.

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

- DOF.3033 - “Mains in tolerance”. The controller activates this output when the mains voltages and the frequency are in tolerance from the configured time.

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

- ST.016 - “Mains present (voltages/frequency)”.
- ST.017 - “Mains absent or out of thresholds”.
- ST.018 - “Delay for mains in thresholds”.
- ST.019 - “Mains in thresholds”.
- ST.020 - “Delay for mains absent or out of thresholds”.

The following functions allows mapping the mains measurements to analogue outputs (use the "conversion curves" to adapt the single value to the output (0-100%)):

- AOF.3201 - “Frequency of the mains”.
- AOF.3211 - “Voltage of the mains”.
- AOF.3221 - “Active power of the mains”.

The following internal measurements (related to the mains) are available for the PLC:

- AM.012 - “Mains frequency”.
- AM.013 - “Mains voltage L1-N”.
- AM.014 - “Mains voltage L2-N”.
- AM.015 - “Mains voltage L3-N”.
- AM.016 - “Mains voltage N-Battery”.
- AM.017 - “Mains voltage L1-L2”.
- AM.018 - “Mains voltage L2-L3”.
- AM.019 - “Mains voltage L3-L1”.
- AM.020 - “Mains voltage L-L average”.
- AM.068 - “Mains active energy (total)”.
- AM.069 - “Mains active energy (partial)”.
- AM.070 - “Mains reactive energy (total)”.

- AM.071 - “Mains reactive energy (partial)”.
- AM.074 - “Active power on the mains”.

7.4.4 Using the sensor for the mains (parallel to the mains)

See the document [6] for a description of the use of the mains sensor for the parallel with the mains.

7.5 Generator

Using the connector Y4, the controller measures the generator voltages and frequency, to protect the loads and the generator itself from operating outside valid ranges. See paragraph 3 for wirings diagrams and notes.

Before using the sensor, you must properly configure it, using the following parameters.

Unless the sensor is four-poles, the controller allows different wirings, selectable by parameter P.0101 (“Generator AC 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 5.10.2).

When external voltage transformers (VTs) are used, properly set:

- P.0103 (“Voltage transformers for the generator (primary side)”).
- P.0104 (“Voltage transformers for the generator (secondary side)”).
- P.0151 (“Input type for generator voltages”).

Paragraph 3 describes how and when the VTs are required. Parameters P.0103 and P.0104 allows selecting the VTs ratio. Use P.0151 to select the voltage scaling to be used in the controller (it refers to the L-L voltage):

0. 400.
1. 100.

WARNING! you can select “0 – 400V” even if the rated voltage on the secondary side of the VTs is 100Vac (you are just going to lose accuracy); but don’t select “1 – 100V” if the rated voltage is 400V, because you may damage the controller.

7.5.1 Rated values

Finally, 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! Don’t’ 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: $$I_{nom} = \frac{P.0106 * 1000}{P.0102}$$

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

Multi-phases wiring:

Finally, the controller calculates the rated reactive power using the apparent power (P.0106) and the active rated power (P.0125). The rated reactive power is calculated for a minimum allowed power factor of 0.80, both leading and lagging.

INFORMATION! for two-phases systems, the controller considers 2/3 of the calculated values.

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

GC800 SCM manages two types of generators: synchronous and asynchronous. Use parameter P.0100 (“Type of generator”) to select the proper one (default “0-Synchronous”).

For both types, 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.

GC800 SCM can evaluate the global “level” in different ways.

7.5.2 Asynchronous generator

This type of generator can only operate in parallel with the mains, for power generation. To use such generator, you must:

- Select the application SPtM or MPTM.
- Have a speed measurement system (pick-up, W, ECU over CAN bus).
- Configure the GCB circuit breaker as "not synchronized" (P.0854, see document [6]).

The controller operates in a different way with an asynchronous generator:

- It starts the engine only if the “mains” is present and its conditions allow the power production.
- It can recognize the “engine running” and “engine at operating speed” conditions only through the engine rotation speed. That’s why we need a physical measurement system.
- Before closing the GCB, it must verify the voltages presence on the parallel bars (can only operate in parallel): it then closes the GCB without synchronization, because the generator doesn’t provide any voltage if not in parallel.

7.5.2.1 Speed level detection.

Since this kind of generator does not generate any voltage before closing the GCB (thus no frequency too), the only way to detect the generator “level” is using engine speed.

Parameter	Description	Default value	Speed (rpm)
P.0701	Engine's nominal speed	1500 rpm	1500
P.0224	Threshold for engine stopped (rpm)	7.0 %	105
P.0225	Threshold for engine started (rpm)	20.0 %	300
P.0358	Minimum speed threshold	90.0 %	1350
P.0333	Threshold for maximum speed (pick-up/w) (12)	120.0 %	1800
P.0202	Hysteresis for generator's measures	2.5 %	37.5

The hysteresis applies to:

- P.0358 (with the default values, between 1350 rpm and 1385.7 rpm).
- P.0333 (with the default values, between 1762.5 rpm and 1800 rpm).

These values define the following bands:

Speed range (rpm)	Band
0 – 105	A: absent
105 – 300	B: hysteresis
300 - 1350	C: low
1350 – 1385.7	D: hysteresis
1385.7 - 1762.5	E: ok
1762.5 – 1800	F: hysteresis
1800 – x	F: high

If the rotation speed is in "B", "D" or "F" bands, it keeps the level it had before (hysteresis). For example, if the rotation speed 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”.

7.5.2.2 Magnetization resistances

It’s quite common, in working with asynchronous generators, to use external resistances allowing the magnetization of the generator itself, before loading it. These resistances are inserted one second before the GCB closure: they connect the mains to the generator (bypassing GCB), allowing a limited circulation of current in the generator. This current is used for its magnetisation.

The resistances are short-circuited by the GCB circuit breaker, once closed. If, for any reason, GCB cannot be closed, these resistances tend to over-heating. Their use is not allowed for longer than three seconds: after this time (with GCB still open) the controller disconnects them and prevents a new GCB closure for the time set with P.0257 (“Cooling time of the resistances of magnetization”): this delay allows the resistances to cool down.

To control the connection/disconnection of the resistances, configure a digital output as DOF.2121 (“Magnetization of the asynchronous generator”): the controller activates the output when it wants to insert the resistances.

GCB closing sequence is therefore:

- Activation of DOF.2121 output and subsequent insertion of the resistances.
- Waiting for one second to allow the magnetization of the generator.
- GCB closure command.
- If GCB closes, the controller disconnects the resistances and the procedure ends.
- If GCB cannot be closed within three seconds, the controller removes the GCB closure command, disconnects the resistances and waits P.0257 seconds. Then the sequence restarts from the beginning.

Note that each GCB closure attempt lasts two seconds (regardless of the time set on the digital input that acquires its feedback), not to leave the resistances inserted for more than three seconds.

7.5.2.3 Power-factor capacitors

It’s quite common, in working with asynchronous generators, to use external capacitors for correcting the power factor. The controller, when properly configured, inserts the capacitors after P.0258 seconds (“Delay for the insertion of the power factor correction capacitors”) from the GCB closure. It disconnects the capacitors when it opens GCB.

To control the connection/disconnection of the capacitors, configure a digital output as DOF.2121 (“Power factor correction capacitors”): the controller activates the output when it wants to insert the capacitors.

7.5.3 Synchronous generator

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

7.5.3.1 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”.

Thresholds P.0305 and P.0307 are also used to manage the generator protections on 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, thresholds are still used to define the frequency level: this avoid GCB closure if frequency is not “Ok”.

7.5.3.2 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
P.0328	Apply thresholds for the voltages also to measurements phase-neutral?	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-L2. If enabled by P.0328 also L1-N and L2-N
- P.0101 = 3 (3P4W): L1-L2, L2-L3, L3-L1. If enabled by P.0328 also L1-N, L2-N and L3-N.
- P.0101 = 4 (3P3W): L1-L2, L2-L3, L3-L1.

Thresholds P.0301 and P.0303 are also used to manage the generator protections on 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, thresholds are still used to define the frequency level: this avoid GCB closure if frequency is not “Ok”.

7.5.3.3 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".

7.5.4 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 synchronous generator (or of the rotation speed for asynchronous generators) is not "Ok" consecutively for two seconds.
- **In tolerance**: synchronous generator’s voltages and frequency status (or of the rotation speed for asynchronous generators) are “Ok” for at least 0.5 seconds.
- **Transitory**: during the transition between the two previous statuses.

7.5.5 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”.

The following functions allows mapping the generator measurements to analogue outputs (use the "conversion curves" to adapt the single value to the output (0-100%)):

- AOF.3101 (“Frequency of the generator”).
- AOF.3111 (“Voltage of the generator").
- AOF.3121 (“Active power of the generator").

The following internal measurements (related to the generator) are available for the PLC:

- AM.001 – “Generator frequency”.
- AM.002 – “Generator voltage L1-N”.
- AM.003 – “Generator voltage L2-N”.
- AM.004 – “Generator voltage L3-N”.
- AM.005 – “Generator voltage N-Battery”.
- AM.006 – “Generator voltage L1-L2”.
- AM.007 – “Generator voltage L2-L3”.
- AM.008 – “Generator voltage L3-L1”.
  AM.009 – “Generator voltage L-L average”.
- AM.023 – “Current L1”.
- AM.024 – “Current L2”.
- AM.025 – “Current L3”.
- AM.026 – “Auxiliary current (or neutral current)”.
- AM.027 – “Differential current”.
- AM.028 – “Toroid current”.
- AM.030 – “Nominal active power”.
- AM.031 – “Active power L1”.
- AM.032 – “Active power L2”.
- AM.033 – “Active power L3”.
- AM.034 – “Total active power”.
- AM.037 – “Nominal apparent power”.
- AM.038 – “Apparent power L1”.
- AM.039 – “Apparent power L2”.
- AM.040 – “Apparent power L3”.
- AM.041 – “Total apparent power”.
- AM.044 – “Reactive power L1”.
- AM.045 – “Reactive power L2”.
- AM.046 – “Reactive power L3”.
- AM.047 – “Total reactive power”.
- AM.055 – “Power factor L1 (calculated from kW and kVA)”.
- AM.056 – “Power factor L2 (calculated from kW and kVA)”.
- AM.057 – “Power factor L3 (calculated from kW and kVA)”.
- AM.058 – “Total power factor (calculated from kW and kVA)”.

- AM.059 – “Total Cos(phi) (calculated from kW and kvar)”.
- AM.062 – “Generator active energy (total)”.
- AM.063 – “Generator active energy (partial)”.
- AM.064 – “Generator reactive energy (total)”.
- AM.065 – “Generator reactive energy (partial)”.

7.6 Start inhibition.

In AUTO mode, the controller can start the engine when required by the application’s logic. Using “start inhibition” feature, the operator can force the controller to stop or keep the engine stopped, overriding the application’s logic. GC800 HMI shows a padlock on the top-bar (visible in all display pages) to indicate that at least one “start inhibition” request is active.

INFORMATION! this feature does not work in TEST and REMOTE START sub-modes.

Different “start inhibition” requests are available.

7.6.1 Request from digital input.

The controller uses any digital input configured as DIF.2501 (“Inhibition of start”): it requires the “start inhibition” if at least one of these inputs is active.

The “delay” configured for the input is ignored. You can use parameter P.0207 to set a delay between input's physical activation and this function's logic activation: the controller forces zero seconds fixed delay if not AUTO mode. You can use parameter P.0208 to set a delay between input's physical deactivation and this function's logic deactivation: the controller forces two seconds fixed delay if the generator is already running.

INFORMATION! The function DIF.2501 may appear like the function DIF.3101 (“External sensor for mains”). This is partially true only for AMF applications. The two functions have different operating logic and purposes. The first emulates the internal mains sensor behaviour, the second is used to explicitly avoid the start of the engine whatever the mains status; this reflects to the status signalling, which, in this way, remains more coherent with the real status of the plant.

7.6.2 Request from scheduler.

The controller provides a scheduler (configurable by parameters P.0421, P.0422 and P.0423), allowing to select the days of the week and a time interval (common to all selected days) during which the generator is allowed to work. Outside this time interval (and during not-selected days), the controller activates a “start inhibition” request to keep the genset stopped. Since real time clock is required for this feature, if the current date/time is not reliable the controller activates the anomaly AL.057 (“Clock not valid”).

Parameter P.0421 (“Generator enable days”) allows to choose the days of the week. P.0422 (“Generator enable start time”) refers to the days selected by P.0421, while P.0423 (“Generator enable stop time”) refers to the same day, if its value is higher than P.0422, or to the following day if lower (across midnight). Moreover, setting P.0422 and P.0423 to the same value, you define a full day range.

7.6.3 Request from load management.

In multiple-gensets applications, the "load management" feature (see document [6]) can require some controllers to keep their engines stopped if not required to supply the loads. The controller activates a “start inhibition” request to keep its engine stopped in this situation.

7.6.4 Request from “mains conditions do not allow power production”.

Some applications (SPTM or MPTM) allow the generator only to produce power in parallel to the mains (see [6]). In case of mains anomalies, the controller immediately opens the GCB circuit breaker: then it waits maximum P.0899 seconds (“Maximum mains failure time before engine stop”) to see if the “mains” becomes again suitable for power production.

After this time, the controller will stop the engine, by activating a “start inhibition” request; it will remove the request when the mains conditions allow power production.

7.6.5 Request from “some GCB not open”.

In multiple-gensets applications, if a GCB circuit breaker is closed while its related engine is stopped or stopping, that engine might be driven by other generators connected to the same parallel bars, or its alternator may be reverse powered. This is not a safe condition both for the engine and for the alternator.

The other controllers (connected through PMCB CAN bus) can detect this situation. Using P.0804 (“Allow GCB closure with wrong number of gensets over the PMCB bus?”), you can tell other controllers to avoid closing their GCB, or to force their GCB opening (to avoid reverse powering the faulty generator).

Once the controller opened the GCB, it waits for maximum P.0899 seconds: after this time, it stops the engine, by activating a “start inhibition” request; it will remove the request when the failure is fixed.

7.6.6 Request from MC controller.

When a “start inhibition” request is activated on a MC controller, that MC broadcasts the request to all controllers connected to the PMCB CAN bus. GC800 SCM can receive this broadcast request from any connected MC controllers: If **all of them** require the “start inhibition”, then GC800 SCM activate a local request (if at least one MC is not broadcasting the request, the genset should be ready to operate on its mains or its loads, thus the controller ignores the requests coming from other MCs).

7.6.7 Events and signalling

The controller records the following events related to “start inhibition” (if enabled with bit 6 of P.0441 parameter):

- EVT.1013: request from digital input activated.
- EVT.1014: request from digital input de-activated.
- EVT.1221: request from scheduler activated.
- EVT.1222: request from scheduler de-activated.
- EVT.1223: request from “mains conditions” activated.
- EVT.1224: request from “mains conditions” de-activated.
- EVT.1225: request from “some GCB not open” activated.
- EVT.1226: request from “some GCB not open” de-activated.

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

- ST.080: request from digital input.
- ST.081: request from scheduler.
- ST.082: request from load management.
- ST.083: request from mains conditions.
- ST.084: request from “some GCB not open”.
- ST.086: request from MC controller.

7.7 GCB closure inhibition

In AUTO mode, once the controller started the engine, it normally tries to close the GCB circuit breaker. Using “GCB closure inhibition” feature, the operator can force the controller to open or keep the GCB opened, overriding the application’s logic.

INFORMATION! when the application allows this, the controller always unload the generator before opening the GCB.

INFORMATION! this feature works in TEST and REMOTE START sub-modes too.

Different “GCB closure inhibition” requests are available.

7.7.1 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.

7.7.2 Request from “mains conditions do not allow power production”.

Some applications (SPTM or MPTM) allow the generator only to produce power in parallel to the mains (see [6]). In case of mains anomalies, the controller immediately opens the GCB circuit breaker: it then must keep GCB opened, by activating a “GCB closure inhibition” request. It will remove the request when the mains conditions allow power production.

7.7.3 Request from communication ports.

See paragraph 7.1 for protecting the controller from commands sent over the communication ports. Two available options:

- By sending proper Modbus commands:
  - “31” or “32” to activate the request.
  - “33” to de-activate the request.
- By sending proper SNMP commands.

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.

INFORMATION! the controller does not accept this command for AMF applications in case of mains failure.

7.7.4 Request from “some GCB not open”.

In multiple-gensets applications, if a GCB circuit breaker is closed while its related engine is stopped or stopping, that engine might be driven by other generators connected to the same parallel bars, or its alternator may be reverse powered. This is not a safe condition both for the engine and for the alternator.

The other controllers (connected through PMCB CAN bus) can detect this situation. Using P.0804 (“Allow GCB closure with wrong number of gensets over the PMCB bus?”), you can tell other controllers to avoid closing their GCB, or to force their GCB opening (to avoid reverse powering the faulty generator). Once the controller opened the GCB, it activates a “GCB closure inhibition” request (for prevents future closing); it will remove the request when the failure is fixed.

7.7.5 Request from MCB synchronization in progress.

In multiple-genset application, a common request Is to synchronize all the running gensets to the mains. An external device (usually an MC controller) will send proper speed/voltage command to all genset controllers. During this synchronization process, to avoid disturbing, if the GCB of this genset is open, GC800 SCM activates a “GCB closure inhibition” (until the synchronization ends).

7.7.6 Request from MC controller.

MC controllers may require to genset controllers to open all their GCB circuit breaker. GC800 SCM react to this request by activating a “GCB closure inhibition”.

7.7.7 Events and signalling

The controller records the following events related to “GCB closure inhibition” (if enabled with bit 6 of P.0441 parameter):

- EVT.1080: request from digital input activated.

- EVT.1201: request from “mains conditions” activated.
- EVT.1202: request from communication port activated.
- EVT.1203: request from “some GCB not open” activated.
- EVT.1204: request from MCB synchronization in progress activated.
- EVT.1205: request from MC controller activated.
- EVT.1081: all requests de-activated.

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

- ST.088: request from digital input.
- ST.089: request from “mains conditions”.
- ST.090: request from communication port.
- ST.091: request from “some GCB not open”.
- ST.092: request from MCB synchronization in progress.
- ST.093: request from MC controller.

7.8 Engine

The controller can start, stop and protect the engine by means of a series of thresholds on the acquired measures (oil pressure, coolant temperature, speed etc.).

7.8.1 Nominal values

7.8.1.1 Nominal battery voltage

The controller does not provide any parameter for configuring the rated battery voltage. Supposing the controller is supplied by the battery, the controller measures its power supply voltage and auto-detects the rated value: If the power supply voltage is lower than 16 Vdc, the rated voltage is 12 Vdc, otherwise is 24 Vdc.

The controller performs the auto-detection only when powered and each time you force the OFF mode.

7.8.1.2 Nominal power

Parameter P.0125 (“Nominal power of the engine”) (kW).

It is important to properly set this parameter because there are thresholds expressed as percentage of it.

Moreover, the controller manages a “PI control loop” to regulate the generator active power during parallel operations. This PI loop does not operate in kW, but in percentages of P.0125. You must manually calibrate the PI loop by setting the proper values for the “P” and “I” factors. Any change in P.0125 may result in a new calibration of this factors (see document [6]).

7.8.1.3 Nominal speed

Parameter P.0701 (“Engine's nominal speed”) (rpm).

In any application except DRIVE, you have first to proper configure the alternator. Its configuration includes P.0150 (“Number of poles of the generator”). If P.0150 is different from zero, the controller automatically calculates the rated speed from the rated frequency (P.0105) and ignores parameter P.0701.

Instead, if P.0150 is set to zero (or for DRIVE applications) the controller uses P.0701: it is important to properly set this parameter because there are thresholds expressed as percentage of it.

7.8.2 Engine measurements

7.8.2.1 Battery voltage

The controller has two channels for measuring its power supply voltage, supporting application with multiple batteries for redundancy cranking systems (see paragraph 5.3). An eventual ECU connected through CAN bus can also send this measurement: since the controller’s measurements cannot be disabled, the protections never operate on the ECU’s value (but GC800 HMI shows this value if available).

7.8.2.2 Engine power

The controller uses its AC sensors (voltage/current) to measure the electrical active power produced by the generator and use this measurement as “engine power” (not considering eventual losses). An ECU connected through CAN bus can also send this measurement: the protections never operate on the ECU’s value (but GC800 HMI shows this value if available).

7.8.2.3 Engine speed

The controller can acquire/measure the engine rotation speed. It is not mandatory (except in DRIVE application or when using an asynchronous generator). The controller can use the engine speed to:

- Detect the running/stopped status of the engine.
- Implement minimum/maximum speed protections.
- PI loop for speed control.

GC800 SCM can acquire this value in different ways, listed in the order in which they are assessed:

- Magnetic pick-up (MPU). See paragraph 3 for electrical notes, and paragraph 5.9.1 for connecting the MPU to the controller. If you want to use this method, you must configure parameter P.0110 (“Number of teeth of the pick-up wheel”) to match your real engine. If P.0110 is set to zero, the controller evaluates the next method.
- W signal (engine’s battery charger). See paragraph 3 for electrical notes, and paragraph 5.9.2 for connecting the W signal to the controller. If you want to use this method, you must configure parameter P.0111 (“Rpm/W ratio”) to match your real engine. If P.0111 is set to zero, the controller evaluates the next method. It could be not easy to find the proper value for P.0111: paragraph 5.9.2 describes an empirical way to find it.
- Via CAN bus from an electronic ECU. If no ECU is configured (P.0700 = 0), or if the ECU does not provide this value, the controller evaluates the next method.
- From the generator frequency. This method is not available for asynchronous generators, because there are no voltages (thus no frequency) before GCB closure. This method is not available for DRIVE application too (no generator at all). If you want to use this measurement method, you must configure parameter P.0150 (“Number of poles of the generator”). If P.0150 is set to zero, since there are no other measurement methods, **the speed measurement won’t be available** (GC800 HMI hides this measurement or shows it with dashes instead of digits).

7.8.2.4 Other measurements

GC800 SCM can acquire a lot of analogue measurements from the engine. If connected through the CAN bus to an ECU, it reads most of them directly from the ECU. The analogue inputs always have priority over the ECU values (in case both are used for the same measurement). Lowe-index input has priority on other inputs (in case of duplicated configuration).

The controller provides many functions for the analogue inputs’ configuration. Some of them can be used are pre-programmed for commercial resistive senders; you can use them only on analogue input 1…6, if properly configured and wired (see 5.6.1):

- AIF.1000 (“Oil pressure (VDO)”): for standard VDO sensor (10 Ohm 0 bar, 180 Ohm 10 bar).
- AIF.1100 (“Oil temperature (VDO)”): for standard VDO sensor (481 Ohm 40 °C, 10 Ohm 180 °C).
- AIF.1110 (“Coolant temperature (VDO)”): for standard VDO sensor (290 Ohm 40 °C, 10 Ohm 150 °C).
- AIF.1200 (“Oil level (VDO)”): for standard VDO sensor (10 Ohm 100%, 180 Ohm 0%).
- AIF.1210 (“Coolant level (VDO)”): for standard VDO sensor (10 Ohm 100%, 180 Ohm 0%).
- AIF.1220 (“Fuel level (VDO)”): for standard VDO sensor (10 Ohm 100%, 180 Ohm 0%).

For all other functions, you must provide a proper conversion curve, to convert the electrical measurement in the required value:

- AIF.1001 (“Oil pressure – generic”).
- AIF.1101 (“Oil temperature – generic”).
- AIF.1111 (“Coolant temperature – generic”).
- AIF.1201 (“Oil level – generic”).
- AIF.1211 (“Coolant level – generic”).
- AIF.1221 (“Fuel level – generic”).
- AIF.1231 (“Fuel level in litres – generic”).
- AIF.1601 (“Intake manifold temperature”).
- AIF.1603 (“Exhaust gas temperature - left”).
- AIF.1605 (“1605-Exhaust gas temperature - right”).
- AIF.1641 (“1641-Boost pressure”).

7.8.2.5 Signalling

The following functions allows mapping the generator measurements to analogue outputs (use the "conversion curves" to adapt the single value to the output (0-100%)):

- AOF.3001 (“Engine speed”).

- AOF.3011 (“Oil pressure”).
- AOF.3013 (“Oil temperature”).
- AOF.3015 (“Oil level”).
- AOF.3023 (“Coolant temperature”).
- AOF.3025 (“Coolant level”).
- AOF.3035 (“Fuel level”).

The following internal measurements (related to the generator) are available for the PLC:

- AM.088 - “Engine speed (SPN 190 - SAE J1939)”.
- AM.091 - “Engine oil level (SPN 98 - SAE J1939)”.
- AM.092 - “Engine coolant level (SPN 111 - SAE J1939)”.
- AM.093 - “Engine fuel level (%)”.
- AM.094 - “Engine fuel level (L)”.
- AM.096 - “Engine fuel rate (actual) (SPN 183 - SAE J1939)”.
- AM.097 - “Engine fuel rate (average) (SPN 1029 - SAE J1939)”.
- AM.100 - “Engine fuel used (total) (SPN 250 - SAE J1939)”.
- AM.101 - “Engine fuel used (partial) (SPN 182 - SAE J1939)”.
- AM.104 - “Battery voltage (ECU) (SPN 158 or 168 - SAE J1939)”.
- AM.105 - “Battery voltage (controller)”.
- AM.120 - “Barometric pressure (SPN 108 - SAE J1939)”.
- AM.121 - “Engine oil pressure (SPN 100 - SAE J1939)”.
- AM.122 - “Engine coolant pressure (SPN 109 - SAE J1939)”.
- AM.123 - “Engine fuel delivery pressure (SPN 94 - SAE J1939)”.
- AM.124 - “Engine injector timing rail pressure (SPN 156 - SAE J1939)”.
- AM.125 - “Engine injector metering rail pressure (SPN 157 - SAE J1939)”.
- AM.126 - “Engine intake manifold pressure (SPN 102 or 3563 - SAE J1939)”.
- AM.127 - “Engine oil pressure 2”.
- AM.128 - “Engine inlet air pressure (SPN 106 - SAE J1939)”.
- AM.134 - “Ambient air temperature (SPN 171 - SAE J1939)”.
- AM.135 - “Engine ECU temperature (SPN 1136 - SAE J1939)”.
- AM.136 - “Engine oil temperature (SPN 175 - SAE J1939)”.
- AM.137 - “Engine coolant temperature (SPN 110 - SAE J1939)”.
- AM.138 - “Engine fuel temperature (SPN 174 - SAE J1939)”.
- AM.139 - “Engine intake manifold temperature (SPN 105 - SAE J1939)”.
- AM.140 - “Engine turbocharger compressor outlet temperature (SPN 2629 - SAE J1939)”.
- AM.141 - “Engine exhaust gas temperature - Left manifold (SPN 2434 - SAE J1939)”.
- AM.142 - “Engine exhaust gas temperature - Right manifold (SPN 2433 - SAE J1939)”.
- AM.143 - “Engine intercooler temperature (SPN 52 - SAE J1939)”.
- AM.144 - “Engine alternator “bearing 1” temperature (left or rear) (SPN 1122 - SAE J1939)”.
- AM.145 - “Engine alternator “bearing 2” temperature (right or front) (SPN 1123 - SAE J1939)”.
- AM.146 - “Engine alternator “winding 1” temperature (SPN 1124 - SAE J1939)”.
- AM.147 - “Engine alternator “winding 2” temperature (SPN 1125 - SAE J1939)”.
- AM.148 - “Engine alternator “winding 3” temperature (SPN 1126 - SAE J1939)”.
- AM.149 - “Auxiliary temperature 1 (SPN 441 - SAE J1939)”.
- AM.150 - “Auxiliary temperature 2 (SPN 442 - SAE J1939)”.
- AM.151 - “Engine oil temperature 2 (SPN 1135 - SAE J1939)”.
- AM.152 - “Engine coolant temperature 2”.
- AM.153 - “DPF soot load % (SPN 3719 - SAE J1939)”.
- AM.154 - “DPF ash load % (SPN 3720 - SAE J1939)”.
- AM.155 - “DPF time since last regeneration s (SPN 3721 - SAE J1939)”.
- AM.156 - “SCR catalyst tank level % (SPN 1761 - SAE J1939)”.
- AM.157 - “SCR catalyst tank temperature (SPN 3031 - SAE J1939)”.
- AM.158 - “DPF outlet gas temperature (SPN 3246 - SAE J1939)”.

- AM.159 - “DPF exhaust gas temperature (SPN 3241 - SAE J1939)”.
- AM.160 - “DPF inlet gas temperature (SPN 3242 - SAE J1939)”.
- AM.225 - “Particulate trap lamp command (SPN 3697 - SAE J1939)”.
- AM.226 - “Particulate trap status (SPN 3701 - SAE J1939)”.
- AM.227 - “Particulate trap active regeneration status (SPN 3700 - SAE J1939)”.
- AM.228 - “Particulate trap passive regeneration status (SPN 3699 - SAE J1939)”.
- AM.229 - “Particulate trap manual regeneration status”.
- AM.230 - “Particulate trap active regeneration inhibited by user (SPN 3703 - SAE J1939)”.
- AM.231 - “Exhaust system high temperature lamp command (SPN 3698 - SAE J1939)”.
- AM.232 - “DEF Tank 1 Low Level Indicator (SPN 5245 - SAE J1939)”.
- AM.233 - “Cleaning lamp command for SCR system (SPN 6915 - SAE J1939)”.
- AM.234 - “SCR system cleaning inhibited by user command (SPN 6918 - SAE J1939)”.

7.8.3 Engine running/stopped detection.

We define three engine statuses:

- **Stop**: the controller can activate the starter motor.
- **Running**: the controller disconnects the starter motor and impedes its reactivation.
- **Moving**: the engine is rotating, but the speed is too low:
    - Starter motor already activated: the controller waits to see if the engine starts.
    - Starter motor not activated: the controller does not allow its activation (as the engine is rotating).

The controller detects the engine status using **all the available** following methods.

7.8.3.1 From speed measurement.

This method is enabled if:

- The speed measurement is available (see paragraph 7.8.2.3).
- P.0224 not “0” (“Threshold for engine stopped (rpm)”).
- P.0225 not “0” (“Threshold for engine started (rpm)”).
- P.0224 < P.0225.

The two thresholds are percentages of the nominal speed (see 7.8.1.3), which must be valid. With “factory” defaults, the two thresholds are 105 and 300 rpm.

The instant status of the engine is:

- **Stop:** if the rotation speed is lower than P.0224.
- **Moving**: if the rotation speed is higher than P.0224, but lower than P.0225.
- **Running**: if the rotation speed is higher than P.0225.

7.8.3.2 From the D+ signal.

This method is enabled if:

- The controller acquires the D+ voltage (see paragraph 5.5.1.4).
- P.0230 not “0” (“Threshold for engine stopped (D+)”).
- P.0231 not “0” (“Threshold for engine started (D+)”).
- P.0230 < P.0231.

The two thresholds are percentages of the nominal battery voltage (see 7.8.1.1). With “factory” defaults, the two thresholds are both “0”, thus disabled.

The instant status of the engine is:

- **Stop:** if the D+ voltage is lower than P.0230.
- **Moving**: if the D+ voltage is higher than P.0230, but lower than P.0231.
- **Running**: if D+ voltage is higher than P.0231.

7.8.3.3 From oil pressure.

This method is enabled if:

- P.0232 (“Starter motor disconnection delay from oil pressure”) different from “0”.
- The controller must be able to detect the low oil pressure status (one of the following conditions):
  - One digital input configured as DIF.4221 (“Minimum oil pressure”).
  - One digital input configured as DIF.4222 (“Low oil pressure”).
  - The oil pressure measurement is available and:
    - The threshold P.0341 (“Threshold for minimum oil pressure”) is not “0”.
    - The threshold P.0339 (“Threshold for low oil pressure”) is not “0”.

Factory default value for P.0232 is “0.0”, thus disabled.

The instant status of the engine is:

- **Stop:** if all the available “low/min oil pressure” indication are active (low oil pressure).
- **Running**: if at least one of the available “low/min oil pressure” indication is not active (oil in pressure), from the time configured by P.0232.

7.8.3.4 From generator voltage.

This method is enabled if:

- Not DRIVE application.
- Synchronous generator.
- P.0226 not “0” (“Threshold for engine stopped (V)”).
- P.0227 not “0” (“Threshold for engine started (V)”).
- P.0226 < P.0227.

The two thresholds are percentages of the nominal voltage (P.0102), which must be different from “0”. With “factory” defaults, the two thresholds are 60 and 80 Vdc.

The instant status of the engine is:

- **Stop**: all available genset voltages are lower than P.0226.
- **Moving**: at least one available voltage is higher than P.0226 but are lower than P.0227.
- **Running**: at least one available voltage is higher than P.0227.

INFORMATION! the controller uses the L-N voltage for single-phase application, and L-L voltages only for multi-phases applications.

7.8.3.5 From generator frequency.

This method is enabled if:

- Not DRIVE application.
- Synchronous generator.
- P.0228 not “0” (“Threshold for engine stopped (Hz)”).
- P.0229 not “0” (“Threshold for engine started (Hz)”).
- P.0228 < P.0229.

The two thresholds are percentages of the nominal frequency (P.0105), which must be different from “0”. With “factory” defaults, the two thresholds are 5 and 10 Hz.

The instant status of the engine is:

- **Stop**: if the frequency is lower than P.0228.
- **Moving**: if the frequency is higher than P.0228, but lower than P.0229.
- **Running**: if the frequency is higher than P.0229.

7.8.3.6 From CAN bus connection (ECU interface)

This method is enabled if:

- An ECU is properly configured (P.0700).
- The ECU sends the “engine running” information over the CAN (not the speed or the oil pressure).

