POWER FROM WITHIN

MC400 CONTROLLER

SMARTECH

A DIVISION OF MECC ALTE

TECHNICAL MANUAL

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Revision	Date	Notes
00	14/05/2018	First version of the manual for the version 01.00 of the controller.
01	28/03/2019	Updated paragraphs 5.5.3 and 8.8 (016)
02	30/09/2019	Valid for version 1.02 of the controller. 5.11.4, 6.5.3.9, 6.5.3.10, 6.5.3.11, 6.5.3.12, 7.4.1.3
03	09/09/2021	Valid for version 1.05 of the controller. 5.4.3, 5.5.5, 6.5.2.17, 6.5.5.2, 7.9.3.1
04	13/07/2022	Valid for version 1.07 of the controller. 6.5.5.2, 7.4.2
05	01/09/2022	Valid for version 1.08 of the controller. 5.11.4
06	29/09/2022	Valid for version 1.09 of the controller. 5.4.3, 5.6.3, 7.8.2, 7.9.2.5, 8.057, 8.279
07	05/05/2025	Valid for version 2.00 of the controller.
08	04/09/2025	Valid for version 2.02 of the controller. 1.1, 5.11.4, 5.11.5, 6.5.2.6
09	30/10/2025	Update paragraphs:1.6, 3, 4, 5.4.3, 5.9.1, 5.9.1.1, 5.9.1.2, 5.9.2.1, 5.9.2.2, 5.9.3, 5.9.3.1, 5.9.3.2, 5.9.4.1, 5.9.4.2, 5.10.1, 5.10.2.3, 5.11, 6.2, 6.4.5, 6.5.2.18, 6.5.3.2, 6.5.3.3, 6.5.3.4, 6.5.3.5, 6.5.3.6, 6.5.3.7, 6.5.3.8, 6.5.3.13, 6.5.3.14, 7.1, 7.2.2, 7.4, 7.4.1.2, 7.4.1.2.2, 7.7.2, 7.8, 7.9.3.4, 8.1, 8.2, 8.3, 9.4

Table of Contents

1 Introduction

1.1 References

[1] Mecc Alte EAAM0609xx - MC400 Parameters Chart".

[2] Mecc Alte EAAM0458xx - BoardPRG4.xx Manual.

[3] Mecc Alte EAAS0341xx - Serial communication and SMS protocol.

[4] Mecc Alte EAAS0610xx - MC400 Modbus Registers.

[5] CANopen – Cabling and Connector Pin Assignment – CiA Draft Recommendation DR-303-1

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

[7] Mecc Alte EAAP0457xx - USB driver Installation Guide

[8] Mecc Alte EAAM0199xx - Parallel functions manual.

[9] Mecc Alte EAAM0867xx - Smart Cloud Manual

1.2 Introduction and prerequisites

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 controller; before carrying out any operation on them, make sure to open the MCB and MGCB circuit breakers or to open the related fuses.

Do not remove or change any connection while the gensets are running (or more generally, while the plant is operating).

Do not disconnect for any reason the terminals of the current transformers (CT)

Wrong operations on the connections can cause the disconnection of the loads from the grid or the gensets.

Please read this manual carefully before using the controller.

The controller uses many configurable parameters, and it is therefore impossible to describe all their combinations and effects. This document does not describe of all of them: see documents [1] for this purpose. Consider that document as part of this manual.

Mecc Alte provides the controller with a generic "default" configuration; is at the installer's care to adjust the operating parameters to the specific application.

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

1.3 Notes on the parameter's configuration of the controller

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

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

BoardPrg4 also allows the configuration, saving or loading of the characteristic curves of non-standard analogue sensors with resistive or voltage output.

BoardPrg4 supports all Mecc Alte controllers; you can connect the PC to the controller using any communication resource of the controller itself (RS232, RS485, USB, Ethernet).

1.4 Definitions

This document uses the word "**ALARM**" to indicate a fault that makes the gensets operation impossible; the MGCB circuit breaker (or the GCBs circuit breakers) are immediately opened (without any power unload). The genset controllers will turn off the engines with standard procedure (with cooling cycle).

The word "**UNLOAD**" indicates a fault that makes the gensets operation impossible; before opening the MGCB circuit breaker (or the GCBs circuit breakers), the genset controllers will transfer the power from the gensets to the grid (if possible and configured). Then, they will turn off the engines with standard procedure (with cooling cycle).

The word "**WARNING**" indicates a fault that requires an operator action but does not require the opening of MGCB (or GCBs) circuit breakers, and that does not require the shutdown of the gensets.

1.4.1 Acronyms

AIF: It identifies a function for the configuration of the analogue inputs ("*Analogue Input Function*"). The number that follows the caption "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.

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

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

GCB: This term identifies the circuit breaker that connects the genset to the load (or to the parallel bars in case of plants with more gensets) ("*Genset Circuit Breaker*").

MCB: This term identifies the circuit breaker that connects the grid to the load (*"Mains Circuit Breaker"*).

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

MPM: See the description of the type of plant in [8].

MPtM: See the description of the type of plant in [8].

MPtM + MSB: See the description of the type of plant in [8].

MSB: See the description of the type of plant in [8].

MSB + MSTP: See the description of the type of plant in [8].

PMCB: It identifies the communication bus (by Mecc Alte) that allows all devices exchange information to manage the parallel functions described in the document [8] ("*Power Management Communication Bus*").

SPM: See the description of the type of plant in [8].

SPtM: See the description of the type of plant in [8].

SPtM + SSB: See the description of the type of plant in [8].

SSB: See the description of the type of plant in [8].

SSB + SSTP: See the description of the types of plant in [8].

1.5 Conventions

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

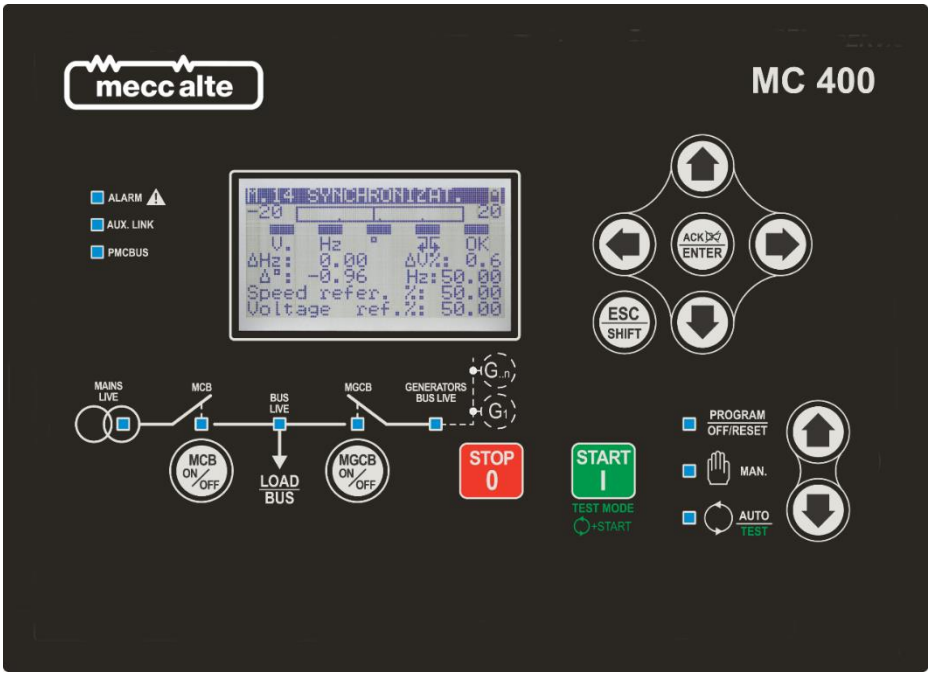
1.6 Revisions of the software

Several parts of this manual refer to the controller's software revisions. These revisions are marked with the assigned Mecc Alte code (shown on the rear panel of the controller). The format of the code is EB0250275XXYY, where “XX” is the main version and “YY” is the minor version. Thus, the code EB02502750100 refers to the controller software release "1.00". The page “S.03” of the TFT display also shows the software revision.

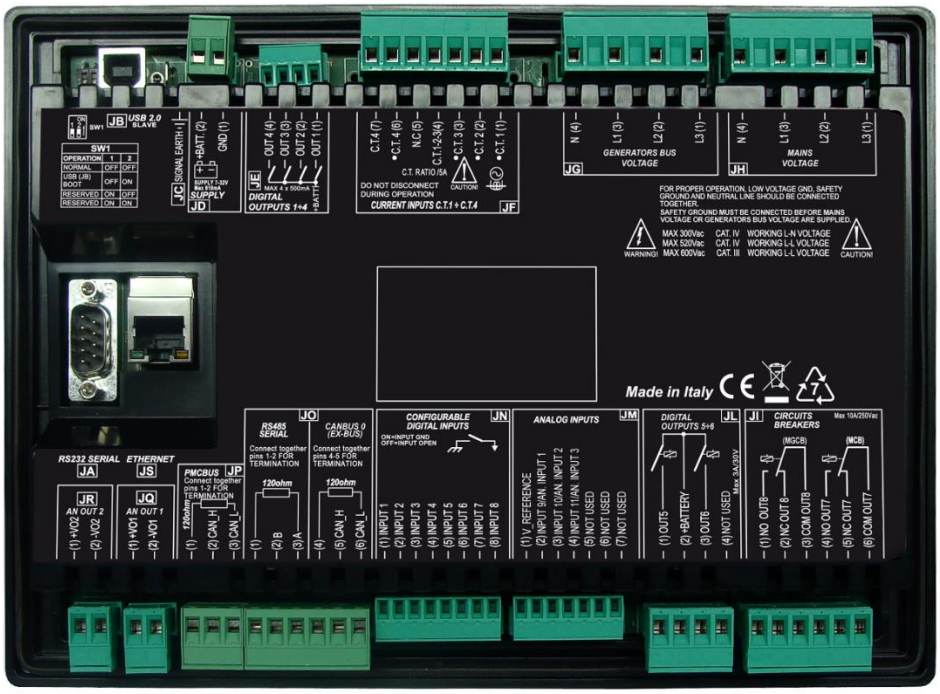
MC400 uses the following firmware:

- EB0250275XXYY

2 Views of the controller



MC400 Front view



MC400 Rear view

3 Technical features

INFORMATION! GND refers to the potential of the terminal JD-1

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

Supply power voltage +VBATT.	
Nominal power supply (Vn).	12 Vdc or 24 Vdc.
Power supply range (Vn variation)	From 7 to 32 Vdc The controller identifies the plant operation at 12 or 24V to manage its alarms when powered up and whenever OFF/RESET mode is selected: it is used to signal over/under voltages.
Starting minimum voltage.	During the engine cranking, the operation is guaranteed up to Vbat ≥ 5 Vdc for indefinite time.
Input capacitance.	About 880 µF.
Sampling rate.	10 kHz.
Measurement Resolution.	12 bits.
Power consumption in stand-by:	400mA @ Vbatt =13,5 Vdc display lamp on 310mA @ Vbatt =13,5 Vdc display lamp off 210mA @ Vbatt =27,0 Vdc display lamp on 190mA @ Vbatt =27,0 Vdc display lamp off
Maximum power consumption during operation: Digital input & outputs active. Analogue outputs @ +10V. Ethernet ports in communication USB communication active. Can Bus communication active. Lamp LCD on **Static outputs and +D not active**	Max 810mA @ 7 VDC 480mA @ 13,5 VDC 345mA @ 27 VDC 340mA @ 32 VDC **INFORMATION! All the current supplied to the four static outputs (Digital outputs 01…04) flows through the positive input +BATT (JB-2). The declared max current consumption does not include the load drawn by the controller's digital DC outputs. These additional loads must be considered to ensure proper sizing of the protection fuse and the wiring cable cross-section.**
Protection.	Protection against polarity reversal with built-in self-resetting fuse. Overvoltage protection with integrated TVS: typical tripping voltage 39 Vdc. Circuit protection against load dump transients and voltage surge (1.2/50 µs): ±1 KV Line-Line. ±2 KV Line-Earth.

Grid and generators/bus voltage inputs. (JH and JG)	
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 controller supply negative (GND). External fuse maximum 1 A..
Nominal range (Vn).	100 to 480 Vac phase to phase.
Measuring range	Grid: from 35 Vac *(minimum required for sensing frequency)* to 354* Vac for measures phase to neutral Generators Bus: from 20 Vac *(minimum required for sensing frequency)* to 354* Vac for measures phase to neutral. * **With voltage N-GND = 0 Vac**
Maximum voltages applicable. *	MAX 300Vac in CAT.IV for measurements phase to neutral. MAX 520Vac in CAT.IV for measurements phase to phase. MAX 600Vac in CAT.III for measurements phase to phase. * Up to 2000 m (6561 ft.)
Scale	It can be adjusted through the controller parameters between 100V and 400V.
Max tension in Common-Mode from GND	Max 100 Vac @ 440Vac L-L
Type of measurement.	True RMS measurements (TRMS).
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	> 320 KΩ L-L > 170 KΩ L-N > 390 KΩ L-GND > 310 KΩ N-GND
Measurement/overvoltage categories.	CAT. III, CAT. IV.
Type of measurement.	True RMS (TRMS).
Sampling rate.	10 KHz.
Measurement resolution	12 bits
Measurement accuracy	± 0,5% of full-scale reading.
Phase angle accuracy.	± 0,2° (within nominal voltage range and nominal frequency range).

Current measurement inputs (JF)	
Type of input.	3 inputs with internal SHUNT resistor optimized for the connection towards external current transformer (CT) with common CT's ratio. 1 independent auxiliary current with internal shunt resistor optimized for the connection towards external current transformer (CT) that can be used to measure current / power for grid / loads / gensets or for any other auxiliary source. It is required the use of external current transformers (CT) with a secondary current of 1A or 5A (recommended). **The return connection of the CTs to the negative power supply of the controller (JD-1) is required.** ⚠ **WARNING! The external CT must guarantee at minimum REINFORCED (DOUBLE) isolation for the use of the controller in the Overvoltage CAT. III or Overvoltage CAT. IV**
Nominal Current (In).	-/1 Aac or -/5 Aac from current transformers.
Maximum measurement range.	Up to 5,3Aac
Input impedance.	20 mΩ.
Maximum currents allowed:	+ 40% of the rated current. Possible sinusoidal transient voltage surges up to 20 Aac with progressive loss of the measurement accuracy depending on the amplitude of the surge.
Sampling rate.	10 kHz.
Type of measurement	True RMS measurements (TRMS).
Burden per phase (auto-consumption).	< 1 VA/phase.
Measurement resolution	12 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).

Frequency measurements.	
	Frequencies measured by L1 phase voltage, for both the grid and the generators' bars inputs. Measurements of the frequencies are referred to the controller supply negative.
Nominal Frequency (Fn).	50 Hz or 60 Hz.
Measurement range.	5 to 80 Hz.
Measurement accuracy.	± 50 mHz
Frequency minimum sensitivity on grid voltage inputs	35Vac L1-N @ 50Hz 36Vac L1-N @ 60Hz
Frequency minimum sensitivity on the generators' bars voltage inputs.	10Vac L1-N @ 5Hz 17Vac L1-N @ 50Hz 20Vac L1-N @ 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.	0,1Hz ± 50ppm, 35ppm/C typical.

Digital inputs 01-08 (JN)	
Input type	8 not insulated digital inputs with same supply, internal supply terminal connected to the controller positive JD-2 (+BATT). They are active when the input is connected to the supply negative GND. When they are open, the inputs terminals voltage is Vbatt.
Input impedance.	2.2 kΩ.
Activation/deactivation threshold	2,5Vdc
Voltage withstands	± 40Vdc with respect to negative power supply (with Vbatt= 7Vdc) -15Vdc and +40Vdc with respect to negative power supply (with Vbatt= 32Vdc)
Typical current with closed contact	6,5mA @ +Vbatt= 13,5Vdc 12mA @ +Vbatt= 27Vdc
Open circuit voltage.	Input terminal is a Vbat.
Input signal delay	It can be adjusted by the related parameter for each input

Digital outputs 01-04 (JD)	
Type of output	4 independent static outputs to battery positive. The output current is supplied by the positive supply terminal of the controller JD (2) +Vbatt. All outputs are adjustable by parameter.
Maximum switching capacity	0,5Adc @ 32Vdc for each output with maximum total current for all outputs of 1 Adc
Output resistor (status ON)	Max 350mΩ
Leakage current (status OFF)	Max 5uA@32Vdc
Protections	Internal current limited to about 4A max. on transients <150us Thermal protection, short circuit, overvoltage and inverted polarity. **INFORMATION!** With particularly inductive loads (remote control switches, electromagnets, etc.), a surge-damping diode must still be used.

Digital outputs 05 and 06 (JL)	
Type of output	2 relays with NO contacts. Positive common input terminal (JL-2). The positive common terminal has the function of input for the emergency stop. The measurement of the voltage on the common input is displayed at page S.15 of the display (EM-S): **the function cannot be disabled.** All relay outputs are adjustable by parameter.
Rated supply	Max. 3A @ 30Vdc for each output
Protections	Surge protection diodes incorporated. INFORMATION! With particularly inductive loads (remote control switches, electromagnets, etc.), a surge-damping diode must still be used.

Digital outputs 07 and 08 (JI) - Switch command	
Type of output.	2 relays with dry contacts for the contactors command. All relay outputs are adjustable by parameter.
Rated supply.	Max. 10A @250Vac.

Analogue inputs 01-03 (JM-2 to JM-4) and VREF (JM-1)	
Type of input	3 adjustable analogue inputs. Adjustable as resistive and digital inputs. If used as digital inputs, activation to GND. For the resistive sensors, there is an input for the measurement and compensation of the reference potential with respect to the sensor common negative (JM1-Vref).
Digital inputs	Input activation threshold: 1,2 Vdc. Input deactivation threshold: 2,2 Vdc. If the input is open, it is deactivation. Injected current: 25mA max.
Resistive inputs	Measurement range 0 – 500Ω with error < 0,2% 0 – 2kΩ with error < 1% Injected current: 25mA max. Compensation range (VREF): from -2,7Vdc to 6Vdc
Frequency	10kHz
Resolution	12 bits

Analogue outputs 01 and 02 (JR and JQ)	
Type of output.	2 galvanically insulated ±10Vdc voltage outputs. Each output can be limited as a voltage range (min and max value) by parameters.
Output regulation range.	From -10Vdc to +10Vdc (adjustable by parameters from 0% to 100%)
Resolution	16 bit (0,3mV/bit)
Minimum load impedance.	>10 kΩ.
Insulation rated voltage	3000 Vac Insulation for 60s
Insulation resistance	>1000MΩ @ 500Vdc

COM1 - RS232 Communication interface (JA)	
Type of interface.	1 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***, Modem AT *** Default Setting.**

COM2 - RS485 Communication interface (JO)	
Type of interface.	1 RS485 serial port standard TIA/EIA, with galvanic insulation. Terminal resistor already available (connect pins 1 and 2 of JO).
Electrical signals.	DATA+ (A), DATA– (B).
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***. *** Default Setting**
Insulation voltage	1000 Vdc Insulation for 60s
Insulation resistance	>1000MΩ @ 500Vdc
	INFORMATION! twisted pair shielded cable is recommended to achieve specification and optimisation of immunity-noise.

USB 2.0 Communication interface (JB)	
Type of interface.	1 USB2.0 serial port not insulated, usable in Function mode.
Function Mode.	Connection to PC by Mecc Alte Driver. USB Connector Type B. Type of transmission Modbus RTU Slave.
Maximum distance.	3 m (9.84 ft).

CAN bus Communication interface (JO and JP)	
Type of interface.	2 CAN bus ports with galvanic insulation. Terminal resistor available by connecting pins 1-2 e pins 4-5 together.
CAN bus0.	CAN bus connection with protocol Mecc Alte for the communication with I/O expansion modules.
CAN bus1.	CAN bus connection with protocol Mecc Alte PMCB bus for the communication with other controllers.
Rated impedance.	120Ω.
Insulation voltage	1000 Vac Insulation for 60s
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 200 m (656 ft). CAN bus 1: maximum 200 m (656 ft).

Ethernet Communication interface (JS)	
Type of interface.	1 Ethernet interface 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).
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 3 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.

Display.	
Type of display.	Transflective graphic monochrome LCD with backlight illumination with white LEDs.
Resolution.	128 x 64 pixel
Pixel size.	0,52 x 0,52 mm.
Visual area dimensions.	70 x 38 mm.

Environmental conditions.	
Operating temperature.	From -25°C to +60°C; humidity ≤ 95% without condensation
Stock temperature.	From -30°C to +80°C.
Relative humidity	IEC 60068-2-30 Db Damp Heat Cyclic 20/55°C @ 95% RH 48 Hours IEC 60068-2-78 Cab Damp Heat steady state 40°C @ 95% RH 48 Hours
Operating altitude.	Up to 2000 m (6561 ft).
Pollution degree.	PD2.

Box.	
Material.	PC
Size.	244(W) x 178(H) x 40(D) mm.
Weight.	650g.
Protection degree.	IP65 with gasket for the front panel. IP20 for the panel interior.

3.1 Measurement resolution

Grid and generators' bars voltages.	1Vrms accuracy ±0,5% F.S.
Currents	Min. 0,1A (depends on the C.T.), accuracy ±0,2% F.S.
Grid and generators' bars frequencies.	0,1Hz ± 50ppm, 35ppm/C typical
Powers	Min. 0,1 kW/kVA/kvar (depends on the C.T. ratio)
Power Factor	0,01
Energy	1 kWh/kvarh

4 Installation

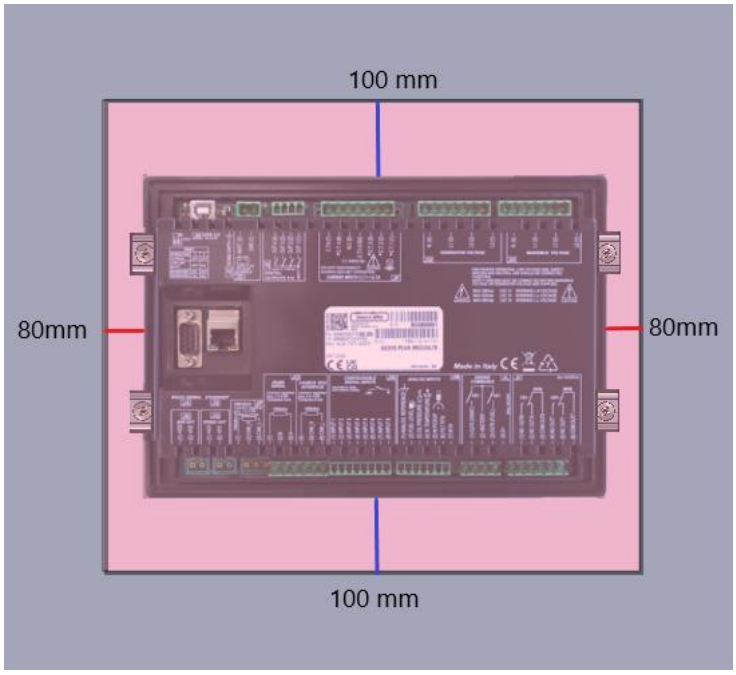
4.1 Mounting

The controller must be mounted permanently on an electrical panel or cabinet. The back of the controller must be accessed only using keys or tools, and only by personnel authorized to perform maintenance operations. The controller must be mounted to make it impossible to remove it without using tools. The electric control panel must guarantee an adequate protection against bad weather.

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

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

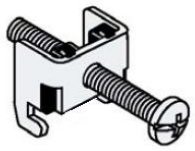
The following figure shows the clearances for mounting the devices and minimum free space (pink colour):



INFORMATION: The dimensions indicated refer exclusively to the minimum area required to ensure basic natural ventilation around the controller. These values shall not be considered as the minimum dimensions of the enclosure or cabinet in which the product is installed. The effective air volume available for heat dissipation depends on the overall design, internal layout, and ventilation features of the final enclosure, and therefore cannot be inferred from the minimum aeration dimensions specified for the controller. Proper thermal verification of the final assembly, including enclosure design and ventilation performance, is the responsibility of the equipment manufacturer or system integrator.

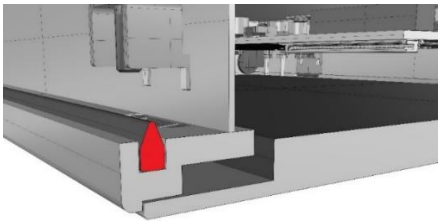
4.1.1 Fixing clamps

The controller must be mounted using four fixing clamps from the accessory pack.



4.1.2 Gasket assembly

The supplied silicon gasket provides improved sealing between the controller and the switchboard door. The gasket must be fitted to the controller before installing it into the control cabinet door. Take care to ensure the gasket is correctly fitted to the controller to maintain the integrity of the seal.



The gasket is shaped like a triangle. The base of the triangle must be inserted into the cavity of the controller; the upper edge of the triangle must engage with the control cabinet door.

INFORMATION: a gasket that has been used for a long period may have scratches or dirt on its surface and could have lost much of its dust and drip resistance. Change the gasket once a year or when scratches or dirt become visible.

4.1.3 Panel-cut Dimensions

INFORMATION: the material around the mounting cutout must provide sufficient strength to guarantee lasting and safe mounting of the controller.

INFORMATION: to achieve the degrees of protection declared, it must be ensured that deformation of the material cannot occur due to the force of the mounting clips or operation of the controller

The degrees of protection of the controller can only be guaranteed if the following requirements are met:

- Material thickness at the mounting cutout for a degree of protection IP65: 1 mm to 4 mm.
- Permissible deviation from plane at the mounting cutout: ≤ 0.5 mm This condition must also be fulfilled for the mounted controller.
- Permissible surface roughness around the seal: ≤ 120 µm.
- The installation area is dry and free from contamination, such as dust or lubricant.

Cut out the door so that it has a groove with the dimensions 218(L) x 159(H) mm.

4.1.4 Mounting the controller

- Place the panel on a clean and level surface with the display face pointing downward.
- Check that the installation gasket of the panel is seated securely and runs all the way around the perimeter of the frame.
- Create the correct sized opening required to install the panel, using the installation dimensions.
- Insert the controller into the panel cutout and verify that the unit fits correctly in the cutout.
- Once the controller is positioned, insert the nose of the fixing clamps into the slot on the sides of the controller.
- Pull the fixing clamps backwards towards the back of the controller.
- Ensure that the gasket is properly positioned in the groove and against the panel.

- Tighten the clamping screws until they contact the control cabinet door.
- Tighten the screws on all clamps, alternating from one side to the other until the front bezel is secure against the mounting panel. Torque the screws to 0,2-0,3 Nm.
- Over tightening of these screws may result in the clamp inserts or the housing breaking.

INFORMATION: do not exceed the recommended tightening torque.

INFORMATION: the mounting surface and the operating controller may not become deformed because of the fixing clamps or through the operation of the controller.

4.2 Wiring

Due to high voltages associated to the measurement circuits of the controller, all the conductive parts of the electrical panel must necessarily be connected to the protective earth by means of permanent connections.

Installing an overcurrent protection controller is required for each phase of the grid and generator voltage inputs. 1A fuses can be conveniently used.

The conductor cross-section of the protective earth of the electrical panel must be at least equal to the section of the wires used for wiring the grid or generator voltage to the panel. In addition, it must comply with the limit value of the overcurrent protection used.

For CAT.III applications, the maximum phase-to-neutral voltage allowed is 300Vac, while the phase-to-phase voltage is 520Vac. Maximum voltage with respect to the protective earth is 300Vac.

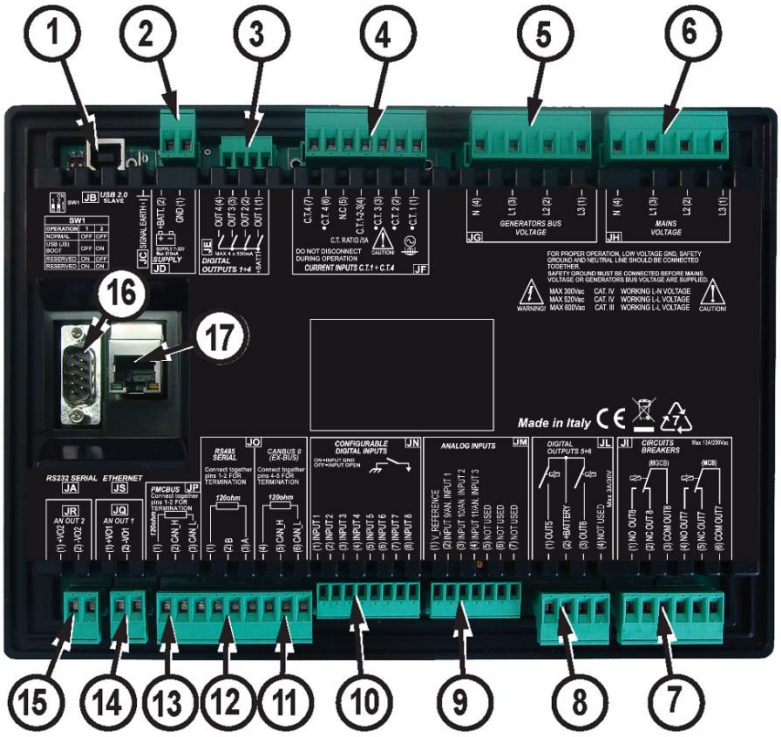
For CAT.IV applications, the maximum phase-to-neutral voltage allowed is 345Vac, while the phase-to-phase voltage is 600Vac. Maximum voltage with respect to the protective earth is 345Vac.

The controller can operate in CAT.III or CAT.IV only if the external current transformers (TA) guarantee a REINFORCED (DOUBLE) insulation.

The controller can operate in CAT.III or CAT.IV only if the supply negative terminal of the controller and the neutral terminal of the generator are connected to the protective earth.

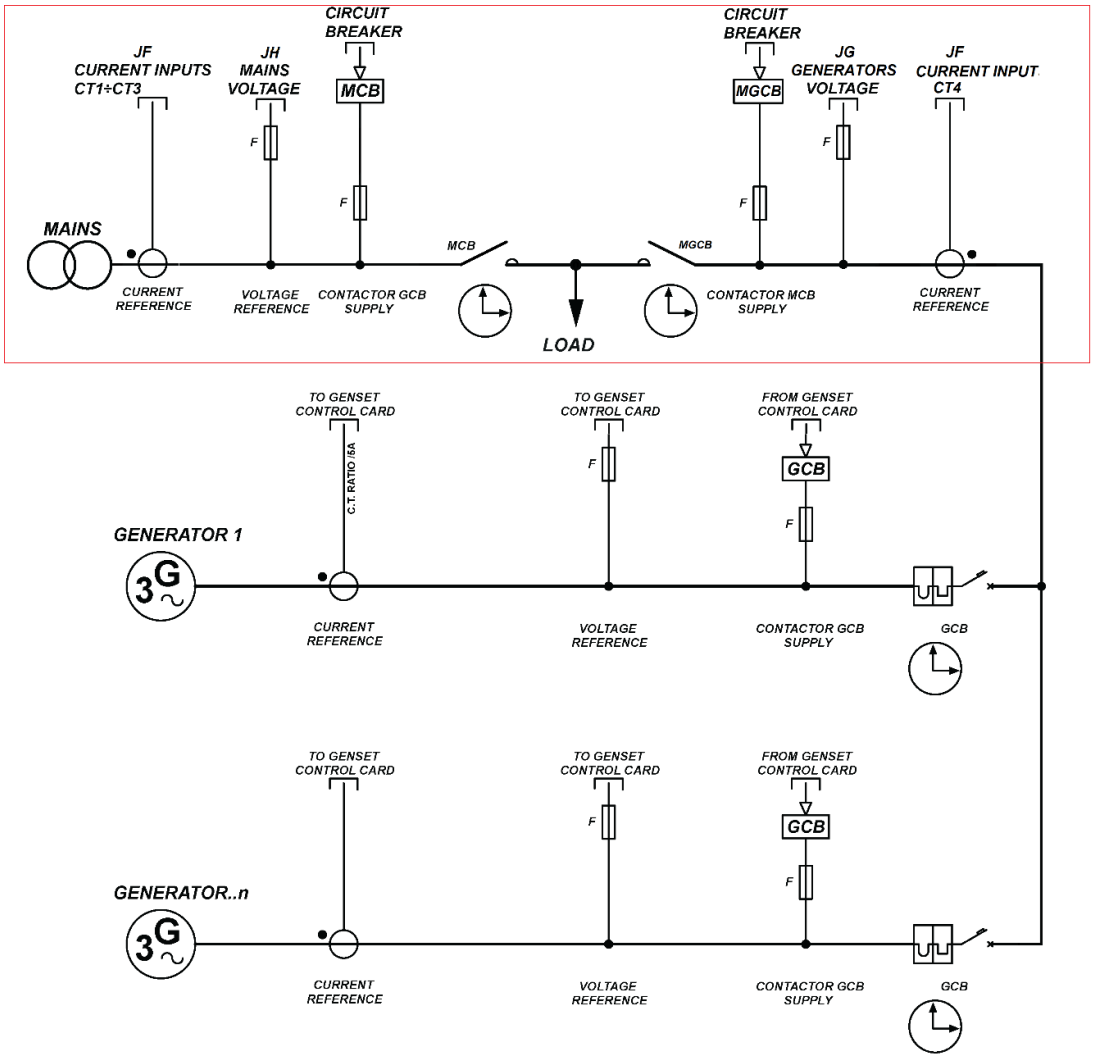
ATTENTION!	**Terminal temperatures may reach up to 80 °C during operation. Use copper conductors only, rated for a minimum insulation temperature of 90 °C (e.g., 90 °C PVC insulated wires or equivalent). Using conductors with a lower temperature rating may result in insulation damage and fire hazard**

5 IN/OUT connections and configuration



N.	NAME	DESCRIPTION	CONNECTOR
1	JB	USB 2.0 Function Interface.	USB – B.
2	JD+JC	Power supply + functional earth.	2 poles x 2,5mm^2 Screw terminal + faston.
3	JE	Digital outputs 1-4.	4 poles x 1,5mm^2 Screw terminal.
4	JF	Current inputs 1-3 and auxiliary current input.	7 poles x 2,5mm^2 Screw terminal.
5	JG	Generators' bars voltages.	4 poles x 2,5mm^2 Screw terminal.
6	JH	Grid voltages.	4 poles x 2,5mm^2 Screw terminal.
7	JI	Digital outputs 7-8.	6 poles x 2,5mm^2 Screw terminal.
8	JL	Digital outputs 5-6.	4 poles x 2,5mm^2 Screw terminal.
9	JM	Analogue inputs 1-3.	7 poles x 1,5mm^2 Screw terminal.
10	JN	Digital inputs 1-8	8 poles x 1,5mm^2 Screw terminal.
11	JO	CAN bus for I/O expansions.	3 poles x 2,5mm^2 Screw terminal.
12	JO	RS485 Communication interface.	3 poles x 1,5mm^2 Screw terminal.
13	JP	PCMBUS Interface for parallel functions.	3 poles x 2,5mm^2 Screw terminal.
14	JQ	Analogue output 1.	3 poles x 2,5mm^2 Screw terminal.
15	JR	Analogue output 2.	3 poles x 2,5mm^2 Screw terminal.
16	JA	Communication interface RS232.	9 Poles Male Canon.
17	JT	Ethernet Interface.	RJ45.

5.1 Basic diagram

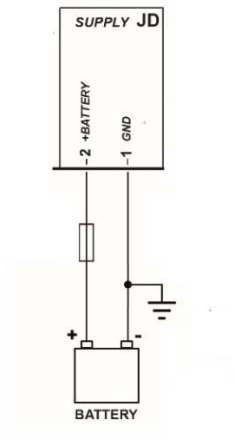


5.2 Functional earth (JC)

The connection to the functional earth **JC** is mandatory to guarantee the proper operation of the controller and the compliance with the EU Electromagnetic Compatibility Regulation.

The connection is functional and not protective; therefore, the cross-section of the wire can be smaller. Connect the other end of the wire to a metal screw of the electrical panel (which must be grounded) next to the **JC** or to a grounding line, using the shortest cable possible.

5.3 Controller supply (JD)



The **JD** connector is the supply connector: connect a DC supply (usually the engine starter batteries) to the **1-GND** terminal (negative) and to the **2-+BATT** terminal (positive).

The minus terminal **1-GND** is the reference and the common return of the digital inputs, outputs and current and voltage measurements. **It must be connected to the protection earth.** The systems that require insulation between the battery negative and the protection earth can be used but can generate operating problems and may require care, as the use of insulation transformers for the voltage measurements of the grid and of the generators' bars.

Although a built-in self-resetting fuse protects the controller, we recommend using a fuse for the protection of the positive line **2-+BATT**. **The power supplied by the JD static outputs flows through the 2 +BATT positive input, so you must pay attention to the fuse dimension.**

At power on, the controller automatically detects if the supply nominal voltage is 12 or 24V for managing the related logics and alarms. In addition, the controller repeats the detection each time you switch to the **OFF/RESET** mode.

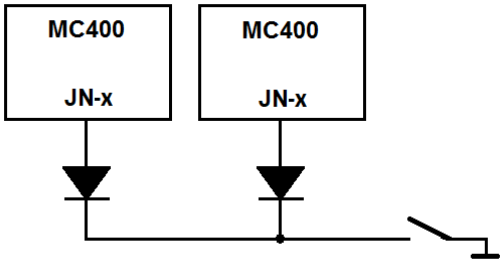
NOTE: when installing, connect the supply voltage positive only after opening all fuses available in the panel.

5.4 Digital inputs 1-8 (JN)

The controller is equipped with a series of 8 opto-insulated digital inputs **(JN)**, which are fully configurable.

Besides these 8 inputs, it is possible to use the analogue inputs **JM** as digital inputs, if not used as measurement inputs (see par. 5.6).

It is possible to share the same command signal of an input with different devices (for example, one signal for three MC400). If you use the inputs of the JL connectors (positive common), it is necessary to separate them with diodes, as in the figure below. This avoids the wrong activation of the input when one of the devices is switched off.

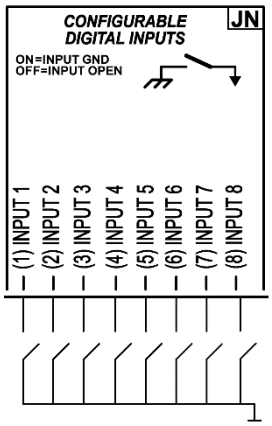


It's also possible to increase the number of digital inputs by adding up to two optional DITEL 16 IN modules (connected by CAN bus) for a total of 32 digital inputs (see par.5.8).

There are also 16 "virtual" digital inputs, which do not exist on the controller or on the expansion modules, but they are represented by the result of the logic combination of physical or virtual inputs, outputs, alarms or logical statuses, by means of the proper programming by BoardPrg3. The virtual inputs can be configured as functions and used as physical inputs; see par.5.4.2.

The status of the digital inputs, virtual inputs and inputs available through DITEL modules is displayed at pages S.11 and S.12 (0=output not active, 1=output active).

5.4.1 JN - Digital inputs 1-8



They are a group of eight opto-insulated digital inputs with common terminal internally connected to the positive supply terminal of the controller +Vbatt. It is possible to activate the inputs by connecting them to the battery negative (GND). When it is left floating, the input brings itself to +Vbatt. Avoid situations where intermediate or undefined voltage levels can occur.

The inputs are configurable (see par. 5.4.3).

By default, the functions of the JN input on the MC400 controller are the following:

Terminal	Digital input	Default function
JN-1	01	**DIF.3003 - "Status of MGCB circuit breaker".**
JN-2	02	**DIF.3002 - "Status of MCB circuit breaker".**
JN-3	03	**DIF.0000 - "Not used".**
JN-4	04	**DIF.2702 - "Enables the load function".**
JN-5	05	**DIF.0000 - "Not used".**
JN-6	06	**DIF.0000 - "Not used".**
JN-7	07	**DIF.0000 - "Not used".**
JN-8	08	**DIF.0000 - "Not used".**

5.4.2 Virtual digital inputs

Besides 8 physical digital inputs and 32 available with the DITEL modules, the controller manages 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. In fact, each virtual digital input can be associated to an AND/OR logic that determines the status (see par. 5.5.5).

The status of the virtual inputs is displayed at pages S.11 (0=output not active, 1=output active).

Example of the use of an AND/OR logic. Let us suppose we would like to activate a warning if the grid exceeds the tolerance thresholds while the MGCB is closed. Let us use the virtual digital input #1 (as example).

- Using the BoardPrg3 software we associate an AND/OR logic configured as AND to the virtual digital input #1, with the following list of conditions:
  - ST.066 (“MGCB status”)
  - ST.017 (“Grid absent or out of tolerance”).

- Therefore, the virtual digital input will be active when the MGCB is closed, and the grid is out of tolerance.
  - Let us set the DIF.4001 function (“Generic warning”) within the P.2151 parameter.
  - Let us set the desired delay (for example 0.5 s) within the P.2152 parameter.
  - Let us set the alarm message (for example “grid voltage warning”) within the P.2153 parameter.