The instant status of the engine can only be **Stop** or **Running**, depending on the received status.

7.8.3.7 Global status

The global status of the engine is:

- **Stop**: if all the available methods detected “**stop**” (continuously for three seconds).
- **Moving**: if at least one of the available methods detected “**moving**” or “**running**” for less than 0.2 seconds.
- **Running**: if at least one of the available methods detected “**running**” continuously for at least 0.2 seconds.

7.8.3.8 Signalling

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

- DOF.3061 - “Engine running”. The controller activates this output when the global engine status “**running**”.

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

- ST.032 - “Engine running”. The controller activates this output when the global engine status “**running**”.

7.8.4 Engine commands

The controller provides eleven engine commands, all mappable to digital outputs:

Function	Acronym	Description	Factory default
DOF.1001	GLOW_PLUGS	Preheating of glow plugs	
DOF.1002	ECU_ENABLE	Enable for engine control unit	
DOF.1003	FUEL	Fuel solenoid	Out 6 (Y10)
DOF.1004	GAS	Gas solenoid	
DOF.1005	START	Command to start the engine	Out 5 (Y10)
DOF.1006	STOP	Stop solenoid	Out 4 (Y10)
DOF.1007	IDLE	Command for idle speed	
DOF.1008	BATT1	Selects battery 1	
DOF.1009	BATT2	Selects battery 2	
DOF.1031	PREHEAT	Coolant preheating	
DOF.1033	PRELUBE	Command for pre-lubrication	

Most of them are also available as internal statuses for AND/OR logics and PLC:

- ST.128 – GLOW_PLUGS.
- ST.129 – ECU_ENABLE.
- ST.130 – FUEL.
- ST.131 – GAS.
- ST.132 – START.

- ST.133 – STOP.
- ST.134 – IDLE.
- ST.135 – PREHEAT.
- ST.136 – PRELUBE.

INFORMATION! when you connect the GC800 SCM to an ECU through CAN bus, the controller manages many of these commands directly through the CAN bus connection (depending on what the ECU can accept), and therefore you do not need to assign them to physical outputs. If you configure them, however, the controller will manage them (together with the command through CAN).

7.8.4.1 Coolant preheating (PREHEAT)

GC800 SCM can control an external heating system, to maintain the temperature of the engine (through its coolant) above a specific temperature. A warm engine is always ready to supply its maximum power.

The function is enabled if:

- The controller acquires the coolant temperature.
- The threshold P.0355 (“Coolant heating activation threshold”) is lower than the threshold P.0356 (“Coolant heating deactivation threshold”).
- You configured one or more digital outputs as DOF.1031, or you used the internal status ST.135 in the PLC or in an AND/OR logic.

The two thresholds guarantee a hysteresis to avoid continue activations/deactivations of the heating system due to minimum temperature shifts. The heating activates if the temperature drops below the threshold P.0355 for at least one second; it turns off when the temperature rises above the threshold P.0356 for at least one second.

The controller manages the heating system even when the engine is running. In this condition we expect that the engine self-heating brings the temperature over P.0356: the controller will turn off the heating system.

7.8.4.2 Command for pre-lubrication (PRELUBE)

GC800 SCM can control an external electrical pre-lubrication pump. In practice, before starting the engine (so when the mechanic pump of the engine is not yet working), the controller can activate an auxiliary pump: in this case, the oil pressure will be ok before starting the engine, ensuring optimal lubrication.

The function is enabled if:

- Parameter P.0242 (“Maximum duration of pre-lubrication cycle”) is not zero.
- The controller must be able to detect the low oil pressure condition (one of the following):
    1. One digital input configured as DIF.4221 (“Minimum oil pressure”).
    2. One digital input configured as DIF.4222 (“Low oil pressure”).
    3. The oil pressure measurement is available and:
        - The threshold P.0341 (“Threshold for minimum oil pressure”) is not “0”.
        - The threshold P.0339 (“Threshold for low oil pressure”) is not “0”.

The controller activates this cycle before starting the engine (before activating the starter motor, thus before moving the engine). The cycle is available both in MAN and AUTO modes.

During the cycle, the controller activates the PRELUBE command. The cycle ends when:

- If the oil pressure measurement is available:
    1. If P.0339 is different from zero, when the oil pressure is higher than P.0339.
    2. If P.0341 is different from zero, when the oil pressure is higher than P.0341.

- If low oil pressure contacts are available:
    1. If DIF.4222 is available: when this input is not active.
    2. If DIF.4221 is available: when this input is not active.

- after P.0242 seconds (maximum time).

As you can see the controller evaluates first the “low oil pressure” condition: if this is not available, it evaluates the “min oil pressure” condition. This ensures that the pressure reaches the higher available threshold.

When the pre-lubrication cycle ends, the starting sequence goes on (with the starter motor): the PRELUBE command remains active until the engine really starts or until the starting sequence ends. In case of repeated crank attempts, the PRELUBE command persists: the controller evaluates the time configured with P.0242 only during the first attempt. When the engine really starts, the controller removes the PRELUBE command: the mechanical pump of the engine does the job.

7.8.4.3 Preheating of glow plugs (GLOW_PLUGS)

The controller provides this command for old diesel engines, requiring heating their glow plugs before starting. Even if not required for this purpose, you can use it to insert a delay between the opening of the fuel solenoid valve and the activation of the starter motor (see note on FUEL description).

The function is enabled if:

- Parameter P.0209 (“Duration of preheating cycle”) is not zero.

The glow plugs pre-heating cycle starts at the beginning of the starting procedure (together with the pre-lubrication cycle, if any).

If the controller is connected to an ECU, and the ECU provides the standard “Engine Wait to Start Lamp” information (SPN 1081 in J1939 protocol), the cycle ends when the lamp is off (engine ready for cranking process). You can tell the controller to ignore the lamp by bit 5 (“Ignore the "wait to start" lamp”) of parameter P.0715 (“Options for Can-Bus”). In any case, the cycle ends after P.0209 seconds.

INFORMATION! GC800 HMI shows the following standard icon when the ECU activates the “Engine Wait to Start Lamp”:

The controller activates the GLOW_PLUGS command during this cycle. When the cycle ends, the starting sequence goes on (with the starter motor control): the command remains active until the engine really starts or until the starting sequence ends. In case of repeated crank attempts, the GLOW_PLUGS command persists: the controller evaluates the time configured with P.0209 only during the first attempt.

WARNING! the glow plugs pre-heating cycle is performed simultaneously with the pre-lubrication cycle. If P.0209 parameter is set to a value higher than P.0242, the glow plugs pre-heating cycle will last P.0209 seconds as well (and vice-versa).

7.8.4.4 Using two battery sets (BATT1 e BATT2)

To increase the genset reliability, some plants provide a double cranking system for the engine. If the first system fails to start the engine, the controller can try using the second one.

The two system can both be electrical, but it is not mandatory. GC800 SCM provides two terminals (Y1) for connecting the positive pole of two battery sets (if any): you can implement enhanced logics on the higher voltage set.

The controller uses its digital output to switch among the two cranking systems. You can use:

- BATT1 command only. Connect an external relay to this command:
    1. Use the NO contact for properly selecting the primary cranking system.
    2. Use the NC contact for properly selecting the backup cranking system.

- BATT1 and BATT2 commands.
    1. Use BATT1 command for properly selecting the primary cranking system.
    2. Use BATT2 command for properly selecting the secondary cranking system.

The function is enabled if:

- At least one output is configured as DOF.1008 (BATT1).

The controller allows to customize the behaviour of this feature:

- P.0256 (“Selection of the main starting system”). You can choose among:

    0. “The higher voltage one”. In case of two electrical starting system, where both battery packs have been connected to Y1. The primary starting system is the one with higher battery voltage (dynamically selected, the battery voltages are frozen before the first crank attempt). Note: if just one battery is connected to Y1, that battery will be the primary system.

    1. “System #1”. The one activated by BATT1 command.

    2. “System #2”. The one activated by BATT2 command.

    3. “Selected by digital input”. Use a digital input configured as DIF.2065 (“Use 2nd battery pack as master”): when the input is active, the primary system is the one activated by BATT2 command.

- P.0255 (“Management of the double starting system”). You can choose among:

    0. “First all attempts on master system”. The controller will perform P.0211 crank attempts on the primary system, and then other P.0211 crank attempts on the backup system.

    1. “Alternate the attempts between the two systems”. The controller alternates the crank attempts among the two system, until all P.0211 attempts has been executed on both systems.

INFORMATION! In AUTO mode, the controller will perform P.0211 crank attempts on both starting system before activating the AL.022 (“Engine not started”) alarm. In MAN mode, instead, it will perform a maximum of P.0252 attempts: it will use both systems only if P.0255 is set to “1”.

The controller always ensures a one-second delay between any commands (BATT1, BATT2 and START). This means:

- Minimum one second before the first crank attempt: this delay is performed at the same time of the pre-lubrication cycle and the glow plugs pre-heating cycle, and it could be extended to the longer time between those configured in P.0242 and P.0209.
- Minimum a two-seconds switching time in case only BATT1 is used (START OFF → one second → BATT1 → one second →).
- Minimum a three-seconds switching time in case BATT1 and BATT2 are used (START OFF → one second → BATT1 → one second → BATT2 → one second).

The switching time is checked during the delay between two crank attempts. Thus, the controller can increase (if required) the delay configured by P.0212.

The controller deactivates both BATT1 or BATT2 two seconds after the real engine starting.

7.8.4.5 Enable for engine control unit (ECU_ENABLE).

When using electronic engine, usually the engine manufacturer requires to power the ECU only when the engine must run. There are some implications:

- The ECU must be powered a bit before starting the engine (for its checks at power on). The required delay depends on the ECU itself.

- The ECU must be unpowered after the engine is fully stopped (it requires to control the stopping cycle, and usually needs time to save data on non-volatile memory).
- Some after-treatment function in the ECU may require keeping it powered for a time after the stop of the engine.
- When the ECU is not powered, the controller can no more read diagnostic data from it; it's often required a way to keep the ECU powered even when the engine is stopped.

You can use the ECU_ENABLE command to supply the ECU. The following parameters allow its customization:

- P.0718 ("ECU power supply mode"). You can choose among:
    0. "When need to start the engine".
    1. "When need to start the engine and in MAN mode". This allows you to keep the ECU powered even when the engine is stopped (for diagnostic purposes).
    2. "Always powered".
- P.0719 ("Delay between ECU power supply and cranking"). This allows you to adjust the power on delay required by the ECU. The controller waits for this delay before starting any other cycles during the starting procedure (before pre-lubrication, before glow-plugs pre-heating, before selecting the starting system).

When used, the controller activates the ECU_ENABLE command as first command on the entire starting cycle and deactivates it at the end of the stopping cycle, when the engine is fully stopped.

7.8.4.6 Fuel solenoid (FUEL)

The FUEL command should be used to control an external solenoid which intercepts the fuel pipe. At the beginning of the starting sequence, the controller opens the valve, thus allowing the fuel to get to the engine. At the beginning of the stopping sequence, the controller closes the solenoid valve: the engine receives no more fuel and then it stops.

The controller activates the FUEL command at the beginning of the starting procedure. It also ensures a minimum delay of 200 ms between FUEL activation and the cranking motor: sometimes, in fact, if the two commands were activated together, the vacuum in the fuel ducts (caused by the starter motor) does not allow the correct opening of the valve (it gets stuck). This delay is automatically extended by the pre-lubrication and glow-plugs pre-heating cycles. If not enough, use the glow-plugs pre-heating cycle (even if not used for glow-plugs) to extend it as required.

Usually, the controller deactivates the FUEL command at the beginning of the stopping cycle. If you use a different stopping system, but a valve is anyway present on the fuel line, it is possible that the vacuum in the fuel circuit caused by the engine that is stopping may prevent the correct movement of the solenoid valve. You can delay the FUEL deactivation from the beginning of the stopping cycle by parameter P.0234 ("Delay between stop and fuel commands").

7.8.4.7 Command to start the engine (START)

Use this command to direct control the starter motor.

The controller never activates the START command if the engine is not fully stopped. It activates the START command to start the engine and removes it immediately when it detects an "engine running" condition. In this way, it avoids that the starter motor is driven by the engine. In case of failure to start, the controller deactivates the START command at the end of the starting attempt.

The duration of each starting attempt is configurable by parameter P.0210 ("Duration of starter command"), used both in MAN and AUTO modes. The controller may increase this duration for gas engines.

7.8.4.8 Gas solenoid (GAS)

This command only makes sense for gas engines. The aim is to perform the purging cycle of the engine. When a gas engine is turned off, unburned gas remains in the feeding circuit. If it won't be disposed of before the next starting

procedure, it could explode unrestrainedly. Therefore, each time the engine needs to be started, the purging cycle removes this unburned gas. The cycle consists in making the engine rotating (through the starting motor) without opening the gas valve: the vacuum caused by the engine is enough to remove the unburned gas.

This function is enabled by setting parameter P.0241 (“Duration of purging cycle”) to a value higher than zero. The controller activates the GAS command (and thus it opens the gas valve) after P.0241 seconds from the activation of the START command: for this reason, if the duration of the starting cycle (P.0210) is lower than P.0241, it is automatically lengthened to a second more than P.0241.

If the starting attempt fails, the controller closes the GAS valve and repeats the purging cycle at next crank attempt.

7.8.4.9 Stop solenoid (STOP)

You can use this command in critical systems where it is preferrable not to stop the engine instead of stopping it by failures in the control system. When the FUEL control is used, in fact, a failure of the solenoid valve control system will result in its closure, and consequently in the stop of engine.

The STOP command is instead active only during the stopping cycle. Its purpose is to block the flow of fuel to the engine only during the stopping phase: when the engine really stops, the controller removes this command. With this solution, it is always possible to start the engine, even at the presence of failures on the STOP control: at limit, it will not be possible to stop the engine.

The controller activates the STOP command at the beginning of the stopping cycle; it removes this command when the engine is really stopped or after P.0213 seconds ("Duration of stop command ").

7.8.4.10 Command for idle speed (IDLE)

The controller uses the IDLE command to reduce the engine rotation speed, by acting directly on the engine speed governor.

After the starting cycle, it’s quite usual to keep the engine at idle speed for a period, to allow it self-warming. After this period, or when the engine is warmed enough, the speed grows to its rated value.

The controller allows configuring the idle speed cycle after the starting procedure with the following parameters:

- P.0233 ("Idle speed cycle duration"). This is the maximum duration of the idle speed cycle: thus, you can disable this feature by setting it to “0”. If enabled, the cycle starts just after the controller detects the “engine running” condition and ends after P.0233 seconds. The cycle is performed both in MAN and AUTO modes.
- P.0223 (“Minimum rated coolant temperature”). If the cycle is enabled, and the engine coolant temperature is available, the controller can stop the idle speed cycle before P.0233 seconds when the coolant temperature becomes higher than P.0223.

The IDLE command is active during the entire idle speed cycle. The controller activates it at the beginning of the start procedure (when enabled), even if the count-down starts after the engine running detection: this avoids unwanted high speed during the crank process.

INFORMATION! the controller sends the IDLE command to the ECU connected through CAN bus (if it supports this command).

The controller also provides the function DIF.2061 (“Request for idle speed”) for digital inputs configuration: this allows the operator to externally control the idle speed cycle. When the input is configured, the controller activates the IDLE command whenever the input is active, even if the engine is stopped. This external command may be useful if you haven’t access to the speed governor (otherwise you can simply connect your command to the IDLE input of the governor itself): for example, with electronic ECUs connected by CAN bus.

During the idle sped cycle, minimum frequency and minimum voltage protections of the generator are disabled. At the end of the cycle, before enabling the protections, the controller waits maximum P.217 seconds (“Maximum time for

operating conditions"): if voltages and frequency don't get within tolerance, the controller activates the AL.008 alarm ("operating conditions not reached").

During the idle speed cycle, the controller does not allow the GCB circuit breaker closure. If the IDLE cycle is requested (with the digital input) while the GCB is closed, the controller opens GCB (by unloading the generator when possible), and then activates the IDLE command.

Parameter P.0710 ("Idle speed for ECU") allows specifying the rotation speed to be used during the idle speed cycle (if the ECU accepts this command).

7.8.5 Consent for start.

The purpose of this feature is to allow external sequences to execute before the controller starts the engine. For example, the pre-ventilation of the generator room.

To use this feature, configure a digital input with the function DIF.2709 ("Consent to start"): the controller will wait until the input is activated before starting the engine. Once the real start sequence begins, the controller does not check the input anymore.

Example of use:

- When the controller needs to start the engine, it sets the internal status ST.036 ("Engine management: starting"), without doing any real action on engine commands.
- Using PLC, you can create your own pre-ventilation sequence. It starts when the controller activates ST.036 and can perform any actions (using digital/analogue outputs).
- When the pre-ventilation ends, the PLC will activate a virtual digital input, configured as DIF.2709.
- When the controller detects the activation of that virtual input, begins the real starting procedure.

7.8.6 Manual control sequence

7.8.6.1 Manual start

When MAN mode is selected, the operator can start the engine in different ways:

- By pressing the START button on GC800 HMI (available in all display pages in the bottom bar). GC800 translates this action in a Modbus command (see next).
- By sending proper Modbus command ("11") over the communication ports (see paragraph 7.1).
- By sending proper SNMP commands over the Ethernet interfaces (see paragraph 7.1).
- By sending proper HTTP commands over the Ethernet (see paragraph 7.1).
- Using a digital input configured as DIF.2033 ("Manual START command"). The activation of the input triggers the command (the passage from not active to active).

The procedure is the same of AUTO mode, only triggered by the operator command. The number of crank attempts is configured by parameter P.0252 ("Number of manual crank attempts", factory default = 1).

7.8.6.2 Manual stop

When MAN mode is selected, the operator can stop the engine in different ways:

- By pressing the STOP button on GC800 HMI (available in all display pages in the bottom bar). GC800 translates this action in a Modbus command (see next).
- By sending proper Modbus command ("21") over the communication ports (see paragraph 7.1).

- By sending proper SNMP commands over the Ethernet interfaces (see paragraph 7.1).
- By sending proper HTTP commands over the Ethernet (see paragraph 7.1).
- By sending a proper SMS message to the REWIND module connected to a serial port of the controller (when available).
- Using a digital input configured as DIF.2034 (“Manual STOP command”). The activation of the input triggers the command (the passage from not active to active).

The procedure is the same of AUTO mode, only triggered by the operator command. The cool-down cycle is executed only if enabled by bit 1 (“Enable the cooling cycle in manual mode”) of parameter P.0249 (“Sequence options”):in this case, if the controller receives a second STOP command during the cool-down cycle, it immediately stops the engine.

7.8.7 Automatic control sequence

In AUTO mode, the controller starts the engine if there are no alarms, unloads and deactivations and if at least one of the following conditions is present:

- When the controller is in TEST sub-mode (see paragraph 7.2.1.1).
- When the controller is in REMOTE START sub-mode (see paragraph 7.2.1.2).
- When there are no “start inhibition requests” (see paragraph 7.6) and:
  - DRIVE, SPM, MPM, SPTM+SSB, MPTM+MSB applications: always.
  - SSB, MSB, SSB+SSTP, MSB+MSTP applications: in case of mains failure or “MCB not closed” warning (if enabled with parameter P.0221 (“Enable generator supply on MCB fault?”)).
  - SPTM and MPTM: when the mains conditions allow the power production.

When none of the previous condition is present, the controller stops the engine (also selecting the OFF mode).

7.8.7.1 Automatic start

The controller automatically executes P.0211 (in AUTO) or P.0252 (in MAN) crank attempts. At the end, if the engine is not started, it activates the AL.022 anomaly (“Engine not started”). It is a warning in MAN mode, otherwise an alarm. See paragraph 7.8.4.4 for the number of crank attempts when using two starting systems.

Parameter P.0210 ("Duration of starter command") allows configuring the duration of each attempt. Parameter P.0212 ("Delay between start attempts"), instead, allows configuring the pause between two consecutive attempts (the controller can increase the pause if needed, see paragraph 7.8.4.4).

When the controller detects the “engine running” condition, it immediately disconnects the cranking motor and, at the end of the eventual idle speed cycle, it waits for the maximum time configured with P.0217 ("Maximum time for operating conditions") until voltages and frequency of the generator are within tolerance:

- If during this phase the engine stops, the controller will continue with the next starting attempts.
- If generator voltages and frequency reach the proper tolerance bands, the starting procedure is ended: the controller enables the minimum voltage and minimum frequency protections.
- Only in AUTO mode, if voltages or frequency are not “ok” after P.0217 seconds, the controller activates the alarm AL.008 “Operating conditions not reached”.

At the end of the automatic starting procedure, the controller manages a further delay allowing the generator to stabilize/warm up before being connected to the load. This delay can be configured with P.0218 parameter ("Delay before supply"): it does not work in MAN.

Within the starting procedure, GC800 automatically manages pre-lubrication, glow plugs pre-heating and cleaning cycles.

7.8.7.2 Automatic stop

First the controller unloads the generator. This is not possible if:

- At least one alarm or one deactivation is active.
- The power cannot be transferred (the generator is not in parallel with another power source).

Then the controller must open the GCB. In case of opening failure, it may decide to keep the engine running. In any case, if GCB is closed, before stopping the engine the controller waits for all GCB opening attempts.

The next step is the cool-down cycle for the engine. This controller skips this step if:

- The controller never closed the GCB since last start of the engine.
- At least one alarm is active.
- The controller is in MAN mode and the cool-down cycle is disabled in MAN (bit 1 of P.0249).
- The auxiliary services of the engine are not powered; thus, the engine must be stopped suddenly. Parameter P.0240 (“Engine's services are powered by”) allows selecting the power source for these services, among:
    0. By the generator.
    1. By the busbars.
    2. By the loads.
    3. By the mains.

    Often the engine has a whole range of auxiliary services (pumps, fans and so on) that are essential for its proper functioning. These auxiliary services are normally powered from an AC voltage: if this voltage is not available, the engine cannot stay in motion. It often happens that, for example in generators that only produce in parallel with the mains, these services are powered by mains voltage, and therefore the engine should be stopped as soon as the mains fails. If there are no voltages on the selected power source, the controller ends the cool-down cycle immediately. Note: the controller can always perform the cool-down cycle if P.0240 is set to 0.

The cool-down cycle simply consists in keeping the engine running without load, for the time set with P.0215 ("Cooling cycle duration"). The controller aborts the cycle if the coolant temperature is lower than P.0271 (“Minimum temperature for cooling cycle”).

At the end of the cool-down cycle, the controller stops the engine, operating on FUEL and STOP commands. Then it waits for the real stopping for maximum P.0214 seconds (“Duration of stopping cycle”): if the engine doesn’t stop it activates the alarm AL.021 (“Engine not stopped”). The same if the engine starts without a proper command by the controller.

INFORMATION! usually, the stop cycle lasts P.0214 seconds even if the engine stops in a shorter time. If during the stop cycle a new start request arises, the stop cycle ends as soon as the engine really stops, allowing a new start.

7.8.8 Masking of oil protections

If no pre-lubrication system is available, GC800 SCM 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 oil & 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.

7.8.9 Events and signalling

The controller records the following events related to the engine management (if enabled with bit 3 of P.0441 parameter):

- EVT.1040: engine stopped.
- EVT.1041: starting cycle in progress.
- EVT.1042: engine is running.
- EVT.1043: cooling cycle in progress.
- EVT.1044: stopping cycle in progress.
- EVT.1045: idle speed cycle in progress.

- EVT.1050: manual start request.
- EVT.1051: manual stop request.
- EVT.1052: automatic start request.
- EVT.1053: automatic stop request.
- EVT.1054: automatic start request (TEST or REMOTE START from digital input).
- EVT.1055: manual stop request (from digital input).
- EVT.1056: automatic start request (TEST or REMOTE START from communication ports).
- EVT.1057: manual stop request (from communication ports).
- EVT.1058: automatic start request (TEST or REMOTE START from scheduler).
- EVT.1060: automatic start request (TEST or REMOTE START from SMS).
- EVT.1061: manual stop request (from SMS).
- EVT.1062: automatic start request (for non-closed MCB).
- EVT.1063: automatic start request (from MC controller).

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

- DOF.3062 - “Ready to supply”. The controller activates this output when the engine is running after P.0218 ("Delay before supply").

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

- ST.033 – “Lube oil protections enabled”.
- ST.035 – “Engine management: stopped”.
- ST.036 – “Engine management: starting”.
- ST.037 – “Engine management: idle speed”.
- ST.038 – “Engine management: delay before supply”.
- ST.039 – “Engine management: ready to supply”.
- ST.040 – “Engine management: cooling down”.
- ST.041 – “Engine management: stopping”.
- ST.096 – “Ready to supply”.

7.8.10 Fuel pump.

GC800 SCM can fully manage an external fuel pump, used to pump the fuel from the storage tank to the daily tank (on the generator).

The controller needs to measure the fuel level in the daily tank (to start the pump when empty and stop the pump when full). You can use both digital and analogue sensors, selectable with P.0401(“Fuel pump sensor type”).

7.8.10.1 Pump control mode.

The controller provides both automatic and manual control of the pump (not to be confused with the controller operating mode): the controller may be in AUTO mode and the pump in MAN mode and vice-versa. The available modes are:

- **MANUAL-OFF**: the controller stops the pump.
- **MANUAL-ON**: the controller starts the pump whenever the daily tank is not full (keeps it always full).
- **AUTOMATIC**: the controller starts the pump when the daily tank is empty, stops the pump when full.

The operator can select the pump operating mode in several ways:

- Through digital inputs:
  - DIF.2241: forces the pump in MANUAL-OFF mode.
  - DIF.2242: forces the pump in MANUAL-ON mode.
  - DIF.2243: forces the pump in AUTOMATIC mode.

  If at least one of the previous inputs is active, the pump mode is forced and cannot be changed with the other methods described below. In case more than one input is active simultaneously, higher priority is assigned to MANUAL-OFF, followed by MANUAL-ON and then AUTOMATIC.

- By changing P.0400 parameter ("fuel pump mode"). GC800 HMI allows changing this parameter directly from the display page dedicated to the fuel pump.

7.8.10.2 Analogue transducer

If P.0401 is set to "0-Analogue sensor", the daily tank level must be available. GC800 can get this information via CAN from the connected ECU (if available), or can use one of its analogue inputs:

- AIF.1220 (VDO sensor, 0%-180 Ohm, 100%-0 Ohm).
- AIF.1221 (user configurable).

You must also properly set the two thresholds:

- P.0402 ("Fuel pump start threshold").
- P.0403 ("Fuel pump stop threshold").

Both the level and the thresholds are expressed as percentages, not Liters. Both thresholds must be different from zero and P.0402 must be lower than P.0403.

If configured (not mandatory), also the protections' thresholds are used; pay attention to set all of them in the proper order (growing, in the following list):

- P.0347 ("Threshold for minimum fuel level").
- P.0345 ("Threshold for low fuel level").
- P.0402 ("Fuel pump start threshold").
- P.0403 ("Fuel pump stop threshold").
- P.0343 ("Threshold for high fuel level").

7.8.10.3 Digital transducer

If P.0401 is set to "1-Digital sensor", GC800 must have at least two contacts, corresponding to the start/stop level of the pump:

- DIF.3301 ("Level for starting fuel pump"). Active when the level is below the threshold.
- DIF.3302 ("Level for stopping fuel pump"). Active when the level is **below** the threshold.

If configured (not mandatory), also the contacts for protections are used; pay attention to set all of them in the proper order (see previous paragraph):

- DIF.4211 ("Minimum fuel level"). Active when the level is below the threshold.
- DIF.4212 ("Low fuel level). Active when the level is below the threshold.
- DIF.4213 ("High fuel level"). Active when the level is above the threshold.

INFORMATION! the function DIF.3302 is not intuitive as all the others. The input must be activated when the level is below the "stopping threshold". This is to reflect the real behaviour of standard five-contacts digital transducers.

7.8.10.4 Level evaluation.

Whichever level sensor type you use, the controller assigns a status to the actual fuel level, evaluating the following conditions in the order they are proposed:

- If the level is lower than the pump start threshold, the fuel level status is “start”.
- If a low-level threshold exists, and the level is lower than this threshold, the fuel level status is “low”.
- If a minimum level threshold exists, and the level is lower than this threshold, the fuel level status is “minimum”.
- If the level is higher than the stop threshold, the fuel level status is “stop”.
- If a maximum level threshold exists, and the level is higher than this threshold, the fuel level status is “maximum”.
- If none of the previous condition is met, the fuel level status is “hysteresis”.

7.8.10.5 Pump control.

The controller can use two digital outputs to manage the fuel pump:

- Function DOF.1032 (“Fuel pump”). **Mandatory.**
- Function DOF.1034 (“Solenoid for fuel pump”). Optional.

The “pump” output is mandatory (otherwise this function is disabled).

The “solenoid” output is optional. If you want to use it, please properly configure the delay P.0405 (“Delay between solenoid and fuel pump”): the controller ensures the opening of the solenoid valve P.0405 seconds before activating the pump, and its closure P.0405 seconds after stopping the pump. All that to avoid that the vacuum caused by the pump within the fuel circuit could get the solenoid valve stuck.

The controller manages the pump depending on the fuel level “status” assigned before:

- **AUTOMATIC**.
  - The controller starts the pump if the status is “start”, “low” or “minimum”.
  - The controller stops the pump if the status is “stop” or “maximum”.
  - The controller keeps the actual command if the status is “hysteresis”.

- **MANUAL-ON**.
  - The controller stops the pump if the status is “stop” or “maximum”.
  - In all other conditions, the controller starts the pump.

- **MANUAL-OFF**.
  - The controller always stops the pump.

The controller always stops the pump (whatever the status is) in the following conditions:

- In case of anomalies activated by digital inputs configured with the following functions:
  - DIF.4051 “Warning (stops fuel pump)”.
  - DIF.4052 “Unload (stops fuel pump)”.
  - DIF.4053 “Deactivation (stops fuel pump)”.
  - DIF.4054 “Alarm (stops fuel pump)”.

- In case of anomalies activated by thresholds on analogue inputs (5.6.4). The bit 14 of the parameters “Configuration #x for the analogue input #” (P.4005 for example), allows you to link the anomaly activated by the threshold to the fuel pump.

- When the controller is in OFF mode. In this case the controller stops the pump after five seconds, avoiding unwanted stopping for temporary controller’s mode switching.

- When the power source of the pump is not available (for at least 5 seconds). Parameter P.0406 (“Power source for the fuel pump”) allows you to select which is the power source of the pump:
  - By the generator.
  - By the bus bars.
  - By the loads.
  - By the mains.
  - Always supplied.

- When the pump activation time exceeds the value configured by P.0404 (“Fuel pump maximum activation time”). If P.0404 is set to zero, this feature is disabled. The purpose is to detect malfunctions in the pump or in the loading circuit: if everything works fine, in fact, the loading procedure should end after a maximum calculable time. You should calculate this time in the worst condition, thus considering the maximum engine consumption. The pump should be dimensioned to be able to fill the daily tank in a reasonable time even when the engine is running at its maximum power. If the pump activation time exceed P.0404, the controller activates the anomaly AL.064 (“Fuel pump failure”).

INFORMATION! the controller stops the pump while the previously anomalies are present, the underlying conditions don’t matter. You must acknowledge/reset the anomalies to allow the controller restarting the pump.

7.8.10.6 Events and signalling

The controller records the following events related to the fuel pump (if enabled with bit 7 of P.0441 parameter):

- EVT.1070: the pump is started.
- EVT.1071: the pump is stopped.

7.8.11 Maintenance

The controller can automatically signal the request of periodic maintenance to the operator through two counters of engine working hours and days counter.

7.8.11.1 Maintenance hours counter 1

To use this function, set the desired service interval into P.0424 (“Maintenance interval 1 (running hours)”). Leave P.0424 to “0” if you don’t need this feature.

The controller starts counting at the setting time of P.0424. Once the configured interval elapses, the controller activates an anomaly (AL.039): you can select the anomaly type by P.0425. The “service request” is saved into non-volatile memory: at next power-cycle of the controller the anomaly AL.039 will still be present.

To clear the “service request”, you must set P.0424 again. You can:

- Set it to zero to disable the anomaly.
- Confirm the present value to restart another identical period.
- Set a different value.

P.0424 and P.0425 parameters require the “installer’s” access level for their programming: this, for example, avoids that final customer can reset the maintenance request.

7.8.11.2 Maintenance hours counter 2

To use this function, set the desired service interval into P.0436 (“Maintenance interval 2 (running hours)”). Leave P.0436 to “0” if you don’t need this feature.

The controller starts counting at the setting time of P.0436. Once the configured interval elapses, the controller activates an anomaly (AL.040): you can select the anomaly type by P.0437. The “service request” is saved into non-volatile memory: at next power-cycle of the controller the anomaly AL.040 will still be present.

To clear the “service request”, you must set P.0436 again. You can:

- Set it to zero to disable the anomaly.
- Confirm the present value to restart another identical period.
- Set a different value.

P.0436 and P.0437 parameters require the “installer’s” access level for their programming: this, for example, avoids that final customer can reset the maintenance request.

7.8.11.3 Days counter for maintenance

To use this function, set the desired service interval into P.0438 (“Interval of days for maintenance”). Leave P.0438 to “0” if you don’t need this feature.

INFORMATION! P.0438 allows setting a day's interval, not "running days".

The controller starts counting at 8:00 AM of the day the operator modified P.0438. Once the configured interval elapses, the controller activates a warning (AL.050). The "service request" is saved into non-volatile memory: at next power-cycle of the controller the anomaly AL.050 will still be present.

To clear the "service request", you must set P.0438 again. You can:

- Set it to zero to disable the anomaly.
- Confirm the present value to restart another identical period.
- Set a different value.

P.0438parameter requires the "installer's" access level for their programming: this, for example, avoids that final customer can reset the maintenance request.

7.8.12 TIER 4 / STAGE V support

The controller fully supports the TIER4 (US) and STAGE V (EU) directives concerning generators emissions. This support consists of two parts: visualization and commands.

7.8.12.1 Visualization: required lamps.

The directives define some standard lamps related to the emission control system. The ECU activates these lamps to warn the operator, thus GC800 must show them:

- GC800 SCM acquires all the lamp requests from the ECU.
- GC800 HMI properly shows these lamps on a specific display page (the one related to the engine, it automatically switches to this page when the ECU issues a new lamp request).

The directives also define:

- Specific icons for each lamp.
- Each lamp can be fixed or blinking to indicate different warning levels; the directives also define two different blink rates (1 Hz and 2Hz).

GC800 HMI uses the proposed icons and respect the fixed/blink rates requests coming from the ECU. Thus, refer to the ECU documentation to understand the meaning of fixed/flashing lamps (the following descriptions are a general indication, and may be different from the specific ECU implementation). See the GC800 HMI technical manual for information on icons colours.

Standard J1939 requests:

- SPN 624 ("Amber Warning Lamp").
- SPN 3040 ("Flash Amber Warning Lamp").

The ECU uses this lamp to signal a "warning". It may be any generic anomaly, not strictly linked to the emission system. The directives, however, define the combination of this lamp with the emission system's related ones.

Standard J1939 requests:

- SPN 623 (“Red Stop Lamp”).
- SPN 3039 (“Flash Red Stop Lamp”).

The ECU uses this lamp to signal a “shutdown” (the ECU itself stopped the engine). It may be any generic anomaly, not strictly linked to the emission system. The directives, however, define the combination of this lamp with the emission system’s related ones. It is red.

Standard J1939 requests:

- SPN 1213 (“Malfunction Indicator Lamp”).
- SPN 3038 (“Flash Malfunction Indicator Lamp”).

The ECU uses this lamp to signal a malfunction in the engine emissions system (or that it is working outside the standard operating conditions).

Standard J1939 requests:

- SPN 3700 (“Aftertreatment Diesel Particulate Filter Active Regeneration Status”).
- SPN 3701 (“Aftertreatment Diesel Particulate Filter Status”).
- SPN 3697 (“Diesel Particulate Filter Lamp Command”).
- SPN 6915 (“SCR System Cleaning Lamp Command”).

The ECU requires to perform the regeneration of the diesel particulate filter. It is solid (not blinking) if the quantity of particulate in the filter is above the "regeneration request" threshold but below the warning threshold (yellow), otherwise flashing (red).

It is also used to indicate that the regeneration is in progress (usually green in this condition)

Standard J1939 requests:

- SPN 3703 (“Diesel Particulate Filter Active Regeneration Inhibited Due to Inhibit Switch”).
- SPN 6918 (“SCR System Cleaning Inhibited Due to Inhibit Switch”).

The ECU cannot perform the required regeneration of the diesel particulate filter because the operator explicitly prohibited it. It is usually solid (not blinking). If, however, the condition persists for a long time and the soot level in the filter becomes extremely high, the ECU activates a diagnostic code with “Red Stop Lamp” and stops the engine: in this case the lamp blinks.

Standard J1939 requests:

- SPN 3698 (“Exhaust System High Temperature Lamp Command”).

The ECU uses this lamp to signal 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”).

The ECU uses this lamp to signal a low level of the Diesel Exhaust Fluid (DEF) tank. It can be solid (not blinking) if the level is below normal, flashing in case the very low level resulted in a power derating.

INFORMATION! The SPN indications in the previous description refers to the J1939 standard. Each ECU manufacturer can specify different messages for requesting the lamps: refer to the ECU documentation.

7.8.12.2 Visualization: required measurements.

The directive requires the visualization of a minimum set of information:

- Percent of soot in the Diesel Particulate Filter (DPF).
- Percentage of ash in the Diesel Particulate Filter (DPF).
- Level of the Diesel Emissions Fluid (DEF).

GC800 supports all of them and much more:

- SPN 81 ("Aftertreatment 1 Diesel Particulate Filter Intake Pressure").
- SPN 1761 ("Aftertreatment 1 Diesel Exhaust Fluid Tank Volume").
- SPN 3031 ("Aftertreatment 1 Diesel Exhaust Fluid Tank 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 3241 ("Aftertreatment 1 Exhaust Temperature 1").
- SPN 3242 ("Aftertreatment 1 Diesel Particulate Filter Intake Temperature").
- SPN 3246 ("Aftertreatment 1 Diesel Particulate Filter Outlet Temperature").
- SPN 3251 ("Aftertreatment 1 Diesel Particulate Filter Differential Pressure").
- SPN 3515 ("Aftertreatment 1 Diesel Exhaust Fluid Temperature 2").
- SPN 3516 ("Aftertreatment 1 Diesel Exhaust Fluid Concentration")
- SPN 3699 (“Aftertreatment Diesel Particulate Filter Passive Regeneration Status”).
- SPN 3700 (“Aftertreatment Diesel Particulate Filter Active Regeneration Status”).
- SPN 3701 (“Aftertreatment Diesel Particulate Filter Status”).
- 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 3719 (“Aftertreatment 1 Diesel Particulate Filter Soot Load Percent”).
- SPN 3720 ("Aftertreatment 1 Diesel Particulate Filter Ash Load Percent").
- SPN 3721 ("Aftertreatment 1 Diesel Particulate Filter Time Since Last Active Regeneration").
- SPN 3750 (“Aftertreatment 1 Diesel Particulate Filter Conditions Not Met for Active Regeneration”).
- SPN 4331 ("Aftertreatment 1 Diesel Exhaust Fluid Actual Dosing Quantity").
- SPN 4332 ("Aftertreatment 1 SCR System 1 State").
- SPN 4334 ("Aftertreatment 1 Diesel Exhaust Fluid Doser 1 Absolute Pressure").
- SPN 4360 ("Aftertreatment 1 SCR Intake Temperature").
- SPN 4363 ("Aftertreatment 1 SCR Outlet Temperature").
- 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 5245 ("Aftertreatment Diesel Exhaust Fluid Tank Low Level Indicator").
- SPN 5246 ("Aftertreatment SCR Operator Inducement Severity").
- SPN 5466 ("Aftertreatment 1 Diesel Particulate Filter Soot Load Regeneration Threshold").
- SPN 5826 ("Emission Control System Operator Inducement Severity").
- SPN 5963 ("Aftertreatment 1 Total Diesel Exhaust Fluid Used").
- SPN 6563 ("Aftertreatment Trip Diesel Exhaust Fluid")

7.8.12.3 Commands.

The ECU continuously monitors the status of the DPF (Diesel Particulate Filter): when the level of soot/ash become higher than a specific ECU threshold, it informs the operator by activating the “Diesel Particulate Filter Lamp”, but it not automatically starts the regeneration: it waits for a consent from the operator.

The regeneration is a process that may impact on engine. It may require to:

- To increase the engine speed. This is not compatible with a standard use of the generator: increasing speed results in increasing the generated frequency and this may result in damaging the loads connected to the generator (not feasible at all if the generator is in parallel to any other power source).

- To increasing temperatures. High temperatures usually result in derating the engine performances: the generator may no more be able to fully supply the loads.

For this reason, the ECU waits for a consent before starting the regeneration process. GC800 SCM, as factory default, sends the consent to the ECU when the GCB circuit breaker is open: there are no risks both in increase speed and temperatures. You can override the standard GC800 SCM behaviour by using the function DIF.2073 (“Consent for DPF regeneration”).

Since during the regeneration the speed may increase, the controller disables all maximum speed/frequency protections when the GCB is open end the ECU is performing the regeneration: the relevant protections for the engine temperatures and for the generator voltages remain active.

If an ECU does not need to increase the engine speed (or to derate the engine) during the regeneration, it may not require any consent from the operator. But if you don’t want to allow the regeneration process without your consent, the controller allow you to “inhibit” the regeneration (see below). In other situations, instead, you may want to force a regeneration even if the filter conditions do not require it yet (for example, before starting the engine for a long uninterruptable period): the controller allows you to “force” the regeneration.

The controller implements the “inhibit/forcing” commands in two ways:

- Parameter P.0446 (“DPF regeneration mode”). GC800 HMI allows changing the parameter from the TIER 4 display pages. This parameter can take three values:

0. **Automatic**. The controller does not send any commands to the ECU, which is therefore free to perform the regeneration whenever it wants (the consent is managed, if required).
1. **Forced**. The controller sends the forcing command to the ECU for a maximum of P.0447 seconds ("Maximum duration of DPF regeneration forcing"), then the parameter is reset to "0-Automatic". If the ECU can, it carries out a regeneration cycle, which involves overheating the emission treatment system and derating the engine. Following this command, some of the lamps described above can be activated.
2. **Inhibited**. It activates the ECU inhibition command, which therefore does not regenerate, even if required.

- As an alternative to the parameter, it is possible to use two digital inputs configured with the following functions:
  - DIF.2071 ("Inhibit DPF regeneration").
  - DIF.2072 ("Force DPF regeneration").

  If there is one of the inputs, parameter P.0446 can no longer be changed, because the inputs go to force the value of the parameter.

As a rule, the controller uses the CAN bus line to send these commands to the ECU:

- SPN 3695 ("Aftertreatment Regeneration Inhibit Switch").
- SPN 3696 ("Aftertreatment Regeneration Force Switch").
-

It is also possible to use digital outputs, configured with the following functions:

- DOF.1035 ("1035-Inhibit DPF regeneration").
- DOF.1036 ("1036-Force DPF regeneration").

WARNING! If you do not allow the regeneration for too long (either by not providing the consent or by never removing the inhibition), the filter can reach a so full level that the ECU must shutdown the engine.

WARNING! If you use DIF.2073 for the regeneration consent, pay attention to allow the regeneration only when the engine is in safe conditions,

INFORMATION! the above descripted commands refer to standard J1939 ECUs. Specific ECUs may require a different command behaviour.

7.8.12.4 Signalling

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

- ST.137 – "Inhibit DPF regeneration".
- ST.138 – "Force DPF regeneration".
- ST.368 – "Active regeneration status: not active (spn3700=0)".
- ST.369 – "Active regeneration status: active (spn3700=1)".
- ST.370 – "Active regeneration status: will start soon (spn3700=2)".
- ST.371 – "DPF status: regeneration not required (spn3701=0)".
- ST.372 – "DPF status: regeneration needed - lowest level (spn3701=1)".
- ST.373 – "DPF status: regeneration needed - moderate level (spn3701=2)".
- ST.374 – "DPF status: regeneration needed - highest level (spn3701=3)".

7.8.12.5 DEF - Diesel Exhaust Fluid (AdBlue).

AdBlue is a fundamental component of the aftertreatment systems. Any TIER4 engine has a daily tank for this fluid, and the controller can acquire its level from CAN bus (SPN 1761 "Aftertreatment 1 Diesel Exhaust Fluid Tank Volume", if available). GC800 HMI shows the acquired level.

GC800 SCM can fully manage an external pump, used to pump the AdBlue fluid from an external storage tank to the daily tank of the engine. It uses the level acquired from CAN bus (SPN 1761), if available. Otherwise, it can use some digital inputs (if you configure the digital inputs, the controller ignores SPN 1761).

7.8.12.5.1 Pump control mode.

The controller provides both automatic and manual control of the pump (not to be confused with the controller operating mode): the controller may be in AUTO mode and the pump in MAN mode and vice-versa. The available modes are:

- **MANUAL-OFF**: the controller stops the pump.
- **MANUAL-ON**: the controller starts the pump whenever the daily tank is not full (keeps it always full).
- **AUTOMATIC**: the controller starts the pump when the daily tank is empty, stops the pump when full.

The operator can select the pump operating mode by changing P.1490 parameter (“AdBlue pump mode”). GC800 HMI allows changing this parameter directly from the display page dedicated to the AdBlue pump.

7.8.12.5.2 Analogue transducer

If there are no digital inputs configured for this purpose (see next), the daily tank level must be available from CAN bus (SPN 1761). You must also properly set the two thresholds:

- P.0492 (“AdBlue pump start threshold”).
- P.0493 (“AdBlue pump stop threshold”).

Both the level and the thresholds are expressed as percentages, not Liters. Both thresholds must be different from zero and P.0492 must be lower than P.0493.

7.8.12.5.3 Digital transducer

Configure the two following inputs if you want to manage the fluid level in the daily tank using contacts:

- DIF.3311 (“Level for starting AdBlue pump”). Active when the level is below the threshold.
- DIF.3312 (“Level for stopping AdBlue pump”). Active when the level is below the threshold.

INFORMATION! the function DIF.3312 is not intuitive. The input must be activated when the level is below the “stopping threshold”.

7.8.12.5.4 Level evaluation.

Whichever level sensor type you use, the controller assigns a status to the actual fluid level, evaluating the following conditions in the order they are proposed:

- If the level is lower than the pump start threshold, the fluid level status is “start”.
- If the level is higher than the stop threshold, the fluid level status is “stop”.
- If none of the previous condition is met, the fluid level status is “hysteresis”.

7.8.12.5.5 Pump control.

The controller can use two digital outputs to manage the pump:

- Function DOF.1037 (“AdBlue pump”). **Mandatory.**
- Function DOF.1038 (“Solenoid for AdBlue pump”). Optional.

The “pump” output is mandatory (otherwise this function is disabled).

The “solenoid” output is optional. If you want to use it, please properly configure the delay P.1495 (“Delay between solenoid and AdBlue pump”): the controller ensures the opening of the solenoid valve P.1495 seconds before activating the pump, and its closure P.0405 seconds after stopping the pump. All that to avoid that the vacuum caused by the pump within the circuit could get the solenoid valve stuck.

The controller manages the pump depending on the fluid level “status” assigned before:

- **AUTOMATIC**.
  - The controller starts the pump if the status is “start”.
  - The controller stops the pump if the status is “stop”.
  - The controller keeps the actual command if the status is “hysteresis”.
- **MANUAL-ON**.
  - The controller stops the pump if the status is “stop”.
  - In all other conditions, the controller starts the pump.
- **MANUAL-OFF**.
  - The controller always stops the pump.

The controller always stops the pump (whatever the status is) in the following conditions:

- When the controller is in OFF mode. In this case the controller stops the pump after five seconds, avoiding unwanted stopping for temporary controller’s mode switching.
- When the power source of the pump is not available (for at least 5 seconds). Parameter P.1496 (“Power source for the AdBlue pump”) allows you to select which is the power source of the pump:
  - By the generator.
  - By the bus bars.
  - By the loads.
  - By the mains.
  - Always supplied.
- When the pump activation time exceeds the value configured by P.1494 (“AdBlue pump maximum activation time”). If P.1494 is set to zero, this feature is disabled. The purpose is to detect malfunctions in the pump or in the loading circuit: if everything works fine, in fact, the loading procedure should end after a maximum calculable time. You should calculate this time in the worst condition, thus considering the maximum engine consumption of AdBlue fluid. The pump should be dimensioned to be able to fill the daily tank in a reasonable time even when the engine is running at its maximum power. If the pump activation time exceed P.1494, the controller activates the anomaly AL.095 (“AdBlue pump failure”).

INFORMATION! the controller stops the pump while the previously anomalies are present, the underlying conditions don’t matter. You must acknowledge/reset the anomalies to allow the controller restarting the pump.

7.8.12.5.6 Events and signalling

The controller records the following events related to the AdBlue pump (if enabled with bit 7 of P.0441 parameter):

- EVT.1072: the pump is started.
- EVT.1073: the pump is stopped.

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

- ST.139 – “AdBlue pump command”.
- ST.140 – “AdBlue solenoid command”.

7.8.13 Engine derating.

INFORMATION! it makes sense only when the generator is operating in parallel to other power sources.

This feature allows the operator to require a derating of the engine in particular plant conditions (for example high intercooler/oil/exhaust temperatures). The derating operates by applying a reduction to the current active power setpoint of the generator.

The controller provides four derating steps, selectable by digital inputs:

- DIF.2341 (“Request #1 for engine derating”).
- DIF.2342 (“Request #2 for engine derating”).
- DIF.2343 (“Request #3 for engine derating”).
- DIF.2344 (“Request #4 for engine derating”).

The controller also provides four parameters for each derating step:

- P.1281 - P.1285 - P.1289 - P.1293: the required active power reduction (percentage).
- P.1282 - P.1286 - P.1290 - P.1294: the active power ramp (%/s). The controller will use this ramp to move the generator active power from the previous setpoint (before derating) to the new one (after derating).
- P.1283 - P.1287 - P.1291 - P.1295: the controller must keep the power reduction for this time after the request disappears.
- P.1284 - P.1288 - P.1292 - P.1296: a bit-mapper parameter, allowing to specify options (for the single step):
  - bit 0: if this bit is set, the controller calculates the power reduction as a percentage of the nominal power P.0125 (otherwise it is a percentage of the generator active power in the derating activation time).
  - bit 1: if this bit is set, the controller always performs the full ramp to bring the active power to the reduced setpoint, even if the derating request disappears before.

The controller operates in the following way:

- When a derating input **becomes** active, the controller calculates the new power setpoint, using the parameters related to that input.
- It continuously selects the higher active derating request (the request with higher power reduction among the active ones).
- If the current active power setpoint is different from the one selected in the previous point, the controller uses the configured ramp to gradually move it.
- The controller sends the “derated” power setpoint over the PMCB CAN bus as it was its “nominal power”. The other gensets controller will react by sharing the loads (multiple parallel in island mode) or the power setpoint (multiple parallel to the mains) as the derated genset was a smaller one.

The controller records the following events related to the derating management:

- EVT.1141: a new derating request activated.
- EVT.1142: all derating requests deactivated.

7.8.14 AFR (Air Fuel Ratio)

This feature applies to gas engines only. The controller manages a motorized valve (gas mixer, simply **mixer** in the following) that regulates the percentages of air and gas introduced into the engine's cylinders.

The **mixer** is an electronic device: it accepts (through an analogue input) a "position" setpoint and uses an internal PID loop to bring its real position to the required one, acting on the internal motor and the feedback. GC800 SCM can also manage a mixer which accepts digital commands (OPEN/CLOSE) (see 7.8.14.3).

You can use this feature for:

- Directly adjust the "lambda" value of the exhaust gases.
- Indirectly adjust the "lambda" value of the exhaust gases, monitoring the pressure of the air/gas mixture (MAP "Manifold Air Pressure").
- Adjust the exhaust gas temperature.
- Adjust the cylinders temperature.
- ...

In the controller's terminology, "AFR-IN" identifies the value to be adjusted. GC800 SCM must acquire the "AFR-IN" value. Connect a proper sender to an analogue input of the controller, configured as AIF.1681 ("AFR: AFR-IN sensor"). In the sender configuration (conversion curve), you can:

- Indicate a name for the sender (for example "MAP").
- Indicate the unit of measurement (for example "mbar").
- Indicate the number of decimal digits you want to see (for example "0").

GC800 HMI uses this information to correctly show measurements and thresholds on the AFR display page.

INFORMATION! the controller uses a PID loop to control the mixer, and it operates with percentages. The controller does not provide any parameter to configure the nominal "AFR-IN" value, but uses the higher value set in the conversion curve of the sender. Thus, ensure to add the relevant point to the curve, allowing the controller to correctly calculate percentages.

Optionally, the controller can acquire the temperature of the air/gas mixture (MAT "Manifold Air Temperature") by another an analogue input, configured with the function AIF.1683 ("AFR: MAT sensor"). The controller can use this measurement for:

- Visualization (GC800 HMI).
- Protections.
- Correct the "AFR-IN" setpoint.
- Manage an additional derating (see 7.8.13) for high MAT temperature.

7.8.14.1 Operation

INFORMATION! the following description often refers to the engine's power. The controller does not acquire this measure but uses instead the generator's active power (see 7.8.2.2).

Basically, you must define a "default position for the mixer" for a list of predefined engine's operating conditions (engine stopped, cranking, stopping, no-load operation, low power operation). In these conditions, the controller will simply "request" the configured position to the mixer.

When the engine's active power grows over the P.1333 threshold ("Engine power - point 1"), the controller extracts the "AFR-IN" setpoint from a table and uses a PID loop (that acts on the "requested" position for the mixer) to match the real measurement to the extracted setpoint.

You must properly configure this table. The table provides maximum seven rows. Each row corresponds to a specific engine power level (%): you **must** select the "AFR-IN" value required for that power level, and **optionally** the required "base" mixer position.

If you don't configure the "base" mixer positions (all left to "0"), the PID of the controller is free to move the mixer from 0 to 100% to reach the target "AFR-IN" value (it ignores P.1357); otherwise, it is only allowed to move the mixer around the base position, maximum +/- P.1357 ("Maximum PID correction").

The controller interpolates among the table rows, to extract the "AFR-IN" setpoint corresponding to the actual engine power.

7.8.14.2 Correction of the mixer position

When the engine's power is lower than P.1333, the controller's PID loop is disabled (the operator selected the required mixer position by parameters). In this condition, if you need to dynamically adjust the mixer position based on external conditions, you can use an analogue input configured as AIF.1691 ("Mixer position correction (AFR)"). The controller manages the value acquired by this input as a signed percentage: it adds the acquired value to the configured fixed mixer position. You can assign this function to a virtual analogue input and create any customized PLC logic to adjust the mixer position.

GC800 HMI shows this "correction value" (if available).

7.8.14.3 Mixer position

The controller can optionally acquire the real position of the mixer, using an analogue input configured with the function AIF.1687 ("1687-AFR: Mixer feedback"). Even if not mandatory, this measurement is useful during commissioning. **It becomes mandatory** if the mixer is controlled by two OPEN/CLOSE digital outputs.

GC800 HMI shows this measurement (if available).

7.8.14.4 Actuator position

In the engine control system, the mixer only determines the amount of gas to be sent to the carburation system. Downstream of it, however, a further valve will regulate the quantity of mixture sent to the cylinders (actuator). The two adjustments affect each other; it is therefore convenient to view the position of both valves. The controller can (optionally) acquire the actuator position using an analogue input configured with the function AIF.1689 ("AFR: Actuator feedback").

7.8.14.5 Mixer command

The controller can use two different control systems:

- An analogue output configured as AOF.1021 ("AFR - Mixer command (curve)"). Using the conversion curve, it is possible to adapt the real command signal (Vdc, mA etc.) to the mixer's input, to make the command percentage values coincide with the real position of the mixer (in this phase it may be useful to acquire the mixer position – see 7.8.14.3).
- Two digital outputs configured as DOF.1041 ("AFR - Mixer "open" command") and DOF.1042 ("AFR - Mixer "close" command"). It is mandatory to acquire the mixer position (see 7.8.14.3): internally the controller still calculates a "mixer position setpoint" and needs to know the real mixer position to select the proper OPEN or CLOSE command. This control system is less precise than the analogue one: to avoid continuous commands around the target position, you can configure an acceptable error below which the controller does not activate any output. Use P.1358 ("AFR-IN regulation dead band (UP/DN)") to configure the maximum acceptable error.

The controller provides two control modes (MAN/AUTO) for the mixer (note: independent from the controller's MAN/AUTO mode; the controller can be in AUTO and the mixer in MAN, or vice-versa). You can select the control mode in two ways:

- By using a digital input configured as DIF.2391 (“AFR - Mixer in MAN mode”): if such input is present, the controller ignores P.1301.
- By using parameter P.1301 (“Mixer mode”). GC800 HMI allows you changing P.1301 directly from the AFR display page.

7.8.14.6 Ramps

When the engine’s power is lower than P.1333, the controller responds to any changes in the mixer position setpoint using a ramp, avoiding too big transients. Two ramps are available:

- P.1303 (“Mixer manual ramp”): used with the mixer in MAN.
- P.1305 (“Mixer regulation ramp”): used with the mixer in AUTO.

The ramps are set in "%/s".

The controller uses the P.1305 ramp when switching from “fixed position” to PID regulation and vice-versa. It doesn’t use P.1305 when stopping the genset.

7.8.14.7 Mixer manual control

When the mixer is in MAN mode, the controller uses P.1302 (“Mixer position - manual”) as mixer position setpoint, **even when the engine is stopped**. This allows to test the connection between GC800 SCM and the mixer, and the capability of the mixer to carry out full movements.

WARNING! Ensure to set the proper value for P.1302 before switching the mixer from “AUTO” to “MAN” mode.

GC800 HMI allows to directly change this setpoint from the AFR display page.

7.8.14.8 Mixer automatic control

When the mixer is in AUTO mode, the controller selects its "required" position with different algorithms based on the operating conditions. These algorithms will be described below.

When the engine’s power is lower than P.1333, the controller uses the following setpoints (two groups available):

Description	Unit	Set 1	Set 2
Mixer position - cranking #.	%	P.1314	P.1317
Mixer increment - cranking #.	%	P.1315	P.1318
Mixer position - running #.	%	P.1316	P.1319
Mixer position - low power #.	%	P.1331	P.1332

The controller allows selecting among the two sets with a digital input configured as DIF. 2392 (“2392-AFR - Gas type selection”): if the input is active, the controller uses the SET#2.

The two-sets purpose is to allow different behaviour depending on the gas quality.

7.8.14.8.1 Engine stopping or stopped.

INFORMATION! during this phase, the controller **does not apply** the correction described in 7.8.14.2.

Usually, an additional valve takes care of closing the gas pipe when the engine is stopped or for stopping it. it is therefore not necessary to move the mixer to the "0" position. The controller, however, provides you setpoints:

- When the engine is stopped, it moves the mixer to the position P.1306 (“Mixer position - engine stopped”).
- During the stopping cycle, it moves the mixer to the cranking position (P.1314 or P.1317, see above).

7.8.14.8.2 Starting the engine

INFORMATION! during this phase, the controller applies the correction described in 7.8.14.2.

This phase ends when the controller recognizes the engine running condition. During this phase, the "required" position of the mixer can be determined in two different ways:

- Fixed value. The position of the mixer is determined by the setpoints P.1314 or P.1317. The controller uses this working method if P.1311 (“CH4 management enable”) is set to zero. In case the engine doesn’t start after a crank attempt, parameters P.1315 or P.1318 allows to increment the mixer position for the next cranking attempt (to increase the quantity of gas).
- Regulation based on the percentage of methane (CH4). The controller can optionally acquire a signal indicating the percentage of methane in the gas, using an analogue input configured with the function AIF.1685 (“AFR: CH4 sensor”). You can configure the required mixer position for two methane concentrations (40% and 60%, parameters P.1312 and P.1313, extreme point of the curve): the controller calculates the real required mixer position by interpolating the acquired methane concentration with the two configured points (limiting the

calculated value between P.1312 and P.1313). The controller uses this working method if P.1311 is different from zero.

Parameter P.1304 (“Mixer regulation delay”) allows adding a delay at the beginning of this phase: during this delay the controller doesn’t change the position of the mixer.

7.8.14.8.3 Engine running without load (GCB open)

INFORMATION! during this phase, the controller applies the correction described in 7.8.14.2.

This phase ends when the GCB is closed, or a stopping cycle is commanded. In this phase, the "required" position for the mixer is determined by the parameters P.1316 or P.1319.

7.8.14.8.4 Engine running at low load (GCB closed, kW < P.1333)

INFORMATION! during this phase, the controller applies the correction described in 7.8.14.2.

This phase ends when GCB is opened or if the active power exceeds the threshold P.1333. In this phase, the "required" position for the mixer is determined by the parameters P.1331 or P.1332.

7.8.14.8.5 Engine running at high load (GCB closed, kW > P.1333)

INFORMATION! during this phase, the controller **does not apply** the correction described in 7.8.14.2.

This phase ends when the GCB is opened or if the active power falls below the threshold P.1333.

During this phase, the controller operates using a table previously configured by the operator:

Point	Engine power (%)	AFR-IN required value	Mixer “base” position (%)
1	P.1333	P.1340	P.1347
2	P.1334	P.1341	P.1348
3	P.1335	P.1342	P.1349
4	P.1336	P.1343	P.1350
5	P.1337	P.1344	P.1351
6	P.1338	P.1345	P.1352
7	P.1339	P.1346	P.1353

The maximum number of rows is seven: however, you can use fewer rows simply by leaving the “engine power” parameter to zero for any not used row.

WARNING! For the used rows, set the “engine power” parameters in ascending order, without empty rows. An example using five rows: 30%, 45%, 60%, 70%, 80%, 0%, 0%.

For any used row, you **must** configure the related “AFR-IN required value”. This is mandatory, the controller needs this setpoint to properly work.

Using the data configured in the first two columns of the table, the controller calculates by interpolation the setpoint for the AFR-IN measurement corresponding to the power supplied by the generator. This setpoint can then be slightly changed if the MAT temperature is different from the threshold set with parameter P.1391 (see 7.8.14.10). The PID control loop will then act on the mixer position to bring the AFR-IN measurement to the calculated setpoint.

To stabilize the mixer as much as possible, the controller uses the following precautions:

- The controller uses the average value for the active power instead of the instantaneous value. If the power measurement is more stable, the setpoint for AFR-IN extracted from the table is also more stable.
- The controller averages the setpoint for AFR-IN extracted from the table in a period of one second. This keeps it more stable across variations in the average power.

- You can also add a filter for the AFR-IN sensor. Parameter P.1371 (“AFR-IN filter time”) allows to configure the filter period (in seconds); the controller averages the AFR-IN value in the configured period.

During the regulation, in fact, the variation of the mixer position affects the supplied power (as well as the AFR-IN measurement), which in turn causes a different setpoint for the AFR-IN measurement. By slowing down the control loop with averages, the speed regulator can manage to compensate the power error introduced by the mixer variation, before correcting the mixer again. The regulation loop acts every 100 milliseconds.

Optionally (not mandatory), you can configure the third column of the table: it gives the controller an indication of the theoretical position of the mixer (for the specific engine power) to obtain the specific AFR-IN value. The controller first establishes the "basic" position for the mixer at the current power (interpolation between the points in the table). Then it applies a PID regulation loop, which modifies (only partially) the "base" position, to bring the AFR-IN measurement close to the relative setpoint. Parameter P.1357 establishes the maximum correction applied by the PID with respect to the "base" position. **This system only works well with high quality and constant gas**.

INFORMATION! if you don’t want to use this feature (base mixer positions) set **all points** in the third column to zero.

The table is thus critical for the controlling the mixer: properly setting its points may be a difficult task for the operator. Let’s give an example on how to operate, supposing we must respect a “maximum NOX” value for exhaust gases (to comply with emission regulations). If we only have one MAP sensor available (air/gas mixture pressure), the relative set points are not directly supplied by the engine manufacturer but must be derived empirically. It can be done with the following manual procedure:

- You need an instrument that measures the "NOX" value of the exhaust gases.
- From the documentation, obtain the "NOX" value prescribed by the engine manufacturer or by the emissions regulations (for example 500).
- Put the mixer in MAN mode and set P.1302 to a position that is good for starting.
- Start the engine, close the GCB and bring the generator to the power configured with P.1333 (via a dummy load or via a setpoint for the BASE LOAD if operating in parallel to the grid).
- Act manually on the mixer position (P.1302) until the external instrument shows a "NOX" value close to the prescribed one.
- Read the current MAP pressure and set it in P.1340 (or following).
- Set the current mixer position to P.1347 (or following) or leave it at zero if you only want to regulate with the PID, for example if the quality of the GAS is very variable.
- Repeat the procedure for the other six power setpoints (or less if you don’t need all of them).

After the proper configuration of the table, the controller operates in this way:

- GC800 SCM averages the AFR-IN measurement with the period specified by P.1371.
- GC800 SCM averages the measured engine power and expresses it in percentage.
- By interpolation on the first and second column of the table, it calculates the setpoint for the AFR-IN value. The controller averages the setpoint on a 1 second period.
- Optionally, the controller corrects the previously calculated setpoint if the MAT temperature is different from the threshold P.1391.
- If properly configured, the controller interpolates the "basic" position for the mixer from the first and third columns of the table. If not configured, the "basic" position is the one specified by parameters P.1331 or P.1332.
- The regulation PID modifies the "basic" position of the mixer to bring the AFR-IN measurement close to the calculated setpoint. The gains of the regulation PID can be configured with parameters P.1354 (P), P.1355 (I) and P.1356 (D).
- Parameter P.1357 establishes the maximum percentage correction that the PID can apply to the "base" position of the mixer: it is used only if any of the parameters from P.1347 to P.1353 is different from zero.
- Finally, you can configure a "dead band" threshold (P.1373 – “AFR-IN regulation dead band”): it specifies the error value (difference between the setpoint and the actual value of AFR-IN) below which the controller does

not change the output command (to avoid correcting the position of the mixer due to irrelevant differences). Parameter P.1373 applies a hysteresis configured with P.1372 (“Hysteresis on regulation/protection thresholds for AFR-IN”).

The function DOF.1043 (“AFR - Mixer in dead band”) allows to signal the “dead band” condition to external devices.

7.8.14.9 AFR-IN protections

As mentioned, the controller operates on the mixer trying to bring the AFR-IN value close to the setpoint obtained from the table. Protections are provided if this adjustment is not successful.

The parameter P.1374 (“Maximum AFR-IN regulation error threshold”) establishes the maximum acceptable difference between the setpoint and the AFR-IN value. Instead, parameter P.1375 (“Maximum AFR-IN regulation error delay”) establishes a delay: if the difference between the setpoint and the AFR-IN values remains higher than P.1374 for P.1375 seconds, the controller activates the anomaly AL.222 (“AFR: regulation error”). The type of the anomaly (waring, unload, deactivation, alarm) is established with parameter P.1376 (“Maximum AFR-IN regulation error alarm type”).