5.4.3 Digital inputs configuration

All digital inputs are considered “active” only when the related terminal is connected to the supply negative of the controller; they are considered “not active” when the related terminal is left open.

The logic status of the input can be reversed with respect to the physical status by ticking the “Reversed polarity” box in the input configuration page on BoardPrg3.

The box is only visible if the function selected is other than DIF.0000 – “Not used”.

It is also possible to reverse the logic status (always individually for each input), directly by the controller, using the parameters:

Parameter	Inputs
P.2000	01...16
P.2100	Analogue inputs used as digital ones
P.2200	DITEL #01
P.2250	DITEL #02

Said parameters have a bit for each output:

- A bit set to zero means that the related input is “active” when it is connected to the negative supply of the controller.
- A bit set to one means that the related input is considered “active” when it is not connected to anything (it will become “not active” if it is connected to the supply negative terminal of the controller).

By default, all bits are set to zero.

Each input (both physical and virtual) has three parameters associated:

- One parameter that configures its function (P.2001 for input 1).
- A parameter that configures the delay time (P.2002 for the input 1).
- A parameter that configures a message to show on the display (P.2003 for the input 1).

See document [1] for the parameters list.

The management of the physical and virtual inputs is the same, except that the virtual inputs cannot be inverted.

The status of the digital inputs, virtual inputs and inputs available through DITEL modules is displayed at pages S.11 and S.12 (0=output not active, 1=output active).

The controller uses the parameters that configure the delay and the message for an input only for certain features of that input. The following table highlights when they are used.

NOTE: in BoardPrg3, the boxes for the delay and the message are always displayed, even if the controller does not use them.

The input functions that start with 3xxx are related to the functioning status; those that start with 4xxx activate alarms (alarms, unloads or warnings).

Input function	Name	Delay	Message	Description
DIF.0000	Not used.			Input not used.
DIF.1001	Request for MGCB closure.			It only acts in MAN mode, used to control the manual closing of the circuit breaker. If there is no input configured with the function DIF.1002, this input works as toggle: it commands the closure of the breaker when the same is open and commands the opening when the same is closed. The controller closes the circuit breaker when the input becomes active.
DIF.1002	Request for MGCB opening.			It only acts in MAN mode, used to control the manual opening of the circuit breaker. The controller opens the circuit breaker when the input becomes active.
DIF.1003	MGCB controlled externally.			It indicates to the controller that an external logic temporarily controls the circuit breaker: the controller will acknowledge it without activating faults.
DIF.1004	Synchronization request MGCB.			It is used when an external controller controls the circuit breaker: the external controller activates this input if it wants the controller to carry out the synchronization and supply the “synchronized” contact (or if the controller needs to manage the analogue input connected to an external synchronizer).
DIF.1005	MGCB closure allowed.	Yes		This function allows an external logic to prevent or to delay the circuit breaker closure. If this input is configured, the controller activates an output configured as “ready to close” (DOF.3083) and waits for external acknowledge. If a delay is configured for this input, after this time the controller goes on with closure command even without acknowledgement.
DIF.1006	MGCB opening allowed.	Yes		This function is used only when the opening of the circuit breaker will result in a blackout on the loads. Before opening MGCB, the controller activates an output configured as “ready to open” (DOF.3084) and waits for external acknowledge. If a delay is configured for this input, after this time the controller goes on with opening command even without acknowledgement.
DIF.1031	Request for MCB closure.			It only acts in MAN mode, used to control the manual closing of the circuit breaker. If there is no input configured with the function DIF.1002, this input works as toggle: it commands the closure of the breaker when the same is open and commands the opening when the same is closed. The controller closes the circuit breaker when the input becomes active.
DIF.1032	Request for MCB opening.			It only acts in MAN mode, used to control the manual opening of the circuit breaker. The controller opens the circuit breaker when the input becomes active.

Input function	Name	Delay	Message	Description
DIF.1033	MCB controlled externally.			It indicates to the controller that an external logic temporarily controls the circuit breaker: the controller will acknowledge it without activating faults.
DIF.1034	Synchronization request MCB.			It is used when an external controller controls the circuit breaker: the external controller activates this input if it wants the controller to carry out the synchronization and supply the “synchronized” contact (or if the controller needs to manage the analogue input connected to an external synchronizer).
DIF.1035	MCB closure allowed.	Yes		This function allows an external logic to prevent or to delay the circuit breaker closure. If this input is configured, the controller activates an output configured as “ready to close” (DOF.3081) and waits for external acknowledge. If a delay is configured for this input, after this time the controller goes on with closure command even without acknowledgement.
DIF.1036	MCB opening allowed.	Yes		This function is used only when the opening of the circuit breaker will result in a blackout on the loads. Before opening MGCB, the controller activates an output configured as “ready to open” (DOF.3082) and waits for external acknowledge. If a delay is configured for this input, after this time the controller goes on with opening command even without acknowledgement.
DIF.2001	Command for resetting alarms.			When the input becomes “active”, the controller carries out a reset of all faults. That is equivalent to change the controller mode to OFF/RESET and back again to the desired mode.
DIF.2002	Command for alarm acknowledgment.			When the input becomes “active”, the controller silences the horn and recognizes the faults as the ACK button was kept pressed on the controller display.
DIF.2029	TEST without load (pulse).			When the input becomes “active” with the controller in AUTO, the test of the generators is performed without load, not depending on the value set in parameter “P.0222 – Enable generator supply on test”. The test has a configured duration with parameter P.0420: if set to zero, this test is never performed. If there is a second activation of the input during the test, the test is immediately stopped.
DIF.2030	TEST with load (pulse).			When the input becomes “active” with the controller in AUTO, the test of the generators is performed with load, not depending on the value set in parameter “P.0222 – Enable generator supply on test”. The test has a configured duration with parameter P.0420: if set to zero, this test is never performed. If there is a second activation of the input during the test, the test is immediately stopped.

Input function	Name	Delay	Message	Description
DIF.2031	Request for TEST mode.			When the input is “active”, the mode of the controller switches from AUTO to TEST (the input does nothing if the controller is not in AUTO or if the automatic intervention of the genset is required). When it becomes inactive, the status changes back to AUTO. The test will be performed with or without load based on how configured with parameter P.0222.
DIF.2032	Request for REMOTE START mode.	Yes		If the input is “active”, the controller operating mode changes from AUTO to REMOTE START (the input does nothing if the controller is in OFF/RESET or MAN mode). When it becomes inactive, the status changes back to AUTO.
DIF.2063	Full override protections.			When the input activates, all protections (except some, see [1]) that cause alarms or unloads become warnings.
DIF.2093	Select the import-export mode.			When the input is active, the controller switches to the “import/export” mode during the parallel with the grid, whatever is the mode configured in P.0880.
DIF.2096	Transfer to the generators.			When the input is active, the controller transfers the load from the grid to the gensets, then it opens the MCB circuit breaker.
DIF.2151	Select configuration 1.			When the input becomes “active”, the parameter of the alternative configuration 1 are copied into the work parameters
DIF.2152	Select configuration 2.			When the input becomes “active”, the parameter of the alternative configuration 2 are copied into the work parameters
DIF.2153	Select configuration 3.			When the input becomes “active”, the parameter of the alternative configuration 3 are copied into the work parameters
DIF.2154	Select configuration 4.			When the input becomes “active”, the parameters of the alternative configuration are copied into the work parameters
DIF.2181	Immediate supply.			It is used in plants composed by many gensets: if the input is active, the switch of the users between grid and gensets is carried out after the closing of the first GCB circuit breaker.
DIF.2251	Manual disconnection of loads.			Each time this input becomes active, the “load shedding” function disconnects one load (if possible). See the “load shedding” description for more details.
DIF.2252	Manual re-connection of loads.			Each time this input becomes active, the “load shedding” function reconnects one load (if possible). See the “load shedding” description for more details.

Input function	Name	Delay	Message	Description
DIF.2271	Remote OFF.			When this input is active, the operating mode of the controller is forced to OFF-RESET, and it is not possible to use the pushbuttons on the front panel to change it. **Note: when this input deactivates, if no inputs are configured with the functions DIF.2272 and DIF.2273, the operating mode is forced to the one set before the input activation.**
DIF.2272	Remote MAN			When this input is active, the operating mode of the controller is forced into MAN, and you cannot use the buttons on the panel to change it.
DIF.2273	Remote AUTO			When this input is active, the operating mode of the controller is forced into AUTO, and you cannot use the buttons on the panel to change it.
DIF.2501	Inhibition of start.			When the input is “active”, the automatic start of the generators is inhibited. The “REMOTE START” mode is not influenced by this function
DIF.2502	Inhibition of supply.			Automatically, when this input is “active”, the opening of the MGCB circuit breaker is forced (or the opening of all GCBs if MGCB does not exist or is externally managed), and the closing of MCB too.
DIF.2503	MCB closure inhibition			If this input is active, the controller keeps the MCB circuit breaker open (in automatic modes).
DIF.2511	Front panel lock			When the input is "active," many of the button commands are disabled.
DIF.2512	Remote commands lock			When the input is "active," commands received through the communication ports are disabled.
DIF.2513	Front panel/remote commands lock			When the input is "active," both button commands and those received through the communication ports are disabled.
DIF.2701	Enables remote start request.			If this input is not active, the controller does not accept to go to the “REMOTE START” mode.
DIF.2702	Enables the load function.			Used in the “load management”. See document [8].
DIF.2704	Disables protections on the 4° current.			When this input is “active”, the auxiliary current protection (normally used for differential protection) is disabled.
DIF.2705	Disables protections on analogue measures.			When this input “activates”, the thresholds set on the analogue measures with bit 13 ON, in the third or sixth configuration parameter (see par. 5.6.2) don’t cause the intervention of the relative protections.
DIF.2706	Enables serial port commands.			If this input is not “active”, the commands sent by means of Modbus registers HOLDING REGISTER 101 and 102 are not accepted.
DIF.2708	Enables PPR thresholds ‘1’.			If this input exists but it is not active, the protections for the parallel with the grid configured with parameters P.0922 e P.0924 are disabled. See document [8].

Input function	Name	Delay	Message	Description
DIF.2712	Enables the function 27T.			If this input exists and is not active, the function which disables the generator and interface protections 27 for low grid voltage is disabled.
DIF.2716	Enables the acquisition of the grid kW from analogue input			If this input exists and is active, the active power on the grid connection point is acquired by an appropriately configured analogue input. If it exists and is not active, the active power is measured using the AC inputs of the controller.
DIF.2721	Enable load shedding.			If this input is configured but not active, the “load shedding” function is disabled.
DIF.2722	Enable peak shaving/lopping.			If this input is configured but not active, the “peak shaving/lopping” function is disabled.
DIF.3002	Status of MCB circuit breaker.	Yes		It acquires the circuit breaker status which connects the grid to the users. An input configured in this way is used to activate a warning in the event of a discrepancy between the controls to the circuit breaker given by the board and the status of the same circuit breaker. Warning can be also issued in this case or, even, depending on the configuration, the generators can be started in case of MCB closure failure. It is also used to detect the status of the circuit breaker when it is commanded by external devices.
DIF.3003	Status of MGCB circuit breaker.			It acquires the general circuit breaker status, which connects the genset parallel bars to the users. It is used for the parallel logics and to disable the “load management” if the loads are not connected to the gensets.
DIF.3004	Status of GCB of other gen-sets.			Use this input if the gensets must work in parallel with other gensets controlled by “not Mecc Alte” controllers: indicates MC400 that at least another genset has its own GCB closed.
DIF.3101	External sensor for grid.			When the input is “active”, the grid is considered “in tolerance”
DIF.3102	No voltages on parallel bars.			Used in parallel plants, where the controller cannot directly measure the voltage on the parallel bars. The active input indicates that there is no voltage on the bars.
DIF.3103	External protections for parallel to grid			Connect the external controller, which manages the protections of parallel with the grid, to this input. The input must be active when no protection has triggered.
DIF.3104	No voltages on loads.			Used in parallel plants, where the controller cannot directly measure the voltage on the loads. The active input indicates that there is no voltage on the loads.
DIF.3201	General status (page 1).		Yes	When this input is “active”, the controller displays the text set in the parameters associated to the input on page S.08.

Input function	Name	Delay	Message	Description
DIF.3202	Important status (page 1).		Yes	When this input is “active”, the controller displays the text set in the parameters associated to the input on page S.08, which is immediately shown.
DIF.3203	General status (page 2).		Yes	When this input is “active”, the controller displays the text set in the parameters associated to the input on page S.09.
DIF.3204	Important status (page 2).		Yes	When this input is “active”, the controller displays the text set in the parameters associated to the input on page S.09, which is immediately shown.
DIF.3205	General status (page 3).		Yes	When this input is “active”, the controller displays the text set in the parameters associated to the input on page S.10.
DIF.3206	Important status (page 3).		Yes	When this input is “active”, the controller displays the text set in the parameters associated to the input on page S.10, which is immediately shown.
DIF.4001	Generic warning.	Yes	Yes	When the input is active, a warning is issued: the message shown is the one set in the parameters associated to the input.
DIF.4002	Generic unload.	Yes	Yes	When the input is active, an unload is issued: the message shown is the one set by means the related “text” parameter.
DIF.4004	Generic alarm.	Yes	Yes	When the input is active, an alarm is issued: the message shown is the one set by means the related “text” parameter.
DIF.4005	Warning transmitted to gen-sets.	Yes	Yes	When the input is active, a warning is issued: the message shown is the one set in the parameters associated to the input. All the connected genset controllers will activate the warning “warning from master controller”.
DIF.4008	Alarm transmitted to gen-sets.	Yes	Yes	When the input is active, an alarm is issued: the message shown is the one set by means the related “text” parameter. All the connected genset controllers will activate the alarm “alarm from master controller”.
DIF.4021	Warning (forces MCB open).	Yes	Yes	When the input is “active” a warning is issued: the message shown is the one set in the parameters associated to the input. The controller forces MCB opened.
DIF.4022	Unload (forces MCB open).	Yes	Yes	If the input is active, an unload is issued: the message shown is the one set in the parameters associated to the input. The controller forces MCB opened.
DIF.4024	Alarm (forces MCB open).	Yes	Yes	When the input is “active”, if the GCB command is active, a warning is issued: the message shown is the one set in the parameters associated to the input. The controller forces MCB opened.
DIF.4062	Unload (subject to override).	Yes	Yes	When the input is “active”, an unload is normally activated. If the Override function of the protections is activated, a warning activates. The message shown is the one set on the parameters associated to the input.

Input function	Name	Delay	Message	Description
DIF.4064	Alarm (subject to override).	Yes	Yes	When the input is “active”, an alarm is normally activated. If the Override function of the protections is activated, a warning activates. The message shown is the one set by means of the related parameters.
DIF.4261	Production line opened.	Yes		When the input is “active”, the controller realises to be no more in parallel with the grid and stops the genset with an alarm.

5.5 Digital outputs 1-8 (JE, JI, JL)

The controller has eighteen digital outputs: four relay outputs (**JI** and **JL**) and four positive static outputs (**JE**). It is possible to add two DITEL modules 16 IN, each of which manages up to two DITEL 8 OUT relay modules, for 32 additional outputs, in addition to the one on the controller.

5.5.1 JL - Digital outputs 5-6

The outputs of the **JL** connector are free (not configured) as default and can be freely configured by means the parameter of the controller.

The status of these outputs is displayed at pages S.13 (0=output not active, 1=active output).

The default functions of the JL outputs are:

Terminal	Digital output	Type	Default function
JL-1	5	Normally open contact, of the relay 5.	**DOF.0000 – “Not used”.**
JL-2	-	Terminal positive common input	
JL-3	6	Normally open contact, of the relay 6.	**DOF.0000 – “Not used”.**
JL-4	-	-	

In detail:

5.5.1.1 JL-2 COMMON PLUS Common positive

Positive input common 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 power supply by means of a contact of the emergency button: that is, this connection must be interrupted by keeping the emergency button pressed. Several emergency buttons may be used by series connecting them to each other. **This function cannot be disabled.**

Without voltage on that input (that is, pressing the emergency button,), in operational modes (MAN, AUTO, TEST, etc.) the controller generates the alarm AL.048 “A048 Emergency Stop”. It is not possible to configure the controller to deactivate the alarm for emergency stop.

The voltage at terminal JL-2 is measured for the management of the relative alarm and is displayed on page S.15 at EM-S.

Attention: do not use the terminal as common negative for the two relays outputs. Inside, in effect, are damper diodes for the opening over voltages that would enter in conduction and could be immediately damaged.

5.5.1.2 JL-1 Digital output 5

Positive relay output, with maximum capacity of 3A @30VDC. Integrated internal diode for damping opening over voltages. This terminal shows the battery voltage present on connector **JL-2**; 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 over voltages.

Attention: for currents over the nominal one use an external restart relay.

The output can be freely configured by means of parameter P.3005, see paragraph 5.5.4 and document [1] for the parameters list.

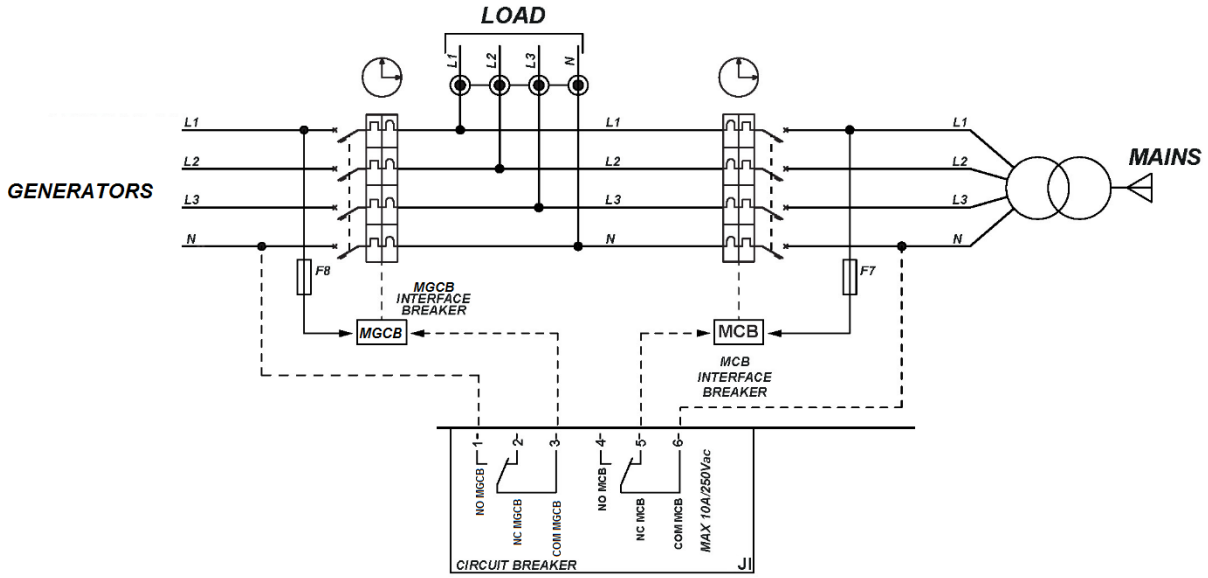
5.5.1.3 JL-3 Digital output 6

Positive relay output, with maximum capacity of 3A @30VDC. Integrated internal diode for damping opening over voltages. This terminal shows the battery voltage present on connector **JL-2**; 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 over voltages.

Attention: for currents over the nominal one use an external restart relay.

The output can be freely configured by means of parameter P.3006, see paragraph 5.5.4 and document [1] for the parameters list.

5.5.2 JI - Digital outputs 7-8: outputs for the command on the loads switching.



The controller uses two 10A@250Vac relays in clean contact for the switching commands of the loads. On JI connector, a clean contact in exchange for each of the two relays is available.

The default functions of the outputs on the controller are:

Terminal	Digital output	Type of output	Default function
JI-1	7	Normally open contact of the relay 7.	**DOF.2034 - "Stable closing command for MGCB"**
JI-2		Normally closed contact of the relay 7.	
JI-3		Common contact of the relay 7.	
JI-4	8	Normally open contact of the relay 8.	**DOF.2004 - "Stable opening command for MCB"**
JI-5		Normally closed contact of the relay 8.	
JI-6		Common contact of the relay 8.	

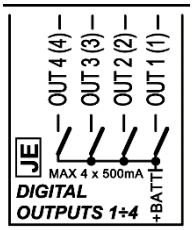
The output 7 is necessary to (as default) connect the loads to bus bar of the generators. The output 8 is necessary to (as default) connect the loads to the grid. Both the relays can be used for other functions.

The normally closed contact of output 8 and the normally open contact of output 7 should be used; in this way, even with deactivated controller, however the loads remain connected to the electric grid.

For the circuit breakers management see par. 7.9.

If there is only one circuit breaker, the MCB output (terminals 4... 6 of JI) is not used, it can be therefore associated to a different function (see par. 5.5.4).

5.5.3 JE - Digital outputs 1-4



They are four digital outputs, programmable. When activated, they bring themselves to the positive supply voltage which is on the **JD-2** supply terminal. The nominal capacity of each single output is 500mA: the total current is therefore 2A. **Do never overpass these values.**

The outputs are independent and individually protected from overloads, short circuits, polar inversion and overheating. The protection of overload intervenes limiting the current peak at an instantaneous value of 4A, to allow the activation of loads which need a higher transitory current than the nominal. When this condition is lasting, after 150us the gradual intervention of the thermal protection begins, until the output is turned off.

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

All the current supplied by the outputs must be kept available by means of **JD-2 +BATT; ensure that the eventual protection fuse on the supply positive have adequate capacity and intervention time to protect both the outputs and the controller in any usage condition.**

The default functions of these outputs are:

Terminal	Digital output	Type of output	Default function
JE-1	01	Static output at battery positive	**DOF.0000 - "Not used".**
JE-2	02		**DOF.0000 - "Not used".**
JE-3	03		**DOF.0000 - "Not used".**
JE-4	04		**DOF.0000 - "Not used".**

5.5.4 Digital outputs configuration

All digital output of the controller and those of the additional DITEL modules, are individually programmable.

The status of the digital outputs is displayed at pages S.13 and S14 (0=output not active, 1=output active).

As default, all outputs activate when required by the relative function (e.g. the load shedding outputs operates when a load must be disconnected).

Using BoardPrg3 it is possible to invert the activation by simply selecting the box "Inverted polarity", on the top of the configuration page of each output.

However, operating directly on the controller it is possible to invert the outputs logics (still individually for each output) using the parameters:

Parameter	Outputs
P.3000	01...18
P.3200	DITEL #01
P.3250	DITEL #02

A bit to zero means that the output is normally at rest. It operates when it is required by the associated function.

A bit to one means that the output is normally activated. It goes at rest when it is required by the associated function.

The map of the outputs on the controller is:

BIT	Hexadecimal value	Digital output	Terminal
1	0001	Output 01	JE-1
2	0002	Output 02	JE-2
3	0004	Output 03	JE-3
4	0008	Output 04	JE-4
5	0010	Output 05	JL-1
6	0020	Output 06	JL-2
7	0040	Output 07	JI-3
8	0080	Output 08	JI-4

While the map for the outputs on the four DITEL 8 OUT modules is:

Bit	Hexadecimal value	Digital output
1	0001	Output 01
2	0002	Output 02
3	0004	Output 03
4	0008	Output 04
5	0010	Output 05
6	0020	Output 06
7	0040	Output 07
8	0080	Output 08
9	0100	Output 09
10	0200	Output 10
11	0400	Output 11
12	0800	Output 12
13	1000	Output 13
14	2000	Output 14
15	4000	Output 15
16	8000	Output 16

If you want to invert the logic of an output, it is necessary to add in the relative parameter its corresponding value: e.g. If you want to invert the outputs 3 and 4 on the controller, it is necessary to set P.3000 = 000C (thus 0004+0008); if you want to invert the outputs 5 and 10 of the DITEL (16 IN + 16 OUT) second group, it is necessary to set P.3250 = 0210 (thus 0010+0200).

By default, all bits are set to zero.

The digital outputs can be used directly as command for external devices of the controller or as signalling of operation conditions.

The following three function, not linked to the operation sequences of the controller, are selectable for any digital output:

- DOF.0102 - “Commanded by the serial ports”. The controller does not command the output with own internal logics, but with the commands received by means of the serial ports.
- DOF.0103 - “Logics AND/OR”. See 5.5.5.

Following the configurable functions on digital outputs.

Output function	Name	Description
DOF.0000	Not used.	Output not used.
DOF.0102	Managed by the serial ports.	The controller does not command the output with own internal logics, but with the commands received by means of the serial ports.
DOF.0103	AND/OR logics.	The output status is the result of the combination of the logics AND/OR, see par. 5.5.5
DOF.1005	Request to start.	This output is active when the controller needs to start generators.

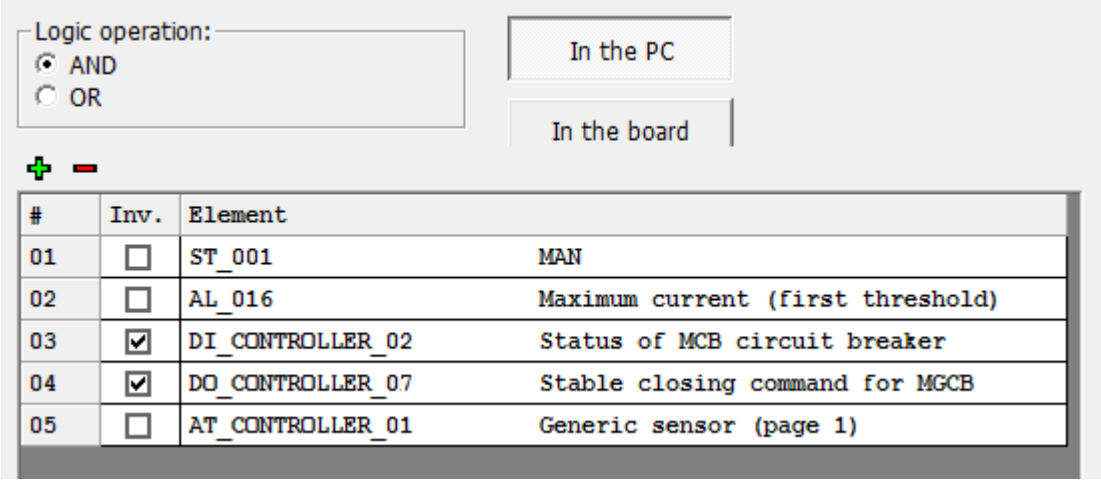
Output function	Name	Description
DOF.2001	Minimum voltage coil for MCB (NC).	See par. 7.9.
DOF.2002	Coil for opening of MCB.	See par. 7.9.
DOF.2003	Coil for closure of MCB.	See par. 7.9.
DOF.2004	Stable opening command for MCB.	See par. 7.9.
DOF.2031	Minimum voltage coil for MGCB.	See par. 7.9.
DOF.2032	Coil for opening of MGCB.	See par. 7.9.
DOF.2033	Coil for closure of MGCB.	See par. 7.9.
DOF.2034	Stable closing command for MGCB.	See par. 7.9.
DOF.2251	Load shedding 1.	This output is related to the “load shedding” function. The output is activated when the load must be disconnected from the generators. See the “load shedding” description for more details.
DOF.2252	Load shedding 2.	This output is related to the “load shedding” function. The output is activated when the load must be disconnected from the generators. See the “load shedding” description for more details.
DOF.2253	Load shedding 3.	This output is related to the “load shedding” function. The output is activated when the load must be disconnected from the generators. See the “load shedding” description for more details.
DOF.2254	Load shedding 4.	This output is related to the “load shedding” function. The output is activated when the load must be disconnected from the generators. See the “load shedding” description for more details.
DOF.3001	Off/Reset.	It activates when the controller is in OFF/RESET mode.
DOF.3002	Manual.	It activates when the controller is in MANUAL mode.
DOF.3003	Automatic.	It activates when the controller is in AUTOMATIC mode.
DOF.3004	Test.	It activates when the controller is in TEST mode.
DOF.3005	Remote start.	It activates when the controller is in REMOTE START mode.
DOF.3011	Not in Off/reset.	It activates when the controller is in MAN or AUTO mode.
DOF.3012	One of the automatic modes.	It activates when a controller is in an automatic operation mode, which is AUTO, TEST, or REMOTE START.
DOF.3030	Voltages on loads.	It activates when there is voltage on the loads.
DOF.3031	Voltage on generators.	It activates when there is voltage on the bars of the generators.
DOF.3033	Grid in tolerance.	It activates when the grid parameters are inside the window “grid live”.
DOF.3034	PPR ok.	This output deactivates when an anomaly is diagnosed on the grid voltage which requires the interruption of the parallel with the grid itself.
DOF.3037	Parallel to grid allowed.	This output activates when the grid status allows the parallel with the grid itself.
DOF.3062	Ready to supply.	This output is active when loads can be connected to generators.
DOF.3081	Ready to close MCB.	This output is activated before the closing of the circuit breaker only if one input is configured as “MCB closure allowed” (DIF.1035): it is deactivated (and so the circuit breaker will be closed) when that input is active or after the delay configured for the input elapses.
DOF.3082	Ready to open MCB.	This output is activated before the opening of the circuit breaker only if one input is configured as “MCB opening allowed” (DIF.1036): it is deactivated (and so the circuit breaker will be opened) when that input is active or after the delay configured for the input elapses.
DOF.3083	Ready to close MGCB.	This output is activated before closing the circuit breaker only if one digital input is configured as “MGCB closure allowed” (DIF.1005): it is deactivated (and so the circuit breaker will be closed) when that input is active or after the delay configured for the input.

Output function	Name	Description
DOF.3084	Ready to open MGCB.	This output is activated before opening the circuit breaker only if one digital input is configured as “MGCB opening allowed” (DIF.1006): it is deactivated (and so the circuit breaker will be opened) when that input is active or after the delay configured for the input.
DOF.3091	Synchronisation for MGCB.	It activates during the synchronisation for the closure of the MGCB circuit breaker.
DOF.3092	Synchronisation for MCB.	It activates during the synchronisation for the closure of the MCB circuit breaker.
DOF.3093	Synchronization in progress.	It activates during the synchronisation for the closure of the MCB or MGCB circuit breakers.
DOF.3094	Synchronized.	It activates during the synchronisation for the closure of the MCB or MGCB circuit breakers, when the gensets are synchronous with the grid.
DOF.3096	In parallel with the grid.	It activates when the gensets are supplying in parallel with the grid.
DOF.3151	Reset of the anomalies.	The board activates this output for one second when the internal sequence for the cancellation of anomalies is carried out.
DOF.3152	External horn.	It activates together with the internal siren.
DOF.3153	Lamp test.	It activates in OFF/RESET mode, pressing STOP button; it can be used to turn on internal control lights of the controller, and there is one only procedure to evaluate the control lights.
DOF.3154	Acknowledge of the anomalies.	The board activates this output for one second when the internal sequence for the acknowledge of the anomalies is carried out.
DOF.4001	Warnings.	It activates when there are warnings.
DOF.4002	Unloads.	It activates when there are unloads.
DOF.4004	Alarms.	It activates when there are alarms.
DOF.4005	Alarms and unloads.	It activates when there are alarms or unloads.
DOF.4035	Anomalies of circuit breakers	It activates when there are anomalies on the MGCB or MCB circuit breakers, which is: • 013: MCB not closed. • 014: MGCB not closed. • 023: MCB not open. • 024: MGCB not open.

5.5.5 AND/OR logics

The AND/OR logics are basically a list of Boolean conditions (true/false - on/off - 1/0), configurable by the operator (programming), evaluated by the controller and the result of which can be assigned to a digital output or to a virtual digital input. To use the AND/OR logics with one digital output, use the function DOF.0103.

Note: the configuration of the AND/OR logics cannot be carried out directly from the controller display, but it must be carried out by PC with the BoardPrg3 software.



First, the operator must decide whether the conditions list must be evaluated as AND (they must be all verified) or as OR (at least one condition verified). **It is not possible to have mixed AND/OR logics (it is possible to do it using virtual digital inputs, see below).**

Up to 30 conditions can be added. Each condition can be individually denied: in the previous picture, for example, the controller will check the digital input 2 and the digital output 17 to be both **not active**. The following conditions can be added:

- DI_XXX: logic statuses of all digital inputs (physical and virtual).
- DO_XXX: logic statuses of all digital outputs.
- AL_XXX: presence of warning/alarms.
- ST.XXX: internal statuses of the controller.
- AT_XXX: statuses connected to the thresholds on analogue measures (see par. 5.6.2).

The following chart shows the list of the internal statuses available for the AND/OR logics.

Status	Description
ST.000	OFF_RESET.
ST.001	MAN.
ST.002	AUTO.
ST.003	TEST.
ST.004	AVVIAMENTO REMOTO.
ST.006	Acknowledgment of anomalies in progress.
ST.007	Reset of anomalies in progress.
ST.008	Warnings.
ST.009	Unloads.
ST.011	Alarms.
ST.012	Not recognized warnings.
ST.013	Not recognized unloads.
ST.015	Not recognized alarms.
ST.016	Grid present (voltages/frequency).
ST.017	Grid absent or out of thresholds.
ST.018	Delay for grid in thresholds.
ST.019	Grid in thresholds.
ST.020	Delay for grid absent or out of thresholds.
ST.048	Load busbars live (voltages).
ST.049	Generators bus-bars live (voltages).
ST.052	Grid fault protections activated (grid absent).
ST.053	Protection 27 activated (U<<, 1° threshold).
ST.054	Protection 59 activated (U>>, 1° threshold).
ST.055	Protection 81< activated (f<<, 1° threshold).

Status	Description
ST.056	Protection 81> activated (f>>, 1° threshold).
ST.057	Protection ROCOF activated.
ST.058	Protection VECTOR JUMP activated.
ST.059	Protection 27 activated (U<, 2° threshold).
ST.060	Protection 59 activated (U>, 2° threshold).
ST.061	Protection 81< activated (f<, 2° threshold).
ST.062	Protection 81> activated (f>, 2° threshold).
ST.064	GCB status.
ST.065	MCB status.
ST.066	MGCB status.
ST.068	MGCB closure command (stable).
ST.069	MCB closure command (stable).
ST.070	MGCB minimum voltage coil.
ST.071	MGCB opening pulse.
ST.072	MGCB closure pulse.
ST.073	MCB minimum voltage coil.
ST.074	MCB opening pulse.
ST.075	MCB closure pulse.
ST.080	Start inhibited by contact.
ST.081	Start inhibited by clock/calendar.
ST.083	Start inhibited because it is not possible to supply without grid and grid is absent.
ST.084	Start inhibited because another genset has the GCB not opened.
ST.088	GCB closure inhibited by contact.
ST.089	GCB closure inhibited because it is not possible to supply without grid and grid is absent.
ST.090	GCB closure inhibited by serial port.
ST.091	GCB closure inhibited because another genset has the GCB not opened.
ST.092	MGCB closure inhibited because MCB parallel failure.
ST.093	MGCB closure inhibited because no gensets available.
ST.094	MGCB closure inhibited by TEST without load.
ST.095	GCB closure inhibited by reverse synchronization.
ST.096	Ready to supply.
ST.097	MCB synchronization in progress.
ST.098	MGCB synchronization in progress.
ST.099	Synchronized.
ST.100	Ramp up in progress.
ST.101	Ramp down in progress.
ST.102	Supplying in parallel with grid.
ST.104	Supplying.
ST.108	Emergency plant.
ST.109	Parallel to grid plant.
ST.112	Synchronism per second.
ST.113	Synchronism per minute.
ST.114	Synchronism per hour.
ST.127	Daylight Save Time.
ST.128	Generators automatic start requested.
ST.129	Generators automatic start requested for MCB closing failure.
ST.130	Generators automatic start requested by "peak shaving".
ST.136	Generators stop requested for no automatic start request.
ST.137	Generators stop requested for unloading.
ST.138	Generators stop request for alarms.
ST.139	Manual stop request.
ST.140	Stop request for island mode inhibit.

Status	Description
ST.141	Stop request for some GCBs "not open".
ST.144	GCB closed on genset 01.
ST.145	GCB closed on genset 02.
ST.146	GCB closed on genset 03.
ST.147	GCB closed on genset 04.
ST.148	GCB closed on genset 05.
ST.149	GCB closed on genset 06.
ST.150	GCB closed on genset 07.
ST.151	GCB closed on genset 08.
ST.152	GCB closed on genset 09.
ST.153	GCB closed on genset 10.
ST.154	GCB closed on genset 11.
ST.155	GCB closed on genset 12.
ST.156	GCB closed on genset 13.
ST.157	GCB closed on genset 14.
ST.158	GCB closed on genset 15.
ST.159	GCB closed on genset 16.
ST.160	GCB closed on genset 17.
ST.161	GCB closed on genset 18.
ST.162	GCB closed on genset 19.
ST.163	GCB closed on genset 20.
ST.164	GCB closed on genset 21.
ST.165	GCB closed on genset 22.
ST.166	GCB closed on genset 23.
ST.167	GCB closed on genset 24.
ST.168	GCB closed on genset 25.
ST.169	GCB closed on genset 26.
ST.170	GCB closed on genset 27.
ST.171	GCB closed on genset 28.
ST.172	GCB closed on genset 29.
ST.173	GCB closed on genset 30.
ST.174	GCB closed on genset 31.
ST.175	GCB closed on genset 32.
ST.192	Unloading on genset 01.
ST.193	Unloading on genset 02.
ST.194	Unloading on genset 03.
ST.195	Unloading on genset 04.
ST.196	Unloading on genset 05.
ST.197	Unloading on genset 06.
ST.198	Unloading on genset 07.
ST.199	Unloading on genset 08.
ST.200	Unloading on genset 09.
ST.201	Unloading on genset 10.
ST.202	Unloading on genset 11.
ST.203	Unloading on genset 12.
ST.204	Unloading on genset 13.
ST.205	Unloading on genset 14.
ST.206	Unloading on genset 15.
ST.207	Unloading on genset 16.
ST.208	Unloading on genset 17.
ST.209	Unloading on genset 18.
ST.210	Unloading on genset 19.

Status	Description
ST.211	Unloading on genset 20.
ST.212	Unloading on genset 21.
ST.213	Unloading on genset 22.
ST.214	Unloading on genset 23.
ST.215	Unloading on genset 24.
ST.216	Unloading on genset 25.
ST.217	Unloading on genset 26.
ST.218	Unloading on genset 27.
ST.219	Unloading on genset 28.
ST.220	Unloading on genset 29.
ST.221	Unloading on genset 30.
ST.222	Unloading on genset 31.
ST.223	Unloading on genset 32.
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.
ST.240	Genset 01 available.
ST.241	Genset 02 available.
ST.242	Genset 03 available.
ST.243	Genset 04 available.
ST.244	Genset 05 available.
ST.245	Genset 06 available.
ST.246	Genset 07 available.
ST.247	Genset 08 available.
ST.248	Genset 09 available.
ST.249	Genset 10 available.
ST.250	Genset 11 available.
ST.251	Genset 12 available.
ST.252	Genset 13 available.
ST.253	Genset 14 available.
ST.254	Genset 15 available.
ST.255	Genset 16 available.
ST.256	Genset 17 available.
ST.257	Genset 18 available.
ST.258	Genset 19 available.
ST.259	Genset 20 available.
ST.260	Genset 21 available.
ST.261	Genset 22 available.
ST.262	Genset 23 available.

Status	Description
ST.263	Genset 24 available.
ST.264	Genset 25 available.
ST.265	Genset 26 available.
ST.266	Genset 27 available.
ST.267	Genset 28 available.
ST.268	Genset 29 available.
ST.269	Genset 30 available.
ST.270	Genset 31 available.
ST.271	Genset 32 available.
ST.272	CAN 0 BUS-OFF.
ST.273	CAN 0 ERR-PASSIVE.
ST.274	CAN 0 ERR-ACTIVE.
ST.275	No communication on CAN 0.
ST.276	CAN 1 BUS-OFF.
ST.277	CAN 1 ERR-PASSIVE.
ST.278	CAN 1 ERR-ACTIVE.
ST.279	No communication on CAN 1.
ST.288	Timer 1.
ST.289	Timer 2.
ST.290	Timer 3.
ST.291	Timer 4.
ST.304	START key pressed.
ST.305	STOP key pressed.
ST.306	MGCB key pressed.
ST.307	MCB key pressed.
ST.308	MODE_UP button pressed.
ST.309	MODE_DOWN button pressed.
ST.310	UP button pressed.
ST.311	DOWN key pressed.
ST.312	LEFT key pressed.
ST.313	RIGHT key pressed.
ST.314	ENTER key pressed.
ST.315	EXIT button pressed.
ST.316	SHIFT key pressed.
ST.317	ACK button pressed.
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.367	Enable protections 27 for low grid voltage
ST.998	Always ON.
ST.999	Always OFF.