Parameter P.1374 applies a hysteresis configured with P.1732.

7.8.14.10 MAT temperature management

It is very important to keep the temperature of the air/gas mixture (MAT) under control, because too high temperatures entering the cylinders can cause damages. The controller allows using an analogue input configured with the function AIF.1683 (“AFR: MAT sensor”) to acquire this temperature.

7.8.14.10.1 Protections.

Two different protections are provided:

- First threshold:
  - P.1382: threshold (° C).
  - P.1383: delay (s).
  - P.1384: type of anomaly.
- Second threshold:
  - P.1385: threshold (° C).
  - P.1386: delay (s).
  - P.1387: type of anomaly.

The hysteresis configured with P.1381 is applied to the thresholds (P.1382 and P.1386).

The first threshold can be used for the warning AL.223 (“AFR: high temperature for MAT”): set P.1382 different from zero and P.1384 to “1-warning”. It can also be used for derating the engine and to correct the AFR-IN setpoint (see below).

The second threshold is used to stop the generator by the alarm AL.221 (“AFR: maximum temperature for MAT”): set P.1386 different from zero and use parameter P.1387 to select the type of anomaly (unload, deactivation, alarm).

7.8.14.10.2 Derating.

If the cooling system (AFTERCOOLER) cannot dissipate the excess of heat, the MAT temperature rises. Usually this happens only when there is a problem (on the aftercooler itself): the controller can try to overcome the problem by reducing the power supplied by the generator.

To use this function, set parameter P.1388 (“Derating for high MAT temperature”) different from zero. If the generator is working in parallel to the grid and the MAT temperature exceeds the threshold P.1382 for P.1383 seconds, the controller applies the reduction specified from P.1388 (for example 70%) to the power supplied int that moment by the generator and uses the calculated value as a new power setpoint. If the temperature drops (below the P.1382 minus the hysteresis), the controller reactivates the original power setpoint.

INFORMATION! the derating is active (if P.1388 is different from zero) even if the high temperature protection is disabled (P.1383 = 0).

7.8.14.10.3 Table correction based on temperature.

The table described in the previous chapters is normally calibrated to the rated working temperature of the air/gas mixture (MAT), parameter P.1391 (“Rated MAT temperature”). If the real MAT temperature differs from the rated one, you can "adapt" the table by adding or subtracting an offset to the extracted AFR-IN setpoint. Parameter P.1389 (“AFR-IN setpoint correction for MAT temperature”) establishes the offset (signed) to be added to the setpoint extracted from the table, for each degree of difference between the MAT temperature and the threshold P.1391.

The correction is active if P.1389 is different from zero. The correction applied by this function can be limited using parameter P.1390 (“Maximum AFR-IN setpoint correction for MAT temperature”).

7.8.14.11 Incoherent parameters

The controller signals any discrepancies in the configuration of the AFR parameters by activating anomaly AL.224 (“AFR: incoherent parameters”): for example, there is an analogue output for mixer control, but the AFR-IN value is not available.

7.8.14.12 Events and signalling

The controller records the following events related to the AFR management (if enabled with bit 8 of P.0441 parameter):

- EVT.1801: AFR enabled.
- EVT.1802: AFR disabled.
- EVT.1803: Error in AFR MAN/AUTO mode.
- EVT.1804: AFR in AUTO mode.
- EVT.1805: AFR in MAN mode.
- EVT.1806: first set of parameters for AFR.
- EVT.1807: second set of parameters for AFR.
- EVT.1808: mixer position in AUTO: engine stopped.
- EVT.1809: mixer position in AUTO: delay before cranking.
- EVT.1810: mixer position in AUTO: cranking.
- EVT.1811: mixer position in AUTO: running with GCB open.
- EVT.1812: mixer position in AUTO: running with GCB closed - low power.
- EVT.1813: mixer position in AUTO: running with GCB closed - high power.
- EVT.1814: mixer position in AUTO: stopping.
- EVT.1815: Error in mixer position in AUTO mode.

7.9 Circuit breakers management

INFORMATION! int the rest of the chapter CB will be used instead of “circuit breaker”.

Depending on application type, the controller must interact with three CBs:

- GCB (“Generator Circuit Breaker”). GC800 SCM can always control it.
- MCB (“Mains Circuit Breaker”). GC800 SCM can control it only for single-genset applications (P.0802 <= 4).
- MGCB (Master Generators Circuit Breaker). **GC600 SCM cannot control it**.

The controller acquires the status of all CBs (by digital inputs or through CAN bus), even if not controlled by itself. Moreover, it accepts that external logics can control GCB (and MCB in single-genset applications).

Use parameter P.0854 (“Use of GCB”) to tell the controller who manages the GCB, and how:

0. “Not synchronized”: GC800 SCM controls the breaker but cannot use synchronization to close it.
1. “Synchronized”: GC800 SCM controls the breaker and can use synchronization to close it.
2. “Externally managed (not synchronized)”: an external device controls the breaker but cannot use synchronization to close it.
3. “Externally managed (synchronized)”: an external device controls the breaker and can use synchronization to close it.

Parameter P.0855 (“Use of MCB”) provides the same options for MCB: the controller ignores it for multiple-genset applications, where it is always controlled by an external device.

7.9.1 Digital outputs

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

- DOF.2001 - “2001-Minimum volt. coil for MCB **(NC)**”. This feature can be used to supply the minimum voltage coil (if any) of the CB. The “reverse polarity” behaviour of this function ensures to supply the coil when the controller is not powered (allowing external logics to close the CB). The controller deactivates this output to supply the coil (allowing to close the CB): it ensures minimum 0,5 seconds delay before issuing the real closure command.

  The CB can have its own in-built protections. When they trip, they open the CB and provide a “trip contact”. Some small size CBs deactivate the “trip contact” as soon as the minimum voltage coil is not supplied: if the trip contact is connected to GC800 SCM, we should give the controller time to detect the trip contact activation. You can use parameter P.0246 (“Delay before opening MV coil (MCB)”) to force the controller to wait before removing the minimum voltage coil command (in case the CB opens by itself, not following a controller’s command).

- DOF.2002 - “Coil for opening of MCB”. The controller activates this output when it wants to open the CB: it deactivates the output when the CB opens (or when the opening time-out expires).

- DOF.2003 - “Coil for closure of MCB”. The controller activates this output when it wants to close the CB (ensuring that the minimum voltage coil was supplied by at least 0.5 seconds): it deactivates the output when the CB closes (or when the closing time-out expires, or the synchronism condition no longer exists).

- DOF.2004 - “2004-Stable opening command for MCB”. **Don’t use this command with motorized circuit breakers, use it only with contactors**. The “reverse polarity” behaviour of this function provides a closure command to the CB when the controller is not powered. The controller deactivates this output to close the breaker (ensuring that the minimum voltage coil was supplied by at least 0.5 seconds) and activates the output to open the breaker.

INFORMATION! when using the function DOF.2004, the controller can only perform one opening attempt before activating an anomaly.

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 CB. The controller activates this output to supply the coil (allowing to close the CB): it ensures minimum 0,5 seconds delay before issuing the real closure command.

  The CB can have its own in-built protections. When they trip, they open the CB and provide a “trip contact”. Some small size CBs deactivate the “trip contact” as soon as the minimum voltage coil is not supplied: if the trip contact is connected to GC800 SCM, we should give the controller time to detect the trip contact activation. You can use parameter P.0247 (“Delay before opening MV coil (GCB)”) to force the controller to wait before removing the minimum voltage coil command (in case the CB opens by itself, not following a controller’s command).

- DOF.2032 - “Coil for opening of GCB”. The controller activates this output when it wants to open the CB: it deactivates the output when the CB 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 CB (ensuring that the minimum voltage coil was supplied by at least 0.5 seconds): it deactivates the output when the CB closes (or when the closing time-out expires, or the synchronism condition no longer exists).

- DOF.2034 - “Stable closing command for GCB”. **Don’t 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.

INFORMATION! when using the function DOF.2034, the controller can only perform one opening attempt before activating an anomaly.

7.9.2 Digital inputs

The controller uses its digital inputs for purposes related to CBs.

7.9.2.1 Acquiring CBs status.

Three functions are available to get the feedback of the CBs:

- DIF.3001 (“Status of GCB circuit breaker”).
- DIF.3002 (“Status of MCB circuit breaker”).
- DIF.3003 (“Status of MGCB circuit breaker”).

The controller **must** acquire the status of the CBs only for parallel applications, but you can use them in any application (if you want). If available, the controller uses the status of a CB for:

- For issuing “fail to open” or “fail to close” warnings (for MCB and GCB).
- For its own operating sequence.
- When the CB is controlled by an external device.
- To allow GC800 HMI to show the proper CB status.

The controller uses the delay configured for the input (P.2002 or equivalent) as maximum time for opening or closing the CB (when it controls the CB).

For non-parallel applications, if you don’t configure any input for the status of a CB and GC800 SCM controls that CB, it assumes that the CB always follow the controller’s command (it’s closed when commanded closed and vice-versa).

If MCB requires AC voltages for its command coils, and you used the mains voltage as power source for them (typical for SPTM applications), the controller cannot physically close MCB if the mains voltages are not “ok”. If you inform GC800 SCM of this situation using P.0847 (“Is MCB powered by the mains?”) the controller won’t try to close the CB, avoiding “fail to close” anomalies.

7.9.2.2 Temporary commands override.

Even if you configured a CB as “controlled by GC800 SCM” (P.0854 and P.0855), the controller allows external devices to temporarily manage the CB. The external device must inform the controller using a digital input configured as:

- DIF.1003 - “GCB controlled externally”.
- DIF.1033 - “MCB controlled externally”.

When the input is active, the controller never tries to open or close the CB: on the contrary, it adjusts its own controls (minimum voltage coil and stable command) to match the real status of the CB (avoiding unwanted opening/closure when the input will deactivate).

7.9.2.3 Manual controls for the CBs.

The controller, **only when in MAN mode**, allows using its digital inputs to acquire external opening/closure commands for the CBs. They are managed as pulse-command, the action is performed on the activation of the input, not in its active stable state.

- DIF.1001 - “Request for GCB closure”.
- DIF.1002 - “Request for GCB opening”.
- DIF.1031 - “Request for MCB closure”.
- DIF.1032 - “Request for MCB opening”.

7.9.2.4 Request for synchronization.

The controller can synchronize the genset with the mains or with the parallel bars (depending on the status, across MCB or GCB) even if the relevant CB is controlled by an external device. In this case, the external device **must** require this feature to the controller through its digital inputs:

- DIF.1004 - “Synchronization request for GCB”.
- DIF.1034 - “Synchronization request for MCB”.

The controller will perform the synchronization while the input is active. The synchronization will end (or won’t start) when:

- The input becomes not active.
- The related CB is closed.
- There are no voltages on one side of the CB (or the voltages are out of thresholds).
- The operator configured the controller not to perform the synchronization on that CB (P.0854 and P.0855).

7.9.2.5 Forcing MCB to open.

The controller opens the MCB circuit breaker only when this is the only available option; when possible, it always tries to keep MCB closed. However, it provides the function DIF.2503 (“MCB closure inhibition”) for the configuration of its digital inputs: if the controller is in AUTO mode (included TEST and REMOTE START) and the input is active, it opens the MCB circuit breaker.

WARNING! The opening of MCB may result in leaving the loads unsupplied.

7.9.3 Management logic

The following descriptions assume that the controller manages the circuit breakers (not managed by external devices).

Whatever the operating mode is, the controller opens the MCB circuit breaker only when this is the only available option; when possible, it always tries to keep the MCB closed. For AMF applications (where the loads are normally supplied by the mains) the controller can however use MCB as a “protecting device” for the loads. Parameter P.0248 (“Timing for MCB opening”) allows to configure this feature:

- "0-When ready for supply": the controller keeps the MCB closed. In AUTO mode, when the generator will be ready to supply the loads, it will open MCB and close GCB.
- "1-At mains failure": if the mains voltages/frequency are not "ok", the controller opens the MCB (even if in OFF mode) to protect the loads. It will close the CB when the mains will be "ok".

7.9.3.1 Management logic in OFF mode.

The controller opens the GCB (and keeps it open).

The controller keeps the MCB closed (see 7.9.3 for exceptions). However, if MBC is open and P.0847 is different from zero and the mains voltages are not "ok", the controller doesn't try to close the CB.

7.9.3.2 Management logic in MAN mode.

The document [6] describes in detail the logics used by the controller to allow to manually open/close the CB (the logics depend on the type of system).

The operator can operate on the CBs in different ways:

- By using digital inputs (see 7.9.2.3). Since the controller manages these inputs as "pulse" commands (on the activation of the input, not on its active state), this method does not invalidate the others described below. For each CB you can configure both the "closure" and "opening" commands, or just the "closure command": in this case, it will work as a toggle command (opening command when the CB is closed and vice-versa).
- By using the commands provided by GC800 HMI. In the bottom bar (available on all display pages) the operator can simply touch the CBs icon to toggle its status (opening command when the CB is closed and vice-versa). GC800 HMI translate the operator's touch into Modbus commands (see next).
- By sending proper Modbus commands over the communication ports (see paragraph 7.1):
  - "31" to immediately open the GCB.
  - "32" to open the GCB (by unloading the generator if possible).
  - "33" to close the GCB.
  - "41" or "42" to open the MCB.
  - "43" to close the MCB.
- By sending proper SNMP commands over the Ethernet (see paragraph 7.1)
- By sending proper HTTP commands over the Ethernet (see paragraph 7.1)

GCB.

The controller always allows opening the GCB.

The controller allows closing GCB only if **all the following conditions are verified:**

- No alarms, unloads or deactivations are active.
- The controller stared the engine (not started by external devices).
- The voltages and the frequency of the generator are "ok" (or the speed for asynchronous generators).

MCB.

The controller always allows opening the MCB. However, the operation may result in leaving the loads unsupplied. For this reason:

- GC800 SCM checks that requests coming from digital input persist for 5 seconds before accepting it.
- GC800 HMI checks that the operator keeps the icon pressed for 5 seconds before sending the command through Modbus to GC800 SCM.
- For any other opening request (Modbus/TCP, SNMP, HTTP) the external monitoring system (or the operator itself) should double check the plant conditions before sending the opening command.

The controller always allows closing the MCB (except if mains voltages are not “ok” and P.0847 is set to “1” or P.0248 is set to “1”).

When the controller accepts a closure command, if required, it automatically starts the synchronization process: at the end it will automatically close the CB (an opening command during the synchronization aborts the process). If the synchronization is required but cannot be used (for example in non-parallel application) the operator must first open the other circuit breaker, allowing thus a closure without synchronization.

WARNING! the parameter P.0235 (“Open GCB when pass from AUTO to MAN?”) tell the controller what to do on GCB when the operator switches the operating mode from AUTO to MAN:

- P.0235 = 0: the controller keeps the GCB in its status.
- P.0235 = 1: the controller opens the GCB without any power discharge.

7.9.3.3 Management logic in AUTO mode.

The document [6] describes in detail the logics used by the controller to allow to manually open/close the CB (the logics depend on the type of system).

As general rule:

- When a “start request” is present, the controller always closes the GCB, unless a “GCB closure inhibition” is present (see 7.7).
- The controller opens the MCB circuit breaker only when this is the only available option; when possible, it always tries to keep MCB closed.
    - Loads protections (see 7.9.3).
    - Explicit opening request by DIF.2503 (see 7.9.2.5).
    - Non-parallel application and GCB must be closed.
    - Parallel-to-mains application and the mains is not “ok” and MCB is the “interface device”.

7.9.4 Commutators.

Only for the SSB applications (single genset AMF), the controller can manage a commutator instead of two circuit breakers. The required configurations are:

- Configure MCB as “0-Not synchronized” (P.0855).
- Configure GCB as “0-Not synchronized” (P.0854).
- Do not use the “temporary commands override” feature (see 7.9.2.2).
- Do not configure any digital output with functions DOF.2001 to DOF.2004 (MCB commands).
- Do not use internal statuses ST.069, ST.073 to ST.075 (MCB commands).
- Configure a digital output with the function DOF.2034 (“Stable closing command for GCB”) (or use the equivalent internal status ST.068).

The controller activates the DOF.2034 output to switch the loads from the mains to the generator. It deactivates the output to switch back the loads from the generator to the mains.

If the commutator provides the closure contact of the two sides, the controller can acquire (and correctly manage) them by input function DIF.3001 and DIF.3002 (see 7.9.2).

Moreover, it is possible to configure a minimum time before which it isn't possible (either manually or automatically) to reverse the commutator switching command (P.0220 “Contactors holding time”). This is useful because if the command is inverted during the movement phase, with some type of power switches it is possible that they lock themselves, and a manual action will be required to unlock them.

7.9.5 Pause during loads switching.

If the controller directly manages both MCB and GCB but it cannot use synchronization to close one or both (for any reason), it can always use commutation: the controller opens the other CB and then closes the needed one. Parameter P.0219 (“Contactors swap delay”) allows configuring the pause where both CBs are open.

7.9.6 MTS and GTS

In multi-generators applications, the controller is not able to directly manage the MCB and MGCB circuit breakers (usually one or more MC controllers are required for this). In very simple applications, which don’t require synchronization to close MCB and MGCB, it’s possible to use two digital outputs per controller to manage them:

- DOF.2091 (“Closure command for GTS”).
- DOF.2092 (“Opening command for MTS”).

Note we use different names (MTS instead of MCB, and GTS instead of MGCB) to highlight the simplified management provided for this circuit breakers. MTS means “Mains Transfer Switch” and GTS means “Generators Transfer Switch”.

The real CB commands must be properly wired with series/parallel connections of the two outputs provided by each controller (see document [6] for any detail of this feature).

Parameter P.0806 (“Minimum deliverable power on bus bars for supply”) allow to define the loads (kW) applied to the parallel bars once GTS will be closed: the controllers ensure to have enough generators in parallel before closing GTS (or no more generators available):

- Set P.0806 to “0” if you want to close GTS as soon as the first genset closes its GCB.
- Set P.0806 to “30000” (maximum value) if you want to close GTS only when all available gensets closed their GCB.

Whatever you set in P.0806, you can force the GTS closure after the first GCB using a digital input configured with the function DIF.2181 (“Immediate supply”).

7.9.7 Events and signalling

The controller records the following events related to the CBs management (if enabled with bit 5 of P.0441 parameter):

- EVT.1030: GCB close command
- EVT.1031: GCB open command
- EVT.1035: MCB close command
- EVT.1036: MCB open command

The controller records the following events related to the CBs management (if enabled with bit 4 of P.0441 parameter):

- EVT.1032: GCB closed.
- EVT.1033: GCB open.
- EVT.1037: MCB closed.
- EVT.1038: MCB open.

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

- ST.064 - "GCB status".
- ST.065 - "MCB status".
- ST.066 - "MGCB status".
- ST.068 - “GCB steady closing command”.
- ST.069 - “MCB steady closing command”.
- ST.070 - “GCB Under voltage coil command”.
- ST.071 - "Impulse open command for GCB”.
- ST.072 - "Impulse close command for GCB”.
- ST.073 - “MCB Under voltage coil command”.

- ST.074 - "Impulse open command for MCB”.
- ST.075 - "Impulse close command for MCB”.

8 Anomalies

This chapter describes all the anomalies managed by the controller. Some of them acts as protections for the loads, for the generator or for the engine. Some of them simply signals specific events happened in the plant. Before describing them in detail, some definitions are required.

We define four typologies of anomaly:

- **Warnings**: these anomalies do not require shutting the engine down. They report situations that are not dangerous now, but the operator must take some action because, if ignored, they could degenerate in one of the following categories.
- **Unloads**: these anomalies behave like deactivations (see below). They are not dangerous for the loads and for the genset: thus, the controller unloads the generator (if possible) before opening the GCB (it uses the fast-unloading ramp P.0875 in this phase). Then the controller stops the engine with standard procedure, i.e., with the cooling cycle. The operator must reset the alarm for restarting the engine.
- **Deactivations**: these anomalies require shutting the engine down. They are dangerous for the loads but not immediately for the engine. For this reason, the controller opens immediately the GCB (without unloading the generator), then it stops the engine with standard procedure, i.e., with the cooling cycle. The operator must reset the alarm for restarting the engine.
- **Alarms**: these anomalies require shutting the engine down. They are dangerous for the loads and/or for the engine and the generator. For this reason, the controller opens immediately the GCB breaker (without unloading the generator), and stops the engine with emergency procedure, i.e., without the cooling cycle. The operator must reset the alarm for restarting the engine.

When the controller activates an anomaly, it also does the following task:

- The connected GC800 HMI activates its internal hooter and shows icons on the top bar (available in all display pages) indicating the presence of an anomaly.
- GC800 SCM activates the digital outputs configured as DOF.3152 (“External horn”). The purpose is to use a more powerful signalling or a lamp.
- The operator can silent both hooters (see below).
- The connected GC800 HMI shows the display page containing all the active anomalies. For each anomaly it shows the activation date/time, the code (including a letter indicating the type of anomaly) and a textual description. The anomaly blinks until the operator acknowledges it.
- If operates on the engine and on GCB depending on the kind of anomaly (as described above).

The operator can perform the following actions on anomalies:

- **Silence** the hooters.
- **Acknowledge**: this informs the controller that the operator took care of the event.
- **Reset**: this informs the controller that the anomaly is no longer active.

Alarms, deactivations and unloads always require a reset. The controller, instead, automatically resets the warning when acknowledged by the operator and the cause is no more present.

8.1 Silence the hooters

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

- 0: the hooters will never be activated.
- 999: only the operator can silent the hooters.

- Any other values: the controller deactivates the hooters P.0491 seconds after the last activation: the operator can manually silent them before P.0491.

The operator can silent the hooters in different ways:

- By touching the “ack” icon on GC800 HMI while the hooter is active. This icon is available in the display page dedicated to anomalies.

  INFORMATION: GC800 HMI is connected to GC800 SCM through a communication port. Thus, the previous operation will result in sending a proper Modbus command over the communication port (see next point).

- By sending proper Modbus command (“51”) over the communication ports (see paragraph 7.1):
- By sending proper SNMP commands over the Ethernet (see paragraph 7.1)
- By sending proper HTTP commands over the Ethernet (see paragraph 7.1)

INFORMATION: the “silence” command does not “acknowledge” the anomalies.

8.2 Acknowledge the anomalies.

The operator can acknowledge the anomalies in different ways:

- By touching the “ack” icon on GC800 HMI while the hooter is not active. This icon is available in the display page dedicated to anomalies.

  INFORMATION: GC800 HMI is connected to GC800 SCM through a communication port. Thus, the previous operation will result in sending a proper Modbus command over the communication port (see next point).

- By sending proper Modbus command (“52”) over the communication ports (see paragraph 7.1):
- By sending proper SNMP commands over the Ethernet (see paragraph 7.1)
- By sending proper HTTP commands over the Ethernet (see paragraph 7.1)
- With a digital input configured as DIF.2002 (“Command for alarm acknowledgment”): the controller executes the command on the input activation (not when it’s active).

INFORMATION: the “acknowledge” command also “silences” the hooters.

Once acknowledged, the anomaly stops blinking on GC800 HMI.

GC800 SCM automatically resets “acknowledged warnings” when their activation causes are no more present. On the contrary, the controller never automatically resets any “not acknowledged warning”.

8.3 Reset 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 touching the “reset” icon on GC800 HMI. This icon is available in the display page dedicated to anomalies.

  INFORMATION: GC800 HMI is connected to GC800 SCM through a communication port. Thus, the previous operation will result in sending a proper Modbus command over the communication port (see next point).

- By sending proper Modbus command (“53”) over the communication ports (see paragraph 7.1):

- By sending proper SNMP commands over the Ethernet (see paragraph 7.1)
- By sending proper HTTP commands over the Ethernet (see paragraph 7.1)
- By sending a proper SMS message to the REWIND module connected to a serial port of the controller (when available).
- With a digital input configured as DIF.2001 (“Command for resetting alarms”): the controller executes the command on the input activation (not when it’s active).

INFORMATION: the “reset” command also “acknowledges” all anomalies and “silences” the hooters.

8.4 Events 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.3154 (“Acknowledge of the anomalies”). The controller activates this output for one second when it executes an “acknowledge” command (external devices may need this command).
- DOF.4001 (“Warnings”): at least one “warning” is active.
- DOF.4002 (“Unloads”): at least one “unload” is active.
- DOF.4003 (“Deactivations”): at least one “deactivation” is active.
- DOF.4004 (“Alarms”): at least one “alarm” is active.
- DOF.4005 (“Alarms, deactivations and unloads”): at least one unload or one deactivation or 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.203 - “Negative sequence (46)”.
  - AL.106 - “Maximum reactive power (exported) (32Q)”.
  - AL.061 - “Loss of excitement (40)”.
  - AL.006 - “Generator maximum current #1 (50/51)”.
  - AL.016 - “Generator maximum current #2 (50/51)”.
- DOF.4032 (“Anomalies of the engine”): at least one of the following anomalies is active:

- AL.022 - “Engine not started”.
- AL.021 - “Engine not stopped”.
- AL.039 - “Service required (1st counter)”.
- AL.040 - “Service required (2nd counter)”.
- AL.050 - “Service required (counter of days)”.
- AL.096 - “Magnetic pickup failure”.
- AL.099 - “Minimum speed (from measure)”.
- AL.018 - “Maximum speed (from measure) (12)”.
- AL.017 - “Maximum speed (from digital input) (12)”.
- 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.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.005 - “Engine's battery charger failure (from D+)”.
- AL.105 - “Engine's battery charger failure (from CANBUS)”.
- AL.037 - “Low battery #1 voltage (from measure)”.
- AL.036 - “Low battery #2 voltage (from measure)”.
- AL.137 - “Low battery voltage (from CANBUS)”.
- AL.038 - “High battery #1 voltage (from measure)”.
- AL.020 - “High battery #2 voltage (from measure)”.
- 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.4033 (“Anomalies of speed regulator”): at least one of the following anomalies is active:
  - AL.017 - “Maximum speed (from digital input) (12)”.
  - AL.018 - “Maximum speed (from measure) (12)”.
  - AL.118 - “Maximum speed (from CANBUS) (12)”.
  - AL.099 - “Minimum speed (from measure)”.
  - 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.011 - “Power reverse (32R)”.

- DOF.4034 (“4034-Anomalies of the fuel”): at least one of the following anomalies is active:
  - AL.025 - “Minimum fuel level (from contact)”.
  - AL.026 - “Minimum fuel level (from measure)”.

- AL.027 - “Low fuel level (from contact)”.
- AL.028 - “Low fuel level (from measure)”.
- AL.029 - “High fuel level (from contact)”.
- AL.030 - “High fuel level (from measure)”.
- AL.160 - “Water in fuel (from CANBUS)”.

- DOF.4035 (“4035-Anomalies of circuit breakers”): at least one of the following anomalies is active:
  - AL.013 - “MCB not closed”.
  - AL.014 - “GCB not closed”.
  - AL.023 - “MCB not opened”.
  - 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.009 - “Unloads”.
- ST.010 - “Unloads”.
- ST.011 - “Alarms”.
- ST.012 - “Not recognized warnings”.
- ST.013 - “Not recognized unloads”.
- ST.014 - “Not recognized deactivations”.
- ST.015 - “Not recognized alarms”.

8.5 OVERRIDE of protections

WARNING: **the use of these functions can cause serious damages to the engine. Mecc Alte cannot be considered anyway liable due to malfunctioning and damages to things and/or people occurred because of the utilization of the OVERRIDE function**.

This term defines the capability of the controller of temporarily disabling a series of protections. The OVERRIDE function, when activated, converts a set of alarms, deactivations and unloads into simple “warnings”: in this way, the controller still indicates the presence of a problems, but doesn't stop the engine. This feature is useful in hospitals (for example): there are situations in which it is preferable to damage the engine, and supply power for the longest period possible, rather than safeguarding the engine, but leaving operating rooms without lights.

The controller manages three different OVERRIDE requests; all of them can be activated through digital inputs. Use the following functions to configure the digital inputs:

- DIF.2062 (“Override engine's protections”).
- DIF.2063 (“Full override of protections”).
- DIF.2064 (“Override generator's protections”).

Each OVERRIDE function turns a specific set of “alarms/deactivations/unloads” into " warnings". The next chapters, for each protection, describe which OVERRIDE request have effect on it, using the following rule:

- Letter “E” if the anomaly is subject to engine’s protections OVERRIDE.
- Letter “F” if the anomaly is subject to full OVERRIDE.
- Letter “G” if the anomaly is subject to generator’s protections OVERRIDE.

The OVERRIDE function also affects "generic" anomalies related to digital inputs. The following functions for the configuration of digital inputs activate anomalies that are subject to the override request “E”:

- DIF.4012 - “Unload (after oil delay)”.
- DIF.4013 - “Deactivation (after oil delay)”.

- DIF.4014 - “Alarm (after oil delay)”.
- DIF.4062 - “Unload (subject to override)”.
- DIF.4063 - “Deactivation (subject to override)”.
- DIF.4064 - “Alarm (subject to override)”.

The OVERRIDE function also affects protections activated through thresholds on analogue measures. Set the bit 15 of the “configuration” parameter of a threshold (P.4005 for example) to make the related protection overridable by request “E”.

GC800 HMI shows messages indicating if any of the OVERRIDE request is active (on the status page).

Note: the ECU of an engine can manage the override requests by its own. In this case, the ECU does not stop the engine in case of anomalies and sends an “override” signal over CAN bus: GC800 SCM receives such signal and GC800 HMI shows it.

The controller records the following events related to the override requests:

- EVT.1082: a new override request has been activated.
- EVT.1083: no more override requests are active.

8.6 Anomalies related to digital inputs.

The controller manages a significant number of 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.

8.6.1 Specific.

They are configured with functions DIF.4211 and following. The controller knows how to manage these anomalies and provides specific alarm codes and proper error messages (thus it doesn’t use the input-related “message” parameter). The following chapters will describe each of them.

8.6.2 Generic.

They are configured through functions DIF.4001 to DIF.4064. The selected function gives the controller information about how to manage the anomaly (kind of anomaly, masked by some conditions etc.): the operator should at least configure the alarm message using the input-related “message” parameter.

The controller assigns numeric codes 701 through 806 to generic anomalies related to digital inputs:

Inputs	Alarms code
1…20	AL.701 to AL.720
Analogue inputs 1…6 (when used as digital)	AL.721 to AL.726
Analogue inputs 7 (when used as digital)	AL.887
Virtual digital inputs 1…16	AL.727 to AL.742
Digital inputs on expansion modules 1…144	AL.743 to AL.886
Digital inputs on expansion modules 145…160	AL.685 to AL.700

The function code identifies the kind of anomaly; you can focus on the last digit of the function (1=warning, 2=deactivation, 3=unload, 4= alarm):

Warnings	Deactivations	Unloads	Alarms
DIF.4001	DIF.4002	DIF.4003	DIF.4004
DIF.4011	DIF.4012	DIF.4013	DIF.4014
DIF.4021	DIF.4022	DIF.4023	DIF.4024
DIF.4031	DIF.4032	DIF.4033	DIF.4034
DIF.4031	DIF.4032	DIF.4033	DIF.4034

DIF.4041	DIF.4042	DIF.4043	DIF.4044
DIF.4051	DIF.4052	DIF.4053	DIF.4054
	DIF.4062	DIF.4063	DIF.4064

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.4002, DIF.4003, DIF.4004. Required conditions: none.
- DIF.4011, DIF.4012, DIF.4013, DIF.4014. Required conditions:
  - Engine started by the controller.
  - Engine running at least from P.0216 seconds.

  The “protections override feature” (“E” request, see 8.5) acts on these anomalies.
- DIF.4021, DIF.4022, DIF.4023, DIF.4024. Required conditions:
  - GCB closed.
- DIF.4031, DIF.4032, DIF.4033, DIF.4034. Required conditions:
  - Engine’s FUEL solenoid opened (see 7.8.4.6).
- DIF.4041, DIF.4042, DIF.4043, DIF.4044. Required conditions:
  - Engine’s GAS solenoid opened (see 7.8.4.8).
- DIF.4051, DIF.4052, DIF.4053, DIF.4054. Required conditions: none. The controller stops the fuel pump when these anomalies are active (see 7.8.10).
- DIF.4062, DIF.4063, DIF.4064. Required conditions: none. The “protections override feature” (“F” request, see 8.5) acts on these anomalies.

8.7 Anomalies related to analogue inputs.

The controller manages a significant number of 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 doesn't know how to manage them.

The controller assigns numeric codes 301 through 554 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 1st threshold.
- Odd codes refer to the 2nd threshold.

Inputs	Alarms codes
Analogue inputs 1…6	AL.301 to AL.312
Analogue inputs 7	AL.553 to AL.554
Virtual analogue inputs 1…8	AL.313 to AL.328
Analogue inputs on expansion modules 1…112	AL.329 to AL.552

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 add an initial wording to the configured message:

- “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 #1, 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).

  INFORMATION! if you set the delay to “0”, you disable the anomaly.
- P.4005 and P.4008: they allow to deeper configure the anomaly (see 5.6.4).

8.8 Fault 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.

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

Type:	Deactivation
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<<)”). P.0328 (“Apply thresholds for the voltages also to measurements phase-neutral?”).
To disable:	P.0302 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- DRIVE application.
- Asynchronous generators.
- Engine stopped, stopping, starting.
- When the generator is in parallel with the mains, during a LVFRT (“Low Voltage Fault Ride Through”) transient.
- After starting the engine, until firstly the generator voltages/frequency become “ok”.
- In MAN when GCB is open (unless specifically enabled by bit 2 of parameter P.0249).

The controller activates the protection if the lowest generator voltage (L-L or L-N or both, depends on P.0101 and on P.0328, see 7.5.3.2) is lower than the configured threshold for the configured delay.

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

Type:	Alarm
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>>)”). P.0328 (“Apply thresholds for the voltages also to measurements phase-neutral?”).
To disable:	P.0304 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- DRIVE application.
- Asynchronous generators.
- Engine stopped, stopping, starting.

The controller activates the protection if the highest generator voltage (L-L or L-N or both, depends on P.0101 and on P.0328, see 7.5.3.2) is higher than the configured threshold for the configured delay.

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

Type:	Deactivation
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
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- DRIVE application.
- Asynchronous generators.
- Engine stopped, stopping, starting.
- After starting the engine, until firstly the generator voltages/frequency become “ok”.
- In MAN when GCB is open (unless specifically enabled by bit 2 of parameter P.0249).

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

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

Type:	Alarm
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
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- DRIVE application.
- Asynchronous generators.
- Engine stopped, stopping, starting.
- During the regeneration process for the “Diesel Particulate Fiter”.

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

8.8.5 AL.005 - Engine's battery charger failure (from D+).

Type:	Configurable with P.0357
Related parameters:	P.4115 (“Function of the analogue input 7”). P.0349 (“Delay for belt break”). P.0357 (“Action for belt break”).
To disable:	P.0349 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- P.4115 different from AIF.1300 (“D+ signal”)-
- Engine stopped, stopping, starting.

The controller activates the protection if the D+ voltage is lower than 6 Vdc for the configured delay.

8.8.6 AL.006 – Generator maximum current #1 (50/51)

Type:	Configurable with P.1254
Related parameters:	P.0107 (“C.T. primary”). P.0139 (“C.T. secondary”). P.0106 (“Nominal power of the generator”). P.0102 (“Nominal voltage of the generator”). P.0101 (“Generator AC wiring”). P.1250 (“Curve for the protection #1 on maximum current”). P.0309 (“Threshold for the protection #1 on maximum current”). P.0310 (“Delay for the protection #1 on maximum current”). P.1254 (“Action for the protection #1 on maximum current”).
To disable:	P.0310 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

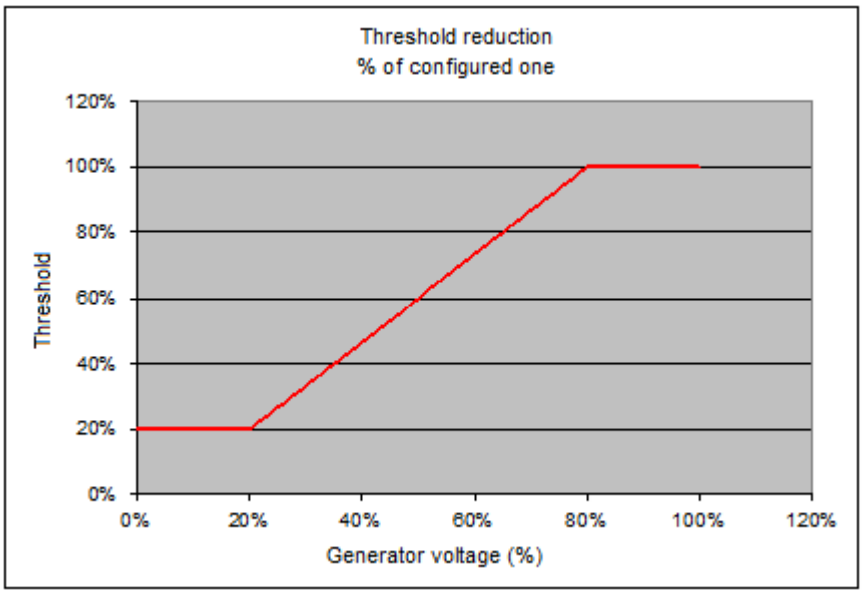
- DRIVE application.
- The controller does not acquire the generator’s current (CTs ratio not set, or CTs on loads and GCB open).
- Engine stopped, stopping, starting.

The protection operates on all available generator currents.

Parameter P.1250 allows selecting the curve to be used:

- “0-Immediate”. The controller activates the protection when at least one current is higher than the configured threshold for the configured delay.

- “1-Immediate (voltage-restrained)”. The controller can automatically reduce the configured threshold when the generator voltage decreases. In detail:
  - The lowest generator voltage is higher than 80 % of the rated: use the configured threshold.
  - The lowest generator voltage is lower than (or equal to) 20 % of the rated: use 20% of the configured threshold.
  - The lowest generator voltage is between 20 % and 80 % of the rated: the threshold is reduced in percentage.



The controller activates the protection when at least one current is higher than the **calculated** threshold for the configured delay.

- "2-Manufacturer extremely inverse". The trip time is not fixed but depends on how higher the current respect to the configured threshold is (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.
  - 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):

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

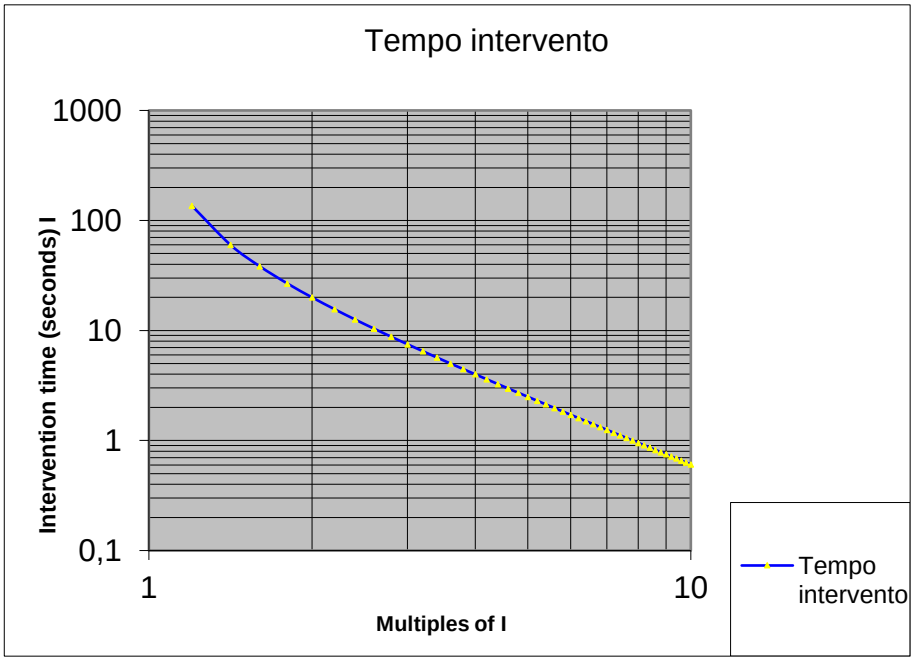
  With the constants "k" = 1, "c" = 0 and "a" = 2 the equation changes to the following:

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

  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):



- "3-3-Manufacturer extremely inverse (voltage-restrained)". The controller can reduce the thrip threshold as described for P.1250 = "1". The protections operate (with the reduced threshold) as described for P.1250 = "2".

8.8.7 AL.007 – Manual stop command in automatic mode

Type:	Alarm
Related parameters:	
To disable:	
Suitable operating modes:	AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates the protection if receives a "manual stop command" from a communication port when in AUTO mode.

INFORMATION! GC800 HMI never sends such command.

WARNING! Pay attention in using this feature: the controller reacts opening the GCB and stopping the engine (without cooling cycle).

Several ways for sending this command to the controller:

- By sending proper Modbus command ("22") over the communication ports (see paragraph 7.1).
- By sending proper SNMP commands over the Ethernet (see paragraph 7.1)
- By sending proper HTTP commands over the Ethernet (see paragraph 7.1)
- By sending a proper SMS message to the REWIND module connected to a serial port of the controller (when available).

8.8.8 AL.008 – Operating conditions not reached.

Type:	Alarm
Related parameters:	P.0217 ("Maximum time for operating conditions").
To disable:	P.0217 = 0
Suitable operating modes:	AUTO, TEST, REMOTE START
Subject to override requests:	"F", "G"

Disabled when:

- DRIVE application.
- Engine stopped, stopping, starting, idle speed.

The controller activates this protection if generator voltages and frequency do not reach their "ok" values within the configured delay from the end of the "idle speed cycle" (see 7.8.4.10) of the engine.

8.8.9 AL.010 – Maximum auxiliary current from toroid (50).

Type:	Configurable with P.1265
Related parameters:	P.8108 (“Rated current on toroid's primary side”). P.8135 (“Rated current on toroid's secondary side”). P.0106 (“Nominal power of the generator”). P.0102 (“Nominal voltage of the generator”). P.0101 (“Generator AC wiring”). P.1265 (“Curve for the protection on the auxiliary current (Y3)”). P.1266 (“Threshold for the protection on the auxiliary current (Y3)”). P.1267 (“Delay for the protection on the auxiliary current (Y3)”). P.1268 (“Action for the protection on the auxiliary current (Y3)”).
To disable:	P.1267 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- The controller does not acquire the current from the toroid input (Y3).

The threshold is a percentage of the rated current (see 7.5.1 for the determination of the rated current from P.0101, P.0102 and P.0106 parameters).

See the description of AL.006, considering the parameters defined in the previous table.

8.8.10 AL.011 – Power reverse (32R)

Type:	Alarm
Related parameters:	P.0125 (“Nominal power of the engine”). P.0313 (“Threshold for power reverse (32R)”). P.0314 (“Delay for power reverse (32R)”).
To disable:	P.0314 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- DRIVE application.
- The controller does not acquire the generator’s current (CTs ratio not set, or CTs on loads and GCB open).
- Engine stopped, stopping, starting.

The controller activates this protection if the active power is negative and has an absolute value continuously above the configured threshold for the configured delay.

8.8.11 AL.013 – MCB not closed.

Type:	Warning/Deactivation
Related parameters:	P.2001 (“Function of the input 01”) or equivalent for the other inputs. P.2002 (“Delay for the input 01”) or equivalent for the other inputs.
To disable:	P.2002 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- The controller does not directly manage the CB.
- The controller does not acquire the real status of the CB (DIF.3002).
- The “delay” parameter of the input acquiring the status is set to zero. **For parallel application, the feedback of the CB is mandatory: thus, you can’t disable this protection by setting the delay to “0” (the controller uses a two-seconds delay if the parameter is “0”).**

The controller activates this protection during the closure operation (if the CB doesn’t close within the configured delay).

In MAN mode, the controller activates a warning after one closure attempt.

In AUTO mode, the controller activates a deactivation after:

- One closure attempt if P.0221 (“Enable generator supply on MCB fault?”) is different from zero and the mains is “ok” (to leave the loads unsupplied as less as possible).
- Three closure attempts in other conditions.

8.8.14 AL.014 – GCB not closed.

Type:	Warning/Deactivation
Related parameters:	P.2001 (“Function of the input 01”) or equivalent for the other inputs. P.2002 (“Delay for the input 01”) or equivalent for the other inputs.
To disable:	P.2002 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- The controller does not directly manage the CB.
- 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. **For parallel application, the feedback of the CB is mandatory: thus, you can’t disable this protection by setting the delay to “0” (the controller uses a two-seconds delay if the parameter is “0”).**

The controller activates this protection during the closure operation (if the CB doesn’t close within the configured delay).

In MAN mode, the controller activates a warning after one closure attempt.

In AUTO mode, the controller activates a deactivation after three closure attempts.

8.8.15 AL.015 – Maximum current from contact (50)

Type:	Alarm
Related parameters:	P.2001 (“Function of the input 01”) or equivalent for the other inputs. P.2002 (“Delay for the input 01”) or equivalent for the other inputs.
To disable:	P.2002 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- -

The controller activates the protection if the digital input (function DIF.4241 - “Overload”) is active for the configured delay.

8.8.16 AL.016 – Generator maximum current #2 (50/51)

Type:	Configurable with P.1254
Related parameters:	P.0107 (“C.T. primary”). P.0139 (“C.T. secondary”). P.0106 (“Nominal power of the generator”). P.0102 (“Nominal voltage of the generator”). P.0101 (“Generator AC wiring”). P.1255 (“Curve for the protection #2 on maximum current”). P.0311 (“Threshold for the protection #2 on maximum current”). P.0312 (“Delay for the protection #2 on maximum current”). P.1258 (“Action for the protection #2 on maximum current”).
To disable:	P.0312 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

See the description of AL.006, considering the parameters defined in the previous table.

8.8.17 AL.017 – Maximum speed (from digital input) (12)

Type:	Alarm
Related parameters:	P.2001 (“Function of the input 01”) or equivalent for the other inputs. P.2002 (“Delay for the input 01”) or equivalent for the other inputs.
To disable:	P.2002 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- Engine stopped, starting.
- During the regeneration process for the “Diesel Particulate Fiter”,

The controller activates the protection if the input (function DIF.4251 - “Overspeed”) is active for the configured delay.

8.8.18 AL.018 – Maximum speed (from measure) (12)

Type:	Alarm
Related parameters:	P.0110 (“Number of teeth of the pick-up wheel”). P.0111 (“Rpm/W ratio”). P.0150 (“Number of poles of the generator”). P.0700 (“Engine type”). P.0701 (“Engine's nominal speed”). P.0333 (“Threshold for maximum speed (pick-up/w) (12)”). P.0334 (“Delay for maximum speed (pick-up/w) (12)”).
To disable:	P.0334 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- The controller does not acquire the engine speed (see 7.8.2.3).
- Engine stopped, starting.
- During the regeneration process for the “Diesel Particulate Fiter”,

The controller activates the protection if the measured speed is higher than the configured threshold for the configured delay.

8.8.19 AL.020 – High battery #2 voltage (from measure)

Type:	Warning
Related parameters:	P.0371 (“Threshold for high battery #2 voltage”). P.0372 (“Delay for high battery #2 voltage”).
To disable:	P.0372 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- Nothing connected on terminal Y1-3.

The controller activates the protection if the battery voltage at terminal Y1-3 is above the configured threshold for the configured delay. The threshold is expressed as a percentage of the rated battery voltage (see 7.8.1.1).

8.8.20 AL.021 – Engine not stopped.

Type:	Alarm
Related parameters:	P.0214 (“Duration of stopping cycle”).
To disable:	P.0214 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”

Disabled when:

- -

The controller activates the protections if:

- The engine doesn’t stop within P.214 seconds from the stop command.
- Someone else starts the engine.

8.8.21 AL.022 – Engine not started.

Type:	Warning/Alarm
Related parameters:	P.0211 (“Number of crank attempts”). P.0252 (“Number of manual crank attempts”).
To disable:	-
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates the protections if the engine doesn’t start after the configured number of crank attempts. In MAN it is a warning, in AUTO it is an alarm.

8.8.22 AL.023 – MCB not opened.

Type:	Warning/Deactivation
Related parameters:	P.2001 (“Function of the input 01”) or equivalent for the other inputs. P.2002 (“Delay for the input 01”) or equivalent for the other inputs.
To disable:	P.2002 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- The controller does not directly manage the CB.
- The controller does not acquire the real status of the CB (DIF.3002).
- The “delay” parameter of the input acquiring the status is set to zero. **For parallel application, the feedback of the CB is mandatory: thus, you can’t disable this protection by setting the delay to “0” (the controller uses a two-seconds delay if the parameter is “0”).**

The controller activates this protection during the opening operation (if the CB doesn’t open within the configured delay).

In MAN mode, the controller activates the anomaly after one opening attempt.

In AUTO mode, the controller activates the anomaly after:

- Three opening attempts if you don’t use the “stable closure command”.
- One opening attempt if you use the “stable closure command”.

It also activates the protections if someone else closes the CB. The protection is usually a “warning”: the controller activates a “deactivation” when someone else closes the CB, or for systems not allowing power production in parallel to the mains.

8.8.23 AL.024 – GCB not opened.

Type:	Deactivation/Warning
Related parameters:	P.2001 (“Function of the input 01”) or equivalent for the other inputs. P.2002 (“Delay for the input 01”) or equivalent for the other inputs.
To disable:	P.2002 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- The controller does not directly manage the CB.
- 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. **For parallel application, the feedback of the CB is mandatory: thus, you can’t disable this protection by setting the delay to “0” (the controller uses a two-seconds delay if the parameter is “0”).**

The controller activates this protection during the opening operation (if the CB doesn’t open within the configured delay).

In MAN mode, the controller activates the anomaly after one opening attempt.

In AUTO mode, the controller activates the anomaly after:
- Three opening attempts if you don’t use the “stable closure command”.
- One opening attempt if you use the “stable closure command”.

It also activates the protections if someone else closes the CB.

The protection is usually a “warning”: the controller activates a “deactivation” when someone else closes the CB, or for systems not allowing power production in parallel to the mains.

Note: parameter P.0243 (“Enable generator supply on GCB fault?”) allows to keep the engine running (with GCB closed) when this anomaly is activated **as warning** (P.0243=1). We should not stop the generator now because:
- If the generator is in parallel with another power source, that power source will drag it.
- If the generator is supplying loads in “island mode”, during the stopping cycle the loads will be supplied with out-of-tolerance voltages/frequency.

Note: parameter P.0251 ("Enable the opening of MCB for GCB closed and engine not running") allows the controller to open MCB if GCB is “not opened” and the engine must be stopped:

- 0: with this value the loads are safeguarded. If the GCB fails to open due to alarms (therefore with the engine stopping/stopped), the engine will be driven by the mains. This is the default value for the parameter.

- 1: with this value the generator is safeguarded. If the GCB fails to open due to alarms (therefore with the engine stopping/stopped), the controller opens MCB, preventing the mains from dragging the engine. The loads, however, are not supplied.

8.8.24 AL.025 – Minimum fuel level (from contact)

Type:	Alarm
Related parameters:	P.2001 (“Function of the input 01”) or equivalent for the other inputs. P.2002 (“Delay for the input 01”) or equivalent for the other inputs.
To disable:	P.2002 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- -

The controller activates the protection if the input (function DIF.4211 - “Minimum fuel level”) is active for the configured delay.

8.8.25 AL.026 – Minimum fuel level (from measure)

Type:	Alarm
Related parameters:	P.4001 (“Function of the analogue input 1”) or equivalent for the other inputs. P.0700 (“Engine type”). P.0347 (“Threshold for minimum fuel level”). P.0348 (“Delay for minimum level”).
To disable:	P.0348 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- The controller does not acquire the fuel level (see 7.8.2.4).

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

8.8.26 AL.027 – Low fuel level (from contact).

Type:	Warning
Related parameters:	P.2001 (“Function of the input 01”) or equivalent for the other inputs. P.2002 (“Delay for the input 01”) or equivalent for the other inputs.
To disable:	P.2002 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates the protection if the input (function DIF.4212 - “Low fuel level”) is active for the configured delay.

8.8.27 AL.028 – Low fuel level (from measure).

Type:	Warning
Related parameters:	P.4001 (“Function of the analogue input 1”) or equivalent for the other inputs. P.0700 (“Engine type”). P.0345 (“Threshold for low fuel level”). P.0346 (“Delay for low fuel level”).
To disable:	P.0346 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- The controller does not acquire the fuel level (see 7.8.2.4).

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

8.8.28 AL.029 – High fuel level (from contact).

Type:	Warning
Related parameters:	P.2001 (“Function of the input 01”) or equivalent for the other inputs. P.2002 (“Delay for the input 01”) or equivalent for the other inputs.
To disable:	P.2002 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates the protection if the input (function DIF.4213 - “High fuel level”) is active for the configured delay.

8.8.29 AL.030 – High fuel level (from measure).

Type:	Warning
Related parameters:	P.4001 (“Function of the analogue input 1”) or equivalent for the other inputs. P.0700 (“Engine type”). P.0343 (“Threshold for high fuel level”). P.0344 (“Delay for high fuel level”).
To disable:	P.0344 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- The controller does not acquire the fuel level (see 7.8.2.4).

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

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

Type:	Warning
Related parameters:	P.2001 (“Function of the input 01”) or equivalent for the other inputs. P.2002 (“Delay for the input 01”) or equivalent for the other inputs. P.0216 (“Time mask for engine protections”).
To disable:	P.2002 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- Engine stopped, stopping, starting.
- 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.

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

Type:	Warning
Related parameters:	P.4001 (“Function of the analogue input 1”) or equivalent for the other inputs. 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
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- The controller does not acquire the coolant temperature (see 7.8.2.4).
- Engine stopped, stopping, starting.
- 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.

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

Type:	Alarm
Related parameters:	P.2001 (“Function of the input 01”) or equivalent for the other inputs. P.2002 (“Delay for the input 01”) or equivalent for the other inputs. P.0216 (“Time mask for engine protections”).
To disable:	P.2002 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

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

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

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

Type:	Alarm
Related parameters:	P.4001 (“Function of the analogue input 1”) or equivalent for the other inputs. 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
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- The controller does not acquire the coolant temperature (see 7.8.2.4).
- Engine stopped, stopping, starting.
- 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.

8.8.34 AL.035 - Maximum oil temperature (from measure)

Type:	Alarm
Related parameters:	P.4001 (“Function of the analogue input 1”) or equivalent for the other inputs. 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
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- The controller does not acquire the oil temperature (see 7.8.2.4).
- Engine stopped, stopping, starting.
- 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.

8.8.35 AL.036 – Low battery #2 voltage (from measure)

Type:	Warning
Related parameters:	P.0369 (“Threshold for high battery #2 voltage”). P.0370 (“Delay for high battery #2 voltage”).
To disable:	P.0370 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- Nothing connected on terminal Y1-3.
- Engine starting.

The controller activates the protection if the battery voltage at terminal Y1-3 is continuously below threshold P.0369 for time P.0370. The threshold is expressed as a percentage of the rated battery voltage (see 7.8.1.1).

8.8.36 AL.037 – Low battery #1 voltage (from measure)

Type:	Warning
Related parameters:	P.0362 (“Threshold for low battery #1 voltage”). P.0363 (“Delay for low battery #1 voltage”).
To disable:	P.0363 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- Nothing connected on terminal Y1-2.
- Engine starting.

The controller activates the protection if the battery voltage at terminal Y1-2 is below the configured threshold for the configured delay. The threshold is expressed as a percentage of the rated battery voltage (see 7.8.1.1).

8.8.37 AL.038 – High battery #1 voltage (from measure).

Type:	Warning
Related parameters:	P.0364 (“Threshold for high battery #1 voltage”). P.0365 (“Delay for high battery #1 voltage”).
To disable:	P.0365 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- Nothing connected on terminal Y1-2.

The controller activates the protection if the battery voltage at terminal Y1-2 is above the configured threshold for the configured delay. The threshold is expressed as a percentage of the rated battery voltage (see 7.8.1.1).

8.8.38 AL.039 – Service required (1st counter).

Type:	Configurable by P.0425
Related parameters:	P.0424 (“Maintenance interval 1 (running hours)”). P.0425 (“Kind of action for maintenance 1”).
To disable:	P.0424 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- -

The controller activates the protection after P.0424 engine running hours since last parameter P.0424 setting. The counter is saved into non-volatile memory, it survives when the controller is unsupplied. See 7.8.11.1

8.8.39 AL.040 – Service required (2nd counter).

Type:	Configurable by P.0437
Related parameters:	P.0436 (“Maintenance interval 2 (running hours)”). P.0437 (“Kind of action for maintenance 2”).
To disable:	P.0436 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

See the description of AL.039 using the parameters described in the table above.

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

Type:	Alarm
Related parameters:	P.2001 (“Function of the input 01”) or equivalent for the other inputs. P.2002 (“Delay for the input 01”) or equivalent for the other inputs. P.0216 (“Time mask for engine protections”).
To disable:	P.2002 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- Engine stopped, stopping, starting.
- 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.

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

Type:	Alarm
Related parameters:	P.4001 (“Function of the analogue input 1”) or equivalent for the other inputs. 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
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- The controller does not acquire the oil pressure (see 7.8.2.4).
- 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.

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

Type:	Warning
Related parameters:	P.2001 (“Function of the input 01”) or equivalent for the other inputs. P.2002 (“Delay for the input 01”) or equivalent for the other inputs. P.0216 (“Time mask for engine protections”).
To disable:	P.2002 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- Engine stopped, stopping, starting.
- 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.

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

Type:	Warning
Related parameters:	P.4001 (“Function of the analogue input 1”) or equivalent for the other inputs. 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
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- The controller does not acquire the oil pressure (see 7.8.2.4).
- 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.

8.8.44 AL.045 – Maximum auxiliary current from CT (50).

Type:	Configurable with P.1264
Related parameters:	P.0108 (“Forth C.T. primary”). P.0135 (“Forth C.T. secondary”). P.0106 (“Nominal power of the generator”). P.0102 (“Nominal voltage of the generator”). P.0101 (“Generator AC wiring”). P.1260 (“Curve for the protection on the auxiliary current (Y2)”). P.0367 (“Threshold for the protection on the auxiliary current (Y2)”). P.0368 (“Delay for the protection on the auxiliary current (Y2)”). P.1264 (“Action for the protection on the auxiliary current (Y2)”).
To disable:	P.0368 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- The controller does not acquire the current from the 4th CT.
- An input configured as DIF.2704 (“Disables protections on 4th current”) is active.

See the description of AL.006, considering the parameters defined in the previous table.

8.8.48 AL.048 – Emergency stop.

Type:	Alarm
Related parameters:	P.0361 (“Delay for emergency stop”).
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates the protection if the voltage on terminal Y10-8 is lower than 1 Vdc for the configured delay. It can also activate the protection when receiving a proper command from the communication ports:

- Modbus command (“99”) over the communication ports (see paragraph 7.1).
- Proper SNMP commands over the Ethernet (see paragraph 7.1)
- Proper HTTP commands over the Ethernet (see paragraph 7.1)

8.8.49 AL.049 – Maximum power

Type:	Configurable by P.0352
Related parameters:	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
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- DRIVE application.
- The controller does not acquire the generator’s current (CTs ratio not set, or CTs on loads and GCB open).
- Engine stopped, stopping, starting.

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

8.8.50 AL.050 - Service required (counter of days).

Type:	Warning
Related parameters:	P.0438 (“Interval of days for maintenance”).
To disable:	P.0438 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- Real time clock not valid.

The controller activates the protection at 8.00 am after P.0438 days since last setting of parameter P.0438. The counter is saved into non-volatile memory, it survives when the controller is unsupplied.

To deactivate it, you must set P.0438 parameter again:

- Set it to zero to disable the anomaly.
- Confirm the present value to restart another identical period.
- Set a different value.

P.0438 require the “installer’s” access level for their programming: this, for example, avoids that final customer can reset the maintenance request.

8.8.51 AL.051 – High controller's temperature.

Type:	Warning
Related parameters:	P.0366 (“High board temperature threshold”).
To disable:	P.0366 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- Real time clock not valid.

The controller activates the protection if its internal temperature is higher than the threshold (without delays)

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

Type:	Alarm
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)”). P.0328 (“Apply thresholds for the voltages also to measurements phase-neutral?”).
To disable:	P.0316 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- DRIVE application.
- Asynchronous generators.
- Single-phase generator.
- Engine stopped, stopping, starting.
- Generator voltages and frequency “ok”
- When the generator is in parallel with the mains, during a LVFRT (“Low Voltage Fault Ride Through”) transient.

The controller activates the protection if the highest voltage difference (L-L or L-N or both, depends on P.0101 and on P.0328, see 7.5.3.2) is higher than the configured threshold for the configured delay.

8.8.53 AL.053 – Currents unbalance (46).

Type:	Alarm
Related parameters:	P.0107 (“C.T. primary”). P.0139 (“C.T. secondary”). 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
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- DRIVE application.
- The controller does not acquire the generator’s current (CTs ratio not set, or CTs on loads and GCB open).
- Engine stopped, stopping, starting.
- Single-phase generator.

The threshold is a percentage of the rated current (see 7.5.1 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.

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

Type:	Warning
Related parameters:	P.4001 (“Function of the analogue input 1”) or equivalent for the other inputs. 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
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- The controller does not acquire the oil temperature (see 7.8.2.4).
- Engine stopped, stopping, starting.
- 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.

8.8.55 AL.055 – Wrong phases sequence (47)

Type:	Configurable by P.0320
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
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- DRIVE application.
- Asynchronous generators.
- Single-phase generator.
- Engine stopped, stopping, starting.
- GCB closed.
- Generator voltages and frequency “ok”

The controller activates the protection if the real phases sequence of the generator doesn’t match the configured one.

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

Type:	Warning
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<)”). P.0328 (“Apply thresholds for the voltages also to measurements phase-neutral?”).
To disable:	P.0302 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- DRIVE application.
- Asynchronous generators.
- Engine stopped, stopping, starting.
- When the generator is in parallel with the mains, during a LVFRT (“Low Voltage Fault Ride Through”) transient.
- After starting the engine, until firstly the generator voltages/frequency become “ok”.
- In MAN when GCB is open (unless specifically enabled by bit 2 of parameter P.0249).

The controller activates the protection if the lowest generator voltage (L-L or L-N or both, depends on P.0101 and on P.0328, see 7.5.3.2) is lower than the configured threshold for the configured delay.

8.8.57 AL.057 – Clock not valid.

Type:	Warning
Related parameters:	P.0420 (“Test duration”). P.0426 (“Days for remote start”). P.0438 (“Interval of days for maintenance”). P.0421 (“Generator enable days”). P.1901…P.1964 (calendars)
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates the protection if the internal real time clock is not valid, and some function requires it.

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

Type:	Warning
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
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- DRIVE application.
- Asynchronous generators.
- Engine stopped, stopping, starting.
- After starting the engine, until firstly the generator voltages/frequency become “ok”.
- In MAN when GCB is open (unless specifically enabled by bit 2 of parameter P.0249).

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

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

Type:	Warning
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>)”). P.0328 (“Apply thresholds for the voltages also to measurements phase-neutral?”).
To disable:	P.0394 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- DRIVE application.
- Asynchronous generators.
- Engine stopped, stopping, starting.

The controller activates the protection if the highest generator voltage (L-L or L-N or both, depends on P.0101 and on P.0328, see 7.5.3.2) is higher than the configured threshold for the configured delay.

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

Type:	Warning
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
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- DRIVE application.
- Asynchronous generators.
- Engine stopped, stopping, starting.
- During the regeneration process for the “Diesel Particulate Fiter”.

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

8.8.61 AL.061 – Loss of excitement (40)

Type:	Alarm
Related parameters:	P.0321 (“Threshold for loss of excitement (40)”). P.0322 (“Delay for loss of excitement (40)”).
To disable:	P.0321 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- DRIVE application.
- The controller does not acquire the generator’s current (CTs ratio not set, or CTs on loads and GCB open).
- Engine stopped, stopping, starting.

The controller activates this protection if the reactive power is negative and has an absolute value continuously above the configured threshold for the configured delay.

8.8.62 AL.062 – CANBUS 0 (engine): BUS-OFF.

Type:	Configurable by P.0709
Related parameters:	P.0700 (“Engine type”). F.1700 (“Voltage regulator (AVR) type”). P.0730 (“Gas control device model”). P.0709 (“Action on Can-Bus fault”).
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- P.0700, F.1700 and P.0730 are all set to zero.

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

8.8.64 AL.064 - Fuel pump failure

Type:	Warning
Related parameters:	P.0404 (“Fuel pump maximum activation time”).
To disable:	P.0404 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- Fuel pump not managed (see 7.8.10).

The controller activates this protection if the pump runs form more than the configured delay.

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

Type:	Warning
Related parameters:	P.4001 (“Function of the analogue input 1”) or equivalent for the other inputs. P.0700 (“Engine type”). P.0353 (“Threshold for low coolant temperature”). P.0354 (“Delay for low coolant temperature”).
To disable:	P.0354 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- The controller does not acquire the coolant temperature (see 7.8.2.4).

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

8.8.66 AL.095 - AdBlue pump failure

Type:	Warning
Related parameters:	P.1494 (“AdBlue pump maximum activation time”).
To disable:	P.1494 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- AdBlue pump not managed (see 7.8.12.5).

The controller activates this protection if the pump runs form more than the configured delay.

8.8.67 AL.096 - Magnetic pickup failure.

Type:	Configurable by P.0388
Related parameters:	P.0110 (“Number of teeth of the pick-up wheel”). P.0111 (“Rpm/W ratio”). P.0387 (“Delay for magnetic pickup failure”). P.0388 (“Action for magnetic pickup failure”).
To disable:	P.0387 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- P.0110 and P.0111 both set to zero.
- The controller can detect the engine running condition only from one of its speed sensors (see 7.8.3.1, no other methods available).

The controller activates the protection if the measured speed from one of its sensors (if enabled) is zero while the engine is running (thus, the controller needs at least two methods for detecting the engine running).

8.8.68 AL.097 – Communication failure with the AVR.

Type:	Configurable by P.1707
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.1706 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

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.

8.8.69 AL.098 – Communication failure with the ECU.

Type:	Configurable by P.0709
Related parameters:	P.0700 (“Engine type”). P.0709 (“Action on Can-Bus fault”). P.0711 (“Maximum time without messages from engine”).
To disable:	P. 0711 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

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.

8.8.70 AL.099 – Minimum speed (from measure).

Type:	Deactivation
Related parameters:	P.0110 (“Number of teeth of the pick-up wheel”). P.0111 (“Rpm/W ratio”). P.0150 (“Number of poles of the generator”). P.0700 (“Engine type”). P.0701 (“Engine's nominal speed”). P.0358 (“Minimum speed threshold”). P.0359 (“Minimum speed delay”).
To disable:	P.0359 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”

Disabled when:

- The controller does not acquire the engine speed (see 7.8.2.3).
- Engine stopped, stopping, starting, idle speed cycle.
- After starting the engine, until firstly the speed become “ok”.
- In MAN when GCB is open (unless specifically enabled by bit 2 of parameter P.0249).