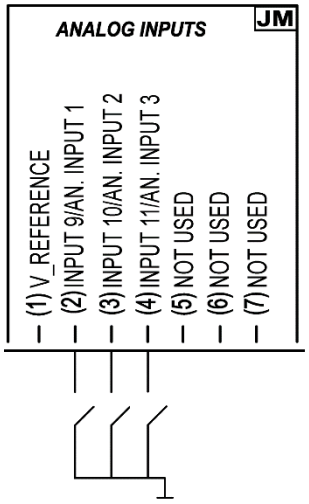
Using the virtual digital inputs, it is possible to create mixed AND/OR logics (composed by AND/OR together). Let us suppose we want to activate the digital output #1 when the digital inputs #1 and #2 are active, or if the digital input #3 is active.

Fist, we must associate to the virtual digital input #1 e.g. an AND/OR logic configured as AND, which checks that the first two inputs are both active. Then we must associate to the digital output #1 an AND/OR logic configured as OR, which checks that the virtual digital input #1, or the digital input #3 are active. We should use the virtual digital input #1 as “support” for the AND condition. In this case, it is not necessary to associate any function to the virtual digital input.

5.6 Analogue inputs 1-3 (JM)

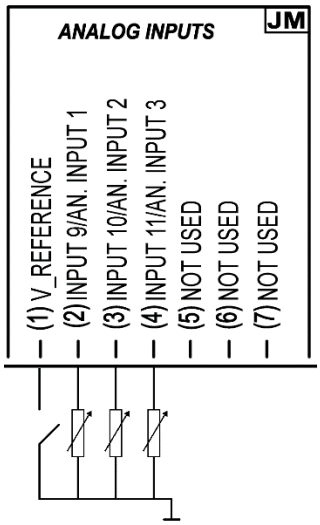
The controller is equipped by three resistive analogue inputs available on terminal **JM**.

All these inputs can also be configured individually as digital inputs (function AIF.0100 in parameter P.4001 or equivalent). In this case, the analogue inputs from 1 to 3 will be additional digital inputs from 9 to 11. The status of the virtual inputs is displayed at page S.11 (0=output not active, 1=output active). The inputs not configured as digital will be displayed with a dash. If set as digital (function AIF.0100 in parameter P.4001 or equivalent), the inputs are considered active when the measured voltage is higher than 4.0Vdc; they are considered not active when the measured voltage is lower than 3.5Vdc. They cannot therefore be activated as the other inputs by connecting it to the mass:



It is also possible to use a DIVIT expansion module and two DIGRIN or DITHERM optional expansion modules, connected via CAN bus to acquire further 4 signals of voltage/current and up to 6 temperatures.

5.6.1 JM - Analogue inputs 1-3



The controller is equipped with three inputs designed for the connection to resistive-type sensors JM-2, JM-3, JM-4. There is also an input for the measurement of their common ground potential JM-1. The three values of the voltage measured on terminals, and their related value of sensors resistance, are displayed on page S.15.

The default functions of the outputs are:

Terminal	Analogue input	Default function
JM-2	Analogue input 1	**AIF.0000 - "Not used".**
JM-3	Analogue input 2	**AIF.0000 - "Not used".**
JM-4	Analogue input 3	**AIF.0000 - "Not used".**

5.6.2 Configuration of digital inputs (AI_CONTROLLER)

The analogue inputs can be used for the acquisition of several predefined values or to acquire generic sensors (therefore user-adjustable). Some values can be only acquired by some inputs (see following chat in this paragraph).

It is possible to apply to all physical analogue inputs (JM e DIVIT) a conversion curve (not to the virtual analogue inputs and to DIGRIN and DITHERM).

To each analogue input (JM, DIGRIN, DITHERM, DIVIT and virtual) a set of 8 parameters is associated, to define the function type, an alternative denomination and a series of generic thresholds and configurations usable for different functions. Following are listed, as examples, those relative to the JM-2 input. For parameters of other inputs, refer to document [1] or to configuration page I/O of BoardPrg3.

NOTE: On BoardPrg3 the parameters are all displayed only when the input is configured as analogue, and not as digital. The analogue inputs of the expansion modules are only displayed if the module is configured.

You will have:

- One parameter which configures its function (P.4001 for input JM-2).
- A parameter that configures a message to show on display (P.4002 for the input JM-2).
- Two thresholds consisting of three parameters each:
  - A parameter which configures the threshold value (P.4003 and P.4006 for input JM-2).
  - A parameter which configures the delay to manage the "out of threshold" (P.4004 and P.4007 for input JM-2).
  - A parameter which configures the checking options and the actions in case of "out of threshold" (P.4005 e P.4008 for the input JM-2).

The parameter which contains a message for a given analogue input (in the example parameter P.4002), the controller displays it each time the thresholds are used to activate alarms and/or warnings (see after). It is also used for the following functions of the analogue inputs AIF.2001, AIF.2003 e AIF.2005. In this case, the measurement acquired will be displayed on pages M.14, M.15 and M.16, preceded by the configured message. **NOTE: it is also possible to use function AIF.2051 instead of the three preceding ones. In this case, the measurement acquired will be not displayed; it can be used with the thresholds to manage digital outputs and activate warnings/alarms.**

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

- Bit 0. If this bit is "OFF", the controller checks if the measurement is higher than the threshold. If this bit is "ON", the controller checks if the measurement is lower than the threshold.
- Bit 1. If this bit is "OFF", the controller sets to OFF the internal status related to this analogue measurement, if the measurement is out of threshold. If this bit is "ON", the controller sets to ON the internal status related to this analogue measurement, if the measurement is out of threshold.
- Bit 3. If this bit is "ON", the controller transmits the anomaly to generators also.
- Bit 4. If this bit is "ON", the controller activates a warning if the measurements is out of threshold.
- Bit 5. If this bit is "ON", the controller commands an unload if the measurements is out of threshold.
- Bit 7. If this bit is "ON", the controller activates an alarm if the measurements is out of threshold.

- Bit 8. If this bit is “ON”, the controller checks that MCB is closed to activate eventual warnings/alarms configured with the preceding bits.
- Bit 9. If this bit is “ON”, the controller checks that MGCB is closed to activate eventual warnings/alarms configured with the preceding bits.
- Bit 13. If this bit is “ON”, to activate eventual warnings/alarms configured with the preceding bits, the controller checks the status of eventual digital inputs configured with function “DIF.2705 – Disable the protections on analogue measurements”. The warnings/alarms will be activated if no digital input is configured like that, or if they are all OFF.
- Bit 15. If this bit is “ON”, the anomaly is subject to override of the protections.

It is possible to set any combination of these bits.

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. See the example in the next chapter for the virtual analogue inputs.

The following chart shows the list of functions matchable with the analogue inputs of the controller.

Analogue Input function.	Name	Message	Thresholds	Controller (JM)	DIVIT	DIGRIN / DITHERM
AIF.0000	Not used.			X	X	X
AIF.0100	Used as digital input.			X		
AIF.2001	Generic sensor (page 1).	X	X	X	X	X
AIF.2003	Generic sensor (page 2).	X	X	X	X	X
AIF.2005	Generic sensor (page 3).	X	X	X	X	X
AIF.2051	Generic sensor.	X	X	X	X	X
AIF.2101	Speed offset.			X	X	
AIF.2201	Voltage offset.			X	X	
AIF.2103	External synchronizer.			X	X	
AIF.2105	External MCB synchronizer.			X	X	
AIF.2107	External MGCB synchronizer.			X	X	
AIF.2303	Power on the grid.			X	X	
AIF.2307	Setpoint for system BASE LOAD.			X	X	
AIF.2309	Setpoint for system IMPORT/EXPORT.			X	X	
AIF.2405	Setpoint for system power factor.			X	X	

All the AIF.XXXX odd functions require the use of program BoardPrg3 for the definition or the load of the characteristic curve of the sensor (see par. 0). The measures acquired from DITHERM/DIGRIN modules that are already expressed in °C and do not need any conversion are exceptions.

5.6.3 Virtual digital inputs (AI_VIRTUAL)

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 warnings/alarms related to the internal available measurements.
- To activate digital outputs based on the value of the internal available measurements.

By assigning a value greater or equal to 4001 (AIF.4001) to the parameter “function” of the virtual analogue input, the controller “copies” the value of the measurement identified from the previous parameter in the virtual analogue input: on this measurement, it is then possible to manage the thresholds to activate digital outputs and anomalies.

The following chart shows the list of functions matchable with the analogue inputs of the controller.

Virtual Analogue Input function xx.	Name	Message	Thresholds
AIF.0000	Not used		
AIF.4001	Generators/bus frequency.	X	X
AIF.4006	Generators/bus voltage L1-L2.	X	X
AIF.4007	Generators/bus voltage L2-L3.	X	X
AIF.4008	Generators/bus voltage L3-L1.	X	X
AIF.4009	Generators/bus voltage L-L average.	X	X
AIF.4012	Grid frequency.	X	X
AIF.4017	Grid voltage L1-L2.	X	X
AIF.4018	Grid voltage L2-L3.	X	X
AIF.4019	Grid voltage L3-L1.	X	X
AIF.4020	Grid voltage L-L average.	X	X
AIF.4023	Current L1.	X	X
AIF.4024	Current L2.	X	X
AIF.4025	Current L3.	X	X
AIF.4026	Auxiliary current (or neutral current).	X	X
AIF.4031	Active power L1.	X	X
AIF.4032	Active power L2.	X	X
AIF.4033	Active power L3.	X	X
AIF.4034	Total active power.	X	X
AIF.4041	Total apparent power.	X	X
AIF.4047	Total reactive power.	X	X
AIF.4058	Total power factor (calculated from kW and kVA).	X	X
AIF.4059	Total cos(Φ) (calculated from kW and kvar).	X	X
AIF.4063	Generators/bus active energy (partial)	X	X
AIF.4065	Generators/bus reactive energy (partial)	X	X
AIF.4069	Grid active exported energy (partial)	X	X
AIF.4071	Grid reactive exported energy (partial)	X	X
AIF.4073	Grid active exported energy (partial).	X	X
AIF.4075	Active power on loads	X	X
AIF.4099	Grid active imported energy (partial)	X	X
AIF.4101	Grid reactive imported energy (partial)	X	X
AIF.4105	Battery voltage	X	X

It is not possible to use functions major than 4000 for the configuration of physical analogue inputs.

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 us assume to activate a digital output if the grid frequency goes over 50.5 Hz. It is first necessary to manage a minimum hysteresis on the threshold. Otherwise, when the grid frequency is next to the threshold, the output would keep on activating and deactivating for minimum variation of the frequency itself. Let us 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 grid frequency.

Let us set the parameters as follows:

- P.4051 (function #1): 4001 (AIF.4001).
- P.4052 (message #1): “”.
- P.4053 (threshold #1): 50.5 Hz
- P.4054 (delay #1): 0.5 sec
- P.4055 (configuration #1): 0002 (bit 1 OFF, bit 2 ON)
- P.4056 (threshold #2): 50.3 Hz
- P.4057 (delay #2): 0.5 sec
- P.4058 (configuration #2): 0001 (bit 1 ON, bit 2 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 (checks that the measurement is higher than the threshold).
- Bit 1 ON (activates the internal status in “out of Threshold” condition).

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 (checks that the measurement is lower than the threshold).
- Bit 1 OFF (deactivates the internal status in “out of Threshold” condition).

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 par. 5.5.5), it is possible to “copy” the internal status on a physical output.

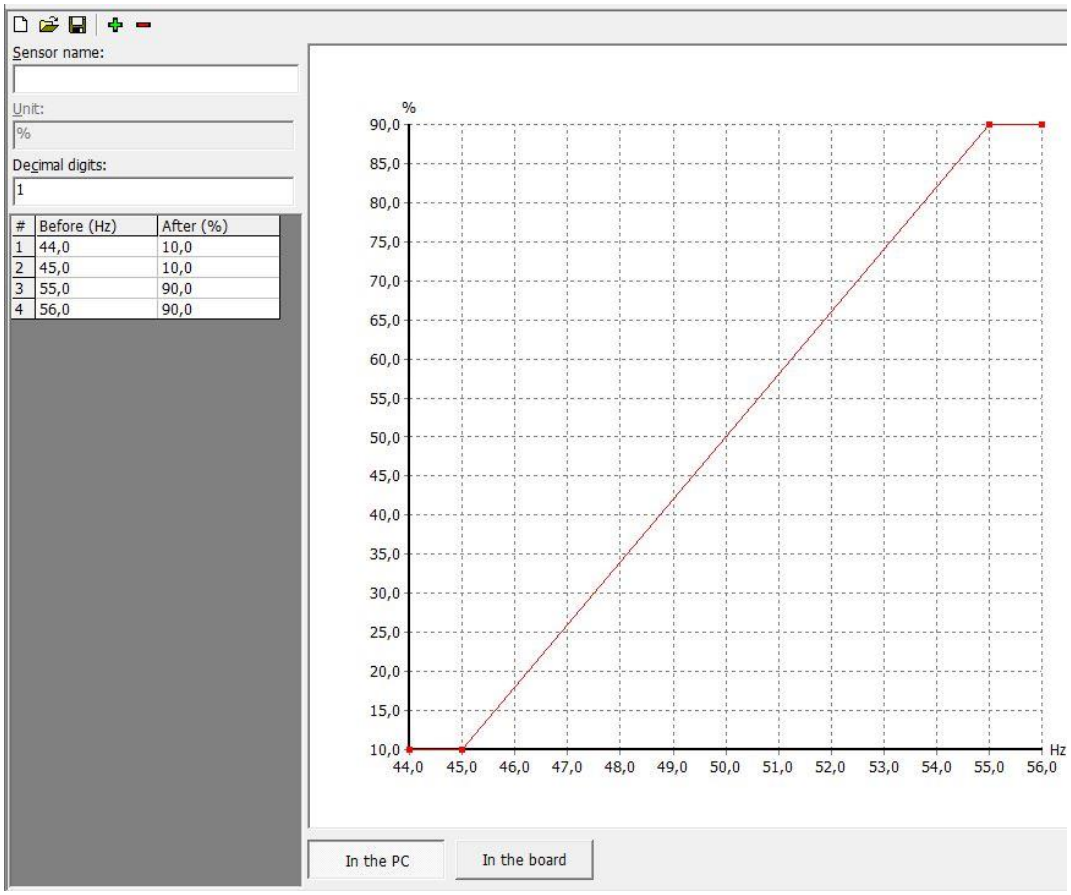
5.6.4 Conversion curves

The conversion curves are a tool which allows to convert a numeric value in another numeric value. They can be used for analogue inputs and for the analogue outputs, for two purposes:

- To convert the acquired value from an analogue input (physical) which is on the controller or on the optional expansion modules from electric value to real unit of measure of the sensor.
- To convert an internal measurement of the controller to a percentage value before writing it on an analogue output.

Note: the configuration of the AND/OR logics cannot be carried out directly from the controller display, but it must be carried out by PC with the BoardPrg3 software.

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



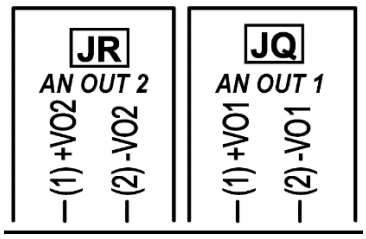
The figure above shows a conversion curve associated to an analogue output. The analogue output has been configured with function AOF.3101 (“Frequency of the generators/bus”). With this configuration, the output will be 10% for a generator’s frequency lower than or equal to 45 Hz, 90% for a frequency 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. Note, in the example, that 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 it allows you to set a saturation limit on one end or on both ends of the curve. In fact, the controller extends to infinity the first and 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 remove 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%.

The BoardPrg3 software allows you (by means of the first buttons on top left) to save the curve on file to be able to use it again in other applications. It is therefore possible to make an archive of the conversions associated to the sensors used.

In case the curve is associated to a physical analogue input configured with functions AIF.2001, AIF.2003 e AIF.2005 (“generic sensor”), the measurement converted will be displayed on pages M.14, M.15 and M.16: in this case, it is also possible to specify (through the conversion curve) how many decimal digits the displayed value and its unit of measure must have.

5.7 Analogue outputs (JQ, JR)



On GC400x only, there are two ANALOGUE outputs to allow the interface with the majority if the devices that need a current or voltage as input signal. To define the function of these outputs there are two parameters available, P.6001 for the output JQ and P.6002 for the output JR. To know which from the functions available to assign to parameters.

The outputs are galvanically insulated, so both outputs terminals must be used. The total variation goes from -10Vdc to +10Vdc. If it is necessary to reduce the variation, you need to add some specific conversion curves to the output's configuration (see par. 5.6.4); if the outputs are configured with the functions AOF.1000 and AOF.1002, it is possible to use the controller parameters (without conversion curves) to reduce the output variation:

- AOF.1000 Function: use parameters P.0856 and P.0857.
- AOF.1002 Function: use parameters P.0862 and P.0863.

The following description refers to P.0856 and P.0857, but the explanation is valid for P.0862 and P.0863 too. To delimit the output from 0Vdc to 10Vdc:

- P.0856 = 50%
- P.0857 = 100%

To delimit the output from 0Vdc to 5Vdc:

- P.0856 = 50%
- P.0857 = 75%

To delimit the output from -2Vdc to +2Vdc:

- P.0856 = 40%
- P.0857 = 60%

The minimum load impedance is 10 kOhm.

The default functions of the outputs on the controller are:

Terminal	Digital output	Type of output	Default function
JQ-1	01	**VO1+:** Analogue signal in voltage with positive polarity.	**AOF.1000 – "Not used".**
JQ-2		**VO1-:** Analogue signal in voltage with negative polarity.	
JR-1	02	**VO2+:** Analogue signal in voltage with positive polarity.	**AOF.1000 – "Not used".**
JR-2		**VO2-:** Analogue signal in voltage with negative polarity.	

5.7.1 Configuration of the analogue outputs

Each analogue output (the two of MC400 controller and the four of the DANOUT module) are all completely configurable. To each output a parameter is associated (e.g. P.6001 for output 1), which configure the function (see doc.[1]).

To all analogue outputs, it is possible to apply a conversion curve.

The following functions, not linked to the operation sequences of the controller, are selectable for any digital output:

- AOF.0102 - “Managed by serial ports”. The controller does not command the output with own internal logics, but with the commands received by means of the serial ports.

The following chart shows the list of functions matchable with the analogue outputs:

Analogue output function	Name
AOF.0000	Not used.
AOF.0102	Managed by serial ports.
AOF.1000	Speed governor.
AOF.1001	Speed governor (with curve).
AOF.1002	Voltage regulator.
AOF.1003	Voltage regulator (with curve).
AOF.3101	Frequency of the generators/bus.
AOF.3111	Voltage of the generators/bus.
AOF.3121	Active power of the generators/bus.
AOF.3201	Frequency of the grid.
AOF.3211	Voltage of the grid.
AOF.3221	Active power of the grid.

When functions AOF.3101 and following are used, you must configure the proportion between the selected measure (voltage, frequency, etc.) and the % value by means of the conversion curves (see par. 5.6.4).

5.8 Optional additional modules

Using the connection CAN bus-0 EXBUS (JM) it is possible to connect the following optional additional modules to the controller:

- 2 DITHERM/DIGRIN modules:
    - DITHERM: 3 galvanically insulated thermocouples for the temperature measurement.
    - DIGRIN: 3 galvanically insulated Pt100 sensors for the temperature measurement.
- 1 DIVIT modules: 4 galvanically insulated analogue inputs 0...5V/0...10V – 0...10mA/0...20mA
- 1 DANOUT modules: 4 galvanically insulated analogue outputs 0...5V/0...10V – 0...10mA/0...20mA
- 2 DITEL 16IN modules: 16 digital inputs opto-insulated (total 32 inputs). To each DITEL 16IN module it is possible to connect 2 DITEL modules 8 OUT relays for a total of 32 digital outputs. It is not possible to use the output modules without their relative input module.

For configurations to do on the modules, refer to the relative user manuals.

Below we use the name DITEMP to refer to a temperature measurement module (DITHERM or DIGRIN).

To use the modules on it is necessary to set the number of modules which are with the parameters.

- P.0141: number of modules DITEL 16 IN (with eventual modules OUT) (max. 2).
- P.0142 the number of DITEMP modules (i.e. DITHERM or DIGRIN) (maximum 2).
- P.0143: the number of DIVIT modules (maximum 1).
- P.0144: the number of DANOUT modules (maximum 1).

Once configured the presence of the modules, they look like digital or analogue inputs or outputs and are managed as those present on the controller.

For the relative parameters see doc [1].

In program BoardPrg3, once the presence of a module is configured, it appears on menu I/O in the left column, with single inputs/outputs ready to be configured.

It is necessary, though, to clarify about DIVIT modules. They can measure any value: it is necessary to convert the measure done (Volt or mA) to the real unit of measure of the acquired value. Such a conversion can be done directly in the module (DIVIT), or on the MC400. Ensure you do not have a double conversion.

It is suggested to:

- Configure the module DIVIT to transmit a percentage value. In the example below, a channel configured to acquire a signal 0-10 mA, will transmit “0” at 0 mA and “100” at 10 mA.

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

- On the MC400, use a conversion curve to convert from a % value to the real unit of measure.

5.9 JG/JH – Grid/ generators bus voltage measure inputs

The connection to the public grid happens though the **JH** connector of the controller. The connection to the generators bus happens though the **JG** connector of the controller.

The controller uses phase L1 (terminals JG-3/JH-3) to measure the frequency.

For CAT.IV use, the maximum working voltage is 300Vac (phase-neutral) and 520Vac (phase to phase). The maximum voltage compared to the protection earth is 300Vac.

If working voltages are greater than these values, step-down transformer must be used to respect the specified limits. The nominal voltages on the primary and secondary of the VT are configurable with parameters P.0117 and P.0118 for the grid and parameters P.0103 and P.0104 for the generator's bus. It is suggested to use voltage transformers having a nominal voltage of 400V on the secondary (this solution can preserve the best available measurement precision of the board).

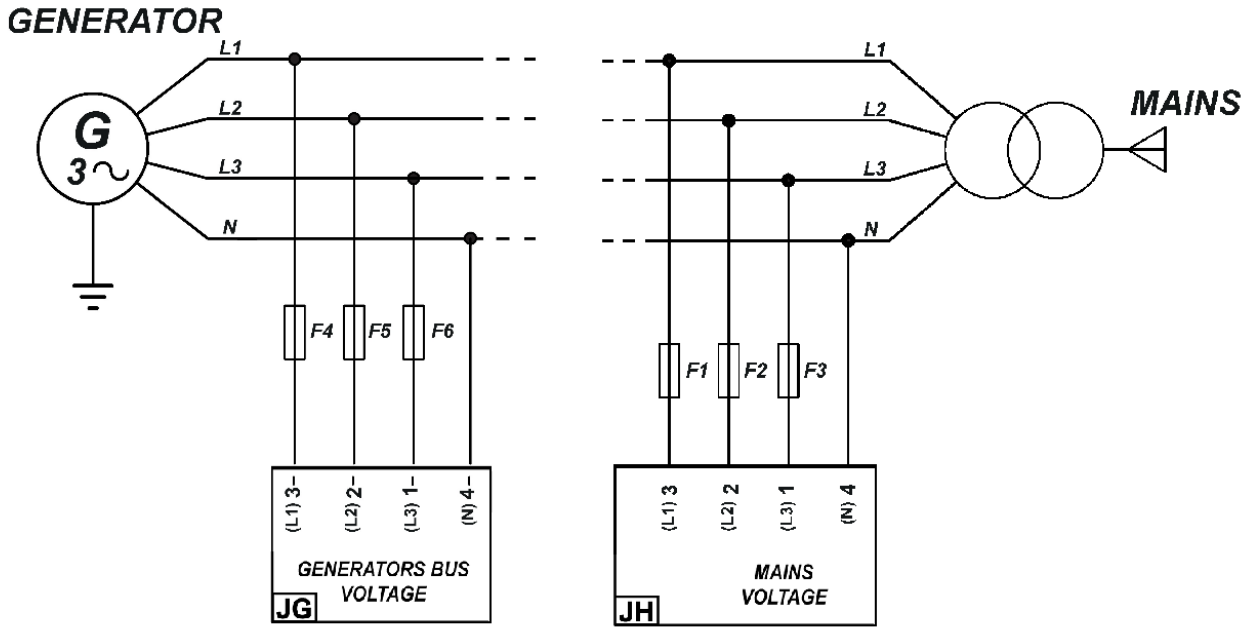
In alternative, it is possible to use VT, with secondary sides of 100V. In this case, it is necessary to configure parameter P.0152 (for the grid) and P.0151 (for the generators bus) for the operation at 100V.

It is also possible to use the Aron insertion of the VTs, which uses only two transformers, instead of three (see par. 5.9.5). In this case, it is necessary not to use the neutral connection.

Attention! Do not connect JG/JH measurement input to TA with 400V secondary sides or directly to the voltage 400V when the controller is configured to read at 100V nominal voltage (parameters P0.152/P.0151 set to 1). The controller could be damaged.

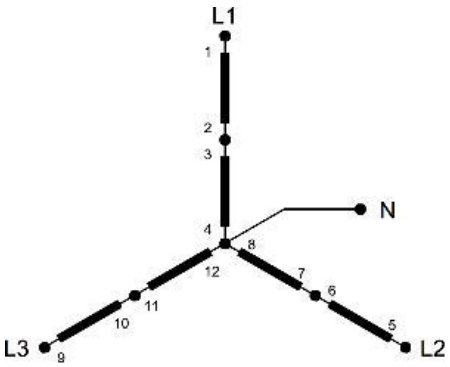
The following chapters show all the possible wirings for the alternator. In the example, it is supposed that each internal winding provides **115 Vac**. The possible connections are:

5.9.1 Star or Wye (three phases, four wires)



This kind of wiring assumes the presence of the Neutral line. If the alternator is Wye-wired but the neutral line is not distributed, leave terminal JH-4 / JG-4 unconnected: the controller internally creates a virtual Neutral point; in this case, if the L-N voltage measures are not required, set P.0101 or P.0119 to "4-Three-phase without neutral".

5.9.1.1 High Wye



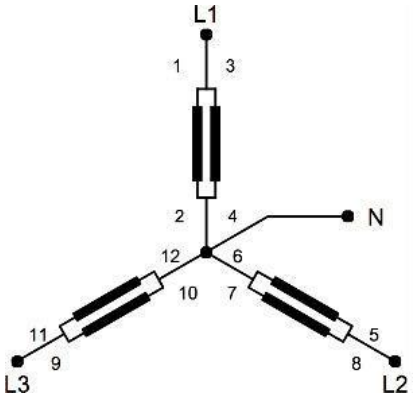
Parameters:

Grid	Generators bus	Value	Description
P.0119	P.0101	3-Three-phase with neutral	Voltages wiring
P.0116	P.0102	400	Nominal voltage (L-L) $(115 \times 2) \times \sqrt[2]{3}$

Available voltage measures:

Measure	Nominal value	Page for grid	Page for generators bus
L1-L2	400	M.02	M.04
L2-L3	400	M.02	M.04
L3-L1	400	M.02	M.04
L1-N	230	M.03	M.05
L2-N	230	M.03	M.05
L3-N	230	M.03	M.05
N-GND	-	M.03	M.05

5.9.1.2 Low Wye



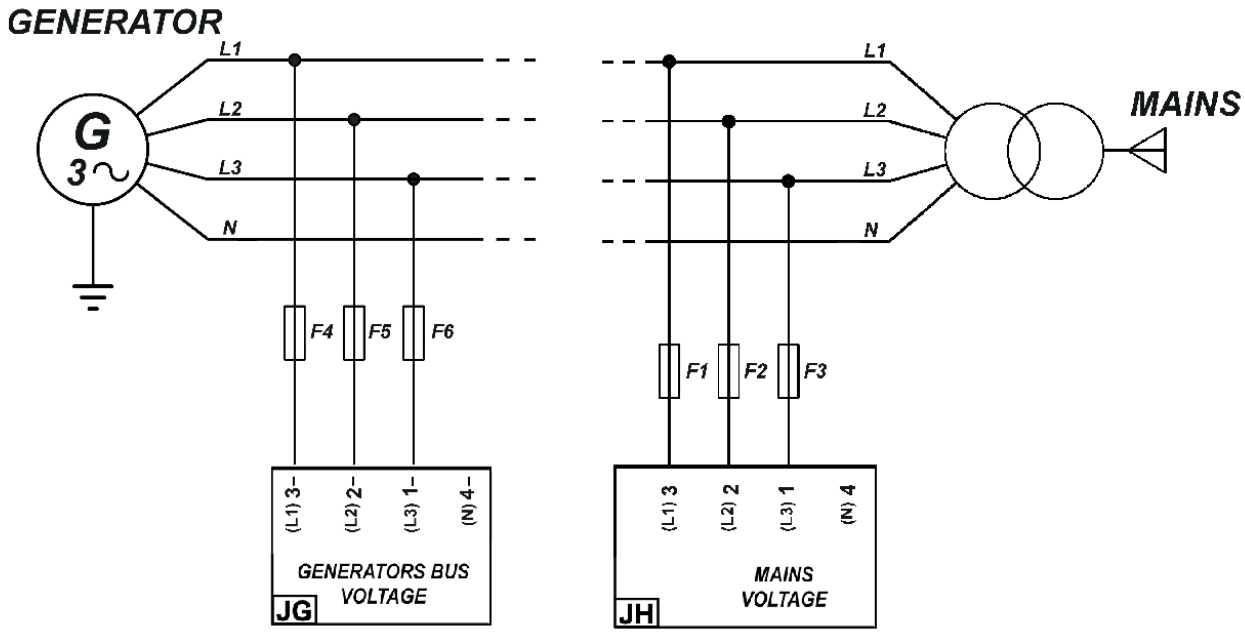
Parameters:

Grid	Generators bus	Value	Description
P.0119	P.0101	3-Three-phase with neutral	Voltages wiring
P.0116	P.0102	200	Nominal voltage (L-L) $115 \times \sqrt[2]{3}$

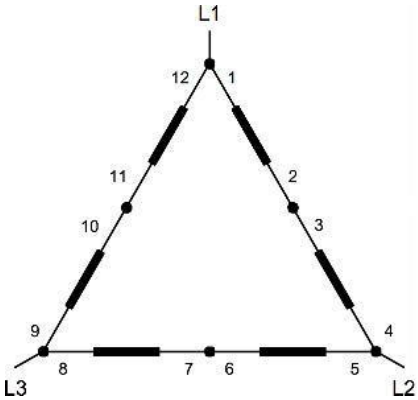
Available voltage measures:

Measure	Nominal value	Page for grid	Page for generators bus
L1-L2	400	M.02	M.04
L2-L3	400	M.02	M.04
L3-L1	400	M.02	M.04
L1-N	230	M.03	M.05
L2-N	230	M.03	M.05
L3-N	230	M.03	M.05
N-GND	-	M.03	M.05

5.9.2 Delta (three phases, three wires)



5.9.2.1 High Delta



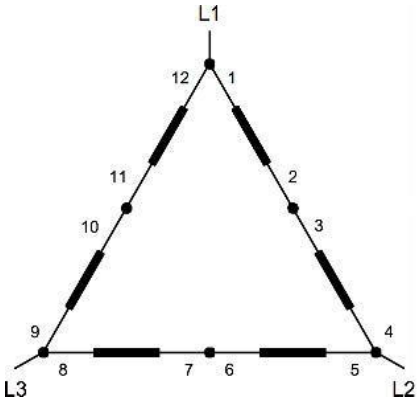
Parameters:

Grid	Generators bus	Value	Description
P.0119	P.0101	4-Three-phase without neutral	Voltages wiring
P.0116	P.0102	400	Nominal voltage (L-L) $(115 \times 2) \times \sqrt[2]{3}$

Available voltage measures:

Measure	Nominal value	Page for grid	Page for generators bus
L1-L2	400	M.02	M.04
L2-L3	400	M.02	M.04
L3-L1	400	M.02	M.04

5.9.2.2 Low Delta



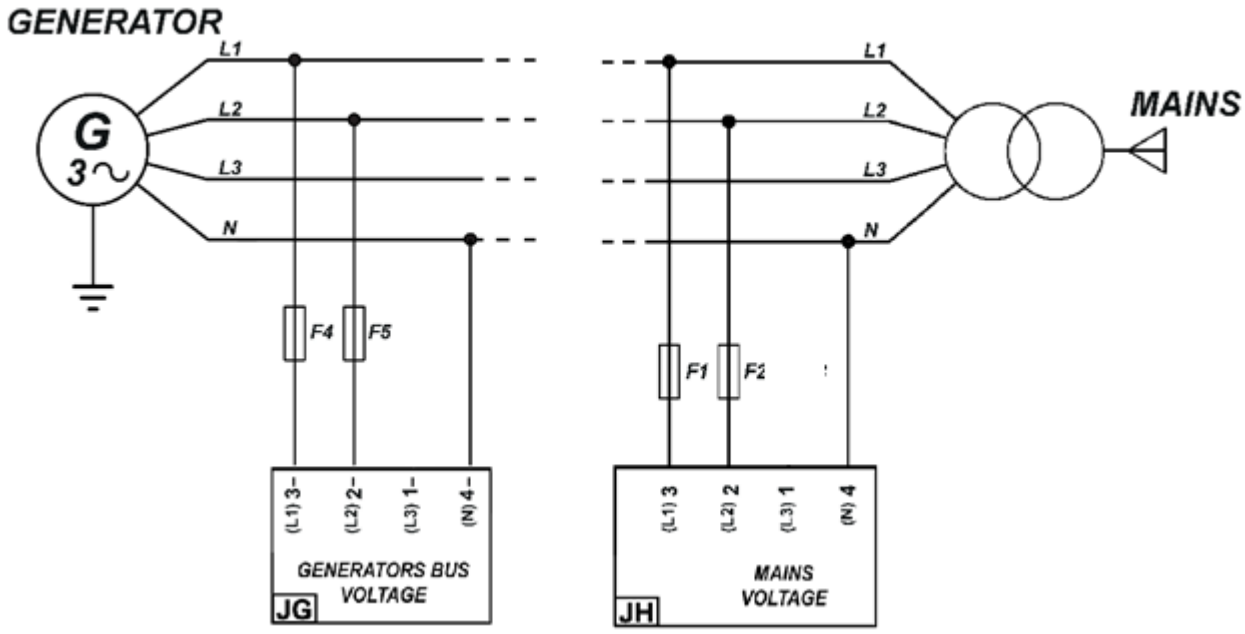
Parameters:

Grid	Generators bus	Value	Description
P.0119	P.0101	4-Three-phase without neutral	Voltages wiring
P.0116	P.0102	200	Nominal voltage (L-L) $115 \times \sqrt[2]{3}$

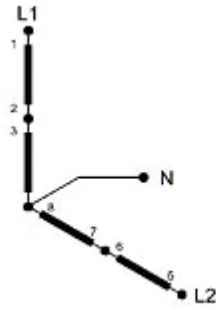
Available voltage measures:

Measure	Nominal value	Page for grid	Page for generators bus
L1-L2	200	M.02	M.04
L2-L3	200	M.02	M.04
L3-L1	200	M.02	M.04

5.9.3 Dual phases (two phases, three wires)



5.9.3.1 High Dual Phases



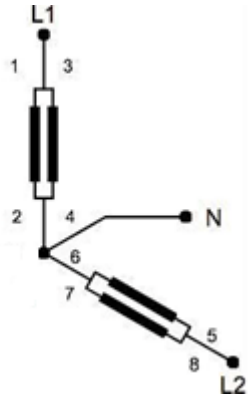
Parameters:

Grid	Generators bus	Value	Description
P.0119	P.0101	2-Two phases with neutral	Voltages wiring
P.0116	P.0102	230	Nominal voltage (L-N) 115 × 2

Available voltage measures:

Measure	Nominal value	Page for grid	Page for generators bus
L1-L2	400	M.02	M.04
L1-N	230	M.02	M.04
L2-N	230	M.02	M.04
N-GND	-	M.02	M.04

5.9.3.2 Low Dual Phase



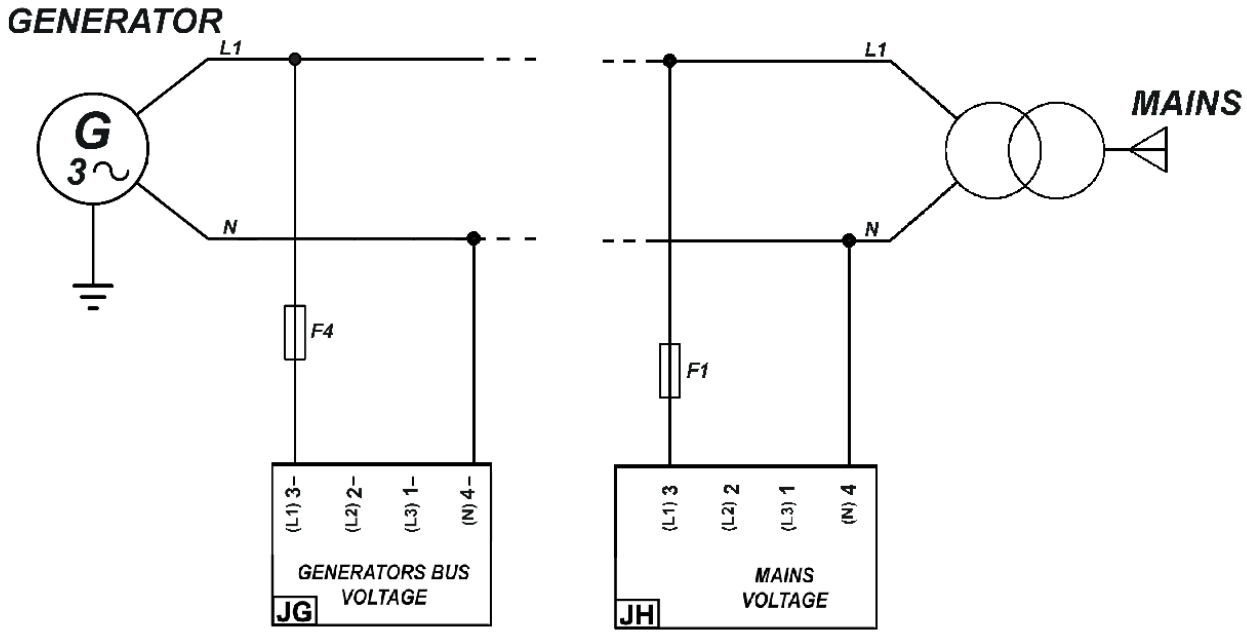
Parameters:

Grid	Generators bus	Value	Description
P.0119	P.0101	2-Two phases with neutral	Voltages wiring
P.0116	P.0102	115	Nominal voltage (L-N) 115

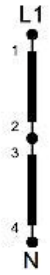
Available voltage measures:

Measure	Nominal value	Page for grid	Page for generators bus
L1-L2	400	M.02	M.04
L1-N	230	M.02	M.04
L2-N	230	M.02	M.04
N-GND	-	M.02	M.04

5.9.4 Single phase (one phase, two wires)



5.9.4.1 High Single Phase



Parameters:

Grid	Generators bus	Value	Description
P.0119	P.0101	1-Single phase	Voltages wiring
P.0116	P.0102	230	Nominal voltage (L-N) 115 × 2

Available voltage measures:

Measure	Nominal value	Page for grid	Page for generators bus
L1-N	230	M.02	M.04
N-GND	-	M.02	M.04

5.9.4.2 Low Single Phase

Parameters:

Grid	Generators bus	Value	Description
P.0119	P.0101	1-Single phase	Voltages wiring
P.0116	P.0102	115	Nominal voltage (L-N) 115

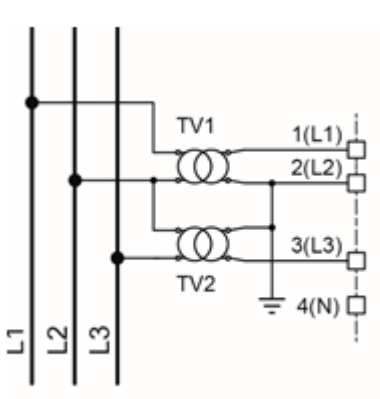
Available voltage measures:

Measure	Nominal value	Page for grid	Page for generators bus
L1-N	115	M.02	M.04
N-GND	-	M.02	M.04

5.9.5 Aron insertion of volt-metric transformers

Both for the generator's bus and for the grid voltage measurement inputs, it is possible to use the Aron insertion of the volt-metric transformers; this allows to use two transformers instead of three. The connection is possible both with the measurement inputs set to 100Vac and with 400Vac nominal voltage.

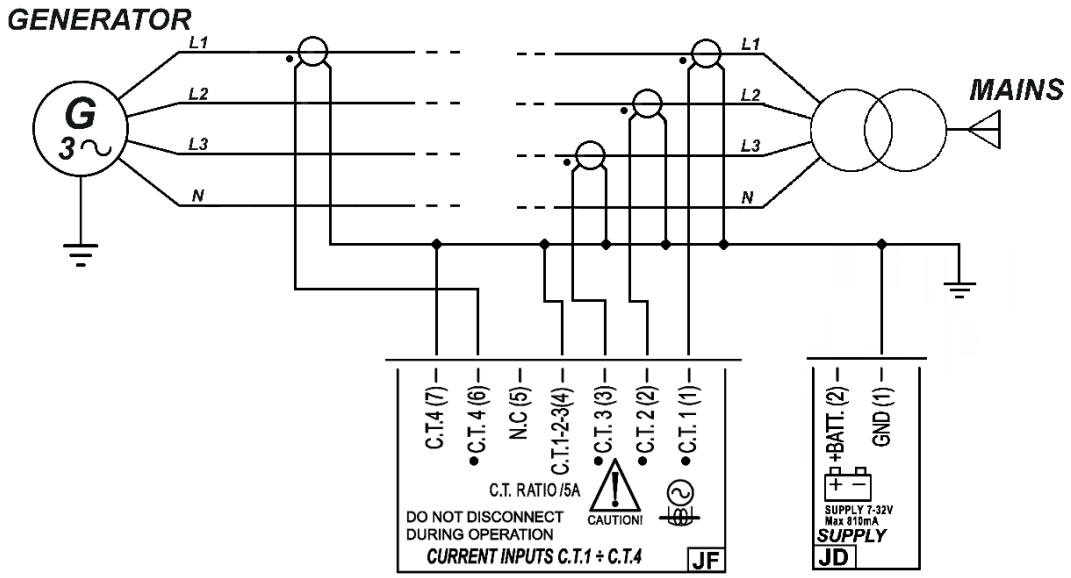
The diagram of the Aron connection is the following:



The diagram is the same both for the generator's bus and for the grid; it is necessary to select the Delta connection mode (see above).

5.10 JF Current measurement inputs.

The currents measurement must be carried out exclusively by external current transformers (CTs) with an appropriate isolation level: a REINFORCED (DOUBLE) insulation for the use of the controller in Overvoltage Category IV.



5.10.1 JF - Currents measurement inputs 1-3

The current measurement must happen by means of external current transformers (CTs). **Do not connect voltage conductors to JF.**

Currents transformers having a nominal current of approximately 5 Aac on the secondary side are the solution that preserves the best available measurement precision of the controller board. Any current measurement needs a power of about 1VA; however, CTs of 5VA are recommended, to compensate for leaks along the connection cables.

The maximum current that the controller can measure directly is of 5.3Aac, beyond which the measurement circuit gets saturated. The controller board is still able to measure, but with gradually decreasing precision, down to about 15Aac **only for transient situations,** such as measuring overcurrent or short circuit currents on the system, using an algorithm to compensate for the saturation of the measurement circuits.

The CTs for the measurement of the three currents have only one terminal clip for the return current, i.e. the JF-4; the fourth auxiliary current has a return separated from the other three through the JF-7 terminal clip.

The measurement is carried out by internal shunt (20mΩ).

NOTE: the returns of all CTs (including the auxiliary JF-7) must also be connected to the negative power supply of the controller.

If the CTs should be connected to other devices in addition to the controller, it must be the last in the series. For acquiring the currents of the generator, the JD connector is used:

- Connect to terminal JF-1 one terminal of the phase L1 C.T.
- Connect to terminal JF-2 one terminal of the phase L2 C.T.
- Connect to terminal JF-3 one terminal of the phase L3 C.T.
- Connect to terminal JF-4 a common connection of the remaining terminals of C.T.s

Leave terminal JF-3 unconnected for dual-phase wirings. Leave terminal JF-2 unconnected for single/dual-phase wirings.

The P.0107 and P.0139 parameters are used for setting the current values of the CTs primary and secondary.

Normally, JF connector is used for the measurement of the currents (and the powers) on the interchange point with the grid; its use is however configurable by means parameter P.0124:

- 0: the CTs are located on the generator's bus.
- 1: the CTs are located on the load's lines.

- 2 (default): the CTs are located on the grid lines.

Parameters P.0107 and P.0139 allows to configure the transformation ratio of the external current transformers. For example, if we use 50/5 current transformers, set P.0107=50 and P.0139=5.

5.10.2 JF – Auxiliary currents measurement (fourth current)

The controller allows to acquire a fourth current measurement, usable e.g. for a power measurement. By default, the fourth measure is not used.

The parameters P.0108 and P.0135 define the currents of the CTs primary and secondary for the auxiliary current.

The controller is configured for the connection of a current transformer (C.T.) for the measure of the current: if it is required to use a toroid (instead of a C.T.) it is necessary to ask for the special option in phase of order (E6202111000XX).

5.10.2.1 Controller without option E620215011000

Parameter P.0109 must be set to "0 - CT".

The current measurement must happen only by means of external current transformers (CT). **Do not connect voltage conductors to JI.** The measurement is carried out by internal shunt (20mΩ).

To these terminals, external current transformers with 5Aac or 1Aac secondary can be connected.

The current measurement requires a power of about 1VA: however, 5VA CTs are suggested to compensate the losses along the connection cables.

The maximum current measurable directly from the controller is 5,3Aac. Over this threshold the measure circuit saturates. The controller can measure (with progressively decreasing precision) up to 15Aac though, e.g. to measure overcurrent or short circuit on the plant, using an algorithm of compensation of saturation of the circuits of measurement.

To acquire the current the connector JI is used:

- Connect to JI-1 terminal the hot pole of external CT.
- Connect to JI-2 terminal the cold pole of external CT.

Parameters P.0108 and P.0135 allows to configure the transformation ratio of the external current transformers. For example, if we use 50/5 current transformers, set P.0108=50 and P.0135=5.

5.10.2.2 Controller with option E620215011000

Parameter P.0109 must be set to "1 - Toroid".

The current measurement must happen only by means of an external toroid. **Do not connect voltage conductors to JI and JE.**

The maximum current measurable directly from the controller is 0,1Aac. Over this threshold the measure circuit saturates. Use one toroid with a transformation ratio which guarantees currents lower than this threshold on the secondary.

To acquire the current the connector JI is used:

- Connect to JI-1 terminal the hot pole of external toroid.
- Connect to JI-2 terminal the cold pole of external toroid.

Parameters P.0108 and P.0135 allows to configure the transformation ratio of the external toroid. For example, if we use 500/1 toroid, set P.0108=500 and P.0135=1.

The cold pole of the toroid (JI-2) must also be connected to the supply negative of the controller.

5.10.2.3 Use of the fourth current

Parameter P.0130 allows to tell the controller where is located the transformer which acquires this measurement.

- 0: the CT is located on the generator's bus.
- 1: the CT is located on the load's lines.
- 2 (default): the CT is located on the grid lines.

The most important parameter to be configured is parameter P.0131 though, that allows to establish which use of current measurement you want to do:

- P.0131 = 0 ("Not used") The controller disables the measurement of the fourth current, which will not be shown on display.
- P.0131 = 1 ("General purpose"). The controller displays the current measurement done on page M.04 with the lettering "Ax".
- P.0131 = 2 ("Neutral"). The controller displays the current measurement done on page M.04 identifying as "An". It also calculates and shows the differential current.
- P.0131 = 4 ("Power measure"). The controller interprets the measurement like the current circulating on L1 phase of the selected source (P.0130) and shows it on page M.04 with the lettering "Ax". The controller also calculates the active power (kW) circulating on L1 phase of the selected source. Finally, for three-phase systems, it multiplies the calculated power by three, assuming that the load is uniformly shared on the three phases. If it was not like this, 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 let it the closest to real. The calculated active power is shown on page M.01.

Settings 1 and 2 allow to establish a threshold on the auxiliary current (P.0367 e P.0368). It is possible to configure a digital input with function DIF.2704 - "Disable protections on fourth current". If the input is active, the thresholds, even if set, are ignored and do not activate anomalies in case of overpassing.

5.11 Communication ports

The controller is equipped with many communication ports for the connection to PC, modem, etc.

MC400 is provided with:

- One USB 2.0 serial port not insulated (Function mode) used to connect a PC for FW update and programming of controller parameters.
- One RS232 (JA) serial port with DB9 male connector usable for the interfacing with an external controller equipped with RS232 interface. The maximum length of the cable is 12 mt.
- One RS485 serial port (JO) with galvanic insulation; the maximum connection length in optimal conditions is 1200 mt. The 120ohm terminal resistor is integrated and can be inserted through S5 selector. The use of a shielded cable with 120ohm impedance is required (e.g. BELDEN 3105A Multi-conductor-EIA Industrial RS-485PLT/CM).
- One CAN bus port (JO) with galvanic insulation for the communication with additional optional modules (DITEL, DITHERM, DIGRIN e DIVIT). The 120ohm terminal resistor is integrated and can be inserted by a simple connection through the pins 4 and 5 of JO. The specific use of the shielded cable is required (e.g. HELUKABEL 800571).
- One CAN bus port (JP) with galvanic insulation for the communication with other devices for genset/grid/tie breaker control. The 120ohm terminal resistor is integrated and can be inserted by a simple connection through the pins 1 and 2 of JP. The specific use of the shielded cable is required (e.g. HELUKABEL 800571).
- One Ethernet port (JS) with RJ45 connector for 10/100 Mbps Ethernet nets connections.

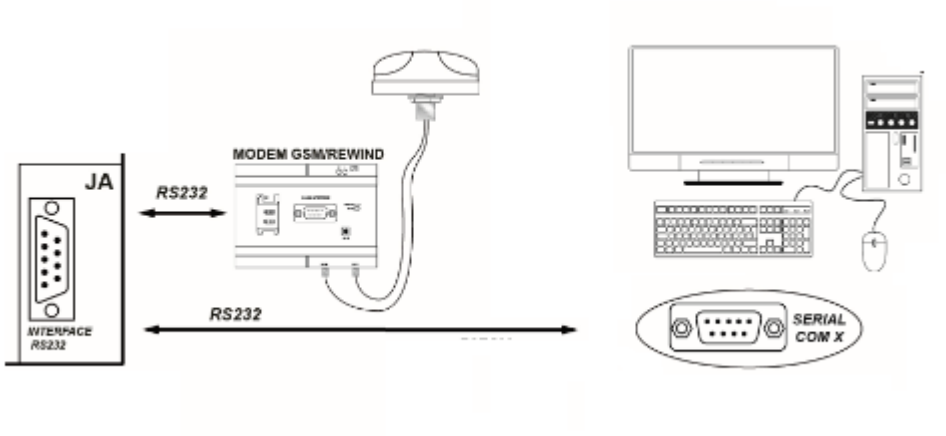
For details related to the communications see specific paragraphs and document [3].

For CAN bus connections see documents [5] e [6].

You can protect the write/command access to the communication ports with two passwords:

- P.0469 (menu 1.1.2). It is an alphanumeric password of up to seven characters. By default, it is blank, which means no password. If set to any value other than blank, it protects the controller from any write access (commands, counter reset, parameter setting). To be able to access in writing, first write the correct password in the provided registers (again via Modbus)
- P.0004 (menu 1.1.2). It is a numeric password (0… 9999). By default, it is set to “123”. If set to any value other than “0”, it protects the controller from commands received through the communications ports. To send commands via Modbus to the controller, you must precede each command with the password contained in P.0004. It is also possible to disable the commands received through the communication ports, using a digital input configured with the functions DIF.2512 (“Remote commands lock”), DIF.2513 (“Front panel/remote commands lock”) or DIF.2706 (“Enables serial port commands”).

5.11.1 JA - Serial port 1 RS232



RS232 JA connector (serial port 1) can be used for the interfacing with an external controller equipped with RS232 interface, e.g. a modem or a PC. The maximum distance of the connection is 12 mt.

The connection can be used for the controller parameter programming through BoardPrg3 program or for the connection to a supervision program as Mecc Alte SmarTech Supervisor3.

For the functions and protocols implemented, refer to document [3]. Connector diagrams as follows:

- JA_01: not connected.
- JA_02 RXD
- JA_03 TXD
- JA_04 DTR
- JA_05 GND
- JA_06 DSR
- JA_07 RTS
- JA_08: not connected.
- JA_09: not connected.

To configure the use of the serial port 1 it is necessary to set the following parameters:

- P.0451: use of serial port 1
- P.0452: Modbus address serial port 1
- P.0453: Baud rate serial port 1
- P.0454: Setting serial port 1

- P.0470: Modbus register orders for serial port 1

The description of these parameters is on document [3].

5.11.1.1 GSM analogue Modem

The analogue/GSM modem must be connected to serial port 1 (JA connector). The modem must be selected among the types evaluated by Mecc Alte.

For the use of a GSM modem, it is necessary that the operator inserts a SIM card of any phone operator. **It is important that on the SIM card the PIN code is disabled: insert the SIM into a phone and disable the PIN code before inserting it into the phone.**

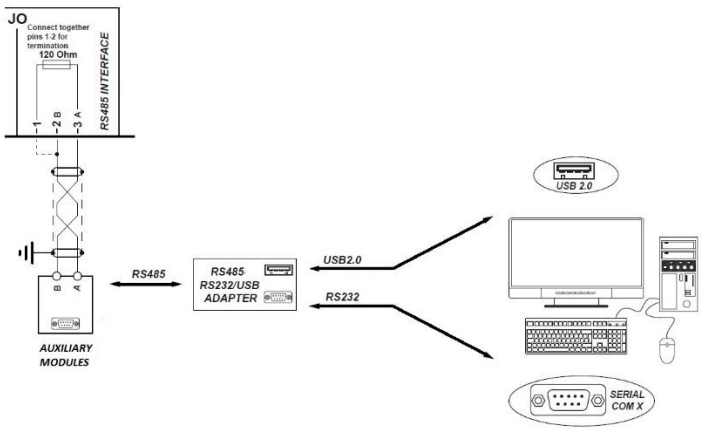
The SIM type to insert depends on the use of the modem:

- If you want to use only SMS messages, any SIM is suitable.
- If you want to use the data exchange with a pc through an analogue modem (classic modem 56k for example), it is necessary a SIM which allows that kind of data. The data exchange happens through the phone channel, but the mobile operators can enable/disable the passage of the data on phone both on the calls done and on those received. Normally, the passage of the data on phone is available on SIM M2M (machine to machine), but it is better to check with your own operator anyway. **Attention: if you talk about data with your phone operator, you refer to the data on TCP/IP protocol (those of the Smartphone), but they are not the data needed, though.**

In any case, the connection of the GSM antenna is necessary.

For the use of SMS or data transmission through phone see document [3].

5.11.2 JO - Serial port 2 RS485



The controller is equipped with a RS485 serial port (serial port 2) galvanically insulated and independent from serial port 1 (RS232), usable to connect via Modbus to a PC or other devices.

For details on RS485 connections, its usage and its parameter programming, refer to document [3].

Connections:

- JO-3: connection RS485 A
- JO-2: connection RS485 B

The RS485 connection needs a 120Ohm termination resistor on both ends of the cable. The controller has integrated resistor; to insert it, it is necessary to act on selector S5. The galvanic insulation guarantees the operation security of the connection also among distant devices and with different mass potentials compared with the controller. The

maximum connection length is 1200m: it is also function of the set transmission baud rate, though. The use of a special shielded cable is provided (see 4.2) with shielded filter connected to earth.

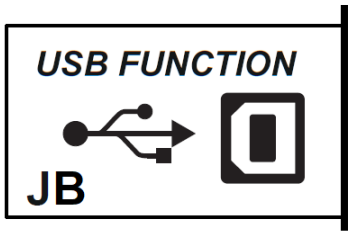
To configure the use of the serial port 2 it is necessary to set the following parameters:

- P.0451: use of serial port 2
- P.0472: Modbus address serial port 2
- P.0473: Baud rate serial port 2
- P.0474: Setting serial port 2
- P.0475: Modbus register orders for serial port 2

The description of these parameters is on document [3].

On serial port 2 cannot be connected a modem; for the rest, it is possible to use it for the same connections possible from RS232 serial port using RS485/RS232 adaptors or RS485/USB when necessary.

5.11.3 JB - USB Serial port



The USB protocol specifications do not allow its use in the permanent industrial field due to the limited length of the cable and of the elevated sensibility to electric disturbs also on PC side. **For this reason, the USB connection cable must be inserted only when it is necessary to operate on the controller and can be removed from the JNA connector when the operation has finished.**

The USB connection with a PC is used for two purposes:

- Firmware upgrade.
- Parameter configuration.

Upgrading the controller firmware is a specific operation of Mecc Alte; besides the FW to be inserted, it requires a procedure and special programs. Also, it must not be done by the installer, except for specific cases previously agreed with Mecc Alte.

The USB port can be used for the programming of parameters with BoardPrg3 program, in alternative to the RS232/RS485 serial connection or Ethernet.

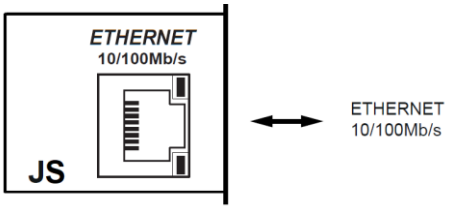
It is necessary that on the PC to be connected the driver **CDC_Meccalte_Win.inf** supplied by Mecc Alte is installed; for the driver installation, refer to document [7].

Once installed the driver, the PC will detect the controller as a new serial port, to be used exactly as it was a RS232 serial port.

The configuration parameters are:

- P.0478: Modbus address USB serial port.
- P.0479: Modbus registers order for USB serial port.

5.11.4 JS - Ethernet port 10 100Mbps



The Ethernet port with RJ45 connector is provided for data connection via LAN. For details on net connection and protocol, refer to document [3].

It is possible to connect the controller inside a LAN or directly to a PC (point to point connection). The connection makes possible the use of Mecc Alte SmarTech Supervisor3 supervision SW, BoardPrg4 configuration and all available functionalities through the TCP/IP Modbus protocol.

The connection of the controller inside a LAN also allows to maintain updated the internal calendar with UTC, besides the possibility to assign a public IP address (static or dynamic) directly to the controller itself.

Parameters for the configuration.

Parameter	Name	Default
P.0500	IP Address. Set it only if DHCP protocol is not required (otherwise this field is filled by the DHCP server): set the IP address assigned to the controller.	192.168.0.1
P.0501	Subnet mask. Set it only if DHCP protocol is not required (otherwise this field is filled by the DHCP server): set the value used by the network the controller is connected to.	255.255.255.0
P.0502	Network Gateway. Set it only if DHCP protocol is not required (otherwise this field is filled by the DHCP server): set the value used by the network the controller is connected to.	0.0.0.0
P.0503	Modbus/TCP Port. Indicate the port on which the controller can accept incoming Modbus/TCP communications. The port 502 is standard for Modbus/TCP protocol: change it only when required.	502
P.0505	Order of the Modbus registers. When 32-bit information is required, it establishes if the 16 more significant bits must be sent first, or those less significant.	0-LSWF
P.0509	NTP server address. Set the IP address of the server that provides updated date/time.	0.0.0.0
P.0508	NTP Server port. Set the port on which the NTP server is listening. The port 123 is standard for NTP protocol: change it only when required.	123
P.0510	Primary DNS server. Set it only if DHCP protocol is not required (otherwise this field is filled by the DHCP server): set the IP address of the primary DNS server (server who provides the translation service among names and IP addresses).	0.0.0.0
P.0511	Secondary DNS server. Set it only if DHCP protocol is not required (otherwise this field is filled by the DHCP server): set the IP address of the secondary DNS server (server who provides the translation service among names and IP addresses).	0.0.0.0
P.0514	DHCP server address. Set to “255.255.255.255” if DHCP protocol is required (any other value disables that protocol).	255.255.255.255
P.0513	DHCP server port. Set the port on which the DHCP server is listening. The port 67 is standard for DHCP protocol: change it only when required.	67

Parameter	Name	Default
P.0456	Plant name. If DHCP protocol is used, the controller can be contacted from the Network using this name.	
P.0515	Period of inactivity (min)	5

To reach the controller inside a LAN net, it is necessary to configure at least parameters P.0500, P.0501 e P.0502. It is possible to proceed in two ways:

- It is possible to manually configure the three above mentioned parameters, with congruent values with the network to which we connect (the sub-net mask and the router/gateway are specific of each network, the IP address must be univocal in the network). To proceed this way, it is necessary that parameter P.0514 is set to 0.0.0.0.
- It is possible to dynamically acquire from the network the values for the three above mentioned parameters. To do so, it is necessary that the controller can connect to a DHCP server (Dynamic Host Configuration Protocol). To proceed this way, it is necessary that parameter P.0514 is set to 255.255.255.255 and that parameter P.0513 is set to 67 (67 is the standard port for the DHCP server, if your server uses a different port, set it in P.0513). Also, parameter P.0456 must contain the name to which server DHCP will match the IP address (see after DNS description).

Once the controller has valid values for parameters P.0500, P.0501 and P.0502 (see page S.05), can be contacted through Modbus-TCP protocol on the assigned IP address and on TCP port configured with P.0503, for example with the supervision SW (Mecc Alte SmarTech Supervisor3) and of configuration (BoardPrg3). When using DHCP protocol, the controller will be reachable through the Modbus-TCP protocol both on IP address and on the configured name, on P.0503 port.

The controller also supports the DNS protocol (Domain Name System). The DNS system is a system used for the conversion of the names of the network knots in IP addresses and vice-versa. The controller uses this function to convert the name of the server “Mecc Alte Smart Cloud” into an IP address, but also to register in the net with a name. The name must be configured through P.0456 and must be univocal in the net. To use the DNS system, it is required:

- If you do not use a DHCP server (see above), it is necessary to set the IP address of the DNS server in P.0510 (it is possible to set the address of a secondary DNS server in P.0511).
- If you use a DHCP server (see above), the IP address of the DNS server is acquired by the controller directly from the DHCP server.

Parameters P.0508 and P.0509 allows to set the IP address and the port to be used to connect to a NTP server (Network Time Protocol), in such way to keep synchronized and updated the internal calendar with date and time of the reference time zone (that is, of the UTC time). Setting one or both parameters to zero the function will be disabled. For more details refer to the document 9.2.1.

The real IP addresses (those configured manually or those obtained by DHCP server) are visible on page S.05.

When no packets are received on the Ethernet port for a duration longer than the configured Period of Inactivity (P.0515), the on-board Ethernet port is reset. This is a safe procedure to prevent hardware faults and allow fault recovery and auto-negotiation on the network. When P.0515 is set to 0, the port is never automatically reset, and this feature is disabled.

5.11.5 Mecc Alte Smart Cloud System

SMARTCLOUD **Mecc Alte Smart Cloud** system is a centralized cybersecure system of data collection: such data are then consultable through a WEB interface. It allows users to connect, continuously monitor and even control multiple Mecc Alte controllers in the cloud in a limited way. The controllers can communicate with Smart Cloud system through Ethernet port using TLS 1.2 security protocol and removing the requirement for static and public IP address.

The controller uses a proprietary Cloud Link protocol as the preferred connection type that supports any type of network. Thus, it can be connected behind the router on the internal network or on the public internet. The required

parameters are Channel ID (P.0563), Cloud Link User (P.0564) and Cloud Link Password (P.0565) are unique for each of them.

Parameter	Name	Default
P.0560	Cloud Link enable	0-No
P.0561	Cloud Link server Address	smartcloud.meccalte.com
P.0562	Cloud Link Server Port	23010
P.0563	Cloud Link Channe ID	
P.0564	Cloud Link User	
P.0565	Cloud Link Password	

These parameters are configurable on the controller through the relative programming menu, with the BoardPrg4xx in the appropriate configuration page of the controller. In details:

- **P.0560** parameter set to value “1-YES” enables the data issue towards Smart Cloud server.
- **P.0561** parameter configures the IP address or the name of the Smart Cloud server. It is possible to set the IP server address in text format or the server’s name in full (i.e., “smartcloud.meccalte.com”) which will be converted by the controller into IP address using the DNS server (suitably configured or automatic on GPRS). It is possible to disable the connection towards the server setting the empty string.
- **P.0562** parameter configures the Smart Cloud server port. By setting the port address to zero the connection towards the server is disabled. The default port is 23010.
- **P.0563** parameter configures the Cloud Link channel identifier.
- **P.0564** parameter configures the Cloud Link user.
- **P.0535** parameter configures the Cloud Link password. It requires Super User password to be modified.

The Cloud Link credentials are provided with the controller. In case these have not been provided, please contact Mecc Alte.

It is also necessary to keep the date and time updated, by enabling the NTP protocol (see P.0508 and P.0509 parameters).

The client identifier of the controller and the status information for the communication with Smart Cloud are displayed on page S.06. In details:

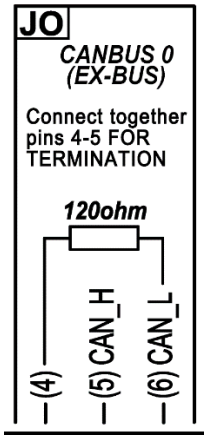
- **CL-IP**: identifies the IP address of the Smart Cloud server to which the data are sent.
- **CL-ID**: identifies the plant name which is supposed to correspond to the one given on Mecc Alte Smart Cloud to allow an easy identification of the controller on Smart Cloud server web page.
- **Server connected**: indicates the number of servers connected to the controller and that the supervision connection is active to Cloud-Link.
- **Clients connected**: indicates the number of clients connected to the controller (which are exchanging data via the Modbus TCP/IP protocol).

For details about communication with Mecc Alte Smart Cloud server. See document [9][9].

5.12 CAN bus Communication ports

For the connections below mentioned, use a cable suitable for CAN bus (see documents [5] [6]).

5.12.1 JO - CAN bus port 0



This interface is used for the connection to expansion modules DITHERM, DIGRIN, DIVIT, DITEL, DANOUT.

The CAN bus interface is galvanically insulated.

Connections:

- Connect terminal JO-5 to terminal CAN_H of the expansion modules.
- Connect terminal JO-6 to terminal CAN_L of the expansion modules.

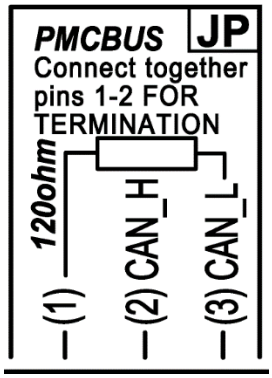
Connect the shielding mesh of the shielded cable to the protective earth or to signal on both sides.

The CAN bus connection needs a 120Ohm termination resistor on both ends of the cable. The terminal resistor is integrated in our controller; to insert it, you need to act on switch S1. NOTE: the termination must always be inserted unless the connection carries on towards other devices and the controller is not one of the two extremes.

We recommend the use of a proper shielded cable (e.g. HELUKABEL 800571).

For the configuration of the additional expansion modules, see par. 5.8.

5.12.2 JP - CAN bus port 1



This CAN bus interface must be used to connect among themselves all Mecc Alte genset/grid/bus coupler controllers): through this communication channel (PMCB – Power Management Communication Bus), the controllers exchange all necessary data to manage the parallel functions (see document [8]).

The CAN bus interface is galvanically insulated.

Connections:

- Connect terminal JP-2 to terminal CAN_H of the other Mecc Alte controllers.

- Connect terminal JP-3 to terminal CAN_L of the other Mecc Alte controllers.

Connect the shielding mesh of the shielded cable to the protective earth or to signal on both sides.

The CAN bus connection needs a 120Ohm termination resistor on both ends of the cable. It is therefore necessary to insert such resistance only on the first and on the last Mecc Alte controller. Note: the connection of the controllers can never be star, but it must be daisy chain. The terminal resistor is integrated in our controller; to insert it, you need to act on switch S6.

We recommend the use of a proper shielded cable (e.g. HELUKABEL 800571).

Use the parameters of menu 8 for the parallel functions (parameter P.0800 enables/disables this CAN bus interface).

6 Main functions

6.1 Front panel

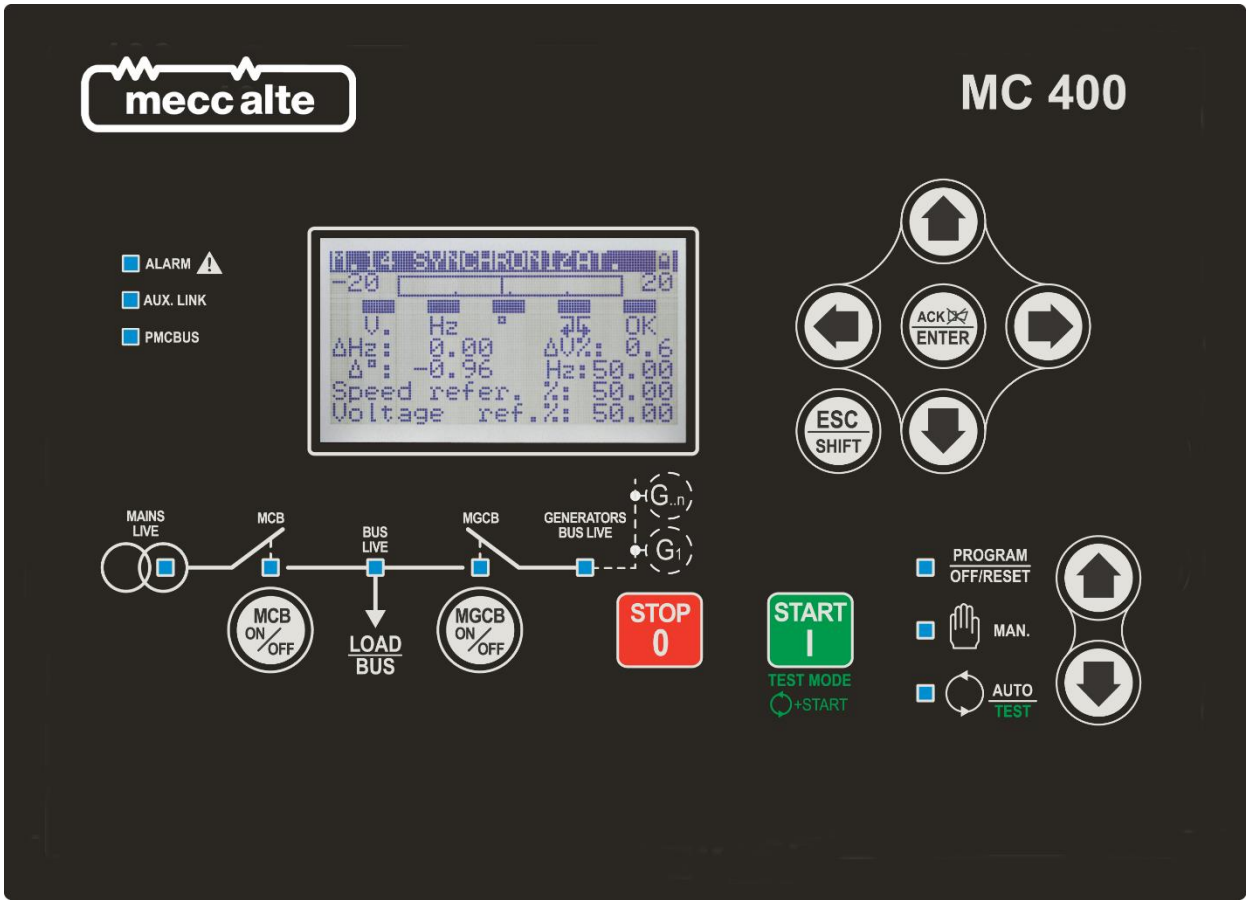


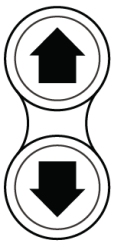
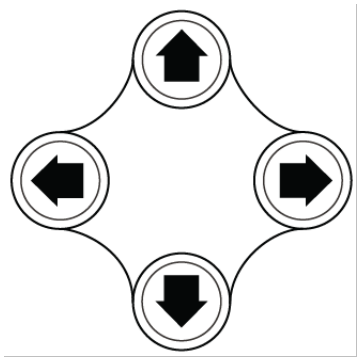
Fig. 1 - Front Panel

The controls consist of 12 buttons.

The front panel also has some luminous indicators.

6.2 Buttons

It is possible to disable quite all the commands activated with the buttons, using a digital input configured with the functions DIF.2511 (“Front panel lock”) or DIF.2513 (“Front panel/remote commands lock”): the commands are enabled if the input is not active or if it does not exist.

Pushbutton		Function
MODE UP  **MODE DOWN**	**OFF/RESET** **PROGRAM**	The controller is disabled; all anomaly signals are disabled. The MGCB circuit breaker is opened (if it exists and is managed by the controller). The MCB circuit breaker is closed (if it exists and is managed by the controller). You can program the parameters.
	MAN	The controller is set for manual generators control. Press the **START** button to start the generators (if MGCB circuit breaker exists and is opened, the generators close their GCB and work in parallel). Press the **STOP** button to stop the generators (that will stop after GCB has been opened and the engine has been cooled). Press the **MCB** button for manual opening/closing of the circuit breakers that connects the grid to the loads. Press the **MGCB** button for manual opening/closing of the circuit breakers that connects the generators bus to the loads.
	AUTO TEST	The controller automatically manages the gensets operation, so they will be started if required by the operating conditions. By pressing the **START** button it is possible to activate/deactivate the TEST mode. If not otherwise configured, it does not close the MGCB circuit breaker. The **STOP** button, if not otherwise configured, causes the stop of the gensets and the activation of an alarm.
		In programming mode, it cancels the changes made to a variable value, brings up the previous menu level, or exits programming mode. If it is pressed for at least two seconds in any menu, you exit the programming mode retaining the current menu position for further programming access. If it is pressed in any window, it displays the status information on the upper line (displaying them cyclically). Depending on the selected page, if pressed together with the **ENTER** button for at least 5 seconds while in OFF/RESET mode, it can reset counters to zero, reload default values of the programming parameters or cancel history logs, force exit from BUS OFF mode of the CAN bus. When used during the keyboard regulation function, it aborts the function.
		Navigation buttons of the multifunction display. These buttons let you select the previous or next page on the display in all modes, except in the PROGRAM AND HISTORY LOG mode. **Horizontal navigation buttons**: in PROGRAM mode, they are used to position the cursor when entering the strings. Used in combination with the **ESC/SHIFT** button, they allow to adjust the contrast: **ESC/SHIFT + LEFT**: to decrease the contrast (lighten). **ESC/SHIFT + LEFT**: to increase the contrast (darken). **Vertical navigation buttons**: in PROGRAM and HISTORY LOG they allow to scroll the menus and the variables / registrations. You can increase/decrease the value of the variable. Used in combination with **ESC/SHIFT** button, they allow to scroll through the menus ten entries at a time or increase/decrease the variables ten units at a time.

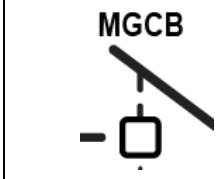
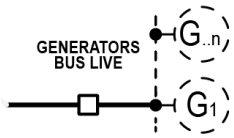
Pushbutton	Function
	In the PROGRAM menu, you can enter the programming mode and open a submenu, change a variable or parameter, and confirm the operation. In ARCHIVE menu, it allows to activate the HISTORY LOG menu and allows the entrance in the selected archive. It allows to “accept” eventual anomaly signalling on the memory while turning on. When there is an alarm, by pressing the button you deactivate the siren. A further press of the button recognises the presence of an anomaly and resets any alarm signals if the operating conditions have returned to normal. Alarms can only be reset by activating the "OFF/RESET" mode.
	<u>The pushbutton only works in manual.</u> It allows to command the opening and the closing of the MCB circuit breaker (if it exists and is managed by the controller). If the synchronization is required for closing, by pressing the pushbutton the synchronization sequence is activated. By pressing it during the paralleling with the grid, it allows to open the MCB circuit breaker: if it is possible, the controller transfers the load to the gensets before opening of the circuit breaker.
	<u>The pushbutton only works in manual.</u> It allows to command the opening and the closing of the MGCB circuit breaker (if it exists and is managed by the controller). If the synchronization is required for closing, by pressing the pushbutton the synchronization sequence is activated. By pressing it during the paralleling with the grid, it allows to open the MGCB circuit breaker: if it is possible, the controller transfers the load to the grid before opening of the circuit breaker. If MGCB does not exist or is externally managed, it is possible to use this button for opening /closing the GCB circuit breakers of the generators: this function must be enabled by means bit 3 of parameter P.0495.
	In MAN mode, it can be used to start all the gensets “controlled by MC400”. In AUTO mode, if automatic gensets start is not required, it changes the operating mode to TEST. If automatic gensets start is required, it can be used to restart gensets controlled by MC400 that are stopped for a low load condition. In TEST mode, it changes the operating mode from TEST to AUTO. Together with the STOP pushbutton, at the power up it allows entering the controller special functions.
	In OFF/RESET mode, the pushbutton turns all LEDs on (to check if there are any faults). In MAN mode, it is used to stop all the gensets “controlled by MC400”. In AUTO, TEST and REMOTE START modes, the controller normally issues an alarm (A007) and stops all gensets “controlled by MC400” (this behaviour can be disabled by means bit 0 of parameter P.0495). Together with the START pushbutton, at the power up it allows entering the controller special functions.

6.3 Indicators (ref. to fig. 1 and 2)

It is possible to modify the brightness of the light indicators (all together) using parameter **P.0496**: the higher the parameter value, the brighter the light indicators. The value can be set between 1 to 10 (default value = 5).

LED OFF	LED steady ON	LED flashing
☐	▣	⧈

Signalling		Function
PROGRAM / OFF/RESET	▣	The controller is in the OFF/RESET operating mode.
	⧈	Flashing at 50% on: it indicates that you are accessing the PROGRAMMING menu.
	☐	The controller is in another operating mode.
MAN.	▣	The controller is in the MANUAL operating mode.
	☐	The controller is in another operating mode.
AUTO / TEST	▣	The controller is in the AUTOMATIC operating mode.
	⧈	Flashing at 50% on: the controller is in the TEST operating mode.
		Flashing at 90% on: the controller is in the REMOTE START operating mode.
	☐	The controller is in another operating mode.
ALARM	▣	There is at least one active alarm or unload.
	⧈	Flashing at 50% on: there is at least one active warning.
	☐	There are no anomalies.
AUX. LINK	▣	At least one Modbus or Modbus/TCP communication is running over the serial ports, the USB port or the ETHERNET port.
	☐	No Modbus nor Modbus/TCP communications are running.
PMCBUS	▣	The CAN bus interface is active and in ERROR-ACTIVE mode.
	⧈	Flashing at 25% on: there are communication errors, the CAN bus interface is in ERROR-PASSIVE mode.
		Flashing at 75% on: there are communication errors, the CAN bus interface is in BUS-OFF mode.
MAINS LIVE	▣	Grid voltages are steadily within the tolerance range.
	☐	No grid voltages.
	⧈	Flashing at 50% on: during transition between the previous two statuses.
		Flashing at 25% on: grid voltages under tolerance thresholds.
		Flashing at 75% on: grid voltages above tolerance thresholds.
MCB	☐	The MCB circuit breaker is opened (or it does not exist).
	▣	The MCB circuit breaker is closed.
	⧈	Flashing at 25% on: MCB opened after a closing command.
		Flashing at 75% on: MCB closed after an opening command.
		Flashing at 50% on: during synchronization (it flashes in alternation with the BUS LIVE).
BUS LIVE	▣	Voltages are present on the loads.
	☐	No voltages on the loads.
	⧈	Flashing at 50% on: during the synchronization (it flashes in alternance with MGCB during the direct synchronization, flashes in alternance with MCB during the reverse synchronization).

Signalling		Function
	☐	The MGCB circuit breaker is opened.
	▣	The MGCB circuit breaker is closed (or it does not exist).
	⧈	Flashing at 25% on: MGCB opened after a closing command.
		Flashing at 75% on: MGCB closed after an opening command.
		Flashing at 50% on: during synchronization (it flashes in alternation with the BUS LIVE).
	▣	Voltages are present on the generator's bus.
	☐	No voltages on the generator's bus.

6.4 Multifunctional display

6.4.1 LCD lighting

The back-light lamp is managed by the controller, which switches it off the after a programmable time (P.0492) if no buttons are pressed in the meantime. Press any button to switch the lamp on again, (we recommend using the ESC/SHIFT button as it has no function when used alone). This function can be disabled by setting parameter P.0492 to 0.

Using parameter P.0493 it is possible to force the lamp always on when at least one generator is running.

6.4.2 Contrast adjustment

Depending on the environmental temperature conditions, the contrast may require adjustment to correctly view the display.

Press in sequence the ESC/SHIFT + LEFT buttons to reduce the contrast (lighten), press the ESC/SHIFT + RIGHT buttons to increase it (darken).

6.4.3 Mode navigation

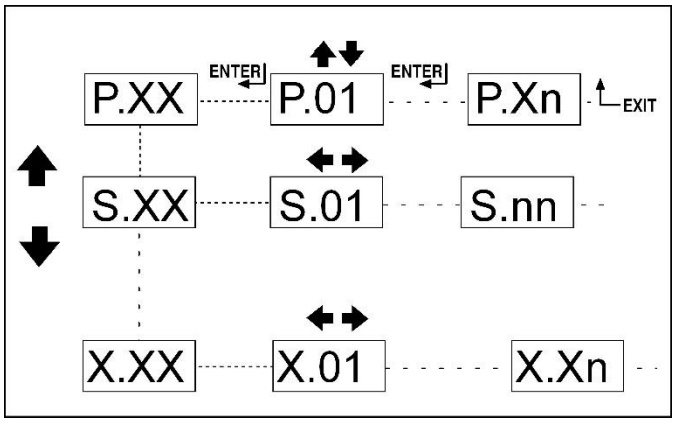
The display has different visualization modes composed by different pages.