The controller activates the protection if the measured speed is lower than the configured threshold for the configured delay.

8.8.71 AL.100 – Maximum differential current (64).

Type:	Alarm
Related parameters:	P.0377 (“Threshold for maximum differential current (64)”). P.0378 (“Delay for maximum differential current (64)”).
To disable:	P.0378 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- DRIVE application.
- The controller does not acquire the generator’s differential current (four CTs or toroid ratios not set, or CTs/toroid on loads and GCB open).

The controller can measure the differential current in two ways:

- Using its four CTs: set P.0131 (“Usage of the fourth current”) to “2-Neutral current (combined with three other currents)” and place the 4th CT on the neutral line of the generator.
- Using the toroid input: set P.8131 (“Usage of the toroid's current”) to “3-Differential current” and ensure the four generator lines passes all inside the toroid.

The controller activates the protection if the measured differential current is higher than the configured threshold for the configured delay.

8.8.105 AL.105 - Engine's battery charger failure (from CANBUS).

Type:	Warning
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can-Bus alarms disable mask”).
To disable:	Set bit 11 of P.0704 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

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.

8.8.106 AL.106 - Maximum reactive power (exported) (32Q)

Type:	Alarm
Related parameters:	P.0379 (“Threshold for maximum exported reactive power (32Q)”). P.0380 (“Delay for maximum exported reactive power (32Q)”).
To disable:	P.0380 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- DRIVE application.
- The controller does not acquire the generator’s current (CTs ratio not set, or CTs on loads and GCB open).
- Engine stopped, stopping, starting.

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

8.8.118 AL.118 Maximum speed (from CANBUS) (12).

Type:	Warning
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can-Bus alarms disable mask”).
To disable:	Set bit 10 of P.0704 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates the protection when reported by the ECU.

8.8.119 AL.132 - High coolant temperature (from CANBUS).

Type:	Warning
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can-Bus alarms disable mask”).
To disable:	Set bit 4 of P.0704 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates the protection when reported by the ECU.

8.8.120 AL.134 - Maximum coolant temperature (from CANBUS).

Type:	Alarm
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can-Bus alarms disable mask”).
To disable:	Set bit 5 of P.0704 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- -

The controller activates the protection when reported by the ECU.

8.8.121 AL.135 - Minimum coolant level (from CANBUS).

Type:	Alarm
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can-Bus alarms disable mask”).
To disable:	Set bit 7 of P.0704 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- -

The controller activates the protection when reported by the ECU.

8.8.122 AL.136 - Low coolant level (from CANBUS).

Type:	Warning
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can-Bus alarms disable mask”).
To disable:	Set bit 6 of P.0704 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates the protection when reported by the ECU.

8.8.123 AL.137 - Low battery voltage (from CANBUS).

Type:	Warning
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can-Bus alarms disable mask”).
To disable:	Set bit 9 of P.0704 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates the protection when reported by the ECU.

8.8.124 AL.142 – Minimum oil pressure (from CANBUS)

Type:	Alarm
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can-Bus alarms disable mask”).
To disable:	Set bit 1 of P.0704 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- -

The controller activates the protection when reported by the ECU.

8.8.125 AL.144 – Low oil pressure (from CANBUS).

Type:	Warning
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can-Bus alarms disable mask”).
To disable:	Set bit 0 of P.0704 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates the protection when reported by the ECU.

8.8.126 AL.158 - High oil temperature (from CANBUS).

Type:	Warning
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can-Bus alarms disable mask”).
To disable:	Set bit 2 of P.0704 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates the protection when reported by the ECU.

8.8.127 AL.159 - Maximum oil temperature (from CANBUS).

Type:	Alarm
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can-Bus alarms disable mask”).
To disable:	Set bit 3 of P.0704 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- -

The controller activates the protection when reported by the ECU.

8.8.128 AL.160 - Water in fuel (from CANBUS).

Type:	Warning
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can-Bus alarms disable mask”).
To disable:	Set bit 8 of P.0704 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates the protection when reported by the ECU.

8.8.198 AL.198 - Warnings - Yellow lamp (from CANBUS).

Type:	Warning
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
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

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

8.8.199 AL.199 – Alarms - Red lamp (from CANBUS)

Type:	Alarm/Warning (bit 13 of P.0704)
Related parameters:	P.0700 (“Engine type”). P.0704 (“Can-Bus alarms disable mask”).
To disable:	Set bit 15 of P.0704 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- -

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

8.8.200 AL.200 – CANBUS 1 (PMCB): BUS-OFF

Type:	Warning
Related parameters:	P.0800 (“PMCB bus mode”).
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- P.0800 is set to zero.

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

8.8.201 AL.201 - CANBUS 1 (PMCB): duplicated address.

Type:	Warning
Related parameters:	P.0800 (“PMCB bus mode”). P.9501 (“Device address for PMCB”).
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates this protection if receives messages with its own device address.

8.8.202 AL.202 - CANBUS 1 (PMCB): wrong number of controllers.

Type:	Warning
Related parameters:	P.0800 (“PMCB bus mode”). P.0803 (“Number of gensets over PMCB bus”).
To disable:	P.0803 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates this protection if the number of genset controllers (included itself) sending messages over the CAN bus is different from the configured one for two seconds.

WARNING! if in the system there are BTB100 controllers that signal the bus tie breaker opened, the controller does not activate this alarm.

8.8.203 AL.203 – Negative sequence (46).

Type:	Deactivation
Related parameters:	P.0107 (“C.T. primary”). P.0139 (“C.T. secondary”). P.0106 (“Nominal power of the generator”). P.0102 (“Nominal voltage of the generator”). P.0101 (“Generator AC wiring”). P.0325 (“Threshold for negative sequence I2 (46)”). P.0326 (“Delay for negative sequence I2 (46)”). P.0319 (“Phases sequence for generator”)
To disable:	P.0326 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- DRIVE application.
- The controller does not acquire the generator’s current (CTs ratio not set, or CTs on loads and GCB open).
- Engine stopped, stopping, starting.
- Single-phase generator.

The threshold is a percentage of the rated current (see 7.5.1 for the determination of the rated current from P.0101, P.0102 and P.0106 parameters).

The controller activates the protection if the “negative sequence current” is higher than the configured threshold for the configured delay.

The “negative sequence current” is calculated as 1/3 of the module of the vector’s sum of the three phase currents, by putting out of phase of 120° in a direction the L2 current and of 120° in the other direction the L3 current (it depends on the phase’s sequence). If the load on the three phases is balanced and of equal cos (ϕ), the “negative sequence current” is 0. Practically, it represents an index of load unbalance, which considers also angles and not only modules.

8.8.204 AL.204 - Neutral-earth circuit breaker (NECB) not closed.

Type:	Configurable by P.0161
Related parameters:	P.2001 (“Function of the input 01”) or equivalent for the other inputs. P.2002 (“Delay for the input 01”) or equivalent for the other inputs. P.0161 (“Action for the neutral-earth circuit breaker (NECB) failure to close”).
To disable:	-
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- The controller does not directly manage the CB.
- The controller does not acquire the real status of the CB (DIF.3005).
- The “delay” parameter of the input acquiring the status is set to zero.

The controller activates this protection during the closure operation (if the CB doesn’t close within the configured delay).

8.8.205 AL.205 - Neutral-earth circuit breaker (NECB) not opened.

Type:	Warning
Related parameters:	P.2001 (“Function of the input 01”) or equivalent for the other inputs. P.2002 (“Delay for the input 01”) or equivalent for the other inputs.
To disable:	-
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- The controller does not directly manage the CB.
- The controller does not acquire the real status of the CB (DIF.3005).
- The “delay” parameter of the input acquiring the status is set to zero.

The controller activates this protection during the opening operation (if the CB doesn’t open within the configured delay).

8.8.206 AL.206 - Maximum error of active power.

Type:	Configurable by P.0383
Related parameters:	P.0381 (“Threshold for maximum error of active power”). P.0382 (“Delay for maximum error of active power”). P.0383 (“Action for maximum error of active power”). P.0125 (“Nominal power of the engine”)
To disable:	P.0382 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”, “G”

Disabled when:

- DRIVE application.
- The controller does not acquire the generator’s current (CTs ratio not set, or CTs on loads and GCB open).
- Engine stopped, stopping, starting.
- Not in parallel with another power source.

The controller activates this protection if the difference between the active power and its reference is above the configured threshold for the configured delay.

INFORMATION! the protection acts only if the active power is lower than the setpoint.

8.8.207 AL.207 - Maximum time in parallel to the grid.

Type:	Warning
Related parameters:	P.0890 (“Maximum time in parallel to the grid”). P.0897 (“MCB opening for maximum time in parallel to the grid”).
To disable:	P.0890 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- Not parallel applications.

The controller activates the anomaly if the generator is in parallel to the mains for more than the configured time. The controller forces the GCB opening and impedes its reclosing until the operator acknowledges the warning. This warning can be activated also in case the “transfer to genset” function is active, if at the end of the time set, the power has not

been switched to the genset yet (because the nominal power of the genset is not enough to supply the load): in this case, if the power absorbed by the load decreases, the controller will automatically close GCB even in case of warning.

Parameter P.0897 allows to select in which conditions the controller must allow opening the MCB in case the anomaly is active:

- Bit 0: MAN.
- Bit 1: AUTO.
- Bit 2: TEST.
- Bit 3: RMOTE START.
- Bit 7: In case of GCB opening failure.

8.8.208 AL.211 - Shared input written by another device.

Type:	Warning
Related parameters:	P.0800 (“PMCB bus mode”).
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates the anomaly if another controller connected to the PMCB CAN bus writes the same shared digital/analogue inputs written by this one.

8.8.221 AL.221 - AFR: maximum temperature for MAT.

Type:	Configurable by P.1387
Related parameters:	P.1381 (“Hysteresis on MAT temperature”). P.1385 (“High MAT temperature threshold”). P.1386 (“High MAT temperature delay”). P.1387 (“High MAT temperature alarm type”).
To disable:	P.1386 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- AFR not configured (see 7.8.14).
- The air/gas mixture temperature is not available (AIF.1683).

The controller activates the anomaly if the temperature of the air/gas mixture remains above the configured threshold for the configured delay. Parameter P.1381 configures the hysteresis applied to the threshold.

8.8.222 AL.222 - AFR: regulation error.

Type:	Configurable by P.1376
Related parameters:	P.1372 (“Hysteresis on regulation/protection thresholds for AFR-IN”). P.1374 (“Maximum AFR-IN regulation error threshold”). P.1375 (“Maximum AFR-IN regulation error delay”). P.1376 (“Maximum AFR-IN regulation error alarm type”).
To disable:	P.1375 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- AFR not configured (see 7.8.14).
- Engine stopped, stopping, starting.

The purpose is to detect a situation in which the control loop cannot bring the AFR-IN measurement close to its setpoint. The controller activates the protection if the regulation error (setpoint - measurement, absolute value) remains above the configured threshold for the configured delay. Parameter P.1372 configures the hysteresis applied to the threshold.

8.8.223 AL.223 - AFR: high temperature for MAT

Type:	Configurable by P.1384
Related parameters:	P.1381 (“Hysteresis on MAT temperature”). P.1382 (“High MAT temperature threshold”). P.1383 (“High MAT temperature delay”). P.1384 (“High MAT temperature alarm type”).
To disable:	P.1383 = 0
Suitable operating modes:	MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- AFR not configured (see 7.8.14).
- The air/gas mixture temperature is not available (AIF.1683).
- Engine stopped, stopping, starting.
- After starting the engine, within the first P.0216 seconds.

The controller activates the anomaly if the temperature of the air/gas mixture remains above the configured threshold for the configured delay. Parameter P.1381 configures the hysteresis applied to the threshold.

8.8.224 AL.224 – AFR: incoherent parameters.

Type:	Warning
Related parameters:	
To disable:	
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“E”

Disabled when:

- -

The controller activates the anomaly if the configuration parameters of the AFR function are not coherent with each other:

- AFR-IN measurement is not acquired.
- The position of the mixer is not acquired (mandatory with digital commands OPEN/CLOSE).
- The methane percentage measurement is not available (but is required).
- The thresholds relative to the position of the mixer with respect to the percentage of methane are inverted.
- The air/gas mixture temperature measurement is not available (but is required).

GC800 HMI shows detailed information on the cause.

8.8.225 AL.251 – EXBUS: BUS-OFF

Type:	Warning
Related parameters:	
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

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

8.8.226 AL.252 - EXBUS: some modules are missing.

Type:	Warning
Related parameters:	I/O expansion modules configuration
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates this protection if at least one configured expansion module does not send any message over the CAN bus. GC800 HMI shows detailed information on the cause.

8.8.227 AL.253 - EXBUS: some measures are missing.

Type:	Warning
Related parameters:	I/O expansion modules configuration
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

If the operator configures a function for an analogue input on an expansion module, the controller activates this protection if that module does not send the required measurement (probably the module itself is not properly configured). GC800 HMI shows detailed information on the cause.

8.8.228 AL.254 - EXBUS: duplicated address

Type:	Warning
Related parameters:	I/O expansion modules configuration
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates this protection if detected two or expansion module (of the same type) sending data with the same address (check the address configuration of the expansion modules). GC800 HMI shows detailed information on the cause.

8.8.229 AL.255 - EXBUS: sensor disconnected.

Type:	Warning
Related parameters:	I/O expansion modules configuration
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

If the operator configures a function for an analogue input (both controller and expansion modules), the controller activates this protection if detects a “broken wire” situation on that analogue input. GC800 HMI shows detailed information on the cause.

8.8.230 AL.271 – Direct synchronization failure.

Type:	Warning/alarm
Related parameters:	P.0802 (“Type of plant”). P.0854 (“Use of GCB”). P.0852 (“Maximum time for direct synchronization”).
To disable:	P.0852 = 0
Suitable operating modes:	AUTO, TEST, REMOTE START
Subject to override requests:	“F”

Disabled when:

- GCB synchronization not allowed (not parallel application or configured by P.0854).

The controller activates this protection if the synchronization process (for GCB closure) does not end within the configured time. It is always an alarm: it becomes a warning only if the switch is controlled externally (P.0854).

8.8.231 AL.272 – Reverse synchronization failure.

Type:	Warning
Related parameters:	P.0802 (“Type of plant”). P.0855 (“Use of MCB”). P.0853 (“Maximum time for reverse synchronization”).
To disable:	P.0853 = 0
Suitable operating modes:	AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- MCB synchronization not allowed (not parallel application or configured by P.0855).

The controller activates this protection if the synchronization process (for MCB closure) does not end within the configured time.

8.8.232 AL.273 - Parameters not coherent.

Type:	Warning/alarm
Related parameters:	
To disable:	-
Suitable operating modes:	Off, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates this protection if plant configuration parameters are not coherent. GC800 HMI shows detailed information on the cause.

8.8.233 AL.274 - Production line opened.

Type:	Deactivation.
Related parameters:	P.2001 (“Function of the input 01”) or equivalent for the other inputs. P.2002 (“Delay for the input 01”) or equivalent for the other inputs.
To disable:	P.2002 = 0
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates the protection if the input (function DIF.4261 - “Production line opened”) is active for the configured delay.

The input indicates that there is at least one “not know” CB open on the line that connects the generator to the public mains (power production not allowed).

8.8.234 AL.275 - Interface device not opened.

Type:	Alarm.
Related parameters:	P.0802 (“Type of plant”). P.0900 (“Interface device”).
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- -

The controller activates the protection if the CB configured as “interface device” (P.0900) does not open within 0.5 seconds after a mains failure, while the generator is in parallel to the mains.

8.8.235 AL.276 - CANBUS 1 (PMCB): alarm from master controller

Type:	Warning/alarm.
Related parameters:	P.0800 (“PMCB bus mode”). P.0802 (“Type of plant”).
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”

Disabled when:

- -

This protection is forced by an MC controller when an anomaly must be signalled also to the genset controllers (the MC controller shows the reason).

8.8.279 AL.279 - Bus bars voltage not coherent

Type:	Warning/deactivation.
Related parameters:	-
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	“F”

Disabled when:

- -

The controller will activate this warning before closing GCB, if it notices a divergence between the effective presence of voltage on parallel bars and what it expects according to the statuses of the CBs, of the mains and of the any other genset controller connected on PMCB. The anomaly is activated only if there isn’t voltage on bars when, on the contrary, it should be present. For example, if at least another generator has closed GCB, there should be voltage on parallel bars: if the controller doesn't detect it (through the three-phase sensor or through a contact), after two seconds the signalling is activated. Usually the signal is a warning, it becomes a deactivation (only in case of automatic procedures) after 60 seconds if the controller still needs to close the GCB.

8.8.280 AL.282 - Redundancy: wrong configuration.

Type:	Alarm
Related parameters:	P.0281 (“Hot redundancy enable”).
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- “Hot redundancy” feature disabled.

The controller activates this anomaly if there is something wrong in the configuration of the “hot redundancy” feature (see 0). GC800 HMI shows detailed information on the cause.

8.8.281 AL.283 - Redundancy: MASTER controller failure.

Type:	Warning
Related parameters:	P.0281 (“Hot redundancy enable”).
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- “Hot redundancy” feature disabled.

The BACKUP controller detected a failure on the MASTER and took control of the generator.

8.8.282 AL.284 - Redundancy: KBACKUP relay failure.

Type:	Warning
Related parameters:	P.0281 (“Hot redundancy enable”).
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- “Hot redundancy” feature disabled.

The controller (both MASTER or BACKUP) detected a mismatch among its COMMAND/WATCH status and the feedback of the relay which switches the resources among the controllers.

8.8.283 AL.285 - Redundancy: different firmware versions.

Type:	Alarm
Related parameters:	P.0281 (“Hot redundancy enable”).
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- “Hot redundancy” feature disabled.

The MASTER and BACKUP controller run different firmware. Thus, the “hot redundancy” is not available.

8.8.284 AL.286 - Redundancy: BACKUP controller failure.

Type:	Warning
Related parameters:	P.0281 (“Hot redundancy enable”).
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- “Hot redundancy” feature disabled.

The MASTER backup doesn’t receive any message from the BACKUP controller.

8.8.301 AL.301...AL.554 - Generic anomalies linked to analogue inputs.

See 8.7.

Device	Input	Alarm 1	Alarm 2
Controller	#01	301	302
	#02	303	304
	#03	305	306
	#04	307	308
	#05	309	310
	#06	311	312
	#07	553	554

Device	Input	Alarm 1	Alarm 2
Virtual	#01	313	314
	#02	315	316
	#03	317	318
	#04	319	320
	#05	321	322
	#06	323	324
	#07	325	326
	#08	327	328

Device	Input	Alarm 1	Alarm 2
Expansion 1...16	#01	329	330
	#02	331	332
	#03	333	334
	#04	335	336
	#05	337	338
	#06	339	340
	#07	341	342
	#08	343	344
	#09	345	346
	#10	347	348
	#11	349	350
	#12	351	352
	#13	353	354
	#14	355	356
	#15	357	358
	#16	359	360

Device	Input	Alarm 1	Alarm 2
Expansion 17...32	#17	361	362
	#18	363	364
	#19	365	366
	#20	367	368
	#21	369	370
	#22	371	372
	#23	373	374
	#24	375	376
	#25	377	378
	#26	379	380
	#27	381	382
	#28	383	384
	#29	385	386
	#30	387	388
	#31	389	390
	#32	391	392

Device	Input	Alarm 1	Alarm 2
Expansion 33...48	#33	393	394
	#34	395	396
	#35	397	398
	#36	399	400
	#37	401	402
	#38	403	404
	#39	405	406
	#40	407	408
	#41	409	410
	#42	411	412
	#43	413	414
	#44	415	416
	#45	417	418
	#46	419	420
	#47	421	422
	#48	423	424

Device	Input	Alarm 1	Alarm 2
Expansion 49...64	#49	425	426
	#50	427	428
	#51	429	430
	#52	431	432
	#53	433	434
	#54	435	436
	#55	437	438
	#56	439	440
	#57	441	442
	#58	443	444
	#59	445	446
	#60	447	448
	#61	449	450
	#62	451	452
	#63	453	454
	#64	455	456

Device	Input	Alarm 1	Alarm 2
Expansion 81...96	#81	489	490
	#82	491	492
	#83	493	494
	#84	495	496
	#85	497	498
	#86	499	500
	#87	501	502
	#88	503	504
	#89	505	506
	#90	507	508
	#91	509	510
	#92	511	512
	#93	513	514
	#94	515	516
	#95	517	518
	#96	519	520

Device	Input	Alarm 1	Alarm 2
Expansion 65...80	#65	457	458
	#66	459	460
	#67	461	462
	#68	463	464
	#69	465	466
	#70	467	468
	#71	469	470
	#72	471	472
	#73	473	474
	#74	475	476
	#75	477	478
	#76	479	480
	#77	481	482
	#78	483	484
	#79	485	486
	#80	487	488

Device	Input	Alarm 1	Alarm 2
Expansion 81...96	#097	521	522
	#098	523	524
	#099	525	526
	#100	527	528
	#101	529	530
	#102	531	532
	#103	533	534
	#104	535	536
	#105	537	538
	#106	539	540
	#107	541	542
	#108	543	544
	#109	545	546
	#110	547	548
	#111	549	550
	#112	551	552

8.8.561 AL.561...AL.584 – Anomalies of DIPRO-1

DIPRO is a stand-alone protection relay. You can connect it to GC800 SCM through CAN. GC800 SCM receives all its measurements and protections status via CAN:

- Can react to the protections (if configured).
- GC800 HMI shows all the received measurements.

The controller provides four parameters, allowing to “map” DIPRO protections to the controller protections:

- P.0601 (“DIPRO 1 protections configured as warnings”).
- P.0602 (“DIPRO 1 protections configured as unloads”).
- P.0603 (“DIPRO 1 protections configured as deactivations”).
- P.0604 (“DIPRO 1 protections configured as alarms”).

Each parameter provides a bit per protections (see the following table): by properly configuring these bits, you can tell the controller to activate any kind of anomaly (or none of them) when the DIPRO activates its own protections.

For example, if you are not interested in protection 27, set bit 0 of all four parameters to “0”. If you want the controller activating a deactivation for DIPRO’s protection 32, set bit 2 only on parameter P.0603.

Anomaly	Description	Bit
561	Protection 27 (minimum voltage)	0
562	Protection 27T (minimum voltage time dependent)	1
563	Protection 32 (maximum active power)	2
564	Protection 32Q (maximum exported reactive power)	3
565	Protection 46 (negative sequence)	4
566	Protection 47 (wrong phases sequence)	5
567	Protection 50 (fixed time maximum current)	6
568	Protection 50N (fixed time maximum current for earth fault)	7
569	Protection 50V (fixed time maximum current)	8
570	Protection 51 (variable time maximum current)	9
571	Protection 51N (variable time maximum current on neutral line)	10
572	Protection 51V (variable time maximum current)	11
573	Protection 59 (maximum voltage)	12
574	Protection 59N (maximum residual voltage)	13
575	Protection 81< (minimum frequency)	14
576	Protection 81> (maximum frequency)	15
577	Protection 87G (maximum differential current – generator)	16
578	Protection 87T (maximum differential current – transformer)	17
579	Protection 32R (power reverse)	18
580	Protection 40 (reactive power reverse/loss of excitation)	19
581	Protection 64 (restricted earth fault/maximum differential current)	20

8.8.585 AL.585...AL.605 – Anomalies of DIPRO-1

You can connect two DIPRO relay to GC800. See the description in the previous chapter, but using the following parameters:

- P.0605 (“DIPRO 2 protections configured as warnings”).
- P.0606 (“DIPRO 2 protections configured as unloads”).
- P.0607 (“DIPRO 2 protections configured as deactivations”).
- P.0608 (“DIPRO 2 protections configured as alarms”).

8.8.586 AL.685... AL.887 - Generic anomalies linked to analogue inputs.

See also 8.6.

Device	Input	Alarm
Controller	#01	701
	#02	702
	#03	703
	#04	704
	#05	705
	#06	706
	#07	707
	#08	708
	#09	709
	#10	710
	#11	711
	#12	712
	#13	713
	#14	714
	#15	715
	#16	716
	#17	717
	#18	718
	#19	719
	#20	720

Device	Input	Alarm
Analogue inputs used as digital	#01	721
	#02	722
	#03	723
	#04	724
	#05	725
	#06	726
	#07	887

Device	Input	Alarm
Virtual	#01	727
	#02	728
	#03	729
	#04	730
	#05	731
	#06	732
	#07	733
	#08	734
	#09	735
	#10	736
	#11	737
	#12	738
	#13	739
	#14	740
	#15	741
	#16	742

Device	Input	Alarm
Expansion 1...16	#01	743
	#02	744
	#03	745
	#04	746
	#05	747
	#06	748
	#07	749
	#08	750
	#09	751
	#10	752
	#11	753
	#12	754
	#13	755
	#14	756
	#15	757
	#16	758

Device	Input	Alarm
Expansion 17...32	#17	759
	#18	760
	#19	761
	#20	762
	#21	763
	#22	764
	#23	765
	#24	766
	#25	767
	#26	768
	#27	769
	#28	770
	#29	771
	#30	772
	#31	773
	#32	774

Device	Input	Alarm
Expansion 33...48	#33	775
	#34	776
	#35	777
	#36	778
	#37	779
	#38	780
	#39	781
	#40	782
	#41	783
	#42	784
	#43	785
	#44	786
	#45	787
	#46	788
	#47	789
	#48	790

Device	Input	Alarm
Expansion 49...64	#49	791
	#50	792
	#51	793
	#52	794
	#53	795
	#54	796
	#55	797
	#56	798
	#57	799
	#58	800
	#59	801
	#60	802
	#61	803
	#62	804
	#63	805
	#64	806

Device	Input	Alarm
Expansion 65...80	#65	807
	#66	808
	#67	809
	#68	810
	#69	811
	#70	812
	#71	813
	#72	814
	#73	815
	#74	816
	#75	817
	#76	818
	#77	819
	#78	820
	#79	821
	#80	822

Device	Input	Alarm
Expansion 81...96	#81	823
	#82	824
	#83	825
	#84	826
	#85	827
	#86	828
	#87	829
	#88	830
	#89	831
	#90	832
	#91	833
	#92	834
	#93	835
	#94	836
	#95	837
	#96	838

Device	Input	Alarm
Expansion 97...112	#97	839
	#98	840
	#99	841
	#100	842
	#101	843
	#102	844
	#103	845
	#104	846
	#105	847
	#106	848
	#107	849
	#108	850
	#109	851
	#110	852
	#111	853
	#112	854

Device	Input	Alarm
Expansion 129...144	#129	871
	#130	872
	#131	873
	#132	874
	#133	875
	#134	876
	#135	877
	#136	878
	#137	879
	#138	880
	#139	881
	#140	882
	#141	883
	#142	884
	#143	885
	#144	886

Device	Input	Alarm
Expansion 113...128	#113	855
	#114	856
	#115	857
	#116	858
	#117	859
	#118	860
	#119	861
	#120	862
	#121	863
	#122	864
	#123	865
	#124	866
	#125	867
	#126	868
	#127	869
	#128	870

Device	Input	Alarm
Expansion 145...160	#145	685
	#146	686
	#147	687
	#148	688
	#149	689
	#150	690
	#151	691
	#152	692
	#153	693
	#154	694
	#155	695
	#156	696
	#157	697
	#158	698
	#159	699
	#160	700

8.8.900 AL.900 - PLC's parameter not coherent or not set

Type:	Warning
Related parameters:	
To disable:	-
Suitable operating modes:	OFF, MAN, AUTO, TEST, REMOTE START
Subject to override requests:	

Disabled when:

- No valid PLC programs in the controller.

The controller activates this protection to problems in PLC’s execution:

- The PLC program uses more FLASH memory than available.
- The PLC program uses more RAM memory than available.
- The PLC program has an invalid control checksum.
- The controller does not support the PLC version.

- A digital or analogue output controlled by the PLC is not configured with DOF.0101 or AOF.0101 function (“used by the PLC”).
- The PLC program uses a resource (of any kind) not available on this controller (for example, a digital input of a non-connected expansion module).
- An invalid parameter has been specified for one of PLC blocks.
- An invalid type of block has been specified.
- Calculation error during the running of the program.

GC800 HMI shows detailed information on the cause.

8.8.901 AL.901...AL.964 - Anomalies connected to the PLC.

These anomalies are managed by the internal PLC itself, with logic dependant by the PLC program. The programmer defines the kind of anomalies, the activation logic, and the message.

9 Other functions

9.1 PLC logic

The controller provides a PLC environment (“Programmable Logic Controller”) that can execute a program created by the operator. Use the Mecc Alte “PLCEDITOR” software to create the PLC program, to send it to the controller and to debug it.

The controller executes the PLC program 100ms. This rate could be too slow for fast protections.

9.2 Real time clock/calendar

The controller has an internal hardware real time clock, with calendar. It has its own backup power supply (rechargeable battery), so correct date and time survive to power cycles on the controller (months, see paragraph 3). The controller needs a few hours to fully recharge the backup battery.

GC800 HMI shows the current date/time of GC800 SCM.

GC800 SCM uses the date/time for many purposes:

- Periodical and “on-event” recording on history logs.
- Storing the activation date/time of each anomaly.
- Managing schedulers for:
  - Periodical TEST of the engine.
  - Inhibit the automatic start of the generator (for example in the weekend).
  - Forcing the automatic start of the generator.
- Generic purpose calendars.
- Managing the service counters.
- …

If the internal real time clock is not valid (never set or backup battery completely discharged), and the operator scheduled soe operation, the controller activates the warning AL.057 (“Clock not valid”).

You can configure GC800 SCM to automatically synchronize its date/time with an external server. All controllers connected to the PMCB Can bus automatically synchronizes their date/time with the master’s one: the lowest address MC (if any), otherwise the lowest address GC.

If you do not use any automatic date/time synchronization, you can manually set the date/time using the provided parameters; BoardPrg4 provides a command allowing to synchronize the controller’s date/time with the PC’s one.

Parameters:

- P.0411 (“Year”): 0…99.
- P.0412 (“Month”): 1…12.
- P.0413 (“Day of month”): 1…31.
- P.0415 (“Hours”): 0…23.
- P.0416 (“Minutes”): 0…59.
- P.0417 (“Seconds”): 0…59.

The controller automatically calculates the “day of the week” from other data.

Some countries use the DST (“daylight saving time”) feature. In a specific period of the year (typically during the summer) a specific time offset (usually one hour) is added to the local time, to have more lighting hours available over the day. GC800 SCM allows to configure the DST feature with parameters P.0409 and P.0410:

- P.0408 (“Daylight Save Time offset (1=15 min., 4= 1 hour)”). This parameter allows specifying the number of “quarter of hours” to be added during summertime. For example, Italy adds one hour during summer, thus P.0408 must be set to “4”.
- P.0409 (“Legal time”). It supports four values.
    - “0-No”. No automatic management of the DST, and now the DST is not active.
    - “1-No”. No automatic management of the DST, and now the DST is active.
    - “2-Automatic (Europe only). The controller automatically manages the DST, on the European standardized activation/deactivation date:
        - Activation on the last Sunday of March, at 2:00 AM.
        - Deactivation on the last Sunday of October, at 3:00 AM.
    - “3-Automatic via calendar”. The controller automatically manages the DST, on customizable activation/deactivation date:
        - Activation on date/time set by generic calendar #15.
        - Deactivation on date/time set by generic calendar #16.

9.2.1 Synchronization with an external server.

The controller can use its Ethernet ports to contact an external public NTP server and keep its date/time synchronized with the server itself. Since NTP servers work in UTC mode (Universal Time Coordinate), the controller must know where it is located to correctly translate the received date/time to the local ones (also considering DST, see above). Parameter P.0410 (“Time Zone x4 (-47...+48) (1=15 min., 4= 1h)”) allows to select the proper time zone, in “quarter of hours” (with sign). Italy, for example is “UTC+1”: thus, it requires P.0410 = “4”.

See the description in 5.12.8.3.

9.2.2 Weekly planned engine TEST.

AMF applications requires to automatically start the generators only in case of mains failure. If your country provides a stable public grid, your generator will run very rarely: this is not good for the engine, which instead needs to run regularly.

The controller provides this feature allowing periodical start of the engine, by switching the controller in TEST sub-mode. If the grid fails during the TEST, the controller immediately aborts the TEST sub-mode and switches back to AUTO mode, taking care of the situation.

The operator can select one or more days of the week to perform the engine TEST using parameter P.0418 (it is a bit-mapped parameter, one bit for each day of the week). Then it may decide the TEST start time (P.0419) and the TEST duration (P.0420): the selected timespan is used for all selected days.

To keep an engine in optimal conditions, usually it is required to load it while running; the operator can select whether closing GCB or not by parameter P.0222 (“Enable generator supply on TEST?”). Depending on the application type, the test can be in parallel to another power source or in island (supplying the local loads).

9.2.3 Weekly planned operating time.

In some applications, it is useful to inhibit the automatic start of the generator for mains failure in hours or days where the mains are not used. For example, if a factory is closed on Sunday, the engine should never start in this day,

The controller provides this scheduler allowing to activate a “start inhibition” (see 7.6).

The operator can select one or more days of the week using parameter P.0421 (it is a bit-mapped parameter, one bit for each day of the week). Then it may decide the start time (P.0422) and the end time (P.0423): the selected timespan is used for all selected days. The controller allows automatic starts of the engine only in the selected timespan and only the selected days of the week.