Mode	Description	Page identifier
PROGRAMMING	Programming	P. XX
STATUS	Status information	S. XX
MEASURES	Electrical measurements	M.XX
PMCB	Pages related to parallel functions.	B. XX
HISTORY	History logs	H. XX

The navigation among the modes happens through UP and DOWN buttons.

To view the pages inside the mode, use the LEFT and RIGHT buttons.

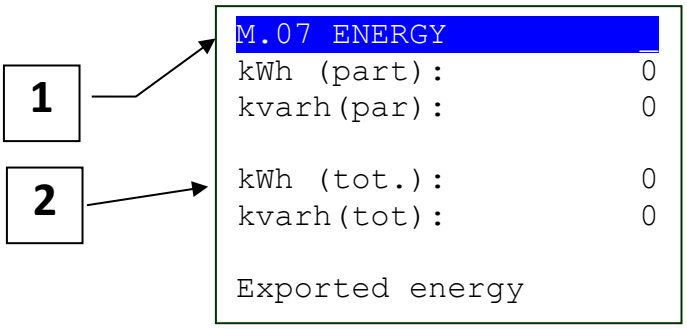
In some modes (P. XX and H.XX), to view the pages press the ENTER button first, and then use the UP and DOWN buttons to navigate between pages.



If the UP and DOWN buttons must be used to manage the functions within the page, the ENTER button must be pressed to activate the said functions, and the ESC/SHIFT button to deactivate them.

6.4.4 Display area layout (ref. to fig. 4)

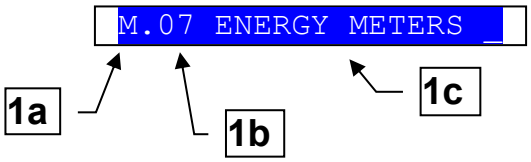
KEY:
1 - Status bar
2 - Data area



6.4.5 Top status bar

The top status bar contains information on navigation and/or some status information.

KEY:
1a - Mode identifier
1b - Page identifier
1c - Page title



The current mode is shown in the relevant field of the top status bar (1a). The mode identifier (1a), and the page identifier (1b) identify and refer to the page so there is no chance of error. The title (1c) provides a description in the current language of the content of the page.

Pressing the **ESC/SHIFT** button, the controller replaces the title (while the button is held) with a status message. By double clicking the **ESC/SHIFT** button, the title is replaced with a status message so long as you remain on that page. If the bit 6 of parameter P.0495 is activated, the controller automatically replaces the title with a status message if there is at least one pending status message with a waiting time (countdown); if the operator selects a new page, the controller shows the title for two seconds, then it shows the status message again.

On the right side, a key icon may appear if:

- A digital input configured with the functions DIF.2511 (“Front panel lock”) or DIF.2513 (“Front panel/remote commands lock”) is disabling the front panel commands.
- A digital input is forcing the controller operating mode (OFF/RESET, MAN, AUTO), and therefore you cannot use the “MODE ▲” and “MODE ▼” buttons.

ATTENTION! the “@” symbol may also appear on the right to indicate that the controller is modifying the non-volatile memory: do not disconnect the power supply when this symbol is visible, otherwise you risk losing the contents of the memory itself.

6.5 Display mode.

6.5.1 Programming (P.XX)

The controller manages a relevant number of parameters, which allows the constructor, the installer and the final customer to configure it based on plant specific needs. This document does not contain the list of parameters (even if many of them are mentioned in the description of the different controller functions), but refer to document [1], for a detailed description. Here is described the general structure of the programming and the operating procedure which allows to read and/or modify the parameters.

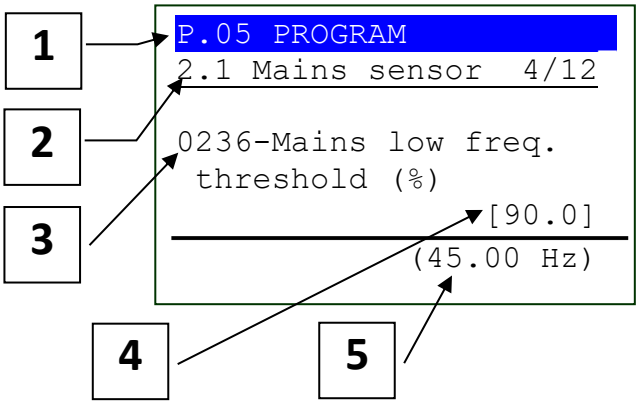
To access the parameter modification mode, select page P.02 with UP and DOWN vertical scroll buttons, then press ACK/ENTER to activate it.

To exit the programming menu and go back to the main window, press button ESC/SHIFT.

WARNING: Assigning an incorrect value to one or more parameters can cause malfunctions, damage to things or injury to people. Qualified personnel must only change the parameters. Parameters may be password protected (see par. 6.5.1.2).

6.5.1.1 Organization

KEY:
1 - Status bar
2 - Current menu
3 - Current parameter
4 - Parameter value
5 - Equivalent value



The first line under the top status bar identifies the current menu (2) with the menu number and the relevant text. A pair of numbers is displayed on the right of this line (4/12 in the example). The first indicates which entry of the menu is selected or which page is displayed, the second indicates how many entries or pages can be displayed in the present menu/submenu.

Each programming parameter (3) has a 4-digit numeric code (e.g. P.0236) to identify the variables regardless of the language used. The current value of the parameter is displayed below the description (4), between brackets. If the parameter configures a value that is a percentage of another item, the controller shows the equivalent value in the measurement unit of the reference item (5).

6.5.1.2 Protection password

Access to the programming mode can be controlled by 4 different password levels, which are listed in order of priority.

- Mecc Alte password.
- MAKER password.
- INSTALLER password.
- USER password.

Each parameter of the controller is associated to a protection level (in document [1] this association is indicated in column “ACC” with a letter “S” to indicate Mecc Alte level, “C” for constructor, “I” for installer and “U” for final user).

A parameter associated to Mecc Alte level is modifiable only setting Mecc Alte password. A parameter associated to the maker level can be modified only by the maker himself (or with the Mecc Alte password). A parameter associated to the installer level can be modified by the maker and the installer (or with the Mecc Alte password). A parameter associated to the end user lever can be modified by the maker, the installer, and the end user (or with the Mecc Alte password).

The general rule says that the parameters are modifiable only when the controller is in “OFF/RESET” mode. Some parameters are an exception and can be modified regardless of the status of the controller board, including when the generators are running. If a parameter cannot be modified, its value will be between “<” and “>”, whilst if modifiable, it is between “[” and “]”: this is valid also for the password restrictions.

The operator who should modify a parameter, must first let the controller recognise him as “Mecc Alte”, “maker”, “installer” or “user”, dialling the right password in parameter P.0000 (menu “1.1.1 - Authentication”). After this operation, he will be able to modify the parameters. The set access code remains in P.0000 memory for about 10 minutes after programming has been completed. After this time, it will be automatically reset, and it should be set again to enter a new programming.

It is possible to customize the password through parameters P.0001 (maker), P.0002 (installer) and P.0003 (user), available on menu “1.1.2 Password configuration”. The value “0” for these parameters indicates password not set. The Mecc Alte password instead, it is a special password, pre-assigned and supplied together with the controller. The password supplied with the controller is always valid. On demand, Mecc Alte can provide a second password, only valid for 2 hours’ operation, though. After this time, a new password must be asked to Mecc Alte.

To obtain the password, the operator should ask Mecc Alte, indicating the “Serial number” of the controller, together with the “Internal code” displayed on page S.03, as shown below:

```
S.03 CONTROLLER
Language:    [ENGLISH]
Ven 26/06/15 08:52:23
Battery:          12.0V

Cod. ID: 00001BB294AF
SW:      EB02502750100
Internal code :  2415
```

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

The following examples show all combinations of password assignment.

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

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

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

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

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

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

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

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

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

No passwords are associated to the user and the installer. The parameters associated to user and installer are free programmable, without entering any code in P.0000. To modify maker associated parameters you must enter “CCC” in P.0000.

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

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

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

As no password is associated to the user, the parameters associated are freely programmable, without entering any code in P.0000. When the user enters “III” in P.0000, he can modify all parameters associated to “installer” and “end user”. When entering “CCC” in P.0000, the operator is identified as “maker” and can modify all parameters, excluding critical ones.

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

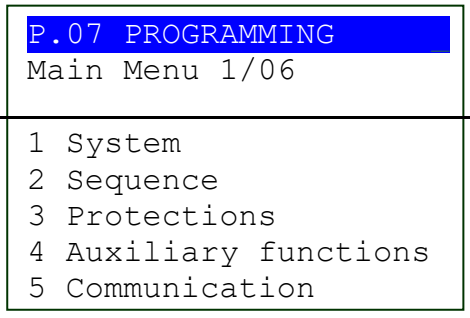
No parameter is modifiable. When the user enters the “UUU” code in P.0000, the controller considers him “user”, but as no password is associated to “installer”, it considers him “installer”. He can modify all parameters associated to the end user and the installer. When entering “CCC” in P.0000, the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

The parameter value can always be read, but the modification can be carried out only if P.0000 contains a proper password. Parameters P.0001, P.0002, P.0003 and P.0469 are excluded: they are not displayed in case P.0000 does not contain a proper password.

Parameter P.0469 (password for serial ports) is viewable and/or modifiable only from operator panel and, at least, with installer rights.

6.5.1.3 Operating procedure

This procedure will describe the keyboard and display use.



- **1 (SYSTEM).** The menu 1-SYSTEM allows first to indicate how the controller is connected to the grid and to the generator bus, and the plant type. It is most important to correctly set these parameters as all thresholds for the protection activation are expressed in percentage compared to them.
- **2 (SEQUENCE).** Working sequence configuration can be modified through the menu 2-SEQUENCE. In this menu, the threshold percentages can be set, the time of acquisition and enabling/disabling of the functions related to the operation sequences.
- **3 (PROTECTIONS).** Protections management is accessible through the menu 3-PROTECTION. As to this, it is important to know that, to enable/disable a protection, you may simply modify the associated time, leaving the threshold unchanged: by setting the time to zero, the protection is disabled. However, this general rule provides some exceptions. Refer to the chapter dedicated to the anomalies, par. , which describes each disabling mode.
- **4 (AUXILIARY FUNCTIONS).** All that is not about the configuration of the system, the sequence and protections is configurable from menu 4-AUXILIARY FUNCTIONS. In this menu are other menus which configure calendars and history logs.
- **5 (COMMUNICATION):** In this menu are the communication settings for the serial ports, for the ETHERNET port, for the USB port and the configuration for the modem.
- **8 (PARALLEL):** The menu 8-PARALLEL allows to configure all the functions related to the parallel with the grid or among gensets.

6.5.1.3.1 Access to programming

The programming is accessible in any operation status of the controller, while the parameter modification is possible only with the controller in OFF/RESET. To enter in programming mode, it is required to act on ▲ and ▼ pushbuttons until the programming screen appear (P.02).

If you are in a mode which puts some limitation in the use of the vertical scroll pushbuttons, it might be necessary to press one or more times the ESC/SHIFT pushbutton (e.g. when viewing history logs or during operations).

Then press ENTER to enter programming.

At the start of the procedure, the menu o the variable used at the last exit from programming is shown (at first entrance the main menu is shown). This is true if the programming procedure has been previously abandoned changing the operation mode of the controller in MAN or AUTO or after a maximum time of permanence without operating in programming or keeping ESC/SHIFT pressed for more than two seconds.

6.5.1.3.2 Menu selection

The name of the current menu is always shown in the first line, followed by the numeric ID of the selected item and the number of menu items. The further lines of the display are used to view the menu items, that is, the submenus. The item selected is drawn in REVERSE. Using ▲ and ▼ pushbuttons, the menu scrolls respectively towards the top or bottom index items, in a cyclical way (that is, pressing ▲ from the first item you pass to the last and vice-versa).

Pressing ACK/ENTER button, you enter a selected submenu (the one highlighted), pressing ESC/SHIFT you leave the menu (going back to the previous menu or leaving the programming to the basic screen if you were already on the main menu).

6.5.1.3.3 Parameters selection

The name of the current menu is always shown in the first line, followed by the numeric Id of the selected item and the number of menu items. The next display lines are all used to view a single parameter:

- Fourth and fifth rows show the univocal parameter code (four decimal digits) followed by the description in the current language.

- The seventh line shows, aligned on the right, the value of the variable, enclosed between square brackets or "< >".
- For some parameters, on the ninth line, a value someway connected to the current value of the parameter is shown. For example, in the case of the low grid frequency threshold (P.0236), the equivalent voltage is shown, calculated from the grid nominal voltage (P.0116) and by the parameter itself (%). This additional value is often displayed when the parameter is expressed as percentage compared to some other value to show the absolute value.
- The last line of the display shows the protection level given to the operator (Mecc Alte, maker, installer or user).

Using ▲ and ▼ buttons, the menu scrolls respectively towards the top or bottom index items, in a cyclical way (that is, pressing ▲ from the first item you pass to the last and vice-versa). Pressing ACK/ENTER button, the modification procedure of the parameter activates (see next paragraph), pressing ESC/SHIFT button you leave the menu (going back to the previous menu).

6.5.1.3.4 Modification of a parameter

A parameter can be modified only if shown between squared brackets ([]); if between "<>", it cannot be modified. In this case, it could be necessary to set a suitable password or to put the controller in OFF/RESET mode.

After visualizing a parameter, to start modifying it, it is necessary to press the ACK/ENTER pushbutton. To confirm the new value, it is necessary to press ACK/ENTER; to cancel the modification and go back to the original value just press ESC/SHIFT.

There are the following types of parameters:

- **Bits:** Some parameters are managed in bit. Each bit at 1 enables a function and each bit at 0 disables a function. Up to 16 bits can be used. A hexadecimal value is attributed to each bit. The parameter must be set with the result of the sum of the hexadecimal values linked to the functions to be enabled. The setting happens as described for the strings, with the exception that it is possible to select only hexadecimal characters (0...9, A....F).

  In the description of these parameters, there will be a chart like the following:

Bit	Value	Description
1	0001	Enable function 1
2	0002	Enable function 2
3	0004	Enable function 3
4	0008	Enable function 4
5	0010	Enable function 5
6	0020	Enable function 6
7	0040	Enable function 7
8	0080	Enable function 8
9	0100	Enable function 9
10	0200	Enable function 10
11	0400	Enable function 11
12	0800	Enable function 12
13	1000	Enable function 13
14	2000	Enable function 14
15	4000	Enable function 15
16	8000	Enable function 16

  If the operator wants to:

  - Disable all functions: he must set 0000 in the related parameter.
  - Enable the functions from 1 to 8: the value to be set is given by the hexadecimal sum 0001+0002+0004+0008+0010+0020+0040+0080 = 00FF.

- Enable e.g. functions 3, 4, 6 and 8: the value to be set is given by the sum of 0004+0008+0020+0080 = 00AC.

- **Numeric:** the value is modifiable using ▲▼ buttons, respectively to increase or decrease the value of one unit (if these buttons are pressed together with ESC/SHIFT, the value will be increased or decreased of ten units at a time). The modification is cyclical: trying to increase the value when it is already at the maximum, it passes to the minimum, and vice-versa.

- **Numerical with selection among a default list** (e.g. the number of phases of the grid): it is valid what said for the numerical parameters, considering that the ▲▼ buttons allows to pass to the following /previous value in the default list (pressed with ESC/SHIFT button, allow to pass to the value which follows/precedes the current one of ten positions).

- **Numeric selected in a number-string couples list** (e.g. the function of a digital input): same as the previous point.

- **Time:** it is valid what said for the numeric parameter, except for the fact that the controller manages the increasing/decreasing keeping valid values (e.g. increasing from 00.59" to "01.00" and not to "00.60").

- **Strings (e.g. phone numbers):** in this case the visualizer highlights (in reverse) the character selected on the string. The ▲▼ pushbuttons work on the selected character (passing to next/previous character of the ASCII table or jumping by ten positions ahead/back if ESC/SHIFT is pressed too), whereas ◄► pushbuttons allow selecting the character to modify. Characters ASCII from 32 (space) to 127 (escape) are settable. Characters ASCII (over 127) and those of control (from zero to 31) are not settable.

- **Hexadecimal strings** (e.g. the bit polarity of the outputs): as for string parameters, but the selectable parameters are only "0-9" and "A-F" (these last in capital letters only).

6.5.1.3.5 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 must verify that this does not happens.

6.5.1.3.6 Exit from programming.

There are three ways to exit the programming:

- Press ESC/SHIFT n times to climb up again to the main menu and then press it again to exit the programming. Coming a next time into programming, the controller will show the main menu.

- Keep ESC/SHIFT pressed for two seconds from any position: you will exit immediately the programming, and you will find yourself exactly at the same point at the next entrance.

- Changing the controller mode to AUTO or MAN: next entry will be exactly in same point.

6.5.1.4 Loading default values

WARNING: This procedure reloads in a permanent way the default parameters in function of the access rights.

In certain situations, it can be useful to reload the default parameters. To do so, it is necessary to select first the OFF/RESET mode, enter programming, then keep the **ACK/ENTER** and **ESC/SHIFT** buttons pressed at the same time and consecutively for five seconds. A message on the display will indicate to the operator the happened reloading of the default values. **The default values are only reloaded for those parameters for which you have access rights.**

6.5.2 Status information (S.XX)

In this mode, the information on the system status is supplied. You can scroll through the various pages using the LEFT and RIGHT buttons.

6.5.2.1 S.01 STATUS

Page S.01 (STATUS) shows system status information. Part of this information is displayed in the upper title bar if you press and hold the **ESC/SHIFT** button. It contains:

- Working mode of the controller (MAN, AUTO, etc.).
- The status of the operation sequence (idle, starting the gensets etc.).
- The status of protections for the parallel with the grid.
- The electric grid status (absent, low, high, etc.).
- The eventual presence of inhibition to start the generators.
- The eventual presence of inhibition to connect the loads to the generators.
- The eventual activation of protections override.
- The signalling of some genset in condition of “GCB not open”.

For many information, a time is also shown; for example, during the generators stopping cycle the lasting time is shown at the end of that cycle.

6.5.2.2 S.02 ANOMALIES

The page S.02 (ANOMALIES) is automatically displayed in case a new anomaly arises. For every anomaly, it is shown:

- A letter identifying the type of it:
  - “A”: alarm.
  - “U”: unload.
  - “W”: Warning.
- A three-digit numeric code that uniquely identify the anomaly. This code flashes if the anomaly has not been acknowledged yet with ACK/ENTER.
- An alphanumeric description, based on the currently selected language and that in some cases can be customized through the controller parameters.

Each anomaly uses two lines of the display. The anomaly shown on the top is the more recent in chronological order. If space is not sufficient to show all the pending anomalies, only the most recent ones are shown. To see also the other, you must:

- Press the ACK/ENTER pushbutton.
- Use the ▲▼ pushbuttons to scroll the anomalies.
- Press ESC/SHIFT to leave the mode.

Some anomalies can show additional diagnostic information. This information is automatically viewed if an anomaly is active: if there are many anomalies active, use the procedure described above to select the single anomalies and see the eventual additional diagnostic information regarding the selected anomaly. The anomalies with additional diagnostic information are:

- 273 (Parameters not coherent or not set). It shows an additional message helping to understand the problem.
- 252 (EXBUS: some modules are missing). It shows an additional message that identifies the configured expansion module, which does not communicate with MC400.
- 253: (EXBUS: some measures are missing). It shows an additional message that identifies the acquisition channel and the expansion module from which we expect to receive a measure, which is lacking instead.

- 254 (EXBUS: duplicated address). It shows an additional message that identifies the type and the address of the expansion module that is connected twice to MC400.
- 255 (EXBUS: sensor disconnected). It shows an additional message that identifies the channel of acquisition and the expansion module which is sending the information of “broken wire”.

6.5.2.3 S.03 BOARD STATUS

This page is dedicated to the information of the controller and contains:

- The current date and hour in extended format (flashing if the clock is not valid).
- The serial number univocal for the controller.
- The code of the software currently uploaded on the controller (see par. 1.6).
- The internal code necessary to obtain a temporary Mecc Alte level password (see 6.5.1.2).
- The power supply voltage.
- The language currently used by the controller. It is also possible to select a different language: press ACK/ENTER button, select the language with buttons ▲ and ▼ and confirm with ACK/ENTER button. Note: MC400 is supplied only with ENGLISH and PORTUGUESE languages. With BoardPrg3 program it is possible to transfer other languages to the controller.

6.5.2.4 S.04 SERIAL COMMUNICATION

This page is dedicated to the status of the communication towards the serial ports and the USB port. In the case of operating problems, check the information in this page.

For each port, the status (stand-by, communicating, etc.) and the counter of receiving errors are displayed. To reset an error counter, you must:

- Press ACK/ENTER: the controller highlights the error counter of the serial port COM1.
- Use the vertical arrows to highlight the counter to be reset.
- Press ACK/ENTER + ESC/SHIFT for 5 seconds: at the end, the controller resets the counter.
- Press ESC/SHIFT.

If a modem is connected to the controller, is also shown:

- The modem model.
- In case of a GSM modem:
  - The name of the telephone provider.
  - The GSM signal level.

6.5.2.5 S.05 NETWORK

This page is dedicated to the status of the connection and communication on the ETHERNET interface.

The controller shows:

- The status of the connection:
  - “Idle”: no communication running, and Ethernet cable disconnected.
  - “Idle - linked”: no communication running, and Ethernet cable connected.
  - “Communication In progress”: communication running.
- The MAC address of the physical net interface.

- The IP address of the controller, the address of the router/gateway, the Subnet-mask and the DNS server address. Those values can be the ones set with the parameters of the controller, or those dynamically acquired by server DHCP (see 5.11.4).

6.5.2.6 S.06 CLOUD LINK (SMART CLOUD)

The S.06 (CLOUD LINK) page is only displayed if the P.0560 parameter is at value 1. It shows the client identifier (useful to search it in Smart Cloud system) and the IP address of Smart Cloud server (with GPRS internal modem, instead of the IP address is shown the DNS name of the server). It also shows the status of the communication with the server:

- Number of the server connected.
- Number of the clients connected.

6.5.2.7 S.07 CAN bus

This page displays the status of the CAN bus interfaces of the controller. MC400 has two interfaces. Each interface displays

- The communication status of the bus. There are three signalling:
  - ERROR-ACTIVE: normal operation.
  - ERROR-PASSIVE: communication is working despite faults (errors).
  - BUS-OFF: Gen-set has interrupted the connection to the bus due to too many errors.

- Communication error counters are displayed. The counters of the instantaneous transmission/reception errors and the maximum values reached are displayed. It is possible to reset the maximum values (and force the output status of BUS-OFF) by pressing for 5 seconds the buttons ACK/ENTER and ESC/SHIFT. Since two CAN interfaces are present, it is necessary to select the desired CAN interface first and then reset the counters: to select an interface press ACK/ENTER digit and use ▲ and ▼ digits.

6.5.2.8 S.08-09-10 GENERIC STATUS

These pages are dedicated to the view of the generic statuses acquired through the digital inputs, configured with functions DIF.3201 and DIF.3202 (page 1), DIF.3203 and DIF.3204 (page 2), DIF.3205 and DIF.3206 (page 3).

The page uses one line for each configured input. If more than 6 inputs are configured, the controller will display all of them in rotation (6 at a time) every 2 seconds: keeping ESC/SHIFT button pressed you stop the rotation. If there are no configured inputs on a page, the page is not displayed.

On each line, the controller shows the configured text for the digital input and the logical status of it.

If you use functions DIF.3202, DIF.3204 and DIF.3206, when the input changes from non-active to active, the controller forces the view of the relative page.

6.5.2.9 S.11 DIGITAL INPUTS

This page shows the status of:

- Digital inputs of the controller.
- Analogue inputs used as digital (if they are not used as digital, they are displayed with dashes).
- Virtual digital inputs.

Pressing ACK/ENTER button, it is possible to change (cyclically) the ways the controller shows the inputs:

- **LOGICAL STATE:** the controller shows the input's logic level (active or inactive) used in the management of the operating sequence.

- **PHISICAL STATE:** the controller shows the electrical level (active or inactive, or high or low) present on the input; this can be the opposite in comparison to the corresponding logic state. Displayed in REVERSE.

- **FOR FUNCTION:** the controller shows a list of functions associated to the digital inputs, showing the logic status (1/0) relative to each function, independently from the input associated to the functions. If more than 8 functions are configured, the controller will display all of them in rotation (8 at a time) every 2 seconds: keeping **ESC/SHIFT button** pressed you stop the rotation.

6.5.2.10 S.12 DIGITAL INPUTS

This page is only shown if some DITEL modules have been configured (see 5.8). It displays the status of the digital inputs acquired from DITEL digital modules. If a DITEL module does not communicate correctly, the controller will display some dashes in place of the input's status. Pressing ACK/ENTER button, it is possible to change (cyclically) the ways the controller shows the inputs:

- **LOGICAL STATE:** the controller shows the input's logic level (active or inactive) used in the management of the operating sequence.
- **PHISICAL STATE:** the controller shows the electrical level (active or inactive, or high or low) present on the input; this can be the opposite in comparison to the corresponding logic state. Displayed in REVERSE.

6.5.2.11 S.13 DIGITAL OUTPUTS

This page shows the status of the digital outputs of the controller. Pressing the ACK/ENTER button, it is possible to change (cyclically) the ways the controller shows the outputs:

- **LOGICAL STATE:** the controller shows the output's logic level (active or inactive) used in the management of the operating sequence.
- **PHISICAL STATE:** the controller shows the electrical level (active or inactive, or high or low) present on the output; this can be the opposite in comparison to the corresponding logic state. Displayed in REVERSE.
- **FOR FUNCTION:** the controller shows a list of functions associated to the digital outputs, showing the logic status (1/0) relative to each function, independently from the output associated to the functions. If more than 6 functions are configured, the controller will display all of them in rotation (6 at a time) every 2 seconds: keeping ESC/SHIFT button pressed you stop the rotation.

6.5.2.12 S.14 DIGITAL OUTPUTS

This page is only shown if some DITEL modules have been configured (see 5.8). It displays the status of the digital outputs acquired from DITEL digital modules. If a DITEL module does not communicate correctly, the controller will display some dashes in place of the output's status. Pressing ACK/ENTER button, it is possible to change (cyclically) the ways the controller shows the outputs:

- **LOGICAL STATE:** the controller shows the output's logic level (active or inactive) used in the management of the operating sequence.
- **PHISICAL STATE:** the controller shows the electrical level (active or inactive, or high or low) present on the output; this can be the opposite in comparison to the corresponding logic state. Displayed in REVERSE.

6.5.2.13 S.15 ANALOGUE INPUTS

The page shows the value of the analogue inputs of the controller (connector JM) and of the emergency stop (EM-S). Pressing ACK/ENTER button, it is possible to change (cyclically) the ways the controller shows the inputs:

- **PHYSICAL STATE**: Foe each input a measure in Volt is displayed.
- **FOR FUNCTION:** the controller shows a list of functions associated to the analogue inputs, showing the acquired value, independently from the input associated to the functions. If more than 6 functions are used for the analogue inputs, the controller will display all of them in rotation (6 at a time) every 2 seconds: keeping the ESC/SHIFT button pressed you stop the rotation.

6.5.2.14 S.16 ANALOGUE INPUTS

This page is only shown if some DITHERM or DIGRIN modules have been configured (see 5.8).

On the left side, the type of module connected is shown ((DIGRIN, DITHERM or DITEMP if the module does not communicate correctly). On the right side, it shows the temperatures acquired by the modules. They can be replaced by:

- "------": if the expansion module does not transmit the measurement.
- "OPEN": if the module signals that the sensor is disconnected.
- "+OVER": if the module signals that the input signal has a too high value, symptom of a fault.
- "-OVER": if the module signals that the input signal has a too low value, symptom of a fault.

6.5.2.15 S.17 ANALOGUE INPUTS

This page is only shown if some DIVIT modules have been configured (see 5.8).

On the right side, it shows the measures acquired by the modules (without any conversion). They can be replaced by:

- "------": if the expansion module does not transmit the measurement.
- "OPEN": if the module signals that the sensor is disconnected.
- "+OVER": if the module signals that the input signal has a too high value, symptom of a fault.
- "-OVER": if the module signals that the input signal has a too low value, symptom of a fault.

6.5.2.16 S.18 ANALOGUE OUTPUTS

This page shows the percentage value currently associated to the two analogue outputs of the controller.

Pressing ACK/ENTER you arrive to a view per function: the controller shows a list of the functions associated to the analogue outputs, displaying the analogue value relative to each function, independently from the output associated to the functions. If more than 6 functions are used for the digital outputs, the controller will display all of them in rotation (6 at a time) every 2 seconds: keeping the ESC/SHIFT button pressed you stop the rotation.

6.5.2.17 S.19 ANALOGUE OUTPUTS

This page is only shown if some DANOUT modules have been configured (see 5.8).

It shows the percentage value currently associated to the four analogue outputs of each DANOUT module (the real corresponding electrical measure depends on the configuration done inside the module DANOUT). The values are shown in reverse if the DANOUT module is not communicating correctly.

6.5.2.18 S.20 GRID PROTECTIONS

The page is displayed only if the type of plant considers the parallel with the grid.

It displays the status of all protections of parallel with the grid. The disabled protections are not displayed. For each protection enabled, the controller displays the initial (for example "27<<"): it is displayed in reverse if the protection has trip (grid out of tolerance).

Codes are: "27<<", "27<", "59>", "59>>", "81<<", "81<", "81>", "81>>", "81R", "VJ", "DI" (by contact). See document [8].

6.5.3 Electrical measurements (M.XX)

In this mode, all the measurements taken by the controller on the electric lines are shown. You can scroll through the various pages using the LEFT and RIGHT buttons.

6.5.3.1 M.01 SYSTEM

This page displays a wiring diagram of the system, highlighting:

- The grid. The symbol of the grid is solid if the grid is within the tolerance range and flashing if the grid is missing or if it exceeds the tolerance range.
- The generator. The symbol of the generator is in “reverse” if the engine is started and if the generator is powered.
- The loads. The symbol of the load is displayed in “reverse” if the loads are powered from the grid or from the generator.
- The GCB, MCB and MGCB circuit breakers. The symbol of the circuit breaker shows:
    - The open/close status.
    - The discrepancy between the status and the circuit breaker command (in this case, the two circuit breaker’s points of contacts flash).
    - The possibility to use the synchronization to close the circuit breaker (if the synchronization can be used, the two circuit breaker’s points of contacts are empty squares, otherwise they are full).
- The power flows, displayed as arrows, in all the parts of the plant. Each arrow points to the power direction. The arrow flashes (to indicate an anomaly) of negative power on the loads and on the generator’s bus.
- The active power measurement and of the power factor in the different parts of the plant.
- The active power and the power factor setpoints for the operation in parallel with the grid.

With parameter P.0494 it is possible to customise the page, hiding one or more of the previous pieces of information.

6.5.3.2 M.02 GRID

The information shown in this page depends on the wiring mode (P.0119):

- Single phase (1P2W):
    - L1-N voltage
    - N-B voltage
    - Frequency.
- Dual phase (2P3W):
    - L1-L2 voltage
    - L1-N voltage
    - L3-N voltage
    - N-B voltage
    - Frequency.
    - Phases sequence (CW/CCW).
- Three phases (3P3W or 3P4W):
    - L1-L2 voltage
    - L2-L3 voltage
    - L3-L1 voltage
    - Frequency.
    - Phases sequence (CW/CCW).

To the bottom right there is an icon that allows immediate identification of the fact that the page is related to the GRID measures.

6.5.3.3 M.03 GRID 2

The controller shows this page only for 3P4W wirings (three phases with neutral, P.0119). It shows:

- L1-N voltage
- L2-N voltage
- L3-N voltage
- N-B voltage
- Phases sequence (CW/CCW).

To the bottom right there is an icon that allows immediate identification of the fact that the page is related to the GRID measures.

6.5.3.4 M.04 GENERATORS BUS

The information shown in this page depends on the wiring mode (P.0101):

- Single phase (1P2W):
  - L1-N voltage
  - N-B voltage
  - Frequency.
- Dual phase (2P3W):
  - L1-L2 voltage
  - L1-N voltage
  - L3-N voltage
  - N-B voltage
  - Frequency.
  - Phases sequence (CW/CCW).
- Three phases (3P3W or 3P4W):
  - L1-L2 voltage
  - L2-L3 voltage
  - L3-L1 voltage
  - Frequency.
  - Phases sequence (CW/CCW).

To the bottom right there is an icon that allows immediate identification of the fact that the page is related to the GENERATOR measures.

6.5.3.5 M.05 GENERATORS BUS 2

The controller shows this page only for 3P4W wirings (three phases with neutral, P.0101). It shows:

- L1-N voltage
- L2-N voltage
- L3-N voltage
- N-B voltage
- Phases sequence (CW/CCW).

To the bottom right there is an icon that allows immediate identification of the fact that the page is related to the GENERATOR measures.

6.5.3.6 M.06 CURRENTS

In this page, phase currents are displayed (depending on the wiring P.0101 or P.0119) measured by the controller. At the bottom-right corner, the controller shows one symbol which immediately permits to identify the real source of the currents (grid, loads or generators bus).

For dual/three phase systems also the negative sequence current is displayed.

If the fourth current is suitably configured, the controller will also display:

- Ax: auxiliary current (visible if P.0131=1 or P.0131=4).
- An: neutral current (visible if P.0131=2).
- Ad: differential current (visible if P.0131=2).

6.5.3.7 M.07 POWERS

The active powers and power factors are shown, total and phase by phase (depending on the wiring P.0101 or P.0119).

At the bottom-right corner, the controller shows one symbol which immediately permits to identify the real source of the powers (grid, loads or generators bus).

6.5.3.8 M.08 POWERS 2

The apparent and reactive powers are shown, total and phase by phase (depending on the wiring P.0101 or P.0119).

At the bottom-right corner, the controller shows one symbol which immediately permits to identify the real source of the powers (grid, loads or generators bus).

6.5.3.9 M.09 ENERGY METERS

In this page the active and reactive energy counters (partial and total) **exported** by the plant to the grid are shown.

On this page, you can reset to zero the partial counters individually. To do so, it is necessary to:

- Press the ACK/ENTER button: one of the counters will result highlighted.
- Use the vertical scrolling UP and DOWN buttons to select the counter to be reset.
- Press the ACK/ENTER button and ESC/SHIFT buttons for 5 seconds.
- Press the ESC/SHIFT pushbutton.

Attention: from version 1.02, if a password has been configured in parameter P.0001 ("user" protection level), it will not be possible to reset the counters until this password is entered (login) in parameter P.0000 (" Access code").

At the bottom to the right, the display shows an icon which identifies the grid, to allow you to easily distinguish this page from the next, which have an identical structure.

6.5.3.10 M.10 ENERGY COUNTERS

In this page the active and reactive energy counters (partial and total) **imported** from the grid to the plant are shown.

On this page, you can reset to zero the partial counters individually. To do so, it is necessary to:

- Press the ACK/ENTER button: one of the counters will result highlighted.
- Use the vertical scrolling UP and DOWN buttons to select the counter to be reset.
- Press the ACK/ENTER button and ESC/SHIFT buttons for 5 seconds.
- Press the ESC/SHIFT pushbutton.

Attention: from version 1.02, if a password has been configured in parameter P.0001 ("user" protection level), it will not be possible to reset the counters until this password is entered (login) in parameter P.0000 (" Access code").

At the bottom to the right, the display shows an icon which identifies the grid, to allow you to easily distinguish this page from the next, which have an identical structure.

6.5.3.11 M.11 ENERGY METERS

In this page the active and reactive energy counters (partial and total) **exported** by the generators to the plant are shown.

On this page, you can reset to zero the partial counters individually. To do so, it is necessary to:

- Press the ACK/ENTER button: one of the counters will result highlighted.
- Use the vertical scrolling UP and DOWN buttons to select the counter to be reset.
- Press the ACK/ENTER button and ESC/SHIFT buttons for 5 seconds.
- Press the ESC/SHIFT pushbutton.

Attention: from version 1.02, if a password has been configured in parameter P.0001 ("user" protection level), it will not be possible to reset the counters until this password is entered (login) in parameter P.0000 (" Access code").

At the bottom to the right, the display shows an icon which identifies the generators, to allow you to easily distinguish this page from the previous, which have an identical structure.

6.5.3.12 M.12 ENERGY METERS

In this page the reactive energy counters (partial) **imported** by the generators from the plant are shown.

On this page, you can reset to zero the partial counters individually. To do so, it is necessary to:

- Press the ACK/ENTER button: one of the counters will result highlighted.
- Press the ACK/ENTER button and ESC/SHIFT buttons for 5 seconds.
- Press the ESC/SHIFT pushbutton.

Attention: from version 1.02, if a password has been configured in parameter P.0001 ("user" protection level), it will not be possible to reset the counters until this password is entered (login) in parameter P.0000 (" Access code").

At the bottom to the right, the display shows an icon which identifies the generators, to allow you to easily distinguish this page from the previous, which have an identical structure.

6.5.3.13 M.13 REGULATIONS

This page is useful in the parallel applications. It displays the generators bus and grid voltages and frequencies at the same time (the voltage shown depends on the wiring P.0101 / P.0119). It is then possible to modify the offsets for the speed and voltage:

- Press the ACK/ENTER button: one of the values is highlighted.
- Using the ACK/ENTER button or ◄► buttons, you select the other value (cyclically).
- Using ▲ and ▼ buttons, it is possible to modify the selected value (if pressed together with ESC/SHIFT the modification is quicker).
- Press the ESC/SHIFT button to end the modification.

The modification is automatically interrupted if you do not press any digits for 10 seconds.

Note: some of these setpoints can be acquired from the analogue inputs: in this case on this page, they are shown, but it is not possible to modify them.

6.5.3.14 M.14 SYNCHRONISATION

This page shows the necessary information for the synchronization.

The controller shows the current phase difference through a horizontal bar, which act as a synchronoscope. Usually it shows phase angles between -180° and +180°. When the phase error falls below 20°, the bar is reduced to show angles between -20° and +20° (in this case the bar is on black background). Under the bar 5 small rectangles are shown. The first three indicate if the voltage, frequency and phase differences allow the closure of the circuit breaker (if the rectangle is empty, the difference is too high and the circuit breaker cannot be closed, if it is filled the difference is in

tolerance). The fourth one indicates a mismatch of phase-rotation direction (also in this case the empty rectangle indicates that the circuit breaker cannot be closed). When all the first four rectangles are entirely filled, the status of the system is correct to close the circuit breaker: so, the fifth rectangle becomes filled, and the controller closes the circuit breaker.

The controller displays numerically the difference of phase, frequency and voltage between gensets and grid.

On the bottom of the page there are offsets for the speed and voltage. If these values are not related to an analogue input, it is possible to directly modify them from this page (see previous paragraph). In this way, it is possible to make a manual synchronization.

6.5.3.15 M.15 SETPOINTS

This page shows and allows to modify (in a unique point) all the applicable setpoints for the plant, relative to the frequency, to the voltage, to the active power and to the power factor. It is useful because on page M.01 are instead shown only the significant setpoints in each moment. For example, if a plant can operate both in BASE LOAD mode and in IMPORT/EXPORT mode, on page M.01 only the setpoints relative to the active operation mode will be shown, while on page M.15 they will all be shown: in this way, the operator can set the setpoints before changing the operation mode. The displayed and modifiable setpoints (if not acquired from analogue inputs) are:

- Offset of speed (P.0840).
- Offset of voltage (P.0867).
- Setpoint of active power for the SYSTEM BASE LOAD (P.0858) and for the SYSTEM IMPORT EXPORT (P.0859) modes.
- Setpoint of power factor for the SYSTEM BASE LOAD and for the SYSTEM IMPORT EXPORT modes (P.0860).

The setpoints are only shown if they are not acquired from analogue inputs and if they are included in the plant configuration.

6.5.3.16 M.16-17-18 EXTERNAL MEASURES

These pages are dedicated to the displaying of the measurements acquired from the analogue inputs configured as "generic sensor". The operator has the option to acquire measures that are not in any way linked to the controller, and to show them on the display. It can also group them (by any standard) and display them on one of the 3 available pages.

The division of the measures on the different pages is done via the function configured in the analogue inputs:

- AIF.2001: page M.16.
- AIF.2003: page M.17.
- AIF.2005: page M.18.

The controller shows one measurement per line: it shows the text configured for the analogue input (P.4002 for the analogue 1), followed by the unit of measure and by the measure itself. If more than 6 measurements are associated to one of these pages, the controller shows them all, rotating them every 2 seconds: keep the ESC/SHIFT button pressed to stop the rotation on the current view.

6.5.4 Measurement from CAN bus PMCB (B.XX)

These pages show the measurement and the statuses acquired by the CAN bus PMCB, which connects among them all Mecc Alte devices.

6.5.4.1 B.01 MC/BTB DEVICES ON PMCB

This page shows the list of the grid controllers and of the tie breaker controllers recognised on the CAN bus PMCB connection. It is useful for diagnostic purposes.

On the top, the PMCB addresses of all grid controllers (MC xxx) are displayed. On the bottom, the PMCB addresses of all tie breaker controllers (BTB xxx) are displayed.

The board shows the message "MC" in “reverse” if is working on MC200 mode (P.9506 = 1).

6.5.4.2 B.02-03-04-05 GENSETS

These pages show the significant data of each genset controller that operates on the PMBC CAN bus. Each page shows up to 6 gensets. Only the relevant pages are shown. It is used one line for each genset, which contains:

- The PMCB address of the genset. MC400 shows the PMCB address in “reverse” if now, it cannot manage this genset (for example if the related genset controller is in OFF_RESET mode or has some alarms).
- The active power supplied by the genset.
- The reactive power supplied by the genset.

If the parameter P.9506 is set to zero, MC400 acts as the old MC100 controller:

In AUTO mode, MC400 starts and stops the generators as required by the loads. Using these pages, the operator can modify this behaviour. For each generator, the operator can select one of these operating modes:

- Automatic management (default). MC400 starts/stops the generator as required by load. In this case, a “**blank field**” is shown on the display between PMCBUS address and nominal power of the selected generator.
- Generator always working. Whatever the load is, this generator must work. In this case, a “**full square**” is shown on the display between the genset address and the nominal power of the selected genset.
- Generator always stopped. Whatever the load is, this generator must be stopped. In this case, an “**empty square**” is shown on the display between the genset address and the nominal power of the selected genset.

It is possible to choose the desired operating mode for each generator directly from these pages:

- Press ACK/ENTER pushbutton:
- By using ▲▼pushbuttons, select the desired genset.
- Change the desired operating mode using ◄►pushbuttons.
- Press ESC/SHIFT to exit selection mode.

Note: if no buttons are pressed for 60 seconds, the selecting procedure is automatically finished.

6.5.4.3 B.06 TOTALS ON PMCB

This page shows the totals calculated on all the genset controllers connected on CAN bus PMCB. The following are shown:

- The total nominal power of the supplying gensets (MDPt, kW).
- The current load ratio of the generator’s bus (DPRt, %).
- The total active power supplied (kW).
- The total reactive power supplied (kvar).
- The total active energy (kWh, sum of energy counters of all genset control boards).
- The total reactive energy (kvar, sum of energy counters of all genset control boards).

6.5.4.4 B.07 LOAD FUNCTION

This page is dedicated to the functions of “load management” (see [8]). By the term “load management” is intended the capacity of the system to start/stop the gensets to only have the strictly necessary gensets running to supply the load (with a small margin, but not too much). This page shows some information relevant for this function.

The information shown is:

- The enabling for this controller of the “load management” function.
- The “load management” mode currently selected (it establishes the criteria with which the genset to be started are chosen).
- The “master” (it is the primary genset, the one which would not be ever stopped). For some “load management” modes this information is not displayed.
- Based on the selected mode, the controller can show in how many hours (or at which time) the system will select a new “master” genset.
- The list of the genset controllers, ordered based on the priority (first the genset with major priority, the last to be stopped). For some “load management” modes this information is not displayed.

It is possible to manually select the “master” genset directly from this page:

- Press the ACK/ENTER button.
- Use ▲▼buttons to select the address of the “master” genset selected.
- Confirm with ACK/ENTER button.

6.5.4.5 B.08 LOAD MANAGEMENT

This page is dedicated to the functions of “load management” (see [8]). By the term “load management” is intended the capacity of the system to start/stop the gensets to only have the strictly necessary gensets running to supply the load (with a small margin, but not too much). This page shows some information relevant for this function.

The information shown is:

- The power supplied by the gensets (percentage with respect to the maximum power the gensets currently running can afford).
- The threshold (%) to compare with the power calculated at the previous point, over which a new genset must be started (or it is necessary to pass to a combination of gensets with a higher nominal power).
- The power supplied by the gensets (percentage relative to the maximum) calculated in case the less priority genset is stopped (or combination of gensets with less nominal power).
- The threshold (%) to compare with the power calculated at the previous point, under which a new genset must be started (or it is necessary to pass to a combination of gensets with a lower nominal power).

Some of these measurements can be viewed in reverse to indicate an “out of threshold” situation (which can require the start or stop of the genset).

When possible, the controller also displays the remaining time to the start of a new genset or to the stop of one of the running gensets.

6.5.4.6 B.09 LOAD SHEDDING

This page is dedicated to the functions of “load shedding”. By the term “load shedding” is intended the capacity of the system to disconnect/re-connect part of the loads if the generators cannot supply them. This page shows some information relevant for this function:

- The status of each group of loads (connected/disconnected). The function can manage up to four groups.

- The status of this function (enabled/disabled).
- The power (%) supplied by the gensets, related to the thresholds for the disconnection and re-connections of the groups of loads.

Some of these measurements can be shown in reverse to indicate an “out of threshold” situation (which can require the disconnection or the re-connection of a group of loads).

When possible, the controller also displays the remaining time to the disconnection or the re-connection of a group of loads.

6.5.4.7 B.10 PEAK SHAVING

This page is dedicated to the functions of “peak shaving” or “peak lopping”. By these terms is intended the capacity of the system to start/stop the gensets when the consumption of the loads from the grid is too high, in a way to limit the loads consumption from the grid. This page shows some information relevant for this function:

- The status of this function (enabled/disabled).
- The power (%) of the loads, related to the thresholds for starting/stopping the generators.

Some of these measurements can be viewed in reverse to indicate an “out of threshold” situation (which can require the start or stop of the gensets).

When possible, the controller also displays the remaining time to the start of a new genset or to the stop of one of the running gensets.

6.5.5 History logs (H.XX)

During the operation, apart from the OFF/RESET mode, the controller makes periodic registration or on event, partially configured with the programming parameters.

The controller manages three types of archives:

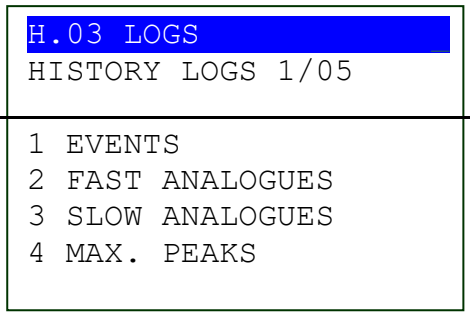
- Events.
- Analogue measures.
- Maximum peaks.

These archives can be accessed in any function mode and status of the controller. To select the function, use the buttons ▲ and ▼ until the HISTORY ARCHIVE (H.01) base page is shown.

If you are in a mode which limits the use of vertical scrolling buttons, it might be necessary to press ESC/SHIFT button one or more times.

Then press the ACK/ENTER button to activate the mode (pass to page “H.03”). At the starting of the procedure, the menu with the different archive function is shown.

6.5.5.1 Archive selection



The second line always shows the numeric indication of the function selected and the number of functions in the menu. The next lines are all used to show the selectable functions. The selected item is highlighted in negative (REVERSE).

Using ▲ and ▼ buttons, the menu scrolls respectively towards the top or bottom index items, in a cyclical way (that is, pressing ▲ from the first item you pass to the last and vice-versa).

Pressing ACK/ENTER button the selected function activates (the one highlighted in negative), pressing ESC/SHIFT you go back to page “H.01”.

6.5.5.2 Pages for events

In the moment in which some events happen (previously configured), the controller adds a registration in this archive. The registration always contains date/hour, numeric code which identifies the event and the controller status. Through BoardPrg3 program, it is possible to select which other information must be registered at every event. It is possible to add maximum 44 information. The capacity of the archive depends on how much information are memorized at every event: with default configuration the total capacity is 523 registrations. If the archive is full and a new event occurs, the less recent is overwritten.

Parameter P.0441 allows to select which events must be registered. It is a parameter configurable at bit:

Bit	Hexadecimal value	Firmware version	Description
0	01	01.00	Board operating mode.
1	02	01.00	Grid status.
2	04	01.00	Generators bus status.
3	08	01.00	Grid fault protections.
4	10	01.00	Circuit breakers status.
5	20	01.00	Circuit breakers commands.
6	40	1.00	Start/stop requests.
7	80	01.00	Loads disconnect.
8	100	01.00	Diagnostics.

A chart follows with the codes for all events.

Code	Version	Even if blocked.	Registration cause.
EVT.1001	01.00	Yes	OFF_RESET.
EVT.1002	01.00	Yes	MAN.
EVT.1003	01.00	Yes	AUTO.
EVT.1004	01.00	Yes	TEST.
EVT.1005	01.00	Yes	REMOTE START.
EVT.1010	01.00		Grid not present.
EVT.1011	01.00		Grid present.
EVT.1012	01.00		Grid in tolerance.
EVT.1013	01.00		Inhibition for start active (from configurable input).
EVT.1014	01.00		Inhibition for start not active (from configurable input).
EVT.1020	01.00		Genset not present.
EVT.1021	01.00		Genset present.
EVT.1022	01.00		Generator in tolerance.
EVT.1030	01.00		MGCB close command.
EVT.1031	01.00		MGCB open command.
EVT.1032	01.00		MGCB closed.
EVT.1033	01.00		MGCB open.
EVT.1035	01.00		MCB close command.
EVT.1036	01.00		MCB open command.
EVT.1037	01.00		MCB closed.
EVT.1038	01.00		MCB open.
EVT.1050	01.00		Manual start command.
EVT.1051	01.00		Manual stop command.
EVT.1052	01.00		Automatic start command.
EVT.1053	01.00		Automatic stop command.
EVT.1054	01.00		TEST start command from digital input.
EVT.1055	01.00		TEST stop command from digital input.
EVT.1056	01.00		TEST start command from communication port.
EVT.1057	01.00		TEST stop command from communication port.
EVT.1058	01.00		TEST start command from clock/calendar.
EVT.1059	01.00		TEST stop command from clock/calendar.
EVT.1060	01.00		TEST start command from SMS.
EVT.1061	01.00		TEST stop command from SMS.

Code	Version	Even if blocked.	Registration cause.
EVT.1062	01.00		Automatic start command for failure to close MCB.
EVT.1074	01.00	Yes	Reset
EVT.1075	01.00		Not valid clock (but used by some functions).
EVT.1076	01.00	Yes	Update clock/calendar.
EVT.1077	01.00	Yes	New power on of the controller.
EVT.1078	01.00	Yes	Default values of parameters reloaded.
EVT.1080	01.00		Inhibition for supply activated (from configurable input).
EVT.1081	01.00		Inhibition for supply not activated.
EVT.1082	01.00		Protection’s override activated.
EVT.1083	01.00		Protection’s override deactivated.
EVT.1086	01.00	Yes	Clock updated for daylight saving time.
EVT.1087	01.00	Yes	Clock updated for standard time.
EVT.1091	01.00		Grid loss protection “27 U<<” tripped.
EVT.1092	01.00		Grid loss protection “59 U<<” tripped.
EVT.1093	01.00		Grid loss protection “81 f<<” tripped.
EVT.1094	01.00		Grid loss protection “81 f<<” tripped.
EVT.1095	01.00		Grid loss protection “81 R” (Df/Dt) tripped.
EVT.1096	01.00		Grid loss protection “Vector Jump” tripped.
EVT.1098	01.00		Grid loss protection (from contact) tripped.
EVT.1099	01.00		Grid loss protection restored.
EVT.1100	01.00		Grid loss protection “27 U<” tripped.
EVT.1101	01.00		Grid loss protection “59 U>” tripped.
EVT.1102	01.00		Grid loss protection “81 f<” tripped.
EVT.1103	01.00		Grid loss protection “81 f>” tripped.
EVT.1104	01.00		Protections 27 enabled.
EVT.1106	01.07		Opening of a circuit breaker as backup for the grid failure on another grid transformer, in parallel with this one.
EVT.1151	01.00		Grid loss protection “27 U<” restored.
EVT.1152	01.00		Grid loss protection “59 U>>” restored.
EVT.1153	01.00		Grid loss protection “81 f<<” restored.
EVT.1154	01.00		Grid loss protection “81 f>>” restored.
EVT.1155	01.00		Grid loss protection “81 R” (Df/Dt) restored.
EVT.1156	01.00		Grid loss protection “Vector Jump” restored.
EVT.1158	01.00		Grid loss protection (by contact) restored.
EVT.1160	01.00		Grid loss protection “27 U<” restored.
EVT.1161	01.00		Grid loss protection “59 U>” restored.
EVT.1162	01.00		Grid loss protection “81 f<” restored.
EVT.1163	01.00		Grid loss protection “81 f>” restored.
EVT.1164	01.00		Protections 27 disabled.
EVT.1166	01.07		End of opening condition of a circuit-breaker as backup for the grid failure on another grid transformer in parallel with this one.
EVT.1191	01.05		The parallel with the grid is allowed
EVT.1192	01.05		The parallel with the grid is not allowed
EVT.1201	01.00		Inhibition for supply activated (from grid out of thresholds).

Code	Version	Even if blocked.	Registration cause.
EVT.1202	01.00		Inhibition for supply activated (from communication ports).
EVT.1203	01.00		Inhibition for supply activated (for some GCB not opened).
EVT.1204	1.00		Inhibition for supply activated (for reverse synchronization).
EVT.1221	01.00		Inhibition for start active (from clock/calendar).
EVT.1222	01.00		Inhibition for start not active (from clock/calendar).
EVT.1223	01.00		Inhibition for start active (for grid out of tolerance for SPtM and MPtM plants).
EVT.1224	01.00		Inhibition for start not active (for grid out of tolerance for SPtM and MPtM plants).
EVT.1225	01.00		Inhibition for start active (for GCB not opened).
EVT.1226	01.00		Inhibition for start not active (for GCB not opened).
EVT.1291	01.00		Load function: new master genset.
EVT.1321	01.00		Load shedding: load #1 disconnected.
EVT.1322	01.00		Load shedding: load #1 re-connected.
EVT.1323	01.00		Load shedding: load #2 disconnected.
EVT.1324	01.00		Load shedding: load #2 re-connected.
EVT.1325	01.00		Load shedding: load #3 disconnected.
EVT.1326	01.00		Load shedding: load #3 re-connected.
EVT.1327	01.00		Load shedding: load #4 disconnected.
EVT.1328	01.00		Load shedding: load #4 re-connected.
EVT.1321	01.00		Number of gensets connected to bus PMCB varied
EVT.1331	01.00		Peak shaving: request to start the generators.
EVT.1332	01.00		Peak shaving: request to stop the generators.

The column “even if blocked” indicates which events are anyway recorded even if the records are blocked (see 6.5.5.4)

All the anomalies are recorded into the events log. They are recorded with their own numerical code, added to:

- 2000: if the anomaly is a warning.
- 3000: if the anomaly is an unload.
- 5000: if the anomaly is an alarm.

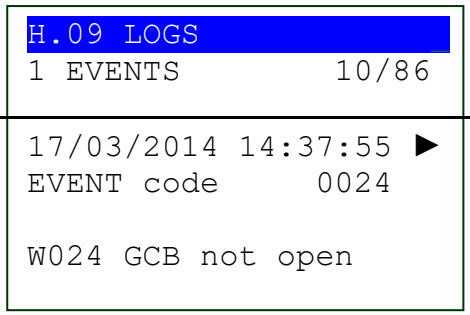
For example, anomaly 273 will be recorded as "2273" when it is activated as a warning, as "5273" if it is activated as an alarm. By viewing the event directly from the controller, the event code "2273" is automatically displayed as "W273", the code 5273 is displayed as "A273".

With the default configuration, each time that an event is recorded, the controller also records the following info (this list can be modified by means of the BoardPrg3 program):

- Date/Time.
- Event code.
- Operating mode of the controller.
- Presence of voltage on the generator’s bus.
- Grid status.
- MGCB circuit breaker status.
- MCB circuit breaker status.
- Grid phase-to-phase voltages and frequency.
- Generators bus phase-to-phase voltages and frequency.
- The three phase currents.
- The total (apparent, active and reactive) powers and the total power factor.
- The power supply voltage and the auxiliary current.

Using the ▲▼ buttons to scroll cyclically trough all recordings. Each event has many information pages (depending on the configuration). Pressing the ◄► buttons allows you to scroll through the pages related to the event.

The structure of the upper part of the pages is the same for all pages. The following figure shows the first page.



The common part contains:

- The second line shows which event is currently displayed, the total number of recorded events and the maximum size of the archive. The most recent event is associated to the highest number.
- The next line shows the date/time of the recording.
- The next line shows the numeric code of the event and its description (variable depending on the selected language).

The content below the dashed line depends on the information configured for the record; with the default configuration, five pages are used:

Page 1. It shows the statutes of the system at the time when the event was recorded: the controller operating mode, the statutes of the generators and of the grid.

Page 2. It shows the statutes of the circuit breakers.

Page 3. It shows the frequency and the phase-to-phase voltages of the grid.

Page 4. It shows the frequency and the phase-to-phase voltages of the generator's bus.

Page 5. It shows the phase currents, the total active power (kW), the total reactive power (kvar), the total apparent power (kVA) and the total power factor.

Page 5. It shows the power supply voltage and the auxiliary current.

The information that was not available at the time of recording are displayed with dashes.

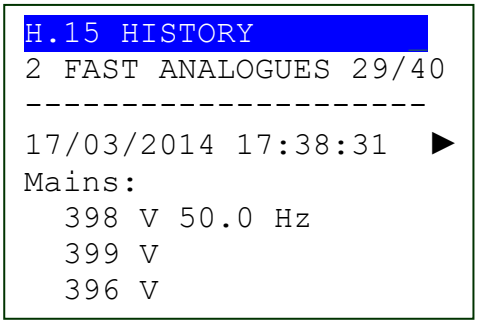
6.5.5.3 Pages for analogues

The controller records the ANALOGUE magnitudes described below; the recording frequency is configured with the parameter P.0442 (seconds) and P.0443 (minutes):

- Date/Time.
- Grid phase-to-phase voltages and frequency.
- Generators bus phase-to-phase voltages and frequency.
- The three phase currents.
- The total (apparent, active and reactive) powers and the total power factor.
- The nominal power, the active power and the reactive power of the generators with GCB closed (totals).
- The power supply voltage and the auxiliary current.

Using the ▲ and ▼ buttons to scroll cyclically trough all recordings. Each record has a variable number of information pages (based on the configuration). By pressing ◄► buttons it is possible to navigate on the pages related to recording.

The structure of the upper part of the pages is the same for all four. The following figure shows the first page.



The common part contains:

- The second line shows which record is currently displayed, the total number of recorded registrations and the maximum size of the archive. The most recent record is associated to the highest number.
- The next line shows the date/time of the recording.

The content below the dashed line depends on the information configured for the record; with the default configuration, 5 pages are used:

Page 1. It shows the frequency and the phase-to-phase voltages of the grid.

Page 2. It shows the frequency and the phase-to-phase voltages of the generator's bus.

Page 4. It shows the phase currents, the total active power (kW), the total reactive power (kvar), the total apparent power (kVA) and the total power factor.

Page 5. It shows the power supply voltage and the auxiliary current.

The information that was not available at the time of recording are displayed with dashes.

6.5.5.4 Fast analogues logs

The fast ANALOGUEs are recorded at a pace configurable by means of the parameter **P.0442** (interval in seconds) and the default interval is 60 seconds. This archive provides a total storage capability of **42** records. Every following record overwrites the older one. The controller records the ANALOGUE values described in par. 6.5.5.3.

6.5.5.5 Slow analogues logs

The slow ANALOGUEs are recorded at a pace configurable by means of the parameter **P.0443** (interval in minutes) and the default interval is 30 minutes. This archive provides a total storage capability of **64** records. Every following record overwrites the older one. The controller records the ANALOGUE values described in par. 6.5.5.3.

6.5.5.6 Locked recordings

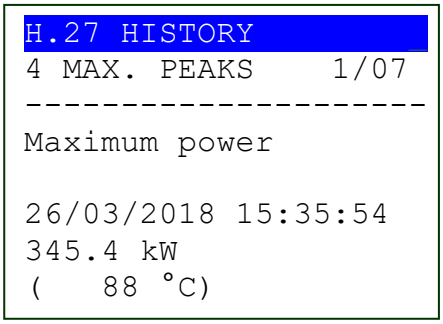
The controller does not perform recordings in the archive of analogues and in the archive of events if it is in OFF/RESET mode and when a shutdown or an unload has been activated. Exceptions are some event codes (highlighted by the wording "Yes" in the column "even if blocked" of the table in 6.5.5.2) and all anomalies. When the recordings are locked, all the windows of the History logs display an intermittent "Locked" message. To unlock the recordings, it is necessary cancel all anomalies and set the board in MAN or AUTO.

6.5.5.7 Pages for peaks

The controller makes a series of maximum and minimum peaks for some significant values.

- Total active power: the maximum peak is recorded, having the date/ associated.
- Currents: the maximum peaks of individual phases are recorded, having the date/time and power factor of that phase associated.

To display all records, the controller uses only one page of the display.



The second line shows the record currently displayed, out of the total number of records (the maximum number of records is 6).

The fourth line shows a description of the peak record currently displayed.

- Maximum power.
- Maximum current (L1).
- Maximum current (L2).
- Maximum current (L3).

The sixth line shows the date and the time of the record, the value of the record (power, current, etc.) On the eighth line a second value can be recorded together with the main value:

- The power factors on single phases are recorded together with the currents.

The information that was not available at the time of recording are displayed with dashes.

Using the ▲ and ▼ pushbuttons it is possible to scan all the records. The buttons ◄ and ► are not used because the controller uses only one page of the display.

6.5.5.8 Exit from archives visualization.

There are two ways to exit from archive visualization:

- Press ESC/SHIFT n times to go to page H.01
- Changing operating mode of the controller.

In both cases, it will be shown the page H.01, from which it is possible to pass to the status and measurements visualization with ▲ and ▼ pushbuttons.

6.5.5.9 Reset of archives

To reset an archive, it is first necessary to show it and then keep ACK/ENTER and ESC/SHIFT pressed for 5 seconds up to when the controller shows a message of happened reset on the display. The archive of maximum peaks does not reset, but the controller forces as maximum peak the current value of the measurements.

6.6 Language selection

The controller allows to select the language to use for all writings displayed on the multifunctional viewer. Currently, 5 languages are supported: Italian, English, Portuguese, French, Spanish and Russian (English as default). The directly available languages are only: English and Portuguese. The others can be transferred to the controller (one at a time) though BoardPrg3 software. See 6.5.2.3 for the language selection procedure.

7 Operation sequence

The rest of the chapter will describe the actions of MC400 on the MCB and MGCB circuit breakers and the commands sent to the gensets controllers via CAN bus PMCB.

MC400 can send some commands (via CAN bus PMCB) to the gensets controllers. These commands are sent to the genset controllers only if they are "**managed by MC xxx**".

MC400 uses a different way (respect the old MC100) for starting and stopping the generators through the PMCB CAN bus. The new system provides more functionalities but requires an updated firmware also an all the genset controllers (GC xxx or DST xxx). For this reason, MC400 can emulate the old MC100.

P.9506 = 1. In this configuration, MC400 emulates the old MC100.

A controller is "**managed by MC xxx**" if:

- It does not have alarms, deactivations or unloads.
- It is not in OFF/RESET, MAN or TEST mode.
- The contact "inhibition for start" is active.
- It does not have requests of "inhibition for supply the loads" (by contact or by communication ports).
- It does not have REMOTE START requests, if not received by MC xxx.
- It does not have the contact to enable the REMOTE START mode, or it is active.

To request the start of a genset, MC xxx sends a "REMOTE START" request to the related genset controller (for this reason a controller must have the "REMOTE START" function enabled to be "managed by MC xxx").

To request the stop of a genset, MC xxx removes the request of "REMOTE START" to the related controller. The controller will stop the genset if:

- There are no requests of REMOTE START and TEST.
- There are no requests of automatic intervention, or the request of "automatic start inhibition" by contact is active.

The two previous conditions are necessary to get the genset controller "managed by MC xxx".

In some conditions, and only if MGCB is present, MC xxx can request the opening of the GCB circuit breakers of the gensets controllers. To do this, MC xxx sends a command of "load inhibition" to the genset controllers. When the opening of the GCB circuit breakers is not required, MC xxx removes the request of "load inhibition": the genset controllers will close the GCB circuit breakers only if there are no requests of "load inhibition" (necessary condition to get the genset controller "managed by MC xxx").

P.9506 = 0. In this configuration, MC400 uses the new command system, which provides enhanced functionalities.

A controller is "managed by MC xxx" if:

- It does not have alarms, deactivations or unloads.
- It is in AUTO mode (not in TEST or in REMOTE START mode).
- It does not have requests of "inhibition for start" (by contact or by Modbus).
- It does not have requests of "inhibition for supply the loads" (by contact or by Modbus).

To request the start of the gensets (all controlled ones), MC400 sends an "automatic start request" over the CAN bus. In the same way, to stop the gensets (all controlled ones), it removes the "automatic start request" from the CAN bus. The genset will stop if:

- Its controller is in AUTO mode.
- There are no requests of automatic intervention, or the request of "start inhibition" by contact or Modbus is active.

In some conditions, and only if MGCB is present, MC400 can request the opening of the GCB circuit breakers of the gensets controllers. To do this, MC400 sends a command of "inhibition for supply the loads" to the genset controllers. When the opening of the GCB circuit breakers is not required, MC400 removes the request of "inhibition

for supply the loads": the genset controllers will close the GCB circuit breakers only if there are no requests of "inhibition for supply the loads".

7.1 Operation mode

Five modes are available for the controller management.

- **OFF_RESET**: the MGCB is open to disconnect the gensets from the loads and/or the grid (if it exists and if it is commanded by MC400). The MCB is closed to connect the loads to the grid (if it exists and if it is commanded by MC400). MC400 removes all the requests of gensets start. All anomalies are cancelled, and it is possible to access the programming to modify the parameters.
- **MAN:** the start and the stop of the gensets are managed by the operator. The opening/closing of the two circuit breakers (if they are present and commanded by MC400) are managed by the operator. The controller automatically activates the synchronization procedure (if required) following the manual command of a circuit breaker closing by the operator. The protections are active: MC400 is always able to open the MGCB circuit breaker (if present) and remove the requests of gensets start. The access to programming is allowed, but only some parameters can be modified.
- **AUTO**: the start and the stop of the gensets and the opening/closing of the MGCB and MCB circuit breakers are managed by the controller (the operator cannot intervene). All the protections are enabled. The access to programming is allowed, but only some parameters can be modified.
- **TEST**: this operating mode differs from AUTO, as MC400 still requires the start of the gensets, without considering that the conditions of the plant require the automatic intervention of the gensets or not (the "automatic intervention inhibition" are ignored in this mode). By parameter P.0222, it is possible to choose if the controller has or has not to connect the load to generators. When the controller goes back to AUTO (when the test ends), the loads are automatically switched on the grid and the gensets are stopped with the normal procedure. If possible, the switch of the loads between grid and gensets is carried out by avoiding their black-out. The controller will pass automatically from TEST to AUTO if the conditions for an automatic gensets intervention are verified. The access to programming is allowed, but only some parameters can be modified.
- **REMOTE START**: this operating mode differs from AUTO, as MC400 still requires the start of the gensets, without considering that the conditions of the plant require the automatic intervention of the gensets or not (the "automatic intervention inhibition" are ignored in this mode). If there are no requests of "inhibition to take the load", the loads are switched on the gensets. The operator cannot command the circuit breakers manually. When this operating mode is deactivated, the controller goes back to AUTO and, if the automatic intervention of the gensets is not requested, the controller opens the MGCB circuit breaker and removes the start requests of the gensets. The access to programming is allowed, but only some parameters can be modified.

The operation mode can be selected in three different ways:

- Using "MODE ▲" and "MODE ▼" buttons on the controller. The buttons must be pressed continuously for at least half a second to force the mode change. The buttons are disabled if at least one of the inputs described at the following point exists and is active (on the first line of the display a flashing key shaped icon is shown).
- Using one or more configured inputs with the following functions:
  - DIF.2271 "OFF from remote".
  - DIF.2272 "MAN from remote".
  - DIF.2273 "AUTO from remote".

  When one of these inputs is active, the controller mode is forced, and it is no longer possible to use either the buttons on the panel or the Modbus commands to modify it (on the first line of the display a flashing key shaped icon is shown).

  When none of these inputs is active, it becomes possible again to use the buttons and the Modbus commands to change the operation mode.

If there are more active inputs at the same time, the priority is given to the input which forces OFF/RESET, followed by the one which forces MAN, and then the one which forces AUTO.

It is not mandatory to use all three inputs. For example, it is possible to use only one input to force the AUTO status; when the input is active, the controller is always in AUTO, when the input deactivates the controller remains in AUTO, but it is possible to use the buttons to pass to MAN or OFF/RESET.

If it is used only the input to force OFF/RESET mode, the controller acts differently: when the input is active, the controller is always in OFF/RESET mode, and when the input goes back on standby, the controller goes back to the mode it was in prior to input activation.

- By Modbus commands. The commands are only managed if none of the above-described inputs is active. These commands can be disabled in different ways (see 5.11). To send the command it is necessary to write in sequence (within 5 seconds):
  - HOLDING REGISTER 101: write the password configured with the parameter P.0004.
  - HOLDING REGISTER 102: write the value:
    - "1" to require the OFF/RESET mode.
    - "2" to require the MAN mode.
    - "3" to require the AUTO mode.

To enable the **TEST** mode requires the controller being first set to AUTO without any automatic start request. All TEST activation modes are described below. If in TEST mode, the AUTO/TEST indicator flashes at a duty of 50%. You can shift to TEST mode as follows:

- Pressing the START pushbutton. Shifting to TEST mode is immediate. To return to AUTO mode, press again the START pushbutton. If the TEST duration (P.0420) is configured (different from zero), this test ends automatically after the time indicated. Parameter P.0222 establishes if the generators are connected to the loads or not.

- When a digital input configured with function DIF.2031 "Request of Test mode" activates, the controller shifts to TEST and returns to AUTO when it deactivates. Parameter P.0222 establishes if the generators are connected to the loads or not.

- By using a digital input configured with the function DIF.2029 ("Request for the test mode without load - impulse"). The controller evaluates the input activation moment (impulse): the controller switches to TEST when this input activates and goes back to AUTO at the end of the time configured in P.0420 (if P.0420 is set to zero, the test is not carried out). If there is a second activation of the input during the test, the test is immediately stopped. During this test, the controller does not connect the generators to the loads, independently from the value configured in P.0222.

- By using a digital input configured with the function DIF.2030 ("Request for the test mode with load - impulse"). The controller evaluates the input activation moment (impulse): the controller switches to TEST when this input activates and goes back to AUTO at the end of the time configured in P.0420 (if P.0420 is set to zero, the test is not carried out). If there is a second activation of the input during the test, the test is immediately stopped. During this test, the controller connects the generators to the loads, independently from the value configured in P.0222.

- By properly configuring the parameters:
  - P.0418: Test enable days.
  - P.0419: Test start time.
  - P.0420: Test duration.

  They allow selecting the days of the week and a time slot within which the working mode switches from AUTO to TEST. In this case, the passage to TEST is automatic in the scheduled days and hour. The controller returns to AUTO when the TEST time interval ends. Parameter P.0222 establishes if the generators are connected to the loads or not.

- By means of a proper command via SMS (see [3]). To use this feature, the parameter P.0420 "Test duration" shall not be set to zero (it indicates in effect the duration of the test). In this case, the controller shifts from

TEST after receiving the SMS and returns to AUTO after the time P.0420. Parameter P.0222 establishes if the generators are connected to the loads or not.

- From a Modbus command. The controller shifts to TEST when it receives the command, returns to AUTO when it receives the opposite command or when it considers the connection interrupted (60 seconds without messages). These commands can be disabled in different ways (see 5.11). To send the command it is necessary to write in sequence (within 5 seconds):
    - HOLDING REGISTER 101: write the password configured with the parameter P.0004.
    - HOLDING REGISTER 102: write the value:
        - “12” to require the vacuum TEST mode.
        - “14” to require the load TEST mode.
        - "21" to return to AUTO.

To activate the “**REMOTE START”** mode, the controller must be in AUTO or in TEST mode. Moreover, it is possible to configure an input with DIF.2701 function ("enable remote start request"): if the input exists, it should be active. This mode can be activated in one of the following modes:

- By means of the digital input configured with the function DIF.2032 (“remote start request”). If input is active, the REMOTE START mode is entered and it is leaved deactivating the input.

- By means of a proper command via SMS (see [3]). In this case, the controller shifts to REMOTE START as soon as it receives the SMS and returns to AUTO when it receives the opposite command. In this case, it is mandatory to configure an input with function DIF.2701 (“enable remote start request”): the input must be active (normally wired on a switch at control panel front to enable the remote commands).

- By properly configuring the parameters P.0426, P.0427 and P.0428, it is possible to define an hour range within which the working mode automatically switches to REMOTE START. Parameter P.0426 allows to establish in which days of the week this function is active. The remaining two allow to set an hour range valid for all selected days. The range start time (P.0427) refers to the days set in P.0426, while the range end time (P.0428) refers to the same day, if its value is higher than P.0427, or to the following day if lower (across midnight). Moreover, setting P.0427 and P.0428 to the same value, you define a full day range.

- By a Modbus command. The controller shifts to REMOTE START once it receives the command, returns to AUTO when it receives the opposite one (it remains in REMOTE START if the connection interrupts before receiving the opposite command). In this case, it is mandatory to configure an input with function DIF.2701 (“enable remote start request”): the input must be active (normally wired on a switch at control panel front to enable the remote commands). These commands can be disabled in different ways (see 5.11). To send the command it is necessary to write in sequence (within 5 seconds):
    - HOLDING REGISTER 101: write the password configured with the parameter P.0004.
    - HOLDING REGISTER 102: write the value:
        - “13” to require the REMOTE START mode.
        - "21" to return to AUTO.

7.1.1 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/RESET”.
- 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”.

Some functions are available for the configuration of the digital outputs related to the operation mode of the controller:

- DOF.3001 - “OFF/RESET”. The board activates this output when in OFF/RESET mode.
- DOF.3002 - “Man”. The board activates this output when in MAN mode.
- DOF.3003 - “Auto”. The board activates this output when in AUTO mode.

- DOF.3004 - “Test”. The board activates this output when in TEST mode.
- DOF.3005 - “REMOTE START”. The board activates this output when in REMOTE START mode.
- DOF.3011 - “Not in OFF/RESET”. The board activates this output when in AUTO or MAN mode.
- DOF.3012 - “One of the automatic modes”. It activates when a controller is in an automatic operation mode, which is AUTO, TEST, or REMOTE START.

Also, the controller operates with AND/OR logics through the following internal statuses:

- ST.000 - “OFF/RESET”.
- ST.001 - “manual”
- ST.002 - “Automatic”.
- ST.003 - “Test”.
- ST.004 - “remote start”.

7.2 Generators bus voltage detection.

The controller needs to know if there are voltages on the generators bus to enable or not the synchronization when it must close a circuit breaker. The following terms are used:

- “Dead” bus: no voltages on generators bus.
- “Live” bus: voltages on generators bus.

The controller can detect the presence of voltage on the generators bus through its three-phase sensor (JF) or through an external sensor.

Note: if there is an external sensor, the internal one is ignored.

Note: if the controller must synchronize the gensets with the grid, it is necessary to use the internal sensor (or an external synchronizer).

The gensets bus status is displayed by means of the led GENERATORS BUS LIVE.

7.2.1 External sensor

Use a digital input configured with the function DIF.3102 (“No voltages on gensets”): when the input is active, the generators bus is considered “without voltage”.

7.2.2 Internal sensor

The controller uses the parameters to configure the sensor:

- P.151: it indicates whether the full-scale voltage is 400V or 100V.
- P.0101: it indicates the generators bus wiring mode.
- P.0102: gensets nominal voltage. Its value must be the nominal phase-to-phase voltage for three-phase systems and phase–to–neutral voltage for single-phase systems.
- P.0103: primary value (Vac) of voltage transformers connected to the JF connector.
- P.1104: secondary value (Vac) of voltage transformers connected to the JF connector.

For the connection of the voltage lines, see paragraph 5.9.

Note: set the nominal voltage to a value different from zero.

The controller uses a fixed threshold, 9% of nominal voltage (with a 3% hysteresis). Generators bus is considered “dead” if all voltages (P.0101) are below the 9% threshold, it is “live” if at least one voltage is above 12% (9 + 3). With default parameters, generators bus is “dead” if all voltages are lower than 36 V; it is “live” if at least one voltage is greater than 48 V. The controller performs these checks for all available L-N and L-L voltages.

7.2.3 Events and signalling

The controller records the following events if the working mode changes (if enabled with bit 2 of P.0441 parameter):

- EVT.1020: no voltages on the generator’s bus.
- EVT.1022: voltages on the generator’s bus.

The following functions, for the configuration of the digital outputs, are related to the generator’s bus voltage:

- DOF.3031 (“Voltage on gensets”): the output is active when there are voltages on the generator’s bus.

7.3 Load bus voltage detection.

The controller needs to know if there are voltages on loads bus to enable or not the synchronization when it must close the circuit breakers. The following terms are used:

- “Dead” bus: no voltages on loads bus.
- “Live” bus: voltages on loads bus.

The controller cannot directly detect voltages on the loads (except when MGCB is not used or always closed). Usually, it recreates this status according to the voltage detected on the grid and on the generator’s bus, and to the circuit breakers status.

If preferred (and for safety reasons also), it is possible to use one digital input configured with the function DIF.3104 (“No voltage on loads”) to acquire this information. Loads bus is “live” if this input is “not active” (logical state).

The loads status is displayed by means of the signal led BUS LIVE.

7.3.1 Signalling

The following functions for the configuration of the digital outputs are related to loads bus voltage:

- DOF.3030 (“Voltage on loads”): the output is active when there are voltages on the loads.

7.4 Grid

The controller acquires grid voltages and frequency, for three main purposes:

- "**AMF**". The controller must detect all anomalies about the grid to start the generators and make them supply the loads. In the same way, the controller detects when grid voltages and frequency are back to their operating values to connect loads to grid and stop the generators.
- **"Protections for the parallel with the grid (PPR)"**. The controller must detect the "loss of grid" while generators are in parallel with grid, to disconnect them from the grid (generator can in this case supply loads or not depending on plant configuration). In the same way, when generators are disconnected from the grid, the controller detects when grid voltages and frequency are back to their operating values to put generators in parallel with grid again.
- For **synchronization** purpose.

The controller uses different sets of parameters for these purposes.

Normally, the controller uses its internal sensor (JG) to measure the grid. For the first two functions, it is possible to use an external sensor alternatively (for the synchronization you must use the internal sensor).

There are some parameters for the configuration of the internal sensor that do not depend on its use:

- P.0105: nominal frequency (Hz).
- P.0152: it indicates if the full scale for the inputs is 400V or 100V.
- P.0119: it indicates the grid wiring mode.
- P.0116: nominal voltage. Its value must be the nominal phase-to-phase voltage for three-phase systems and phase–to–neutral voltage for single-phase systems.
- P.0117: primary value (Vac) of voltage transformers connected to the JG connector.
- P.0118: secondary value (Vac) of voltage transformers connected to the JG connector.

For the connection of the voltage lines, see paragraph 5.9.

Note: set the nominal voltage to a value different from zero.

The grid status is displayed by means of the signal led MAINS LIVE.

7.4.1 Automatic Mains Failure

This function must detect all anomalies on the grid voltage, to start the gensets and connect the loads to them.

Usually, this function is not used if the gensets are in parallel with the grid, Anyhow, if the parallel protections trip while the gensets are in parallel with the grid, the grid is considered "off" for AMF purpose too.

The parameter P.9504 allows to set whether to use the internal sensor ("0") or the external one ("1").

7.4.1.1 External sensor

To use an external grid sensor, P.9504 must be set to 1.

The external grid sensor must be connected to a digital input configured with the function DIF.3101 ("External sensor for grid"). The grid is "in tolerance" when this input is "active" (logical state), is "Absent" when the input is "not active".

7.4.1.2 Internal sensors

To define the grid status, the controller can carry out up to four different checks. They are described below one by one (with examples).

7.4.1.2.1 Frequency check

Parameter	Description	Default value	Frequency (Hz)
P.0105	Nominal frequency	50 Hz	50.00
P.0236	Low frequency threshold	90.0 %	45.00
P.0237	High frequency threshold	110.0 %	55.00
P.0201	Hysteresis	2.5 %	1.25

The hysteresis is applied:

- Upwards the low frequency threshold (so, with parameters default values, between 45.00 Hz and 46.25 Hz).
- Downwards the high frequency threshold (so, with parameters default values, between 53.75 Hz and 55.00 Hz).

Considering these values, we can detect the following bands:

0.00 ----------.
Band A: **absent.**
45.00 ----------.
Band B: hysteresis.
46.25 ----------.
Band C: **in tolerance.**
53.75 ----------.
Band D: hysteresis.
55.00 ----------.
Band G: **high.**
xxx ----------.