9.2.4 Weekly planned operating override.

This feature allows overriding the internal logic of the controller and force it starting the genset in selected days. For example, if a factory knows that on a particular time interval its energy consumption is higher than what allowed by the public grid, it can start the generator and force it operating in parallel to the mains.

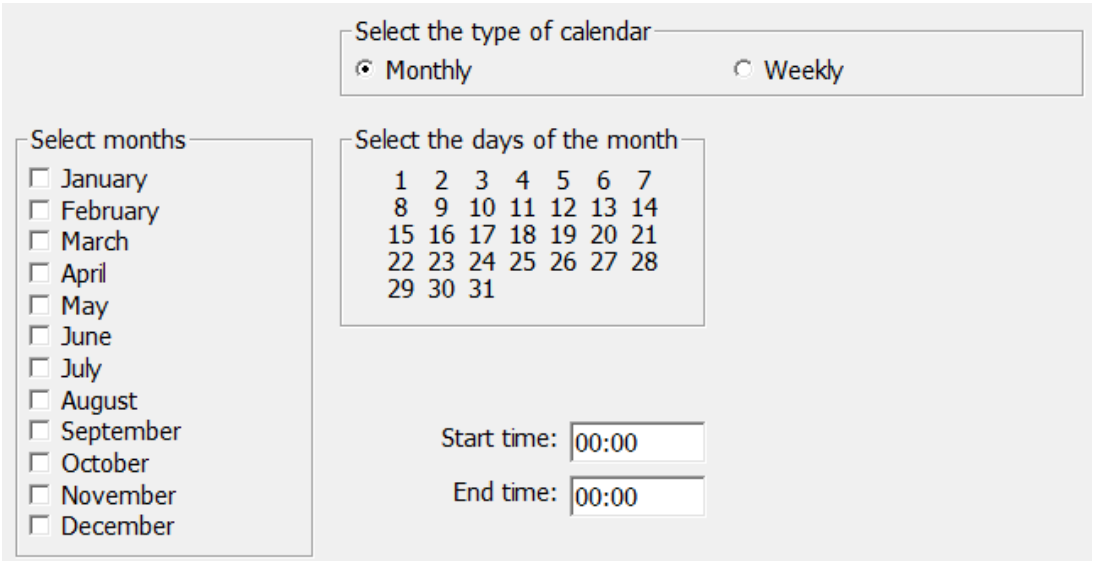
The controller provides this scheduler allowing to switch into REMOTE START mode.

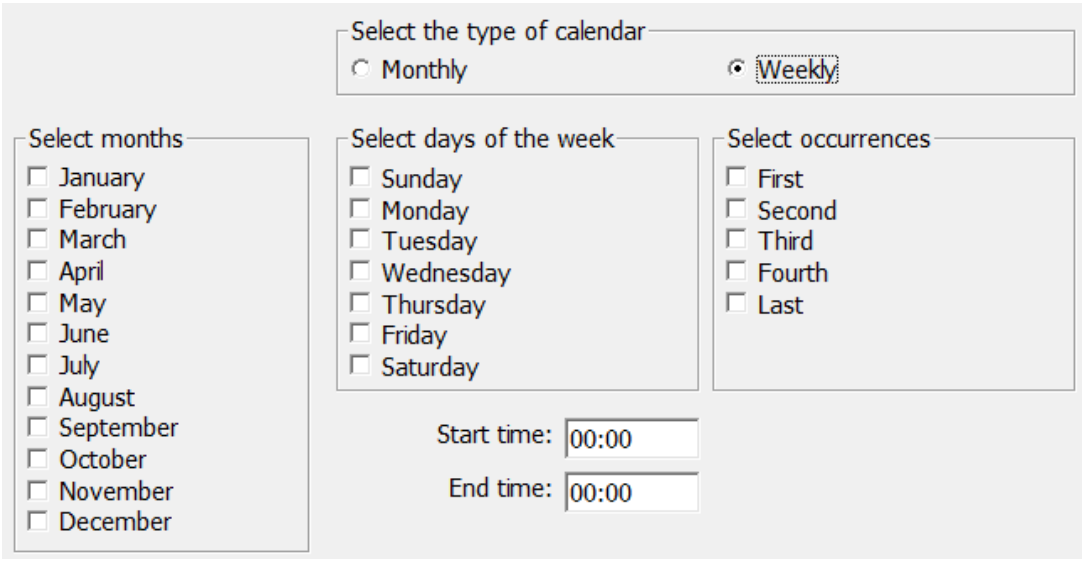
The operator can select one or more days of the week using parameter P.0426 (it is a bit-mapped parameter, one bit for each day of the week). Then it may decide the start time (P.0427) and the end time (P.0428): the selected timespan is used for all selected days. The controller automatic starts the engine in the selected days of the week, in the selected timespan.

9.2.5 Configurable calendars

The controller provides 16 fully configurable calendars. They allow selecting days and timeslots, inside which the controller activates an internal bit. This bit could then be used by AND/OR logics to activate a digital output or to create more complex logics. All calendars are identical: calendars 15 and 16, however, can be used for the activation/deactivation of the daylight save time (if parameter P.0409 is set to “3”).

You can individually select each calendar as “monthly” or “weekly”:





If you want to operate on the controller (not using BoardPrg4), you must modify parameter P.1900. It is a bit-mapper parameter, providing one bit per calendar (0=monthly, 1=weekly).

Then, for both types, you can select any combination of the months in the year (you must select at least one month). If you want to operate on the controller (not using BoardPrg4), you must modify parameter P.1901 (for calendar #1, or the equivalent for other calendars). It is a bit-mapper parameter too, providing one bit per month.

For "**monthly**" calendars, you can then select any combination of the days in the month (you must select at least one day). If you want to operate on the controller (not using BoardPrg4), you must modify parameter P.1902 (for calendar #1, or the equivalent for other calendars). It is a bit-mapper parameter too, providing one bit per day in the month. The selected days are valid for all selected months.

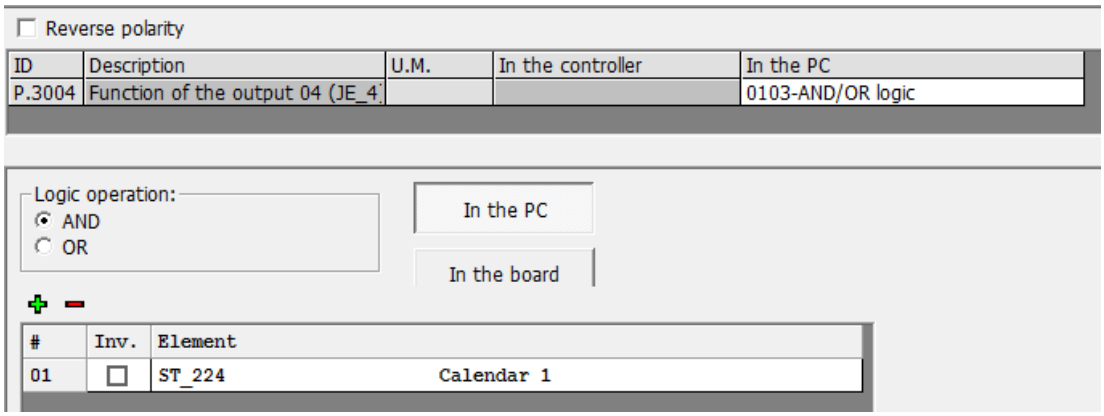
For "**weekly**" calendars, instead, you can select:

- Any combination of the days in the week (you must select at least one day).
- Any combination of the week in the month (you must select at least one week). The last option allows you to specify the last week in the month, that could be the 4th or the 5th depending on the month. A typical example is the management of the daylight save time; in Italy, it is activated on the last Sunday of October, and deactivated on the last Sunday of March. Those Sundays can be the 4° or the 5° occurrence in the month, depending on the first day of the month. Using the "last" option, the problem is solved.

If you want to operate on the controller (not using BoardPrg4), you must modify parameter P.1902 (for calendar #1, or the equivalent for other calendars). It is a bit-mapper parameter. Bits 0…4 allows selecting the week in the month, bits 16…22 the days in the week. The selected weeks are valid for all selected months, and the selected days in all selected weeks.

Finally, for both "weekly" and "monthly" calendars, you can select a timeslot (valid for all selected days). The controller will activate the internal bit only inside the selected timeslot. If you want to operate on the controller (not using BoardPrg4), you must modify parameters P.1903 and P.1904 (for the calendar 1 or equivalent for other calendars). If those parameters are equal, the full day is selected. If the start time is lower than the end time, the timeslot is not across midnight; otherwise, the internal bit is activated after the start time of the selected days, and it is deactivated after the end time of the day after.

Using the AND/OR logics, it is possible to activate a digital output into selected days and timeslot:



Let's show an example for the configuration of the daylight save time for Italy, using calendars 15 and 16:

- We use "calendar 15" for activating the DST on "last Sunday of October, at 2:00 AM".
  - Select "weekly" (bit 14 of P.1900 = "1").
  - Select "October" (P.1957 = "0200").
  - Select "Sunday", "Last" (P.1958 = "00010010").
  - Select "2:00" as start time (P.1959).
  - Select "2:01" as end time (P.1960).
- We use "calendar 15" for deactivating the DST on "last Sunday of March, at 3:00 AM".

- Select “weekly” (bit 15 of P.1900 = “1”).
- Select “March” (P.1961 = “0004”).
- Select “Sunday”, “Last” (P.1962 = “00010010”).
- Select “3:00” as start time (P.1963).
- Select “3:01” as end time (P.1964).

9.2.6 Events and signalling

The controller records the following events:

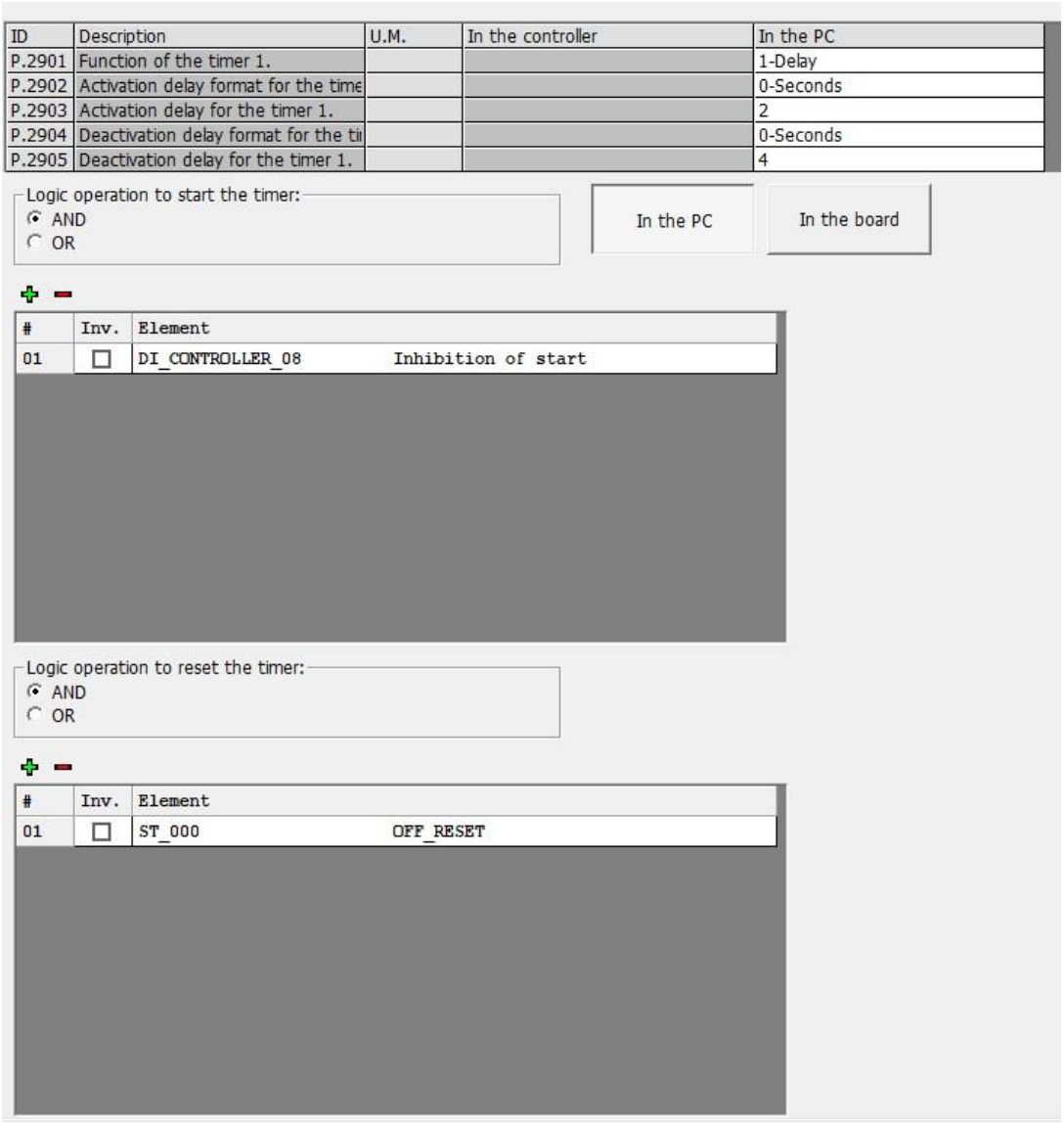
- EVT.1075: real time clock/calendar not valid.
- EVT.1076: Real time clock/calendar updated.
- EVT.1086: clock updated for daylight saving time.
- EVT.1087: clock updated for standard time.

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

- ST.127- “Daylight Save Time”.
- ST.224 - “Calendar 1”.
- ST.225 - “Calendar 2”.
- ST.226 - “Calendar 3”.
- ST.227 - “Calendar 4”.
- ST.228 - “Calendar 5”.
- ST.229 - “Calendar 6”.
- ST.230 - “Calendar 7”.
- ST.231 - “Calendar 8”.
- ST.232 - “Calendar 9”.
- ST.233 - “Calendar 10”.
- ST.234 - “Calendar 11”.
- ST.235 - “Calendar 12”.
- ST.236 - “Calendar 13”.
- ST.237 - “Calendar 14”.
- ST.238 - “Calendar 15”.
- ST.239 - “Calendar 16”.

9.3 Configurable timers

The controller provides four generic fully configurable timers, that can be used together with the AND/OR logics to create complex sequential logics. Each timer, in fact, activates/deactivates an internal bit that can be used by the AND/OR logics. The four timers are identical to each other and are quite similar to the once available in the PLC environment.



For each timer you can select an “activation condition” that starts the timer, and optionally a “reset condition”. When the “reset condition” is true, the internal bit of the timer is forced to “0”. You can create these conditions using AND/OR logics.

Wach timer provides the following five parameters (the list refers to the timer 1):

- P.2901: “Function of the timer 1”.
- P.2902: “Activation delay format for the timer 1”.
- P.2903: “Activation delay for the timer 1”.
- P.2904: “Deactivation delay format for the timer 1”.
- P.2905: “Deactivation delay for the timer 1”.

The controller allows selecting different time bases (seconds, minutes, hours) for the two available delays (activation/deactivation), providing great flexibility.

Each timer can work in four different modes, selectable by the “function” parameter:

0 – Not used.

The internal bit is always "0”.

1 – Delay.

When the “activation condition” becomes true, the controller waits for the P.2902 – P.2903 delay, then activates the internal bit. When the “activation condition” becomes false, the controller waits for the P.2904 – P.2905 delay, then deactivates the internal bit. If the reset condition is “true”, the internal bit is “0” whatever the “activation condition” is.

2 – Pulse.

When the “activation condition” becomes true, the controller activates the internal bit for the P.2902 – P.2903 delay, then deactivates it. When the “activation condition” becomes false, the controller activates the internal bit for the P.2904 – P.2905 delay, then deactivates it. If the reset condition is “true”, the internal bit is “0” whatever the “activation condition” is.

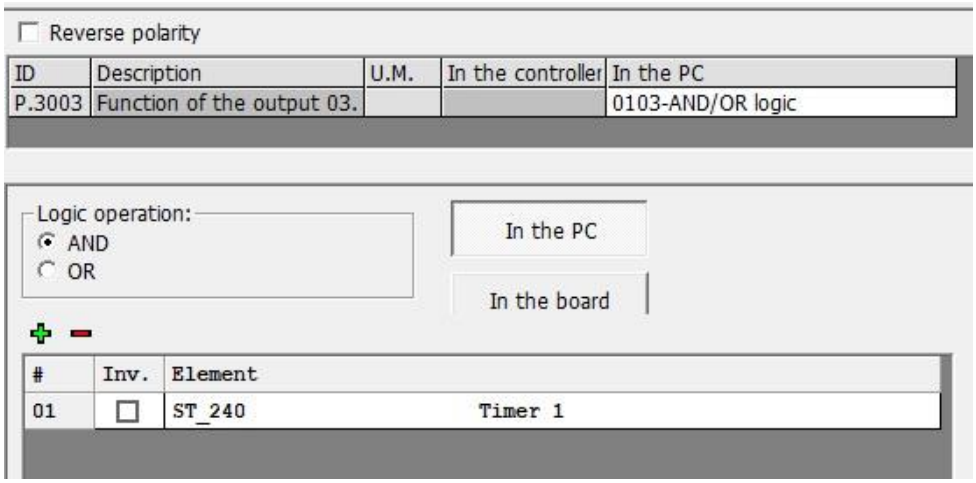
3 – Free run.

When the “activation condition” is true, the controller continuously activates the internal bit for the P.2902 – P.2903 delay, then deactivates it for the P.2904 – P.2905 delay, and so on. If the activation condition is “off”, the internal, bit is “0”. If the reset condition is “true”, the internal bit is “0” whatever the “activation condition” is.

4 – Set/Reset

The controller activates the internal state when the “activation condition” is true. It deactivates the internal bit when the “reset condition” is true (mandatory for this kind of timer). If both conditions are “false”, the internal bit keeps its status.

The following example “maps” the internal bit of the timer 1 to a digital output:



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

- ST.240 - “Timer 1”.
- ST.241 - “Timer 2”.
- ST.242 - “Timer 3”.
- ST.243 - “Timer 4”.

9.4 Thermometer

The controller provides a hardware thermometer, for measuring its internal temperature. GC800 HMI shows the internal temperature of GC800 SCM.

The electronic components inside the controller have an extended working temperature range. Despite this, it is possible (in critical ambient conditions) that the temperature goes out of this range. The controller activates a warning

if the internal temperature grows over the threshold P.0366 (“High board temperature threshold”). Using AND/OR logics, you may “map” the warning to a digital output, to activate an external cooling system.

9.5 Counters

The controller manages a lot of counters:

- Engine:
  - Starts (resettable to zero).
  - Running hours.
  - Running hours (resettable to zero).
  - Running hours with GCB closed (resettable to zero).
  - Running hours with protection override (resettable to zero).
  - Time to next service 1.
  - Time to next service 2.
- Generator:
  - Active energy.
  - Active energy (resettable to zero).
  - Exported reactive energy.
  - Exported reactive energy (resettable to zero).
  - Imported reactive energy.
  - Imported reactive energy (resettable to zero).
- Mains (when available):
  - Exported active energy.
  - Exported active energy (resettable to zero).
  - Imported active energy.
  - Imported active energy (resettable to zero).
  - Exported reactive energy.
  - Exported reactive energy (resettable to zero).
  - Imported reactive energy.
  - Imported reactive energy (resettable to zero).
  - Number of trips of protection 27 (two counters for two protections).
  - Number of trips of protection 59 (two counters for two protections).
  - Number of trips of protection 81L (two counters for two protections).
  - Number of trips of protection 81H (two counters for two protections).
  - Number of trips of protection 81R.
  - Number of trips of protection VJ.
- Controller:
  - Power supply time.
  - Power supply time with internal temperature over 70°C.
  - Power supply time with internal temperature over -30°C.

GC800 HMI shows almost all these counters. You can read them using the Modbus protocol over the communication ports. You can clear (set to “0”) some of them directly by GC800 HMI or using the Modbus protocol (the ones marked as “resettable to zero”).

The controller saves all the counters into non-volatile memory; therefore, they survive to power cycles on the controller. Since non-volatile memories have limited writing cycles, the controller writes them only when something happens (the controller may not save a counter as its value changes). Before remove the power supply to the controller, you must ensure the controller saved the counters. It saves the counters in the following conditions:

- Immediately after each engine start and stop.
- When any engine running hours counter increases.
- When any service counter expires.

- When a “parallel to the mains” protection trips.
- When the controller operating hours counter increases.
- When modified from the communication ports (this includes GC800 HMI).
- When modified by the configuration parameters (service counters).
- **Each time the operating mode is switched to OFF.**

Note that some counters have a decimal part (for example the minutes-counters associated to hours-counters), which is also saved in a non-volatile memory. Powering off the controller in an uncontrolled way can cause the loss of the decimal part. **You must switch the controller to OFF mode to force it saving counters, before switching off the power.**

9.5.1 Signalling

The following internal measurements (counters) are available for the PLC:

- AM.108 - “Engine number of starts (controller)”.
- AM.111 - “Engine total hours of operation (ECU) (SPN 247 - SAE J1939)”.
- AM.112 - “Engine hours of operation (controller) (total)”.
- AM.113 - “Engine hours of operation (controller) (partial)”.
- AM.114 - “Engine hours of operation with GCB closed (controller) (partial)”.
- AM.115 - “Engine hours of operation with protections disabled (controller) (partial)”.
- AM.116 - “Engine minutes to maintenance 1 (controller) (partial)”.
- AM.117 - “Controller hours of operation”.
- AM.118 - “Engine minutes to maintenance 2 (controller) (partial)”.
- AM.119 - “Days to maintenance (controller)”.

9.6 Loads protection from mains breaker damages

Please refer to the document [6] that details this function.

9.7 Thresholds on loads.

Do not confuse this feature with the “load demand” available in parallel systems, described in document [6].

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.

9.8 Non-volatile memory

The controller has a non-volatile memory inside, used to store different information as parameters, counters or other. The memory is divided into different areas. 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 numeric code (hexadecimal); each bit of this code corresponds to a non-valid memory zone:

Bit	Value	Description
0	0001	MAC addresses.
1	0002	Various information (maintenance requests etc.).
2	0004	Counters
3	0008	Historical diagnose codes acquired via CAN bus from the engine (DTC).
4	0010	Alternative configurations for parameters.
5	0020	Controller's configuration.
6	0040	Setpoint for the PLC
7	0080	Messages configured for digital/analogue inputs.

If for example the controller shows the value "0004", this means that the only counters area is not valid. If it shows "0021", this means that the configuration area (0020) and the MAC address area (0001) are not valid.

9.9 CAN bus connection with external devices

The controller provides a CAN bus interface (CAN0, Y28) allowing interfacing with electronic external devices. Those devices can be:

- ECU (Engine Control Unit).
- AVR (Automatic Voltage Regulator).
- Some specific devices controlling the air/fuel ratio (Gas Mixers).

To activate the connection, first, it is necessary to select one or more external devices.

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

- ST.256 - "CAN 0 BUS-OFF".
- ST.257 - "CAN 0 ERR-PASSIVE".
- ST.258 - "CAN 0 ERR-ACTIVE".
- ST.259 - "No communication on CAN 0".
- ST.260 - "CAN 1 BUS-OFF".
- ST.261 - "CAN 1 ERR-PASSIVE".
- ST.262 - "CAN 1 ERR-ACTIVE".
- ST.263 - "No communication on CAN 1".

- ST.264 - “CAN 2 BUS-OFF”.
- ST.265 - “CAN 2 ERR-PASSIVE”.
- ST.266 - “CAN 2 ERR-ACTIVE”.
- ST.267 - “No communication on CAN 2”.

9.9.1 Engine control unit (ECU)

Parameter P.0700 (accessible even byGC800-SCM) 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: using BoardPrg4, 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.

The controller internally uses a percentage speed command. 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 configured with the two previous parameters. 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.714 = 1620.

Parameter P.0710 allows specifying the real speed for the “idle speed cycle”.

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. Furthermore, for the “generic ECU” selected with the value "1" in P.0700, parameter P.0716 specifies the address that the controller must use to transmit commands to the ECU.

If the ECU supports the DROOP feature, the operator can enable it (in the ECU) by using P.0708.

Parameters P.0718 and P.0719 allows configuring how and when the controller must supply the ECU (see 7.8.4.5).

P.0711 allows selecting a maximum communication timeout: if the ECU is supplied and the controller does not receive messages from the ECU for the configured time, it activates an anomaly (8.8.69).

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).

9.9.2 Automatic Voltage regulator (AVR).

Using BoardPrg4, you can select your AVR model (parameter F.1700) among a list of external files (Mecc Alte continuously implements new files for new AVRs or for new versions of existing AVRs).

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.1703 and P.1704 ("Voltage corresponding to 0% or 100% of the internal command"). The controller internally uses a percentage voltage command. 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 (see 6.7).
- 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 (8.8.68).

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).

9.9.3 Gas mixer.

Do not confuse this feature with the AFR function described in 7.8.14.

The controller natively supports the CAN communication with some device produced by Hugli Tech. Parameter P.0730 allows enabling this communication (with the proper device).

The function DIF.23.01, DIF.2302 and DIF.2303 are used only for these specific external devices.

9.10 Historical recordings.

The controller provides three different archives. We can think this archives as three tables of a database. Each table has row and columns:

- Each row contains a set of data (measurements or statuses) frozen at the same time (thus consistent to each other).
- Each column contains a specific measurement (for example the engine speed). Some columns are always present (for example the timestamp indicating when the controller recorded the row): the operator can configure all the other columns (separately for the three archives).

WARNING! Changing the columns configuration results in losing all the data present in that specific archive.

The controller provided a fixed memory space for each archive: the more column you add, the less rows the archive can manage. The operator can configure the column list using BoardPrg4: it shows the archive’s capacity (number of rows) resulting by the selected columns.

If an archive is full, when a new recording is required, the controller overwrites the oldest one, thus having the last always available.

The three archives have different purposes.

9.10.1 On event archive.

With the “factory” configuration, this archive can contain 778 rows.

When something happens in the plant (we call it a new event), the controller may add a row to this archive. Some events are not configurable; thus, the controller always add a row when they happen (for example the anomalies). The operator must explicitly enable/disable all other events, using P.0441. It is a bit-mapped parameters, allowing to enable groups of events:

- Controller's operating mode.
- Mains status.
- Generator status.
- Engine status.
- Circuit breakers status.
- Circuit breakers commands.
- Start/stop requests.
- Pumps commands.
- Diagnostics.

As “factory” default, all groups are enabled, except “diagnostics”.

The fixed columns in this archive are the timestamp and the event code. All other columns are user customizable.

The controller “locks” the archive in the following conditions:

- OFF mode.
- New alarm or deactivation or unload.

When the archive is locked, only some event code can be recorded (column “even if blocked” in the following table):

Code	Even if blocked.	Registration cause.
EVT.1001	Yes	Controller mode: OFF.
EVT.1002	Yes	Controller mode: MAN.
EVT.1003	Yes	Controller mode: AUTO.
EVT.1004	Yes	Controller mode: TEST.
EVT.1005	Yes	Controller mode: REMOTE START.
EVT.1010		Mains off.
EVT.1011		Mains on.
EVT.1012		Mains in tolerance.
EVT.1013		Start inhibition “from digital input” active.
EVT.1014		Start inhibition “from digital input” not active.
EVT.1020		Genset off.
EVT.1021		Genset on.
EVT.1022		Generator in tolerance.
EVT.1030		GCB close command.
EVT.1031		GCB open command.
EVT.1032		GCB closed.
EVT.1033		GCB opened.
EVT.1035		MCB close command.
EVT.1036		MCB open command.
EVT.1037		MCB closed.
EVT.1038		MCB opened.

Code	Even if blocked.	Registration cause.
EVT.1040		Engine stopped.
EVT.1041		Starting cycle.
EVT.1042		Engine running.
EVT.1043		Cooling cycle.
EVT.1044		Stopping cycle.
EVT.1045		Idle speed cycle.
EVT.1050		Manual start request.
EVT.1051		Manual stop request.
EVT.1052		Automatic start request.
EVT.1053		Automatic stop request.
EVT.1054		Automatic start request (TEST or REMOTE START from digital input).
EVT.1055		Manual stop request (from digital input).
EVT.1056		Automatic start request (TEST or REMOTE START from communication ports).
EVT.1057		Manual stop request (from communication ports).
EVT.1058		Automatic start request (TEST or REMOTE START from scheduler).
EVT.1060		Automatic start request (TEST or REMOTE START from SMS).
EVT.1061		Manual stop request (from SMS).
EVT.1062		Automatic start request (for non-closed MCB).
EVT.1063		Automatic start request (from MC controller).
EVT.1070		Fuel pump activated.
EVT.1071		Fuel pump deactivated.
EVT.1072		AdBlue pump activated.
EVT.1073		AdBlue pump deactivated.
EVT.1074	Yes	Reset.
EVT.1075	Yes	Real time clock/calendar not valid.
EVT.1076	Yes	Real time clock/calendar updated.
EVT.1077	Yes	New starting of controller.
EVT.1078	Yes	Default values of parameters reloaded.
EVT.1080		GCB closure inhibition request from digital input activated.
EVT.1081		GCB closure inhibition: all requests de-activated.
EVT.1082		A new protection override activated.
EVT.1083		All protection overrides deactivated.
EVT.1086	Yes	Clock updated for daylight saving time.
EVT.1087	Yes	Clock updated for standard time.
EVT.1091		Mains loss protection “27 U<<” tripped.
EVT.1092		Mains loss protection “59 U>>” tripped.
EVT.1093		Mains loss protection “81 f<<” tripped.
EVT.1094		Mains loss protection “81 f>>” tripped.
EVT.1095		Mains loss protection “81 R” (DF/DT) tripped.
EVT.1096		Mains loss protection “Vector Jump” tripped.
EVT.1097		Mains loss protection (da MC100) tripped.
EVT.1098		Mains loss protection (from contact) tripped.
EVT.1099		All mains loss protection reset.
EVT.1100		Mains loss protection “27 U<” tripped.

Code	Even if blocked.	Registration cause.
EVT.1101		Mains loss protection “59 U>” tripped.
EVT.1102		Mains loss protection “81 f<” tripped.
EVT.1103		Mains loss protection “81 f>” tripped.
EVT.1104		Low Voltage Fault Ride Through enabled.
EVT.1121		Power limitation for mains high frequency activated.
EVT.1122		Power limitation for mains high frequency deactivated.
EVT.1123		Power limitation by contact #1 activated.
EVT.1124		Power limitation by contact #1 deactivated.
EVT.1125		Power limitation by contact #2 activated.
EVT.1126		Power limitation by contact #2 deactivated.
EVT.1127		Power limitation for mains low frequency activated.
EVT.1128		Power limitation for mains low frequency deactivated.
EVT.1133		Power setpoint limitation for high voltage enabled
EVT.1134		Power setpoint limitation for high voltage disabled
EVT.1135		Start of power setpoint limitation for high voltage
EVT.1136		End of power setpoint limitation for high voltage
EVT.1137		Start of power setpoint limitation by ext. command
EVT.1138		End of power setpoint limitation by ext. command
EVT.1141		A new derating request activated.
EVT.1142		All derating requests deactivated.
EVT.1151		Mains loss protection “27 U<<” restored.
EVT.1152		Mains loss protection “59 U>>” restored.
EVT.1153		Mains loss protection “81 f<<” restored.
EVT.1154		Mains loss protection “81 f>>” restored.
EVT.1157		Mains loss protection (by MC100) restored.
EVT.1158		Mains loss protection (by contact) restored.
EVT.1160		Mains loss protection “27 U<” restored.
EVT.1161		Mains loss protection “59 U>” restored.
EVT.1162		Mains loss protection “81 f<” restored.
EVT.1163		Mains loss protection “81 f>” restored.
EVT.1164		Protections 27 disabled.
EVT.1191		The parallel with the mains is allowed.
EVT.1192		The parallel with the mains is not allowed.
EVT.1201		GCB closure inhibition request from “mains conditions” activated.
EVT.1202		GCB closure inhibition request from communication port activated.
EVT.1203		GCB closure inhibition request from “some GCB not open” activated.
EVT.1204		GCB closure inhibition request from MCB synchronization in progress activated.
EVT.1205		GCB closure inhibition request from MC controller activated.
EVT.1221		Start inhibition “from scheduler” active
EVT.1222		Start inhibition “from scheduler” not active
EVT.1223		Start inhibition “from mains conditions” active
EVT.1224		Start inhibition “from mains conditions” not active
EVT.1225		Start inhibition “from GCB not opened” active
EVT.1226		Start inhibition “from GCB not opened” not active
EVT.1241		Load function disabled (from parameter)

Code	Even if blocked.	Registration cause.
EVT.1242		Load function disabled (digital input)
EVT.1243		Load function disabled (for supply mode)
EVT.1244		Load function disabled (from MC100)
EVT.1245		Load function disabled (for mains in tolerance)
EVT.1246		Load function disabled (for inhibitions at starting)
EVT.1247		Load function disabled (for MGCB open)
EVT.1248		Load function disabled (as the exit from the parallel is required for other causes)
EVT.1249		Load function disabled (controller not in AUTO)
EVT.1250		Load function disabled (there are alarms)
EVT.1261		Starting required by load function (as disabled)
EVT.1262		Starting required by load function (load function just enabled)
EVT.1263		Starting required by load function (no GCB closed)
EVT.1264		Starting required by load function (START pushbutton pressed)
EVT.1265		Starting required by load function (initial delay)
EVT.1266		Starting required by load function (priority list not valid)
EVT.1267		Starting required by load function (selected genset)
EVT.1268		Starting required by load function (for minimum number of supplying gensets)
EVT.1269		Starting required by load function (because it is the master genset)
EVT.1270		Starting required by load function (for load threshold)
EVT.1271		Starting required by load function (for load stock)
EVT.1272		Starting required by load function (for priority order)
EVT.1273		Starting required by load function (for priority order)
EVT.1281		Starting required by load function (for not selected genset)
EVT.1282		Starting required by load function (for threshold and load stock)
EVT.1291		New master genset
EVT.1292		The supply mode for the load function is isochronous.
EVT.1293		The supply mode for the load function is SYSTEM BASE LOAD
EVT.1294		The supply mode for the load function is DROOP
EVT.1321		Number of gensets connected to bus PMCB varied
EVT.1801		AFR enabled.
EVT.1802		AFR disabled.
EVT.1803		Error in AFR MAN/AUTO mode.
EVT.1804		AFR in AUTO mode.
EVT.1805		AFR in MAN mode.
EVT.1806		first set of parameters for AFR.
EVT.1807		second set of parameters for AFR.
EVT.1808		mixer position in AUTO: engine stopped.
EVT.1809		mixer position in AUTO: delay before cranking.
EVT.1810		mixer position in AUTO: cranking.
EVT.1811		mixer position in AUTO: running with GCB open.
EVT.1812		mixer position in AUTO: running with GCB closed - low power.
EVT.1813		mixer position in AUTO: running with GCB closed - high power.
EVT.1814		mixer position in AUTO: stopping.
EVT.1815		Error in mixer position in AUTO mode.

The anomalies are recorded with their own numerical code, added to:

- 2000: if the anomaly is a warning.

- 3000: if the anomaly is an unload.
- 4000: if the anomaly is a deactivation.
- 5000: if the anomaly is an alarm.

For example, anomaly 273 will be recorded as "2273" when it is activated as a warning, as "5273" if it is activated as an alarm. GC800 HMI automatically shows “W273” for the event code "2273" and “A273" for the code 5273.

9.10.2 Periodical archive (trend).

With the “factory” configuration, this archive can contain 778 rows.

If the controller is not in OFF mode, and there are no alarms, deactivations and unloads, the controller periodically adds rows to this archive. The operator can deal with the following parameters:

- P.0442 (“Log interval (engine running)”).
- P.0443 (“Log interval (engine stopped)”).

Thus, the controller can record data at different rates depending on the engine status (usually running/faster, stopped/slower). Only the timestamp column is fixed: all other columns are user customizable.

9.10.3 Pre-trigger archive.

With the “factory” configuration, this archive can contain 778 rows.

The controller records “as fast as possible” into this archive (even if OFF mode) until a generic or specific protection trips. Then, it continues recording for a specified time, then stops. The purpose is to give the operator the situation before and after the trip of a specific protections.

The operator can deal with the following parameters:

- P.0444 (“Pre-trigger logging interval”). It allows configuring the recording period (tenths of milliseconds).
- P.0445 (“Event position in the pre-trigger archive”). The controller will ensure that the “trip” event will be exactly in the specified position. Since the number of rows depends on the number of columns, the parameter is a percentage.
- P.0448 (“Selected protection for pre-trigger”). This allows selecting a specific anomaly (set the anomaly code) or any anomaly (set to “0”).

9.10.4 DTC.

DTC means “Diagnostic Trouble Code”. It refers to any “fault” code sent by external devices (ECU, AVR) trough CAN bus. GC800 SCM receives and properly shows these codes when they are active, but also record them (with a proper timestamp) in this archive, allowing to review what happened in the past over the CAN.

This archive is not configurable and provides only 16 rows.

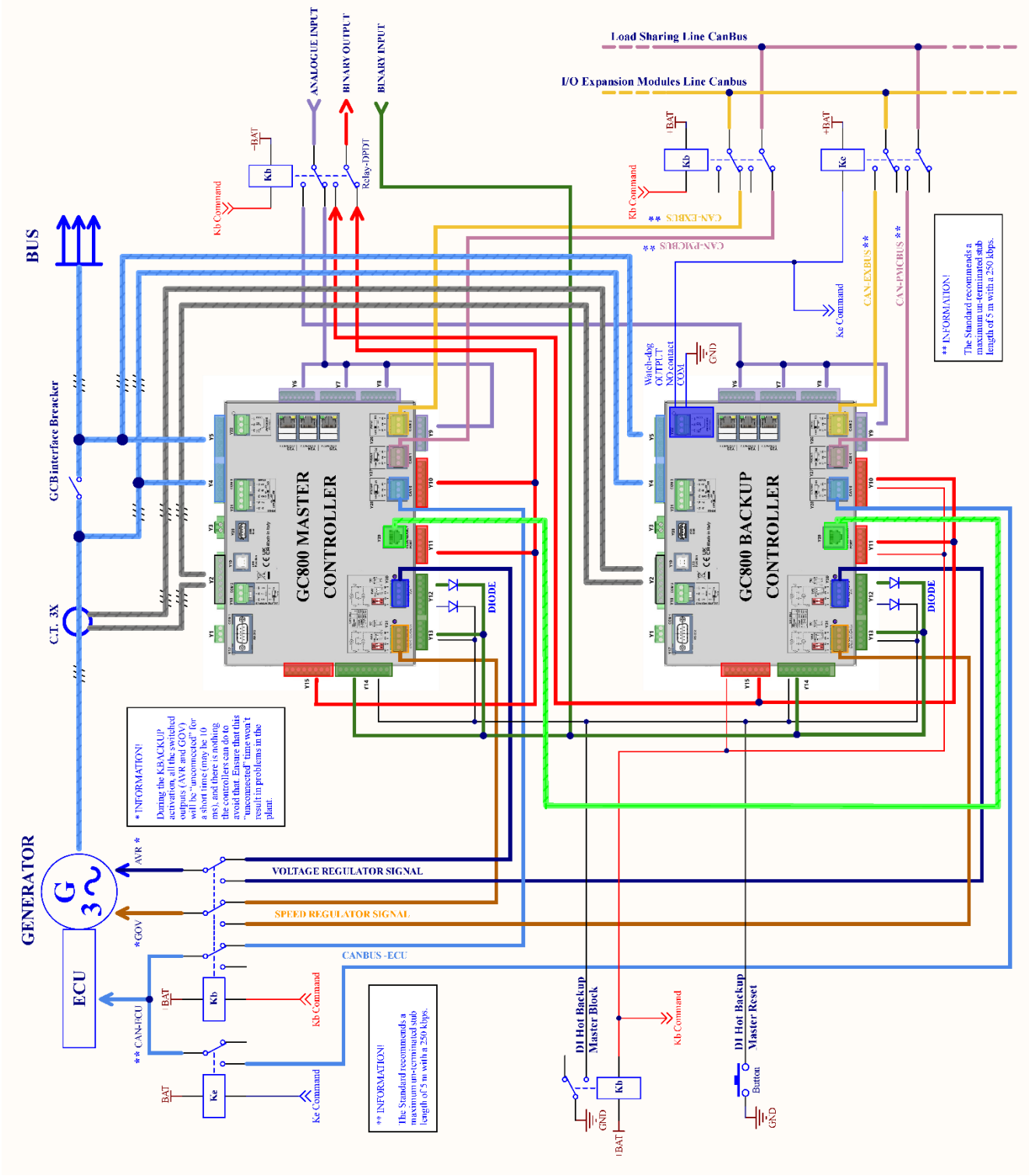
9.10.5 Reset of archives

Both GC800 HMI and the Mecc Alte software “HISVIEW” allows to show the content of the archives (the DTC is not available in HisView). GC800 HMI provide commands to “clear” any specific archive (see GC800 HMI documentation).

9.11 Hot redundancy.

"Hot redundancy" is the ability of a GC800 SCM unit to take control over another GC800 SCM faulty unit, in a transparent way for the plant.

9.11.1 Wiring diagram.



9.11.2 Definitions.

- **MASTER**: the unit that normally controls the system.
- **BACKUP**: the unit that will control the system in case of failures of MASTER.
- **COMMAND**: the unit controlling the system now (normally the MASTER, it is the BACKUP in the event of a failure of the **MASTER**).
- **WATCH**: the unit not controlling the system now (normally the BACKUP).
- **KBACKUP**: the relay (probably a group of relays) used to switch I/O resources between the two controllers.

9.11.3 Requirements.

The two controllers must have the same firmware revision; otherwise, both activate the alarm AL.285 - “Redundancy: different firmware versions”, **making the whole system unavailable**. In this condition, both units operate as COMMAND, but the BACKUP unit does not activate the KBACKUP relay.

However, the controllers may not have the same configuration: MASTER uses the communication line to continuously keep the BACKUP aligned with him (included PLC). The full alignment process may take up to four minutes; however, once aligned, MASTER immediately align BACKUP for any single parameter change. The following parameters are not aligned:

Parameter	Description	Reason
P.0281	Hot redundancy enable.	Different values required for MASTER and BACKUP.
P.0452	COM 1 configuration	The communication port may have different settings, allowing to connect both MASTER and BACKUP to an external monitoring system.
P.0453		
P.0454		
P.0470		
P.0471	COM 2 configuration	
P.0472		
P.0473		
P.0474		
P.0475		
P.0480		
P.0651	COM 3 configuration	
P.0652		
P.0653		
P.0654		
P.0655		
P.0500	Ethernet configuration	
P.0501		
P.0502		
P.0503		
P.0510		
P.0513		
P.0504		
P.0507		
P.0509		
P.0508		
P.0524		
P.0525		
P.0526		
P.0527		
P.7500		
P.7501		
P.7502		
P.7503		
P.7510		
P.7513		

Parameter	Description	Reason
P.7524		
P.7525		
P.7526		
P.7527		
P.7550		
P.7551		
P.7552		
P.7553		
P.7560		
P.7563		
P.7574		
P.7575		
P.7576		
P.7577		
P.0006	Code for options	This code is calculated on the ID number of the controller, which differs among MASTER and BACKUP.

9.11.4 Enabling and MASTER/BACKUP selection.

You must enable this function using parameter P.0281 - “Hot redundancy enable”:

0. DISABLED.
1. BACKUP.
2. MASTER.

To avoid involuntary enabling, the controller protects the parameter by the requires the “super-user” password. If you configure both controllers as MASTER or both as BACKUP, the two controllers activate the alarm AL.282 (“Redundancy: wrong configuration”) **making the whole system unavailable**. In this condition, both units operate as COMMAND, but the BACKUP unit does not activate the KBACKUP relay.

INFORMATION! MASTER does not align parameter P.0281 on BACKUP.

9.11.5 Minimum hardware requirement.

You must connect the two controllers by the Y29 dedicated RS232 serial port (RJ45), using a **crossed** ETHERNET cable. The recommended maximum length of the Ethernet cable is 8 metres (remember, the underlying communication resource is an RS232, not an Ethernet).

You must also use some digital inputs/outputs. Since MASTER aligns the configurations of BACKUP, you must reserve the same digital inputs/outputs on both controllers.

9.11.5.1 Digital outputs.

For the following functions, you must use controller’s outputs (**do not use expansion modules’ outputs**).

- DOF.3161 (“Redundancy: KBACKUP relay command”). **It is mandatory**: if missing, both controllers activate the alarm AL.282 (“Redundancy: wrong configuration”) **making the whole system unavailable**. BACKUP uses this output to control a relay (KBACKUP) for switching the I/O resources between the two controllers (see description below and the wiring diagram). MASTER does not physically use this output, but you still must assign it (aligned configuration).
- DOF.3162 (“Redundancy: controller in COMMAND mode”). It's optional. COMMAND activates this output (both controllers can be COMMAND, but just once at a given time). You can use these outputs to control lamps indicating which controller is really controlling the generator.

9.11.5.2 Digital inputs.

For the following functions, you must use controller's inputs (**do not use expansion modules' inputs**).

- DIF.2111 ("Redundancy: hand over control to MASTER"). **It is mandatory**: if missing, both controllers activate the alarm AL.282 ("Redundancy: wrong configuration") **making the whole system unavailable**.

  After a MASTER failure, BACKUP becomes COMMAND and takes the control of the generator; after fixing the MASTER failure, the operator must use this input to give back the control to MASTER. Parameter P.0282 ("Hot redundancy reset mode") allows accepting the "hand over" command only when both controllers are in OFF mode. The controller executes the command on the input's activation (not in its stable active status). See the description below.

- DIF.2112 ("Redundancy: KBACKUP relay feedback"). **It is mandatory**: if missing, both controllers activate the alarm AL.282 ("Redundancy: wrong configuration") **making the whole system unavailable**. Basically, it acquires an auxiliary contact of the KBACKUP relay:

  - MASTER: the feedback must be "0" when the controller is COMMAND, "1" when it is WATCH.
  - BACKUP: the feedback must be "1" when the controller is COMMAND, "0" when it is WATCH.

  If the acquired status is not the expected one, only BACKUP activates the warning AL.284 - "Redundancy: KBACKUP relay failure": the actual COMMAND unit will still try to control the system.

9.11.6 Switching resources consideration.

9.11.6.1 Power supply (Y1).

Each controller can have its own power source, or you can connect the same power source in parallel to both (each controller measures its own power source). In any case, **you must connect together the negative poles of the two controllers**.

Pay attention on the following terminals:

Terminal	Description	Required voltage
Y12-3	Common terminal for digital inputs 15…20	0 or VBAT
Y10-1	Common terminal for digital outputs 1…4	VBAT
Y10-6	Common terminal for digital outputs 5…6 (used also as emergency input)	VBAT

The previous terminals can be connected in parallel to the two controllers. If they require VBAT (positive DC voltage) and you are using different power supplies for the two controllers, we suggest creating a common positive pole, by connecting the positive poles of the two power sources with diodes. Then connect this common positive in parallel to the previous terminals.

9.11.6.2 CAN bus 0 (Y28).

We strongly recommend keeping this bus always connected in parallel to both controllers. Both will acquire data coming from the external ECU/AVR, but only COMMAND transmits over the bus (sending requests/commands).

If you want, you can disconnect the CAN from the MASTER (always connected to BACKUP) using KBACKUP, but:

- Gold plated contacts are recommended (by the CAN specification).
- Pay attention to the 120 Ohms terminating resistors.
- Remember that CAN does not accept "star" wirings.
- The transition from BACKUP to MASTER must happens with the controllers in OFF mode.

9.11.6.3 CAN bus 1 (Y27).

We strongly recommend keeping this bus always connected in parallel to both controllers. Both will acquire data coming from the other parallel controllers, but only COMMAND transmits over the bus (sending requests/commands).

If you want, you can disconnect the CAN from the MASTER (always connected to BACKUP) using KBACKUP, but:

- Gold plated contacts are recommended (by the CAN specification).
- Pay attention to the 120 Ohms terminating resistors.
- Remember that CAN does not accept “star” wirings.
- The transition from BACKUP to MASTER must happens with the controllers in OFF mode.

9.11.6.4 CAN bus 2 (Y26).

We strongly recommend keeping this bus always connected in parallel to both controllers. Both will acquire data coming from the expansion modules, but only COMMAND transmits over the bus (sending requests/commands).

If you want, you can disconnect the CAN from the MASTER (always connected to BACKUP) using KBACKUP, but:

- Gold plated contacts are recommended (by the CAN specification).
- Pay attention to the 120 Ohms terminating resistors.
- Remember that CAN does not accept “star” wirings.
- The transition from BACKUP to MASTER must happens with the controllers in OFF mode.

9.11.6.5 AC voltages (Y4, Y5).

Connect them in parallel to both controllers.

9.11.6.6 AC currents (Y2, Y3).

Connect the secondary side of the external CTS **in series** to both controllers.

For the toroid input (Y3), connect the external toroid **in series** to both controllers. If the rated current value is not exceeded, there are no problems. If this value is exceeded, one of the two controllers may not have enough measurement dynamics.

9.11.6.7 Digital inputs (Y14, Y13, Y12).

Connect the external signal in parallel to both controllers. **For Y12, add external diodes** (see 5.4.2) to avoid malfunction in case one controller is not supplied. See note on 9.11.6.1 for terminal Y12-7.

The Y29 communication link keeps “analogue used as digital” and “virtual” inputs synchronized. Instead, since the CAN bus links are always connected to both controllers, the “shared” and “expansion” inputs are always available for both.

9.11.6.8 Analogue inputs (Y8, Y7, Y6).

Depending on the physical sender:

- DC voltage: you could connect it in parallel to both controllers.
- DC current (active): you could connect it in series to both controllers.
- Any other: you can’t connect to both controllers.

The Y29 communication link always synchronizes the electrical values (volts, ohms, mA) measured on the sensors as they were switched using KBACKUP; thus, we recommend to always switch them using KBACKUP (even in case of DC voltage or DC current senders). Depending on the sender, you may switch only the hot pole (to reduce the number of switching contact required), but it’s not recommended.

After KBACKUP activation, BACKUP (the new COMMAND) maintains the last synchronized values for 200 ms, giving the external hardware time to connect the sensors to the controller’s inputs and allowing stabilization.

The Y29 communication link keeps “virtual” inputs synchronized. Instead, since the CAN bus links are always connected to both controllers, the “shared” and “expansion” inputs are always available for both.

9.11.6.9 D+ signal (Y9).

Connect it in parallel to both controllers. The Y29 communication link keeps the controllers aligned: even if the physical excitation commands are not perfectly synchronous, nothing happens because of the internal diodes.

9.11.6.10 Speed measurement inputs (Y9).

You can connect the pick-up sender in parallel to both controllers, it just depends on how much signal it can drive. If its driving capacity is not enough, simply switch it by KBACKUP. You can always connect the W signal in parallel to both controllers (but if you prefer, you can switch it by KBACKUP).

The controller assumes both signals are switched by KBACKUP; thus, the Y29 communication link keeps these measurements synchronized. After KBACKUP activation, BACKUP (the new COMMAND) maintains the last synchronized values for 200 ms, giving the external hardware time to connect the sensors to the controller's inputs and allowing stabilization.

9.11.6.11 Digital outputs (Y15, Y11, Y10).

You must always switch the digital outputs using KBACKUP. See note on 9.11.6.1 for common terminal Y10-1 and Y10-8. You can connect terminals Y11-1 and Y11-4 in parallel to both controllers (they are the COM terminal of the two internal dry contact relays).

The Y29 communication link keeps synchronized the internal "image" of the digital outputs (physical, expansion). Thus, the two controllers always activates/deactivates the outputs in the same way. However, the Y29 communication link introduces a small delay, thus WATCH may activate its outputs a bit after COMMAND.

Even if the CAN bus lines are always connected to both controllers, WATCH never sends anything on the buses: that ensures the correct behaviour of digital outputs on expansion module (only COMMAND takes care of them).

INFORMATION! WATCH manages DOF.3161 and DOF.3162 by itself, ignoring the images sent by COMMAND.

INFORMATION! During the KBACKUP activation, all the switched outputs will be "unconnected" for a short time (may be 10 ms), and there is nothing the controllers can do to avoid that. Ensure that this "unconnected" time won't result in problems in the plant.

For example, avoid using stable commands for the circuit breakers (always prefer pulse commands): in this way the outputs are off quite all the time, and nothing happens during the switching. Or (another example) ensure that the short-time closure of the fuel solenoid won't result in an unwanted stop of the engine.

If you cannot do anything to avoid the situation, we suggest using digital outputs on expansion modules: since the expansion module are connected to both controllers, but just one controller sends command to them, nothing will happen during KBACKUP activation.

Since the circuit breaker management is very critical, if you configure a digital output of the controller (1…16) as DOF.2004 or DOF.2034 (stable commands for circuit breakers) in application different from DRIVE and SPM, the controller activates the alarm AL.282 ("Redundancy: wrong configuration") **making the whole system unavailable**.

9.11.6.12 Analogue outputs (Y31, Y30).

You must always switch the analogue outputs using KBACKUP. Depending on the output type, you may switch only the hot pole (to reduce the number of switching contact required), but it's not recommended.

The Y29 communication link keeps synchronized the internal "image" of the analogue outputs (physical, expansion). Thus, the two controllers always command the outputs in the same way. However, the Y29 communication link introduces a small delay, thus WATCH may update its outputs a bit after COMMAND.

Even if the CAN bus lines are always connected to both controllers, WATCH never sends anything on the buses: that ensures the correct behaviour of analogue outputs on expansion module (only COMMAND takes care of them).

INFORMATION! During the KBACKUP activation, all the switched outputs will be “unconnected” for a short time (may be 10 ms), and there is nothing the controllers can do to avoid that. Ensure that this “unconnected” time won’t result in problems in the plant. If you cannot do anything to avoid the situation, we suggest using analogue outputs on expansion modules: since the expansion module are connected to both controllers, but just one controller sends command to them, nothing will happen during KBACKUP activation.

INFORMATION! Therefore, you prefer to use speed controllers and voltage regulators that accept commands via the Can Bus line. For example, Meccalte's **MK2** and **MK3** series AVRs can be directly connected to the controller's “**CAN Bus 0**” line without using auxiliary relays to switch the analogue control signal.

9.11.6.13 Communication ports (Y17, Y18, Y19, Y21, Y23, Y24, Y25).

The controller provides no synchronization for the communication ports. Each controller manages them by its own.

If you connect the two controllers to the same Ethernet LAN, the two controllers must have different IP addresses. In the same way, if you connect both to the same RS485 line, they must have different Modbus addresses.

9.11.6.14 GC800 HMI.

You can use two GC800 HMI, one for each GC800 SCM controller. Each GC800 HMI shows on the top bar an icon indicating if the connected GC800 SCM is MASTRT or BACKUP and if it is currently COMMAND or WATCH.

Alternatively, you can use just one GC800 HMI, connected to both GC800 SCM controllers. In this case, you must connect a KBACKUP contact to a digital input of the GC800 HMI and properly configure the communication detail to be used to connect to the MASTER or to the BACKUP controller. GC800 HMI will use the two configurations depending on the KBACKUP contact.

9.11.7 Operating logic

The Y29 communication links provides a full duplex serial port (TX, RX). It also provides an input signal (DSR) and an output signal (DTR). The external crossed Ethernet cable correctly connect the TX of a controller to the RX of the other, the DTR of a controller to the DSR of the other, and vice-versa.

Each controller, when powered, switches its DTR signal every 5 ms and transmits at least one message every 100 ms. This message contains your MASTER/BACKUP configuration and the current COMMAND/WATCH status. A controller detects the failure of the other if:

- It does not receive messages for 250 ms.
- It does not detect any change in the DSR signal for 25 ms.

9.11.8 At power on.

When you power a controller, it does not know what’s happening on the other one:

- The other may be already powered (thus acting as COMMAND).
- The other may be powered together with this one.
- The other may be still unpowered.

Thus, the controller waits for a minimum time (500 ms for MASTER, 1000 ms for BACKUP) to detect the presence of the other one, and to decide what to do. During this transient, the controller operates as WATCH, avoiding disturbing the other one if it was already powered and operating as COMMAND.

MASTER.

When turned on, MASTER behaves as WATCH for a maximum time of 500ms:

- If at the end of this time it does not detect the presence of BACKUP, it starts operating as COMMAND.

- If it receives messages from BACKUP operating as WATCH, it immediately starts operating as COMMAND (the two controllers were turned on together).
- If it receives messages from BACKUP operating as COMMAND, it stops the transient and remains in WATCH mode (BACKUP was turned on before MASTER and had taken control).

BACKUP.

When turned on, BACKUP behaves like WATCH for a maximum time of 1000ms:

- If at the end of this time it does not detect the presence of MASTER, it starts operating as COMMAND.
- If it receives messages from MASTER operating as COMMAND, it stops the transient and remains in WATCH mode (MASTER turned on before BACKUP or at the same time – in this case the 500 ms interval of MASTER wins).
- If it receives messages from MASTER operating as WATCH: at the end of the transient it switches to COMMAND. In fact, if MASTER is WATCH, it does not return to COMMAND without a command from the operator.

9.11.9 Switching logic.

The transition from MASTER to BACKUP and vice versa is always controlled by BACKUP:

- Automatically from MASTER to BACKUP.
- Upon operator command from BACKUP to MASTER.

In both cases, BACKUP acts on the KBACKUP relay to switch resources between the two controllers. When KBACKUP switches the resources, the new COMMAND controller must wait for the complete movement of the KBACKUP relay and then give a minimum settling time to the hardware before starting to use the I/O resources (this especially applies to analogue inputs). This time starts from the acquisition of the new KBACKUP state and lasts at least 200 ms.

9.11.9.1 From MASTER to BACKUP

When BACKUP (which is operating as WATCH) detect a failure on MASTER (see9.11.7) it takes control (becomes COMMAND) by performing the following operations:

- It activates the warning AL.283 - “Redundancy: MASTER controller failure”.
- It activates the digital output DOF.3161 - “Redundancy: KBACKUP relay command” which:
  - Optionally switches the GC800 HMI to BACKUP.
  - Switches the digital (16) and analogue (2) outputs to BACKUP.
  - Switches the analogue inputs (1...6) to BACKUP.
  - Switches the D+ and the speed measurement inputs to BACKUP.
  - Optionally, disconnects the three CAN lines from MASTER. If this option is used, MASTER will no longer be able to acquire many essential information from the system, therefore the transition from BACKUP to MASTER will have to take place with the controllers in OFF mode.
- It enables a 200 ms transient (allowing stabilization for the BACKUP inputs).
- At the end of the transient:
  - It really starts controlling the generator.
  - It starts transmitting on CAN lines.
  - It activates the warning AL.284 (“Redundancy: KBACKUP relay failure”) if it does not acquire proper KBACKUP feedback.

If MASTER is still working (for example the failure is in the Y29 connecting cale), it detects from the KBACKUP feedback that the BACKUP taken the control: it also activates the warning AL.283 - “Redundancy: MASTER controller failure”.

9.11.9.2 From BACKUP to MASTER

This step never occurs automatically, but always requires a command from the operator. This command consists of a button connected to a digital input of both MASTER and BACKUP (DIF.2111 - “Redundancy: hand over control to MASTER”).

INFORMATION! if the transition from MASTER to BACKUP disconnects the CAN lines from MASTER, this operation must be done with MASTER and BACKUP in OFF mode.

BACKUP.

When the operator presses this button, BACKUP carries out these operations:

- It deactivates the DOF.3161 output - “Redundancy: KBACKUP relay command”:
  - Optionally switches the GC800 HMI to MASTER.
  - Switches the digital (16) and analogue (2) outputs to MASTER.
  - Switches the analogue inputs (1...6) to MASTER.
  - Switches the D+ and the speed measurement inputs to MASTER.
  - Optionally, reconnects the three CAN lines from MASTER.
- It activates a 300 ms transient at the end of which:
  - It activates the warning AL.284 (“Redundancy: KBACKUP relay failure”) if it does not acquire proper KBACKUP feedback.
  - It switches to WATCH mode.

MASTER.

When the operator presses this button, MASTER carries out these operations:

- It assumes that BACKUP (if functioning) deactivates the DOF.3161 - “Redundancy: KBACKUP relay command” output.
- It activates a 200 ms transient (to allow stabilizing the hardware).
- At the end of the transient:
  - It really starts controlling the generator.
  - It starts transmitting on CAN lines.
  - It activates the warning AL.284 (“Redundancy: KBACKUP relay failure”) if it does not acquire proper KBACKUP feedback.

9.11.10 BACKUP failure.

If MASTER is no longer able to communicate with BACKUP, but the KBACKUP feedback indicates that it is still controlling the generator, it activates the warning AL.286 - “Redundancy: BACKUP controller failure”.

9.11.11 Anomalies

WATCH manages two sets of anomalies.

- Since WATCH must align its operating sequence to COMMAND, and anomalies are part of the operating sequence, COMMAND continuously sends its anomalies to WATCH, which uses them only for keeping the operating sequence aligned. But the GC800 HMI won’t show these anomalies.
- WATCH manages a second set of anomalies, activated by itself (for example, emergency STOP, low/high power supply voltage, anomalies relating to the redundancy itself, etc.). The GC800 HMI connected to WATCH will show these anomalies.

As soon as WATCH becomes COMMAND, it discards the second sets of anomalies, and uses the first set as the only relevant one.

9.12 Communication ports

The controller provides the parameter P.0469 for protect themself against unwanted write access from any communication port. It allows configuring an alphanumeric password (maximum 7 chars). A blank password (default) means “no password”.

Once the password is set into P.0469, any write access from any communication port must first be authorized by writing the password in the provided login registers (holding registers 201…204): if the password matches, the controller allows writing access **from that communication point** until the communication ends.

9.12.1 REWIND

The controller supports GPRS connection through an external module called REWIND. You can connect REWIND to RS232 or RS485 serial ports of the controller.

REWIND supports remote connectivity through the mobile network (Modbus TCP protocol). It also supports a special SMS protocol, allowing the operator to send queries/command to the controller by simple text messages.

Moreover, the controller can automatically send text message to the operator, through the REWIND. See the REWIND documentation about properly configuring phone numbers.

GC800 SCM provides two parameters for the SMS management:

- P.0455: allows the operator to select for which events the controller must send an SMS. It is a bit-mapped parameter, providing one bit for each group of events.
- P.0467: allows the operator to select how many SMS the controller must send for each new event.

9.13 Pulse counting.

The controller provides up to 8 “pulse counters”. They count the pulses connected to digital inputs of the controller.

You can configure this feature using the following parameters:

- P.9901 (“Signal edge for counters”). It is a bit-mapped parameter, providing two bits per counter (rising and falling edges). You must select at least one bit for each used counter (obviously the counter won’t count anything if you don’t select any edge).
- P.9904 (“Low signal filter for counters”). It allows specifying the minimum deactivation time (ms) for the inputs (lower durations are considered noises).
- P.9904 (“His signal filter for counters”). It allows specifying the minimum activation time (ms) for the inputs (lower durations are considered noises).

You must properly configure the digital inputs with the functions DIF.2401…DIF.2408 (“Input for pulse counter #x”). You can use this feature only for the digital inputs 13…20 of the controller.

INFORMATION! if you need to count very short or quick pulses, use inputs 15…20: the internal hardware allows fast counting (see 3 for detailed timing information).

You can also use the digital inputs of the controller to reset (set to “0”) the counter. Use the functions DIF.2417…DIF.2424 (“Reset for pulse counter #x”); these functions are available for all digital inputs.

The controller does not provide any scaling system for the acquired counters. However, the PLC can access the counters: you can create a scaling feature in the PLC for converting the counters into real measurements, assign them to virtual analogue inputs and configure the analogue inputs as “generic sensors”: GC800 HMI will show the converted values.

Moreover, the controller supports up to two PC22 expansion modules; each of them can manage up to 4 fast counters.

9.13.1 Signalling

The following internal measurements (counters) are available for the PLC:

- AM.161 - “Pulses counter #1”.
- AM.162 - “Pulses counter #2”.
- AM.163 - “Pulses counter #3”.
- AM.164 - “Pulses counter #4”.
- AM.165 - “Pulses counter #5”.
- AM.166 - “Pulses counter #6”.
- AM.167 - “Pulses counter #7”.
- AM.168 - “Pulses counter #8”.
- AM.169 - “Pulses counter #1 (PC22)”.
- AM.170 - “Pulses counter #2 (PC22)”.
- AM.171 - “Pulses counter #3 (PC22)”.
- AM.172 - “Pulses counter #4 (PC22)”.
- AM.173 - “Pulses counter #5 (PC22)”.
- AM.174 - “Pulses counter #6 (PC22)”.
- AM.175 - “Pulses counter #7 (PC22)”.
- AM.176 - “Pulses counter #8 (PC22)”.

9.14 Generic display pages.

The controller can acquire from the plant generic statuses or generic measurements. The controller won’t use these data, but GC800 HMI can display them.

The controller provides the following function for the digital inputs:

- DIF.3201 (“Generic status (page 1)”).
- DIF.3202 (“Important status (page 1)”).
- DIF.3203 (“Generic status (page 2)”).
- DIF.3204 (“Important status (page 2)”).
- DIF.3205 (“Generic status (page 3)”).
- DIF.3206 (“Important status (page 3)”).
- DIF.3207 (“Generic status (page 4)”).
- DIF.3208 (“Important status (page 4)”).
- DIF.3209 (“Generic status (page 5)”).
- DIF.3210 (“Important status (page 5)”).
- DIF.3211 (“Generic status (page 6)”).
- DIF.3212 (“Important status (page 6)”).
- DIF.3213 (“Generic status (page 7)”).
- DIF.3214 (“Important status (page 7)”).
- DIF.3215 (“Generic status (page 8)”).
- DIF.3216 (“Important status (page 8)”).

Using these functions, the operator can “create” up to eight display pages on GC800 HMI. The HMI will show the inputs statuses, along with the description configured for each input (P.2003 for the digital input 1, or equivalent for the other inputs).

If you use “odd” functions, GC800 HMI will automatically force the relevant display page when the input activates.

In the same way, the controller provides the following function for the analogue inputs:

- AIF.2001 (“Generic sensor (page 1)”).
- AIF.2003 (“Generic sensor (page 2)”).
- AIF.2005 (“Generic sensor (page 3)”).

- AIF.2007 (“Generic sensor (page 4)”).
- AIF.2009 (“Generic sensor (page 5)”).
- AIF.2011 (“Generic sensor (page 6)”).
- AIF.2013 (“Generic sensor (page 7)”).
- AIF.2015 (“Generic sensor (page 8)”).

Using these functions, the operator can “create” up to eight display pages on GC800 HMI (different from the previous ones). The HMI will show the measurements, along with the description configured for each input (P.4002 for the analogue input 1, or equivalent for the other inputs).

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