If the frequency is in the B or D bands, the controller maintains its previous status (hysteresis). For example, if the voltage was in C band and now it is in D band, it is considered “in tolerance” anyway. If instead, the frequency was in A band and now it is in B band, it is considered “off”.

7.4.1.2.2 Voltages check.

Parameter	Description	Default value	Voltage (Vac)
P.0119	Grid voltages wiring	3-Three-phase with neutral	-
P.0116	Nominal voltage	400 Vac	400
P.9505	Presence threshold	17.5 %	70
P.0203	Low voltage threshold	80.0 %	320
P.0204	High voltage threshold	110.0 %	440
P.0201	Maximum hysteresis	2.5 %	10

The hysteresis is applied:

- Upwards the grid presence threshold (so, with parameters default values, between 70 Vac and 80 Vac).
- Upwards the low voltage threshold (so, with parameters default values, between 320 Vac and 330 Vac).
- Upwards the high voltage threshold (so, with parameters default values, between 430 Vac and 440 Vac).

Considering these values, we can detect the following bands:

0 ----------.
Band A: **absent.**
70 ----------.
Band B: hysteresis.
80 ----------.
Band C: **low.**
320 ----------.
Band D: hysteresis.
330 ----------.
Band E: **in tolerance.**
430 ----------.
Band F: hysteresis.
440 ----------.
Band G: **high.**
XXX ----------.

If the voltages are in the B, D or F bands, the controller maintains its previous status (hysteresis). For example, if the voltage was in E band and now it is in D band, it is considered "in tolerance" in any case. If instead, the voltage was in C band and now it is in D band, it is considered "low".

The controller performs these checks for all available L-N and L-L voltages.

7.4.1.2.3 Asymmetry check

Parameter	Description	Default value	Voltage (Volt)
P.0116	Nominal voltage	400 Vac	400
P.0238	Voltage unbalance threshold	10.0 %	40

On three-phase systems, it is possible to consider the grid "out of tolerance" if the three phase-to-phase voltages differs from each other (in absolute value) more than the threshold set. The check is disabled for single-phase systems.

Note: MC400 does not carry out any check on the phase angles, but only on the phase-to-phase voltages.

This threshold does not use any hysteresis. With the parameters default values, if the difference between two phase-to-phase voltages in absolute value is higher than 40 Vac, the grid is considered out of tolerance; otherwise, it is considered in tolerance.

7.4.1.2.4 Cycling sense

Parameter	Description	Default value
P.0239	Required phase sequence	0-Nothing

In three-phase systems, it is possible to consider the grid "out of tolerance" if the phase's cycling sense is different from what specified in the parameter P.0239. In single-phase system, this control is disabled.

To disable this control, simply set the parameter P.0239 to "0-None".

With the parameter P.0239, it is possible to select the cycling sense required by the grid: "1-Clockwise" or "2-Counter-clockwise" The grid is considered "out of tolerance" if the cycling sense is different from the one set.

7.4.1.2.5 Internal sensor status

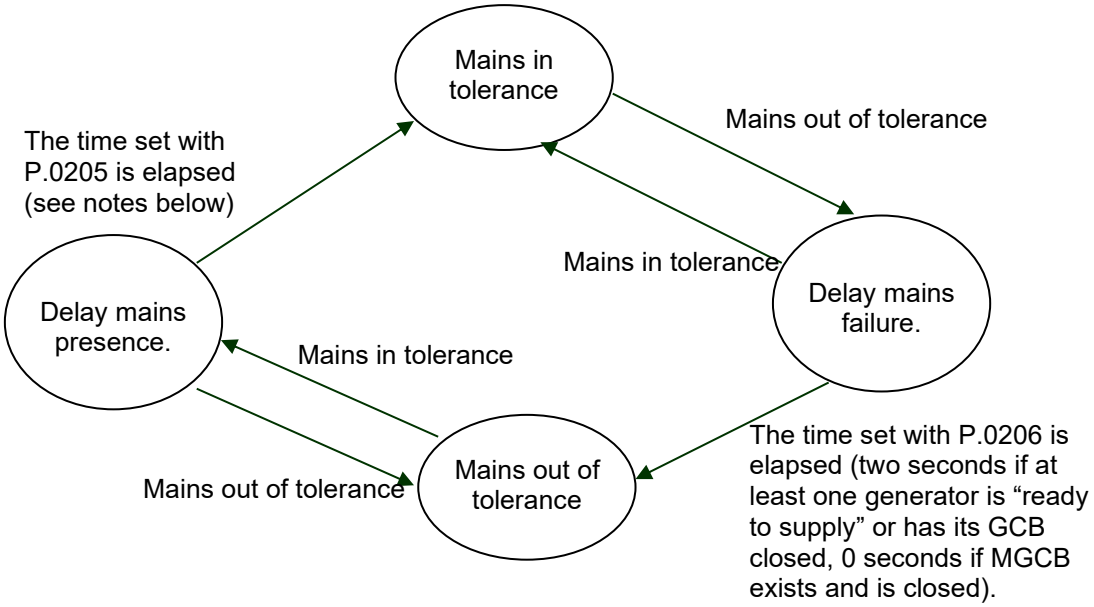
To diagnose the grid "global" status, the following algorithms are utilized, shown in their computing order:

- If **frequency and all voltages** are in the "Off" status, the general status is "Off" too.
- If **frequency and all voltages** are in the "In tolerance" status, the general status is "In tolerance" too. In this case, if the cycling sense or unbalance checks do not give positive results, the grid is considered "Low".
- If **frequency or at least one voltage** is in the "High" status, the general status is "High" too.

- If no one of the previous conditions is verified, the global status is “Low”.

7.4.1.3 Grid general status.

Whatever method is used to acquire the instantaneous status of the grid (internal or external sensor), for the operating logics of the plant the general status of the grid is described in four phases:



The use of the “grid presence delay” (configured with parameter P.0205) depends on the presence of one or more generators supplying the loads, and on the configuration of parameter P.0250. It is a bit-managed parameter. Now two bits are defined:

- Bit 0: used when the controller is in OFF/RESET mode. In this mode, the controller does not normally manage the “grid presence delay” (to re-power the loads as soon as possible since they are not powered by the generators). By setting bit 0 of P.0250 to “1”, the controller manages the "grid presence delay".
- Bit 1: used when the controller is in AUTO mode. In this mode, the duration of the “grid presence delay” depends on the presence of generators supplying the loads, and on the value of this bit:
    - At least one generator supplying the loads: the duration of the “grid presence delay” is set by parameter P.0205.
    - No generator supplying the loads and bit 1 of P.0250 is “1”: the duration of the “grid presence delay” is set by parameter P.0205.
    - No generator supplying the loads and bit 1 of P.0250 is “0”: the duration of the “grid presence delay” is 0 seconds.

7.4.1.4 Events

The controller records the following events if the grid status changes (if enabled with bit 1 in P.0441):

- EVT.1010: the new grid status is permanently “off or out of tolerance”.
- EVT.1011: the new grid status is “present or in tolerance”.
- EVT.1012: the new grid status is permanently “in tolerance”.

7.4.1.5 Signals

The following functions for the configuration of the digital outputs are connected to the grid status:

- DOF.3033 (“Grid in tolerance)”): the output is activated if the grid is permanently in tolerance, or during the delay for the “grid out of tolerance”.

7.4.2 “Loss of grid” protection

This function must detect an anomaly on the grid voltage while the gensets are in parallel with the grid, to disconnect the gensets from the grid.

It is possible to use the internal sensor of the controller or an external protection.

See document [8] for the description of these protections.

From version 1.07, the controller manages simultaneous parallel with multiple grid transformers. It can therefore happen that two grid transformers are in parallel through their respective MCB circuit breakers (and MGCB if they exist). Under these conditions, each MC controller manages the “loss of grid” protection on its own grid transformer. If, for any reason, following a grid failure, an MC controller fails to isolate its own grid transformer from the common bars, the other MC controllers connected to the same bars will open their own circuit breaker, to isolate themselves from the disconnected grid transformer: each MC will open the MGCB circuit breaker if it exists, otherwise it will open the MCB circuit breaker. Events EVT_1106 and EVT_1166 report this condition in the historical archive.

7.5 Synchronization

Synchronization is used when a circuit breaker must be closed and there are voltages on both sides of it. Synchronization can be divided into two separate functions:

- Check for differences in phase, frequency, voltages and phase sequence between generators and grid, to allow a safe closure of the circuit breaker.
- Voltages and frequency regulations, to minimize differences in voltages, frequency and phase.

The controller can manage both functions, but, if needed, allows one or both to be managed externally.

7.5.1 Synchro-check

Before closing a circuit breaker, this function checks the differences in voltages, frequency, phase and cycling sense between the grid and the gensets are within the thresholds configured; if yes, the circuit breaker can be closed in safety, otherwise it cannot be closed.

The controller performs these checks if:

- It directly manages frequency and phase regulations.
- Frequency and phase regulations are managed externally, but the parameter P.0846 forces MC400 to manage the synchro-check.

In these cases, the circuit breaker closure command (MCB o MGCB) is issued only when the “synchronized” status is detected.

The controller does not perform these checks if frequency and phase regulations are managed externally, and parameter P.0846 configures the controller not to manage the synchro-check. In this case, the circuit breaker closing command is immediately issued, as MC400 supposes that an external synchro-check inhibits the physical closing of the circuit breaker if not synchronized.

Obviously, synchronization will never start if one or both side of the circuit breaker are “dead” (without voltages).

Parameter P.0846 allows forcing the use of the MC400 synchro-check with externally managed frequency and phase regulations (its value is ignored if the controller manages the regulation processes). It allows to force the MC400 synchro-check of the circuit breakers (MCB or MGCB) individually or together (if preferred). By default, MC400 synchro-check is always forced by the parameter P.0846.

If the internal synchro-check is forced, but the controller cannot perform it, the warning W273 (incoherent parameter) is issued.

MC400 performs six different checks before allowing the circuit breaker closure: only when all checks are correct, the circuit breaker will be closed.

Voltages in tolerance check

Voltages (both grid and generators ones) must be inside configured thresholds. For example, if we have 200 V on both grid and generators, but nominal voltages are 400 V, the circuit breaker will not be closed, even if voltage difference is zero. This check can be configured with:

- P.0301: minimum voltages threshold (%).
- P.0303: maximum voltages threshold (%).

These thresholds are displayed in percentage. These thresholds are percentage of P.0116 for grid voltages, and of P.0102 for genset voltages).

Each voltage measure is compared with these thresholds: if at least one of them is out of thresholds, the circuit breaker cannot be closed (this situation is shown on display page M.12 by an empty rectangle).

Voltage differences check

If all voltages are inside the configured thresholds, the controller calculates the differences between generators and grid voltages and allows the closure of the circuit breaker only if the differences are below the threshold P.0841. This parameter allows to set the maximum voltage difference (%).

The controller analyses the differences between the voltages measured (grid phase L1 - genset phase L1, etc.) and it displays them in percentage with respect to the gensets voltage. The circuit breaker can be closed only if all differences (%) are below the threshold configured by parameter P.0841 (with a fixed hysteresis of 1%). If at least one difference is higher than the threshold, the closing is not allowed. Obviously, in a single-phase system, the controller will consider the existing one only.

The controller can work also with different nominal voltages between grid and generators (this happens when a transformer is placed between them). In this situation, both voltages (grid and generators) are converted into percentages of their own nominal, and the controller makes the comparison between those percentages: if the grid voltages are 95% of their nominal, also the generators voltages should be 95% of their nominal.

The result of this check (and of the one described above) is displayed in page M.12 by the rectangle that indicates the voltage difference:

- Empty rectangle: voltages or voltage differences are out of thresholds.
- Full rectangle: voltages and voltage differences are inside thresholds.

Frequency in tolerance check

Frequencies (both grid and generators ones) must be inside configured thresholds. For example, if we have 40 Hz on both grid and generators, but nominal frequencies are 50 Hz, the circuit breaker will not be closed, even if frequency difference is zero. This check can be configured with:

- P.0305: minimum frequency threshold (%).
- P.0307: maximum frequency threshold (%).

These thresholds are percentage of P.0105.

Grid and generators frequency are compared with these thresholds: if at least one of them is out of thresholds, the circuit breaker cannot be closed (this situation is shown on display page M.12 by an empty rectangle).

Frequency difference check

If all frequencies are in tolerance, the controller calculates the frequency differences between grid and generators, and it allows the closing only if lower than the threshold configured with the parameter P.0843. This parameter allows to set a max difference in Hz.

The controller analyses the differences between the frequencies measured, and it compares them with the threshold P.0843 (with a fixed 0,1Hz hysteresis): if the difference is higher than the threshold, the closing is not allowed.

The frequency status (the results of this check and of the previous one) is shown on the display page M.12, by the second small rectangle from the left (the one identified by the “Hz” label):

- Empty rectangle: frequencies or frequency differences are out of thresholds.
- Full rectangle: frequencies and frequency differences are inside thresholds.

Phase difference check

The controller must evaluate the phase difference between grid and generators and allow closing the circuit breaker only when this difference is below the threshold configured by parameter P.0842 (with a fixed hysteresis of 1 degree). P.0842 allows setting the maximum phase difference in degrees

The result of this check is shown on the display page M.12, by the third small rectangle from the left (the one identified by the “°” label):

- Empty rectangle: phase difference is out of thresholds.
- Full rectangle: phase difference is inside thresholds.

Sometimes, the plants do use transformers. These transformers can introduce a phase error in voltages. So, it is possible that synchronizing on their primary side, we have a phase error on the secondary side. If the controller regulates for 0° on secondary side, voltages on the circuit breaker may be not synchronized. Parameter P.0845 allows setting a fixed phase offset. If different from zero, the controller regulates for x° on the secondary side, to have 0° on primary side. The parameter P.0845 allows to set (with a sign) the compensation of the transformers phase error (+/-180°).

Phases sequence check.

Only for three-phase plants, the controller checks for the same phases sequence on generators and grid. The circuit breaker can be closed only if the same phases sequence is detected. No parameters are provided for this check.

The result of this check is shown on the display page M.12, by the fourth small rectangle from the left (the one identified by two arrows):

- Empty rectangle: different phase sequences.
- Full rectangle: same phase sequences.

Circuit breaker closing enabled.

MC400 detects a “synchronized” status only when all previous checks (or all the ones applicable) give correct results, consecutively for the time configured by parameter P.0844. When MC400 removes its consent, it does not reactive it for at least one second.

The “closure enable” condition is shown on the display page M.12, by the fifth small rectangle from the left (the one identified by two arrows):

- Empty rectangle: closure not allowed.
- Full rectangle: closure allowed.

Note: circuit breaker closure is enabled only when the controller first detects a “not synchronized” status and then a “synchronized status”. This protects the plants from wiring errors. If MC400 directly manages frequency and phase regulations, it automatically forces generators to go in a “not synchronized” status first, and then in a “synchronized” status.

7.5.1.1 Signals

It is possible to configure an output to signal the synchronism condition externally. This output will be activated during synchronization only, when the controller activates the internal “closure enable” status. The output is configured with the function DOF.3094 (“Synchronized”).

7.5.2 Voltages, frequency and phase regulations

To synchronize generators with grid, it is needed to work on:

- On generator voltages, to make them equal to grid: this avoids current circulation (reactive) when the circuit breaker will be closed. Normally, the gensets voltages should be a little bit higher than grid voltages, to supply (little) reactive power from gensets while closing.

- On generators frequency, to minimize differences on phase and frequency from grid.

The controller can manage both voltage and frequency regulations on generators, by the CAN bus link. Thus, it can minimize differences in voltages, frequency and phase between grid and generators, to allow a safe closure of the circuit breaker.

Note: the gensets controllers always accept these commands, even if they are “not managed by MC xxx”.

Note: these commands are transmitted on CAN bus only during the synchronization.

It is not mandatory using MC400 for this function: if preferred (or if it is needed because, for example, grid voltages are not acquired by MC400), an external analogue synchronizer can be used (GAC or other).

7.5.2.1 Using external synchronizer

Analogue synchronizers act on generator frequency by a command signal. It is possible to connect this signal directly to an analogue input of all genset controllers. Alternatively, (suggested option), it is possible to connect this signal to an analogue input of the controller, which will transfer it via CAN bus to the genset controllers.

Each synchronizer has its own signal type. MC400 can interact only with signals in direct voltages 0-10 Vdc. Some synchronizers have different command signals:

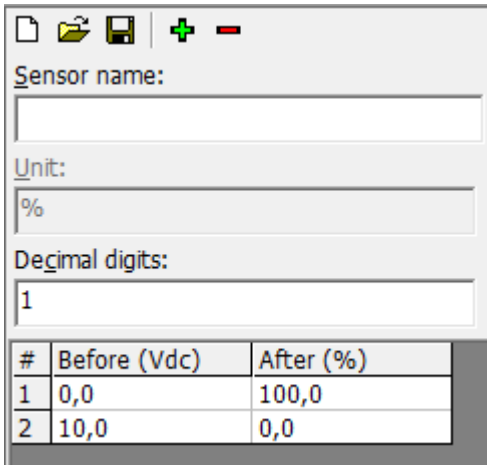
- Current signals (4-20 mA, +/-10 mA). It is simple to convert these signals in Volts DC applying a resistor on them.
- PWM. Not managed by MC400.
- Up/Down. These synchronizers use two digital outputs to request an increase or a decrease of speed. Not managed by MC400.

Within the 0-10 Vdc range, MC400 is fully configurable: for example, MC400 can acquire a 3 to 6 Vdc signal and convert it to -4 to +4 Hz change on gensets. MC400 can be also configured to decrease generators frequency when the synchronizer signal increases (and vice-versa).

To use an external synchronizer, an analogue input of MC400 must be correctly configured. For example, let's suppose to use a GAC synchronizer and connect it to the analogue input 1 (see paragraph [1] for parameters related to analogue inputs):

- P.4001 - "Function of analogue input 1". This parameter allows selecting the analogue input function. For external synchronizers, three functions are available:
    - AIF.2105: if the external synchronizer should be used for the MCB closing only (MGCB synchronization is managed by MC400).
    - AIF.2107: if the external synchronizer should be used for MGCB closing only (MCB synchronization is managed by MC400).
    - AIF.2103: if the external synchronizer should be used for the closing of both MCB and MGCB circuit breakers.
- P.1842 - "Analogue input 1 minimum value". GAC synchronizer works between 0 and 10 V, so this parameter must be set to 0%.
- P.1843 - "Analogue input 1 maximum value". GAC synchronizer works between 0 and 10 V, so this parameter must be set to 100%.

In this way, we configured the input. Now, we must configure the conversion of the measurement from Vdc to Hz. The speed regulation command over CAN bus is a percentage value: 0% corresponds to 4 Hz less then nominal frequency, 100% corresponds to 4 Hz over nominal frequency (so 50% corresponds to nominal frequency). So, it is necessary to convert the signal 0-10 Vdc in a percentage value. GAC synchronizer decreases its command signal to speed-up generators. So, the following conversion curve must be linked to the analogue input 1:



In the previous example, the GAC synchronizer can change generators frequency of +/- 4 Hz. If in the previous table we replace the 100% with 75% and the 0% with 25%, the maximum change of frequency should be +/- 2 Hz. By setting the curve in an asymmetric way, it is possible to compensate electrical offsets (GAC should give a 5 Vdc signal to request the nominal frequency, it may be 5.1 or 4.9).

During the synchronization phase, the controller will change the gensets frequency as required by the external synchronizer.

Note: now, there is no support for the genset voltage regulation by an external synchronizer. This function, if it is enabled, is always managed by MC400.

Note: it is possible to use two different external synchronizers for MCB and MGCB, by wiring them to two different analogue inputs configured with codes DIF.2105 and DIF.2107. For each input is possible to set a specific conversion curve.

7.5.2.2 Using internal synchronizer

Phase/Frequency regulation

The controller regulates the gensets frequency to equalize the two frequencies and reset the phase difference between gensets and grid.

A PI regulator is used to manage the frequency and reset the phase error. It works on phase difference, and can be configured with the following parameters:

- P.0849 - “Gain for phase control loop”.
- P.0850 - “Integrative factor for phase control loop”.

These parameters must be adapted to get the best response from the system. They have the same functions of trimmers on analogue synchronizers.

Note: when you are setting these parameters, be sure the circuit breaker cannot be closed. Do that by opening fuses (if available) or by setting parameter P.0842 to zero.

Voltage regulation

The same concepts explained in the previous paragraph are valid also for voltage regulation. Parameters provided for the voltage PI regulator are:

- P.0868 - “Voltage matching gain”.
- P.0869 - “Voltage matching integrative factor”.

If both parameters are “0”, no voltage regulation is available during synchronization.

7.5.2.2.1 PI regulator

The controller uses two PI regulators internally to regulate the voltage and the speed of the gensets for the synchronization operations. All internal PI regulators can be configured with two parameters:

- The factor proportional to the current error (P) is also called “gain”.
- The factor related to the integral in the error delay (I) is also called “integrative factor”.

In the previous paragraph, there are the parameters associated to each PI regulator.

These two parameters for each PI regulator should be “adjusted” during the installation procedure. In fact, they depend on different factors: the type of engines, the alternator powers, the type of alternators; different parameters could be necessary for similar systems.

The definition of these parameters is not particularly critical if carried out with method. Unfortunately, the empirical adjustment (called Ziegler-Nichols) requires measuring the oscillation period of the measurement (frequency, voltage), which is not always possible (or simple) to do.

For this reason, besides the empirical method, we suggest a simplified method that should help carrying out in a valid way the parameters choice.

The PI regulator parameters can be modified even if the plant is working, by the user panel. It is suggested to carry out the modifications by using the BoardPrg3 program, which is available for free on our Mecc Alte website.

7.5.2.2.1.1 Complete method

1) Set “P” at an initial value (0,100) and “I” at 0,000.
2) Increase “P” until the adjusted measurement starts to oscillate (for example, if you are adjusting the PI that manages the speed during the synchronization, increase “P” until it seems to hear that the engines accelerate / slow down). Decrease/increase the value “P” until an oscillation point is determined (a good estimate is sufficient).
3) Measure the oscillation period (the time between two consecutive peaks of speed).
4) Set “P” at a slight lower value than the one resulted by the division of the current value by 2.2.
5) Set “I” at the value calculated by dividing 1.2 for the period of oscillation measured before (in seconds). A lower value can be set at a lower value, decreasing its performance but increasing the stability range.
6) Further adjustments could be necessary. Check how the system reacts in case of low, medium or high load. In case there still is a system instability, reduce the “P” value again.

7.5.2.2.1.2 Simplified method

To avoid the problem of measuring the oscillation period, you can proceed by referring to what has been described before, up to the point 6 included, except for the point 3 and 5. At point 5, increase/decrease “I” (after having adjusted “P” at point 4) until getting the best performances.

7.5.2.2.1.3 General notes

The parameter “P” cannot guarantee a good adjustment alone. To reduce the error, “P” should be increased, but over a set threshold, the system becomes unstable. The value “P” defined with the described method usually is the best relation between stability and performance.

For a good adjustment, it is necessary to set the factor “I”. Even little values of the parameter “I” change the system performance. The value, obtained by the procedure described, usually supplies the best performances. Anyhow, it is not critical, and it can be set in a greater range of values.

Consider that the factor “I” accumulates the adjustment errors: delay in the recovery of the error can cause over-shoots or under-shoots. Very high values of “I” bring to the oscillation of the system.

Once you found the value that supplies a satisfactory performance, try to decrease it until the performance decreases under the waited minimum. Then select an intermediate value in this range.

In some case, it would be necessary to start a procedure with a minimum value of “I” to guarantee a level of adjustment suitable with the operation of the system. A very low value of “I” (0.01) can be used with light effects on the procedure.

7.5.3 Digital inputs for synchronization

MC400 allows configuring digital inputs with two special functions related to synchronization:

- DIF.1034 (“Synchronization request for MCB”).
- DIF.1004 (“Synchronization request for MGCB”).

These inputs must be used when the related circuit breaker is not managed by MC400, but you want to use PI regulators of MC400 for synchronization. When the input is “active” (logical state), if all necessary conditions for synchronization are present, MC400 starts the synchronization process and signals it to external devices using up to four digital outputs (see next paragraph).

7.5.4 Digital outputs for synchronization

MC400 allows configuring digital outputs with the following special functions related to synchronization:

- DOF.3091 ("Synchronization for MGCB"). It is used when MGCB is managed by MC400, but an external synchronizer must be used. When MC400 starts synchronization process, this output becomes "active" and can be used to supply/enable the external synchronizer. When synchronization ends, the output becomes "not active".
- DOF.3092 ("Synchronization for MCB"). It is used when MCB is managed by MC400, but an external synchronizer must be used. When MC400 starts synchronization process, this output becomes "active" and can be used to supply/enable the external synchronizer. When synchronization ends, the output becomes "not active".
- DOF.3093 ("Synchronization in progress"). It is used when MCB/MGCB is managed by MC400, but an external synchronizer must be used. When MC400 starts synchronization process, this output becomes "active" and can be used to supply/enable the external synchronizer. When synchronization ends, the output becomes "not active".
- DOF.3094 ("Synchronized"). This output can be used in case the synchro-check of the controller is used for a circuit breaker closing (MCB or MGCB), which is commanded by an external logic. This output can be "active" only during synchronization process, when MC400 detects the "synchronized" status between grid and generators. Outside synchronization process, or when generators are not synchronized with grid, this output is "not active". This output should be wired to the external logic that physically closes the circuit breaker (be aware that the output become "not active" after circuit breaker has been closed).
- DOF.0103 (AND/OR logics) with the status:
  - ST.097: synchronization in progress for **MCB** closure.
  - ST.098: synchronization in progress for **MGCB** closure.
  - ST.099: synchronized status detected.

7.5.5 Automatic synchronization

This description refers to the operation in AUTO, TEST and REMOTE START. It also refers to the operation in MAN if the parameter P.0848 ("automatic synchronization in manual mode") is set to "1".

If the internal synchronizer is used, the controller regulates voltage and frequency to get the "synchronized" status: if the "synchronized" status persists for 10 seconds and the circuit breaker doesn't close, MC400 changes generators frequency to force a "not synchronized" status, then starts to synchronize again. This avoids problems when using external synchro-checks in addition to the MC400 one: it is possible that some external synchro-checks do not allow the closure because they have not detected any "unsynchronized" status before.

MC400 allows configuring the maximum duration of synchronizations for the two circuit breakers:

- P.0852: MGCB synchronization maximum time.
- P.0853: MCB synchronization maximum time.

The duration of the synchronization phase on a circuit breaker is managed only in automatic mode (not MAN) and if the related delay is different from zero; in this case an anomaly is activated:

- W272 – "MCB synchronization failure". It is always a warning. The controller can decide to close MCB without synchronization (opening MGCB or GCB), depending on the type of plant and on the configuration (P.9515).
- X271 – "MGCB synchronization failure". If MGCB is directly managed from MC400, it is an alarm, otherwise it is a warning.

7.5.6 Manual synchronisation

This description refers to the operation in MAN if the parameter P.0848 (“automatic synchronization in manual mode”) is set to “0”.

The user must manually regulate the gensets voltage and frequency until the “synchronized” status is detected (this check is always carried out by the controller).

MC400 provides two parameters that allow voltages and frequency regulations on the generators:

- P.0867 - “Voltage offset”.
- P.0840 - “Speed offset”.

Both are expressed as percentage (between 0 and 100%). The first allows changing generators voltages of +/-20 Volt; the second allows changing generators frequency of +/- 4 Hz (the real voltages and frequency ranges depend on single genset controller settings). Setting both to 50%, generators work to their nominal voltages and frequency.

These parameters can be directly changed on display page M.12 (provided for synchronization). It is possible to simplify the procedure using two potentiometers instead of the parameters. The following is needed:

Voltage

- Configure an analogue input with the function AIF.2201 (“Voltage offset”) (parameter P.4001 for analogue input 1).
- Associate the input to a conversion curve, which converts the voltage of the analogue input into a voltage correction (%).

After these configurations, you can change the voltage offset between 0 and 100% by moving the potentiometer between 0 and 10 Vdc (the current voltage offset is shown on page M.12), and consequently you can change the gensets voltage. Note: once you have configured an analogue input with the function AIF.2201, the parameter P.0867 is no more used.

Frequency.

- Configure an analogue input with the function AIF.2101 (“Speed offset”) (parameter P.4001 for analogue input 1).
- Associate the input to a conversion curve, which converts the voltage of the analogue input into a speed correction (%).

After these configurations, you can change the speed offset between 0 and 100% by moving the potentiometer between 0 and 10 Vdc (the current speed offset is shown on page M.12), and consequently you can change the gensets frequency. Note: once you have configured an analogue input with the function AIF.2101, the parameter P.0840 is no more used.

Manual synchronization procedure is:

- Start the gensets (by pressing the START button on the panel).
- Select the page M.12 on the display (this can be carried out also by giving a manual closing command of the circuit breaker – MCB/MGCB pushbutton or digital inputs configured for MCB/MGCB).
- Use parameters P.0868 and P.0840 (or the related potentiometer, if configured) to synchronize the gensets to the grid. When MC400 signals a synchronism status, send a new closing command (pushbutton or related digital input): the circuit breaker will be closed.

7.5.7 MCB synchronization failure

Parameter P.9515 configures the actions of the controller in case of failure of the synchronization for the MCB circuit breaker closing.

- “0 – No blackout”. By setting this value, you configure the controller to avoid any blackout on the loads (in AUTO modes). After having activated the warning of MCB synchronization failure (W272), the controller keeps the loads connected to the gensets. When the operator will acknowledge the warning, MC400 will try again to close MCB through the synchronization.
- “1 – Short blackout”. By setting this value, you allow a short blackout on the loads when the grid is back. After having activated the warning of MCB synchronization failure (W272), the controller opens the MGCB circuit breaker (or it forces the opening of the GCB circuit breakers) to be able to close MCB without synchronization. Once MCB is closed, if the gensets intervention is still required, MC400 will try to close MGCB with synchronization (or it will allow again the GCB closing - with synchronization).

7.6 Inhibition to genset automatic intervention

In automatic mode, MC400 determines, based on the type of system and the current conditions, whether to start the generators. In these conditions, it is possible to force the stopping of the generators by using the "inhibition to automatic intervention" function.

This internal function, once activated, takes priority over any other function: the generators will be shut down, and it will not be possible to restart them. The function operates in AUTO mode, but not in TEST and REMOTE START modes. The activation of this function does not result in the activation of anomalies.

It is possible to activate this function in different ways, described in the following paragraphs. The “INHIBIT” lock symbol (🔒) is shown on the up right corner of the display when an inhibition is active.

7.6.1 Inhibition from contact

The controller can use a digital input programmed for inhibiting the gen-sets automatic operation (function DIF.2501 – “Inhibition of start”). In case of an “active” input, the generators are never automatically started, not even if the plants condition requires it.

Use parameter P.0207 to set a delay between input's physical activation and this function's logic activation: the delay can only be applied if the controller is in AUTO mode, otherwise the delay is null.

Use parameter P.0208 to set a delay between input's physical de-activation and this function's logic de-activation: in case at least one generator is already running, the delay is two seconds (fixed); in case at least one GCB is closed, the delay is null.

When function DIF.2501 is configured for a digital input, the acquisition of this input is subordinated to the set time in P.0207and/or P.0208; the acquisition time related to the digital input is ignored.

The board records any status variation of this inhibition to start in the event log (if enabled with bit 6 of P.0441 parameter):

- EVT.1013: Inhibition active
- EVT.1014: Inhibition not active

7.6.1.1 Differences between “External sensor for grid” and “Inhibition of start”

The two functions have different operating logic and purposes. The first emulates the internal grid sensor behaviour, the second is used to explicitly impede the start of the system whatever the grid status; this reflects to the status signalling, which, in this way, remains more coherent with the real status of the system.

7.6.2 Inhibition from clock

By using P.0421, P.0422 and P.0423 parameters, it is possible to select the days of the week and a time interval during which the generators are enabled to work. Outside this time interval (and during not-selected days), the “inhibition to automatic intervention” function of the generators is active (and then the generators will be stopped).

Parameter P.0421 allows to set the generators' weekly operation days. The remaining two parameters allow to set an hour range valid for all selected days. The range start time (P.0422) refers to the days set in P.0421, while the range end time (P.0423) 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.

The board records any status variation of this inhibition to start in the event log (if enabled with bit 6 of P.0441 parameter):

- EVT.1221: inhibition activated.
- EVT.1222: inhibition deactivated.

7.6.3 Inhibition from load management

In systems where more generators work in parallel, it is possible to use the "load management", which activates only the generators needed to meet the power required by loads in specific times That is, exceeding generators are stopped even though, for example, it is an emergency plant and grid is Off. The “load management” uses the “inhibition to automatic intervention” function to stop generators.

7.6.4 Inhibition due to grid failure

In systems where the generators work only in parallel with the grid, should the grid fail, the controller would force the opening of the MGCB circuit breaker and, after a configurable waiting time (P.0899), it would activate the “inhibition to automatic intervention” to stop the generators until the grid is again "within tolerance".

The controller records every variation of this specific inhibition:

- EVT.1223: inhibition activated.
- EVT.1224: inhibition deactivated.

7.6.5 Inhibition due to “GCB circuit breaker not open”

In systems where more generators work in parallel, a generator's GCB circuit breaker might not open when the generator must be stopped. In this condition, notwithstanding the stop command, the engine would keep running with all external services unpowered (oil pumps and the like). In these conditions, it is possible to inhibit the closure of MGCB (P.0805), and to force its opening in case it is already closed: the generators are stopped (by means of the “inhibition to automatic intervention”) waiting until the problem is solved.

The controller records every variation of this specific inhibition:

- EVT.1225: inhibition activated.
- EVT.1226: inhibition deactivated.

7.6.6 Signalling

The controller makes the statuses of the single “inhibition to automatic interventions” available for the AND/OR logics, through the following internal statuses:

- ST.080: from contact.
- ST.081: from clock/calendar.
- ST.083: it is not possible to work in island mode and grid failure.
- ST.084: for GCB circuit breaker not open.

7.7 Inhibition to supply the loads.

In automatic mode, once the generators have been started, the controller normally tries to close the MGCB circuit breaker (if it exists). In these conditions, it is possible to force the opening of the MGCB by using the “inhibition to supply the loads” function. Note: if the MGCB circuit breaker is not present in the plant, these inhibitions will act on the GCBs of the generators.

This internal function acts in all automatic modes (AUTO, TEST and REMOTE START). The activation of this function does not result in the activation of anomalies.

If the "inhibition to supply the loads" is activated when MGCB is already closed, the controller tries to open it, by carrying out generators power discharge first (if possible).

It is possible to activate this function in different ways, described in the following paragraphs.

The controller records an event when the "inhibition to supply the loads" is deactivated:

- EVT.1081: inhibition deactivated.

7.7.1 Inhibition from contact

It is possible to configure a digital input through DIF.2502 function (“inhibition to supply loads”). When this input is active, the inhibition to supply the loads is active.

The controller records an event when this inhibition is activated:

- EVT.1080: inhibition activated (by contact).

7.7.2 Modbus commands

These commands can be disabled in different ways (see 5.11). To send the command it is necessary to write in sequence (within 5 seconds):

- HOLDING REGISTER 101: write the password configured with the parameter P.0004.
- HOLDING REGISTER 102:
  - “31” or “32” inhibition to supply the loads (it forces MGCB open).
  - “33” to deactivate the inhibition to the automatic supply.

The control remains active for 30 seconds from the time the controller receives it: it is therefore necessary to repeat it about every 25 seconds until the inhibition to power load should be kept active.

The controller records an event when this inhibition is activated:

- EVT.1202: inhibition activated.

7.7.3 Due to grid failure

In systems where the generators work only in parallel with the grid, (see [8]), if the grid fail, the controller will force the immediate opening of the MGCB circuit breaker, and will activate the “inhibition to supply the loads” to avoid its closure. The inhibition will be cancelled when the grid is "within tolerance" again.

The controller records an event when this inhibition is activated:

- EVT.1201: inhibition activated.

7.7.4 Inhibition due to “GCB circuit breaker not open”

In systems where more generators work in parallel, a generator's GCB circuit breaker might not open when the generator must be stopped. In this condition, notwithstanding the stop command, the engine would keep running with all external services unpowered (oil pumps and the like). In these conditions, it is possible to inhibit the closure of MGCB (P.0805), and to force its opening in case it is already closed: the controller activates the “inhibition to supply the loads” to impede the closure (or force the opening) of MGCB.

The controller records an event when this inhibition is activated:

- EVT.1203: inhibition activated.

7.7.5 Inhibition for “synchronization on MCB in progress”

In a system composed of more than one generator, that can supply both in island mode and in parallel with the grid (MSB + MSTP or MPtM + MSB), some external logics (among which another MC400) can act on generators voltage and frequency to synchronize the generators bus to the grid, to close the MCB or MGCB circuit breakers. At this stage, the controller activates the “inhibition to supply the loads” if its own MGCB is open: in this way, it avoids its closure, in order not to disturb the ongoing synchronization.

The controller records an event when this inhibition is activated:

- EVT.1204: inhibition activated.

7.7.6 Inhibition for MCB synchronization failure

If the parameter P.9515 allows a short blackout on the loads in case of MCB synchronization failure, the controller must open MGCB to close MCB without synchronization: to force the opening of MGCB, it uses an “inhibition to supply the loads”.

7.7.7 Inhibition for “no supplying generators”

If parameter P.9503 configures the MGCB circuit breaker as “powered by the generators”, if there are no voltages un the generators bus and there are no GCB closed (detected by the CAN bus), the controller must open MGCB: to force its opening, it uses an “inhibition to supply the loads”.

7.7.8 Inhibition for “TEST without load”

If the controller is in TEST mode, and the “TEST without load” has been selected, the controller must open MGCB: to force its opening, it uses an “inhibition to supply the loads”.

7.7.9 Signalling

The controller makes the statuses of the single "inhibition to supply the load" available, for AND/OR logics, through the following internal statuses:

- ST.088: from contact.
- ST.089: it is not possible to work in island mode and grid failure.
- ST.090: for commands from the serial port.
- ST.091: for GCB not opened.
- ST.092: for MCB synchronization failure.
- ST.093: for “no supplying generators”.
- ST.094: for “TEST without load”.

7.8 Power measurements

The controller has four channels for the measurement of the currents (three main channels and one auxiliary). The operator can specify the electrical lines they are connected to:

- P.0124: it selects the electrical lines to which the three main channels are connected.
- P.0130: it selects the electrical line to which the auxiliary channel is connected.

Both parameters support the following values:

- 0: on the electrical lines of the generators (MGCB).
- 1: on the electrical lines of the loads.
- 2: on the electrical lines of the grid (MCB).

The controller can perform power measurements, using all four channels. For the auxiliary channel, the controller assumes that it is connected to the line L1 of the source selected by the parameter P.0130; if such source is three-phases, the controller multiplies the calculated powers by 3 (or by 2 in case of bi-phase), assuming the loads are correctly shared among the electrical lines. If it is not, the operator can correct the calculations using parameter P.0132:

total kW = L1 kW * 3 * P.0132.

Depending on what configured by means parameters P.0124 and P.0130, the controller assigns the calculated powers to the grid, to the loads or to the generators (MGCB).

7.8.1 Power measurements on the generators

The controller calculates (from the data received through the CAN bus link) the total active and reactive powers supplied by the generators. Then, it calculates the power factor and the load type from these powers. This information is shown on page M.01 under the icon of the GCB circuit breaker (if closed).

7.8.2 Power measurements on the grid

The controller can acquire the active power measurement of the grid in different ways, evaluated in that order:

a) From an analogue input configured with the function AIF.2303 (“Power on the grid”).

b) By the three main current measurement channels, if P.0124 is set to 2.

c) By the auxiliary current measurement channel, if P.0130 is set to 2.

It is possible to use a digital input configured with the function DIF.2716 (“Enables the acquisition of the grid kW from analogue input”). If this input exists and is active, the grid power on the connection point is acquired with method a). If it exists and is not active, the power is measured by methods b) or c).

The controller can acquire the reactive power measurement of the grid in different ways, evaluated in that order:

- By the three main current measurement channels, if P.0124 is set to 2.
- By the auxiliary current measurement channel, if P.0130 is set to 2.

The controller can acquire the power factor and the load type measurement of the grid in different ways, evaluated in that order:

- Measured by the controller using the three main current measurement channels if P.0124 is set to 2.
- Calculates from the active and reactive power on the grid (if both available).

This information is shown on page M.01 under the icon of the MCB circuit breaker (if closed).

7.8.3 Power measurements on MGCB

The controller can acquire the active and reactive power measurements on the MGCB in different ways, evaluated in that order:

- By the three main current measurement channels, if P.0124 is set to 0. In this case, the controller also measures the power factor and the load type.
- By the auxiliary current measurement channel, if P.0130 is set to 2. In this case the controller calculates the power factor and the load type from the active and reactive power on the MGCB (if both available).

This information is shown on page M.01 under the icon of the MGCB circuit breaker (if closed).

7.8.4 Power measurements on the loads

The controller can acquire the active and reactive power measurements on the loads in different ways, evaluated in that order:

- By the three main current measurement channels, if P.0124 is set to 1. In this case, the controller also measures the power factor and the load type.
- By the auxiliary current measurement channel, if P.0130 is set to 1. In this case the controller calculates the power factor and the load type from the active and reactive power on the MGCB (if both available).

This information is shown on page M.01 near the icon of the loads.

7.8.5 Calculated powers

The controller can so manage up to four power measurements (grid, loads, MGCB and generators) but it can measure only two of them (one more is calculated from the data received from the CAN bus link). So, the fourth one must be calculated from the others.

If the controller cannot acquire the powers on the MGCB, it can “copy” them from the powers supplied by the generators, if MGCB is closed and no other MC xxx controller has its own MGCB closed (thus, all the power supplied by the generators is flowing through this MGCB).

If the controller cannot acquire the powers on the loads, it can get them in the following ways:

- If MCB is opened and MGCB is closed: the power on the loads is the same as the power on the MGCB.
- If MCB is closed and MGCB is opened: the power on the loads is the same as the power on the grid.
- If MCB is closed and MGCB is closed: if the powers on the grid and on the MGCB are both available, the controller can calculate the power on the loads as their sum. It can then calculate the power factor and the load type from the calculated active and reactive power.

7.9 Circuit breakers management

The controller can manage both MCB and MGCB circuit breakers. Anyway, it accepts that these circuit breakers could be controlled by external logics (steadily or temporarily).

MGCB circuit breaker is optional for all kinds of plant:

- If it exists, the related lamp shows its status.
- If it does not exist, the controller considers it existent, externally managed and always closed. In this case, the related lamp is always switched on.

MCB circuit breaker is never optional.

- For “island” only plants (“MPM”) it is not managed. The related lamp is always switched off.
- For all other plant types, MCB always exists, and the related lamp shows its status. If it is configured as not existing, the controller signals a wrong configuration by the warning 237 and it considers it existent, externally managed and always opened. In this case, the related lamp is always switched off.

Both circuit breakers can be managed by the controller or by external devices. If they are managed by external devices, their statuses must be connected to MC400 (otherwise, it will signal again a wrong configuration by the warning 273).

Through the P.0854 parameter it is possible to configure the way MC400 must manage the MGCB circuit breaker:

- 0: not managed.
- 0: the circuit breaker is managed by the controller, which cannot use synchronization to close it.
- 1: the circuit breaker is managed by the controller, which can use synchronization to close it
- 2: An external controller controls the circuit breaker, and the controller cannot use synchronization to close it.
- 3: An external controller controls the circuit breaker, and the controller can use synchronization to close it.

At the same way, through P.0855 parameter, it is possible to configure the way the controller must manage MCB circuit breaker (see previous description).

7.9.1 Digital outputs

7.9.1.1 Circuit breakers commands

Four different commands can be used for the management of the **MCB** breakers:

- DOF.2001 - “Minimum voltage coil for MCB (NC)”. This function can be used to supply the minimum voltage coil (if any) of the circuit breaker. The controller enables this output when it wants to open the breaker and disables it when it wants to close the breaker: the real closing command will be activated with at least 0.5 seconds after the disabling of this output. A contact which is **normally closed** should therefore be used, so that when the controller is not supplied, the minimum voltage coil is enabled, and the breaker can be closed. If the breaker should open without any explicit command from the controller (for example for the trip of its protections), it is possible to configure a delay between the breaker opening and the activation of this command (P.0246, for default set to zero): this function is useful for some small size breakers to acquire the TRIP contact (which resets immediately as soon as the breaker is commanded in opening).
- DOF.2002 - “Coil for opening of MCB”. The controller enables this output when it wants to open the circuit breaker: the output goes back in standby once the circuit breaker feedback indicates that it is open (or when the opening time-out expires).
- DOF.2003 - “Coil for closing MCB”. The controller enables this output when it wants to close the circuit breaker (ensuring that the function DOF.2001 has been active for at least 0.5 seconds): the output goes back in standby once the circuit breaker indicates that it is closed (or when the closing time-out expires, or the synchronism condition no longer exists).

- DOF.2004 - "Stable opening command for MCB". The controller activates this output when it wants to open the circuit breaker: the output remains activated even with the circuit breaker is opened. The controller disables this output when it wants to close the breaker (by assuring that the possible DOF.2001 function is active for at least 0.5 seconds): the output remains disabled even when the circuit breaker is closed. Therefore, for the MCB breaker to close with the controller unpowered, the **normally closed** contact must be used. Use this function with contactors, not with the motorized breakers.

Four different commands can be used for the management of the **MGCB** breakers:

- DOF.2031 - "Minimum voltage coil for MGCB". This function can be used to supply the minimum voltage coil (if any) of the circuit breaker. The controller enables this output when it wants to close the breaker and disables it when it wants to open the breaker: the real closing command will be activated with at least 0.5 seconds after the enabling of this output. If the breaker should open without any explicit command from the controller (for example for the trip of its protections), it is possible to configure a delay between the breaker opening and the activation of this command (P.0247, for default set to zero): this function is useful for some small size breakers to acquire the TRIP contact (which resets immediately as soon as the breaker is commanded in opening).

- DOF.2032 - "Coil for opening of MGCB". The controller enables this output when it wants to open the circuit breaker: the output goes back in standby once the circuit breaker feedback indicates that it is open (or when the opening time-out expires).

- DOF.2033 - "Coil for closing MGCB". The controller enables this output when it wants to close the circuit breaker (ensuring that the function DOF.2031 has been active for at least 0.5 seconds): the output goes back in standby once the circuit breaker indicates that it is closed (or when the closing time-out expires, or the synchronism condition no longer exists).

- DOF.2034 - "Stable closing command for MGCB". The controller activates this output when it wants to close the circuit breaker (by assuring that the possible DOF.2031 function is active for at least 0.5 seconds): the output remains activated even with the circuit breaker is closed. The controller disables this output when it wants to open the breaker: the output remains disabled even when the circuit breaker is opened. Use this function with contactors, not with the motorized breakers.

Of course, it is not necessary to use all commands for the circuit breakers. It is important that the controller, if it must command the circuit breaker, manages both the opening and the closing command. The possibilities are:

- Only the stable command.
- The stable command and the minimum voltage coil.
- The closure command and the minimum voltage coil.
- The closure command and the opening command.
- The closure command, the opening command and the minimum voltage coil.

It is possible to use different commands for the two circuit breakers.

The following table shows the statuses of all commands, during each phase of the circuit breaker management. It is referred to MGCB circuit breaker: remember that "minimum voltage coil" and "static command" works in the opposite way for MCB circuit breaker.

Circuit breaker	Minimum voltage coil	Opening coil	Closing coil	Stable command
Opened				
Closing	X		X	X
Closed	X			X
Opening		X		

As in the previous table, the controller activates different commands when the circuit breaker is "open" or "closed". If the circuit breaker status changes, the controller should change some of its commands to follow the new status. This is dangerous because the circuit breaker status is acquired by a digital input, and so possible problems could bring to faulty statuses:

- If circuit breaker status changes from “closed” to “opened”, the controller can follow the new status without big problems. In fact, even if the “opened” status is a “wrong” information (due to disturbs, broken wires and so on), the only problem is an unnecessary opening of the circuit breaker: in AUTO mode, the controller will re-close the circuit breaker if required by plant status. In this case, the controller does not activate anomalies.
- If the controller detects the status of closed-circuit breaker while it is open, the actions depend on the fact that there is an output for “stable command”.
    - **“Stable command” not used.** To adjust the commands, the controller would only have to activate the “minimum voltage coil”. This operation alone does not generate the circuit breaker closing, so it can be carried out without problems. In this case, the controller does not activate anomalies.
    - **“Stable command” used.** To adjust the commands, the controller would have to activate the “stable command”. This operation generates the circuit breaker closing (without any control), so it cannot be carried out. In this case, the controller activates an anomaly.

7.9.1.1.1 Minimum delays between commands

The controller grants that the following delays between commands are respected:

- Half second between minimum voltage coil and any closure commands.
- The delay configured by parameter P.0220 (“Contactors holding time”) between an opening command and the next closure command (if set to zero 0.5 seconds are used).
- The delay configured by parameter P.0220 (“Contactors holding time”) between a closure command and the next opening command (if set to zero 0.2 seconds are used).
- The delay configured by parameter P.0219 (“Contactors swap delay”) between the opening command of one circuit breaker and the closure command of the other circuit breaker.

Moreover, opening and closure commands are never set together.

7.9.1.2 External consents

Two functions are provided, related to the **MCB** circuit breaker management:

- DOF.3081 - “Ready to close MCB”. This function allows an external logic to prevent or to delay the circuit breaker closure. This output is activated before the closing of the circuit breaker only if one input is configured as “MCB closure allowed” (DIF.1035): it is deactivated (and so the circuit breaker will be closed) when that input is active or after the delay configured for the input elapses.
- DOF.3082 - “Ready to open MCB”. This function is used only when the opening of the circuit breaker will result in a blackout on the loads and allows an external logic to prevent or to delay the circuit breaker opening. This output is activated before the opening of the circuit breaker only if one input is configured as “MCB opening allowed” (DIF.1036): it is deactivated (and so the circuit breaker will be opened) when that input is active or after the delay configured for the input elapses.

Two functions are provided, related to the **MGCB** circuit breaker management:

- DOF.3083 - “Ready to close MGCB”. This function allows an external logic to prevent or to delay the circuit breaker closure. This output is activated before the closing of the circuit breaker only if one input is configured as “MGCB closure allowed” (DIF.1005): it is deactivated (and so the circuit breaker will be closed) when that input is active or after the delay configured for the input elapses.
- DOF.3084 - “Ready to open MGCB”. This function is used only when the opening of the circuit breaker will result in a blackout on the loads and allows an external logic to prevent or to delay the circuit breaker opening. This output is activated before the opening of the circuit breaker only if one input is configured as “MGCB opening allowed” (DIF.1006): it is deactivated (and so the circuit breaker will be opened) when that input is active or after the delay configured for the input elapses.

7.9.1.3 Request for synchronization

If the controller manages a circuit breaker, but an external synchronizer should be used, it is possible to use some digital outputs of the controller to enable the external synchronizer. The following functions are available for the configuration of the digital outputs:

- DOF.3091 - "Synchronization for MGCB".
- DOF.3092 - "Synchronization for MCB".
- DOF.3093 - "Synchronization in progress".

On the contrary, if a circuit breaker is externally managed but the internal synchronizer should be used, the following function can be used to signal the "synchronized" status:

- DOF.3094 - "Synchronized".

For more details see document [8].

7.9.2 Digital inputs

The digital inputs of the controller can be used for various purposes, within the scope of the management of the circuit breakers.

7.9.2.1 Acquiring breakers status

Three functions are available to get the feedback of the circuit breakers:

- DIF.3002 - "Status of MCB circuit breaker". Use this function to get the feedback of the circuit breaker (active input when the circuit breaker is closed).
- DIF.3003 - "Status of MGCB circuit breaker". Use this function to get the feedback of the circuit breaker (active input when the circuit breaker is closed).

It isn't always mandatory to connect the feedback of the circuit breakers to the controller: it depends on the type of plant (see the document [8]). If the controller gets the feedback, it will use them to:

- Issuing failed opening or failed closing warnings (MCB and MGCB).
- For its own operating sequence.
- It is also used to detect the status of the circuit breakers when they are commanded by external devices.
- To show the status of the circuit breakers on the front panel LEDs.

The delay associated to the input (P.2002 for input 1 or equivalent parameter for the other inputs) is used as maximum time for opening or closing the breaker.

In theory, for those plants that do not do the parallel with the grid, the controller might also operate without this feedback. In this case, the controller considers that the breaker is closed as soon as the closure command is activated; it considers that it is open as soon as the opening command is activated. As a matter of facts, it is always better to connect the feedback.

Through parameter P.0847 it is possible to define if the MCB breaker is supplied by grid voltage. In this case, with grid off, MCB opens, but the controller does not activate the relative warning of MCB closure failed. In the same way, through parameter P.9503 it is possible to define if the MGCB breaker is supplied by the generator's bus voltage. In this case, with generators bus off, MGCB opens, but the controller does not activate the relative warning of MGCB closure failed.

7.9.2.2 Temporary override of the management of the circuit breakers

It is possible to use some digital inputs to communicate to the controller that the management of one or both circuit breakers is temporarily managed by an external controller (even if P.0854 and P.0855 parameters indicate that the circuit breaker is controlled by the controller):

- DIF.1003 - "MGCB controlled externally".

- DIF.1033 - “MCB controlled externally”.

Until the input is active, the board never tries either to open or close the circuit breaker: but, if the circuit breaker is externally opened/closed, the controller will adapt its own commands to the new status of the circuit breaker, in order not to cause any unwanted opening/closure when the input is deactivated.

7.9.2.3 Manual controls for the circuit breakers

It is possible to connect to the digital inputs of the controller some external buttons to open/close the circuit breakers. The controller will use these inputs (only in MAN) exactly in the same way as the MCB and MGCB buttons present on the panel.

- DIF.1001 - “Request for MGCB closure”.
- DIF.1002 - “Request for MGCB opening”.
- DIF.1031 - “Request for MCB closure”.
- DIF.1032 - “Request for MCB opening”.

7.9.2.4 Request for synchronization

If a circuit breaker isn’t managed by the controller, it will be anyway possible to take advantage of the internal synchronization function (see document [8]). When the external logic wants to close a circuit breaker and synchronization is required, it should ask the controller for the synchronization, by activating a digital input. The following functions are available to configure the digital input:

- DIF.1004 - “Synchronization request for MGCB”.
- DIF.1034 - “Synchronization request for MCB”.

For more details refer to the document [8].

7.9.2.5 Forcing MCB to open

A digital input can be configured with the DIF.2503 function (“MCB closure inhibition”). If the controller is in AUTO, TEST or REMOTE START mode, and an input configured with this function is activated, the controller opens the grid circuit breaker (MCB) and keeps it open, **even if the grid is present**.

7.9.2.6 External consents

The controller, before opening/closing the circuit breakers, can accept consents from outside. The following functions are available to configure the digital input:

- DIF.1005 - “MGCB closure allowed”.
- DIF.1006 - “MGCB opening allowed”.
- DIF.1035 - “MCB closure allowed”.
- DIF.1036 - “MCB opening allowed”.

See the description in 5.4.3.

7.9.3 Management logic

7.9.3.1 MCB command logic

The controller always allows the opening of MCB.

The closing of MCB is possible only if all the following conditions are checked:

- MCB is not forced to open as “interface controller”.
- Only in AUTO, if MCB is configured as “supplied by grid” (P.0847 = 0).
    - The grid must be live and in tolerance per the AMF thresholds.

- If the plant requires the parallel with the grid and it is configured as interface controller, the grid must be in tolerance per the parallel thresholds.

The parameter P.0248 allows to select the timing for MCB opening, when the controller is in AUTO mode (for the emergency service to the grid):

- P.0248=0.
  - Plant without MGCB: following a grid failure, the controller will open MCB when at least one generator is “ready to supply”.
  - Plant with MGCB: following a grid failure, the controller will open MCB just before closing MGCB.
- P.0248=1: following a grid failure, the controller will open MCB as soon as the “grid failure delay” is elapsed.

If the MCB closing is possible, the controller can carry it out in three ways, as described below.

With synchronization. This happens if all the following conditions are checked:

- Only in MAN and AUTO.
- If the plant requires the parallel with the grid (P.0802 >= 7).
- If the synchronization on MCB is enabled (P.0855 = 2 or 4).
- If the grid is in tolerance per the parallel thresholds. Note: in MAN, it is enough that the grid is in tolerance; in AUTO, it must be in the time configured in P.0903 or P.0930.
- If there is voltage on the load’s bus.
- If MGCB exists, it must be closed.
- If there is voltage on the generator’s bus.
- If an external synchronizer has not been configured, at least a GCB circuit breaker must be closed.
- If MCB is externally managed (P.0855 = 4), the digital input that requires the synchronization must be active (function DIF.1034).
- If the gensets are not in parallel with the grid by another MC xxx (MC400 does not allow the simultaneous parallel with two grid).

Directly without synchronization. This happens if all the following conditions are checked:

- If it is not possible to close the circuit breaker with the synchronization (see above).
- If MCB is managed by the controller.
- If there is no voltage on the load’s bus.
- If MGCB does not exist, or if it exists but it is closed:
  - If there is no voltage on the generator’s bus.
  - If there are no gensets with GCB closed.
  - If the plant requires the parallel with the grid (otherwise, the controller does not allow the simultaneous closing of MCB and MGCB).

With changeover (opening MGCB). This happens if all the following conditions are checked:

- If it is not possible to close the circuit breaker with the synchronization (see above).

- If it is not possible to close the circuit breaker without synchronization (see above).
- If MCB is managed by the controller (P.0855 = 1 or 2).
- If MGCB exists (P.0854 <> 0):
    - MGCB must be managed by the controller (P.0854 = 1 or 2).
- If MGCB does not exist (P.0854 <> 0):
    - If P.9506 is set to one, all controllers with GCB closed must be “managed by MC xxx”, so that MC400 can force the opening of GCB.
    - There should not be gensets with GCB closed, managed by controllers that are not connected to CAN bus PMCB.

If none of the three ways can be used, MCB cannot be closed.

7.9.3.2 MGCB command logic

The controller always allows the opening of MGCB.

The closing of MGCB is possible only if all the following conditions are checked:

- MGCB is not forced to open as “interface controller”.
- Only in AUTO, if MGCB is configured as “supplied by gensets” (P.9503 = 0).
    - There must be voltage on the generator’s bus.
    - At least one GCB must be closed.

If the MGCB closing is possible, the controller can carry it out in three ways, as described below.

With synchronization. This happens if all the following conditions are checked:

- Only in MAN and AUTO.
- If the plant requires the parallel with the grid (P.0802 >= 7).
- If the synchronization on MGCB is enabled (P.0854=2 or 4).
- If there is voltage on the load’s bus.
- If MCB is closed.
- If the grid is in tolerance according to the grid parallel thresholds.
- If there is voltage on the generator’s bus.
- If an external synchronizer has not been configured, at least one GCB circuit breaker must be closed.
- If MGCB is externally managed (P.0855 = 4), the digital input that requires the synchronization must be active (function DIF.1004).
- If the warning W271 is not active (“MGCB synchronization failure”).
- If the gensets are not in parallel with the grid by another MC xxx (MC400 does not allow the simultaneous parallel with two grid).

Directly without synchronization. This happens if all the following conditions are checked:

- If it is not possible to close the circuit breaker with the synchronization (see above).
- If MGCB is managed by the controller.
- If there is no voltage on the load's bus, or on the generators bus and there are no gensets with GCB closed.
- If MCB is closed:
    - If there is no voltage on the load's bus.
    - If there are no gensets with GCB closed.
    - If the plant requires the parallel with the grid (otherwise, the controller does not allow the simultaneous closing of MCB and MGCB).
    - The protections for the parallel with the grid must not be active.
- If MCB is open:
    - If the plant allows to supply the loads in island mode (P.0802 <> 8).

With changeover (opening MGCB). This happens if all the following conditions are checked:

- If it is not possible to close the circuit breaker with the synchronization (see above).
- If it is not possible to close the circuit breaker without synchronization (see above).
- If MGCB is managed by the controller (P.0854 = 1 or 2).
- If MCB is managed by the controller (P.0855 = 1 or 2).
- If the plant allows to supply the loads in island mode (P.0802 <> 8).

If none of the three ways can be used, MGCB cannot be closed.

7.9.3.3 Management logic in OFF/RESET mode

If there is a MGCB circuit breaker managed by the controller, and it is closed, the controller commands its opening.

If there is a MCB circuit breaker managed by the controller, and it is open, in OFF/RESET mode it can be closed without synchronization only: the controller waits for the gensets to be disconnected from the loads and then it commands its closing. To have MCB closed, all the following conditions must be checked:

- There must be no voltage on the bus of both loads and grid; otherwise, it is impossible to close without synchronization.
- If there is a MGCB circuit breaker and it is commanded by the controller, it must be open.
- If there is not a MGCB circuit breaker, or it is closed but it is externally managed, all GCB circuit breakers must be open.

The controller removes the request of start for the gensets: this usually causes the immediate opening of the GCB circuit breakers. This opening may happen after the phase of fast unload of the power if the following condition are met:

- MGCB does not exist, or it is closed (externally managed or in case of opening failure): the load is still connected to the gensets.
- There are some gensets "not managed by MC xxx" with GCB closed, which must stay in parallel.

7.9.3.4 Management logic in MAN mode

The command of all circuit breakers is possible only if there are no active alarms and unloads (otherwise, the controller acts as in OFF/RESET).

If the MCB circuit breaker exists and it is managed by the controller, it is possible to request its manual opening and closing in different ways:

- By using the MCB button on the controller panel. This command works as a toggle: it commands the opening if the circuit breaker is closed, it commands the closing if the circuit breaker is open.
- By using the digital inputs of the controller (to connect external buttons that allow the manual opening/closing of the circuit breakers). It is possible to use the following functions to configure the digital inputs:
  - DIF.1032 - “Request for MCB opening”.
  - DIF.1031 - “Request for MCB closing”.

  These commands act on shifting the input from “not active” to “active”, not on the steady “active” state. It is possible to use both opening/closing commands or just the closing one. If only the closing command is used, it acts as “toggle”: it commands the breaker opening if it is closed, or its closing if it is open.
- By Modbus commands. These commands can be disabled in different ways (see 5.11). To send the command it is necessary to write in sequence (within 5 seconds):
  - HOLDING REGISTER 101: write the password configured with the parameter P.0004.
  - HOLDING REGISTER 102: write the value:
    - “41”: it requires the immediate opening of MCB (without the loads transfer from the grid to the generators).
    - “42”: it requires the opening of MCB (with the loads transfer from the grid to the generators).
    - “43”: it requires the closure of MCB (with or without the synchronization).
- By using a proper “SMS” (see document [3]).

If the MGCB circuit breaker exists and it is managed by the controller, it is possible to request its manual opening and closing in different ways:

- By using the MGCB button on the controller panel. This command works as a toggle: it commands the opening if the circuit breaker is closed, it commands the closing if the circuit breaker is open.
- By using the digital inputs of the controller (to connect external buttons that allow the manual opening/closing of the circuit breakers). It is possible to use the following functions to configure the digital inputs:
  - DIF.1002 - “Request for MGCB opening”.
  - DIF.1001 - “Request for MCGB closing”.

  These commands act on shifting the input from “not active” to “active”, not on the steady “active” state. It is possible to use both opening/closing commands or just the closing one. If only the closing command is used, it acts as “toggle”: it commands the breaker opening if it is closed, or its closing if it is open.
- By Modbus commands. These commands can be disabled in different ways (see 5.11). To send the command it is necessary to write in sequence (within 5 seconds):
  - HOLDING REGISTER 101: write the password configured with the parameter P.0004.
  - HOLDING REGISTER 102: write the value:
    - “31”: it requires the immediate opening of MGCB (without the loads transfer from the generators to the grid).
    - “32”: it requires the opening of MGCB (with the loads transfer from the generators to the grid).
    - “33”: it requires the closure of MGCB (with or without the synchronization).
- By using a proper “SMS” (see document [3]).

Note: if MGCB does not exist, or if it is managed by the controller, the manual commands described previously works on the GCB circuit breakers of the controllers that are "managed by MC xxx" (if enabled by bit 3 of parameter P.0495).

It is always possible to command the manual opening of the circuit breakers.

If the MCB opening is required while the gensets are in parallel with the grid, the controller tries to transfer the loads from the grid to the gensets, then opens MCB. If, during the loads transfer, the opening of the circuit breaker is required again (button or active digital input for a second), the MCB circuit breaker is immediately open.

If the MGCB opening is required while the gensets are in parallel with the grid, the controller tries to transfer the loads from the gensets to the grid (by setting 0 kW as power setpoint), then opens MGCB. If, during the unload ramp, the opening of the circuit breaker is required again (button or active digital input for a second), the MGCB circuit breaker is immediately open.

Normally, it is always possible to command the manual closing of the circuit breakers. As described in the previous paragraphs, the controller checks if it can close the circuit breaker with the synchronization or directly without synchronization. If it cannot close it in these ways, check if it can close it with the switch: so, it is possible that the controller opens MCB to be able to close MGCB or vice versa (this behaviour must be enabled by the bit 2 of the parameter P.0495).

The controller activates some warnings for opening or closing failure of the circuit breakers if it acquires their feedback. In case of MCB circuit breaker opening failure, the controller activates the warning W023. In case of MGCB circuit breaker opening failure, the controller activates the warning W024. If the controller commands the closing of MCB without synchronization, and MCB does not close, the controller activates the warning W013. If the controller commands the closing of MGCB without synchronization, and MGCB does not close, the controller activates the warning W013.

7.9.3.5 Management logic in AUTO mode

In automatic modes, the controller autonomously decides if it should start/stop the gensets and open/close the circuit breakers, according to the type of plant, the grid voltage and the status of the digital inputs.

In the **automatic** management of the circuit breakers (not in manual), even if the controller manages the circuit breakers, it is possible to limit the opening/closing externally. In details:

MCB circuit breaker

- If there is a digital input configured with the function DIF.1036 ("MCB opening allowed"), normally the controller waits for this digital input to be activated before opening the circuit breaker.

  The controller ignores the approval if at least one of the following conditions is checked:

  - The controller is in OFF/RESET mode.
  - The controller is in MAN mode.
  - The MGCB circuit breaker does not exist, or it exists but it is closed.
  - The MCB circuit breaker must be opened immediately after the trip of the protections for the parallel with the grid.

  In the other cases, the procedure followed by the controller is:

  - It activates a possible configured output with the function DOF.3082 ("Ready to open MCB"), to signal the external logic its need to open the circuit breaker.
  - It waits that the configured digital input with the function DIF.1036 becomes active; this situation lasts for the time configured for the input (P.2001 for input 1). If the time configured is 0, the situation lasts forever.

- It commands the opening of the circuit breaker.

- If there is a digital input configured with the function DIF.1035 (“MCB closing allowed”), normally the controller waits for this digital input to be activated before closing the circuit breaker.

  The controller ignores the approval if at least one of the following conditions is checked:

  - The controller is in OFF/RESET mode.
  - The controller is in MAN mode.
  - There are active alarms or unloads.
  - The intervention of the gensets is not required and MCB has not been opened by the controller (so MC400 should close it again).

  In the other cases, the procedure followed by the controller is:

  - It activates a possible configured output with the function DOF.3081 (“Ready to close MCB”), to signal the external logic its need to close the circuit breaker.
  - It waits that the configured digital input with the function DIF.1035 becomes active; this situation lasts for the time configured for the input (P.2001 for input 1). If the time configured is 0, the situation lasts forever.
  - It commands the closing of the circuit breaker (with or without synchronization).

MGCB circuit breaker

- If there is a digital input configured with the function DIF.1006 (“MGCB opening allowed”), normally the controller waits for this digital input to be activated before opening the circuit breaker.

  The controller ignores the approval if at least one of the following conditions is checked:

  - The controller is in OFF/RESET mode.
  - The controller is in MAN mode.
  - The MGCB circuit breaker must be opened immediately after the trip of the protections for the parallel with the grid.
  - There are active alarms or unloads.
  - The intervention of the gensets is not required and MGCB has not been closed by the controller (so MC400 should open it again).

  In the other cases, the procedure followed by the controller is:

  - It activates a possible configured output with the function DOF.3084 (“Ready to open MGCB”), to signal the external logic its need to open the circuit breaker.
  - It waits that the configured digital input with the function DIF.1006 becomes active; this situation lasts for the time configured for the input (P.2001 for input 1). If the time configured is 0, the situation lasts forever.
  - It commands the opening of the circuit breaker.

- If there is a digital input configured with the function DIF.1005 (“MGCB closing allowed”), normally the controller waits for this digital input to be activated before closing the circuit breaker.

  The controller ignores the approval if at least one of the following conditions is checked:

- The controller is in OFF/RESET mode.
- The controller is in MAN mode.
- In the other cases, the procedure followed by the controller is:
- It activates a possible configured output with the function DOF.3083 (“Ready to close MGCB”), to signal the external logic its need to close the circuit breaker.
- It waits that the configured digital input with the function DIF.1005 becomes active; this situation lasts for the time configured for the input (P.2001 for input 1). If the time configured is 0, the situation lasts forever.
- It commands the closing of the circuit breaker (with or without synchronization).

Notes MCB

If this circuit breaker exists and is managed by the controller, it is normally kept closed. The controller opens it only in some cases, depending on plant configuration:

- **Parallel to grid.** MCB is opened only if the grid fails and if MCB is configured as interface controller. Additionally, it can be opened if the “transfer to gensets” mode is selected after the loads are entirely moved to the gensets.
- **Stand-by supply.** MCB is opened before the MGCB closing (or GCB closing in case MGCB does not exist), to manage the load switch between grid and gensets. In the same way, MCB is closed after MGCB has been opened (or GCB if MGCB does not exist); if configured as “synchronizable”, the controller will try to close it with synchronization, before opening MGCB.

Notes MGCB

If this circuit breaker exists and it is managed by the controller, the controller closes it (if required) with different time, depending on conditions and plant configuration.

- **Parallel to grid**. Normally the controller closes MGCB (without synchronization) before generator’s GCB. This is the best solution because it avoids multiple synchronization on each genset. This cannot be done if:
  - For any reason, at least one GCB is already closed when the controller must close MGCB.
  - MGCB is supplied by the gensets bus (P.9503=0).
  - The operator has selected to close GCB before MGCB by parameter P.9513.
  - If MGCB cannot be closed without synchronization, the controller waits that at least one GCB is closed and then closed MGCB with synchronization.
  - Pay attention to wrong configurations: if MGCB is configured as “not synchronized” and “supplied by generators bus”, the controller will never be able to close it in parallel with grid (it will be necessary to open MCB, close MGCB without synchronization and then close MCB with synchronization).
- **Stand-by supply**. The controller closes MGCB (without synchronization) after the gensets GCB are closed. Parameter P.0806 allows configuring the timings for MGCB closure:
  - By setting it to 0, the controller closes MGCB after the first circuit breaker GCB has been closed (“immediate supply”).
  - By setting it to 30000, the controller waits the closing of GCB of all the available gensets “managed by MC400”, then it closes MGCB (“end parallel supply”). In this case, the nominal power of generators is not checked.
  - By setting it to an intermediate value, the controller waits that the nominal power of all gensets with GCB closed is greater than the set value and then closes MGCB. Note: if all GCB are closed, the

available power is lower than the threshold, the controller activates a warning (W008) and then closes MGCB.

- It is also possible to use a digital input configured with the function DIF.2181 (“Immediate supply”), to force the MGCB closing after the first GCB, whatever is the value set in parameter P.0806.

7.9.4 Events and signalling

The controller will record any variation of the command and of the status of the circuit breakers in the event archive, if it is enabled respectively through the bits 4 and 5 of P.0441 parameter:

- EVT.1030: MGCB close command
- EVT.1031: MGCB open command
- EVT.1032: MGCB closed.
- EVT.1033: MGCB open.
- EVT.1035: MCB close command
- EVT.1036: MCB open command
- EVT.1037: MCB closed.
- EVT.1038: MCB open.

The controller makes commands and statuses of the circuit breakers available, for AND/OR logics, through the following internal statuses:

- ST.065 - "MCB status"
- ST.066 - "MGCB status"
- ST.068 - “MGCB closure command (stable)”.
- ST.069 - “MCB closure command (stable)”.
- ST.070 - “MGCB minimum voltage coil”.
- ST.071 - "MGCB opening pulse”.
- ST.072 - "MGCB closure pulse”.
- ST.073 - “MCB minimum voltage coil”.
- ST.074 - "MCB opening pulse”.
- ST.075 - "MCB closure pulse”.

7.10 Gensets supplying.

The controller, for its operating sequences, must know if there are gensets that have their GCB closed. Usually, the controller acquires this information via CAN bus PMCB. In case there are gensets that are not connected to the CAN bus link, it is possible to use a digital input configured with the function DIF.3004 ("Status of GCB of other gensets"): if this input is active, the controller considers there is at least one genset with GCB closed.

7.11 Active power management

The controller does not implement any regulations on active power. No PI regulators are provided for active power: the controller selects the power setpoint for generators, and the power regulation task is performed by each genset controller.

The controller can adjust the active power setpoint for generators through the CAN bus link. This setpoint is used by the genset controllers only when generators are in parallel with grid. When they are in "island mode", the genset controllers automatically manage load sharing (without MC400) between available generators, as a percentage of their nominal power.

Important note:

- P.9506 = 1: only the controllers "managed by MC xxx" use the power setpoint transmitted by MC400. The controllers not "managed by MC xxx" use the proper local setpoint. The controller considers this info when calculating the power setpoint transmitted to the genset controllers.
- P.9506 = 0: the MC400 controller transmits its power setpoint as "SYSTEM BASE LOAD". It is automatically managed by the genset controllers, taking care of the ones that are working in a different mode.

Important note: if more MC xxx composes a plant, the system allows the parallel with the grid only on one of them. If the circuit breakers would be all managed externally, there could be more MC xxx managing the parallel with the grid: in this case, the power setpoint used by the gensets is the one transmitted from the MC xxx controller with minor PMCB address.

There are three different operating modes for the parallel with the grid, described in the following.

Important note: whatever is the mode selected on the controller, it corresponds to a power setpoint for the genset controllers.

7.11.1 BASE LOAD

This term is used to indicate the working mode where the power setpoint for generators is selected by the operator and it is not influenced by the local loads.

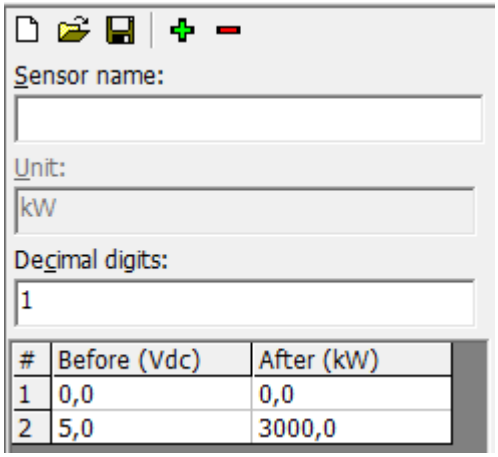
To select this mode, set parameter P.0880 to "1".

In this mode, the operator selects the power setpoint for the plant using parameter P.0858, directly as kW. Values up to 30 MW can be selected. The parameter can be modified also in MAN o AUTO modes, and directly from display page M.01.

Alternatively, it is possible to use a controller analogue input to configure the setpoint. This input can be connected to a potentiometer, or any external controller that should adjust the power setpoint of the plant.

To use the analogue input, do the following:

- Configure an analogue input with the function AIF.2307 ("Setpoint for system BASE LOAD") (parameter P.4001 for analogue input 1).
- Associate a conversion curve to the analogue input, to convert the acquired voltage to a kW setpoint. For example:



After this configuration, by moving the potentiometer between 0 and 5 Vdc the power setpoint varies between 0 and 3000 kW (the setpoint is displayed on page M.01 but cannot be modified from the controller panel). **Note: once you have configured an analogue input with the function AIF.2307, the parameter P.0858 is no more used.**

7.11.2 IMPORT/EXPORT

This term indicates the working mode in which the power setpoint configured by the operator is referred to the interconnection point with the grid and not to the gensets: the setpoint for the gensets is calculated from the selected setpoint and the current power on grid. It is mandatory that the controller can measure the power on grid.

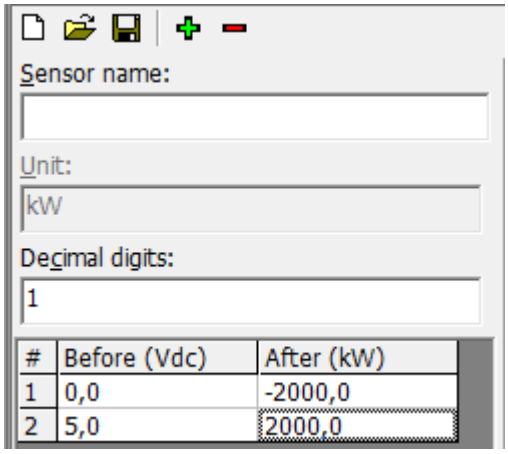
To select this mode, set parameter P.0880 to “2”.

Otherwise, you can set the parameter P.0880 to “1” (“BASE LOAD”) and use a digital input to switch the working mode between “BASE LOAD” and “IMPORT/EXPORT”. The input must be configured with the function DIF.2093 (“Selects the import-export mode”): when the input is “active” (logical status) the working mode is “IMPORT/EXPORT”, when it is “not active” the working mode is “BASE LOAD”.

The operator can select the power setpoint on grid by using parameter P.0859, directly as kW. It allows setting values up to +/-10 MW. A positive value means that the plant should import power from grid, while a negative value indicates that power should be exported to grid. A setpoint equal to zero selects no power transfers over grid: generators should supply only local loads. The parameter can be modified also in MAN o AUTO modes, and directly from display page M.01.

Alternatively, it is possible to use a controller analogue input to acquire the setpoint. This input can be connected to a potentiometer, or any external controller that must adjust the power setpoint of the plant. To use the analogue input, do the following:

- Configure an analogue input with the function AIF.2309 (“Setpoint for system IMPORT/EXPORT”) (parameter P.4001 for analogue input 1).
- Associate a conversion curve to the analogue input, to convert the acquired voltage to a kW setpoint. For example:



After this configuration, by moving the potentiometer between 0 and 5 Vdc the power setpoint varies between -2000 kW (exported) and 2000 kW (imported) (the setpoint is displayed on page M.01 but cannot be modified from the controller panel). **Note: once you have configured an analogue input with the function AIF.2309, the parameter P.0859 is no more used.**

The power setpoint for the gensets depends on the loads connected. So, it may happen that with few loads, the gensets should supply a very low power. In this case, the engines do not work well and if the situation does not change for a long time, they can get damaged. With the parameter P.0904, it is possible to configure a minimum value of power that the controller should require from gensets when they are in parallel with the grid in IMPORT/EXPORT mode.

7.11.3 Transfer to generators

This term indicates a temporary mode that consists in configuring the power currently consumed by the loads as power setpoint for the gensets. Once the gensets reach the setpoint (so the grid is no more supplying the loads), the controller opens the grid circuit breaker (MCB), and the loads are supplied by the gensets.

To select this mode, set parameter P.0880 to “3”. Otherwise, you can set this parameter to “1” (“BASE LOAD”) or “2” (“IMPORT/EXPORT”) and use a digital input to switch the working mode to “Transfer to generators”. This input must be configured with the function DIF.2096 “Transfer to gensets”: when the input is “active” (logical status) the working mode is “Transfer to generators”, when it is “not active” the working mode is the previous one.

This working mode is different if the controller acquires the power on grid or not:

- If the controller acquires the power on grid, the power setpoint for the generators is calculated as in “IMPORT/EXPORT” mode, assuming 0 kW setpoint on grid. When generators reach the setpoint no power is flowing on the grid: the MCB circuit breaker can be opened without load transients on generators.
- If the controller does not acquire the power on grid, the operator must set the power value required by the loads with the parameter P.0858 (or act on the related analogue input). This setpoint will be transmitted to the gensets. Once generators reach this setpoint, MCB circuit breaker will be opened: if setpoint is near actual loads, no load transients will happen on generators.

Note: if generators cannot reach the setpoint (because too loads are applied) MCB circuit breaker will never be opened.

This temporary phase ends when the gensets reach the setpoint or after the configured maximum delay (unless the gensets cannot supply the power required): the duration of the ramp (P.0879) is considered as maximum delay for this management (anyhow, MCB is open only if the gensets can take the load). It is also possible to add a delay by means parameter P.9517: the controller opens MCB only when the power supplied by the generators reached the setpoint continuously for this delay. The default value for this parameter is zero.

7.11.4 Load and unload ramps.

The controller does not directly manage the load ramps, but this function is managed by the gensets controllers.

When the gensets are supplying in parallel with the grid and the MGCB circuit breaker should be opened, the controller commands the unloading process to gensets (if no alarms are activated).

The command consists in setting a power reference to the gensets. This reference is calculated in different ways for the two following conditions:

- There is another MC xxx with MGCB closed. In this case, the gensets are supplying the loads of more than one MC xxx simultaneously. So, the controller cannot bring the gensets power to zero, because it would connect the loads of all MC xxx with MGCB closed to only one grid transformer, which could be overcharged. The controller can proceed in two ways:
    - The controller measures the power that flows through its own MGCB. In this case, the controller calculates the power setpoint for the gensets to bring to zero the power that flows through the MGCB. When the power is close to zero, the controller opens the MGCB, avoiding load transfers on both gensets and grid transformers.
    - The controller does not measure the power that flows through its own MGCB. In this case, it simply opens its own MGCB: anyhow, this leads to a load transfer on both gensets and grid transformers.
- There are no other MC xxx with MGCB closed. In this case, the controller requests to gensets an active power reference equal to 0%. When the gensets power is close to zero, the controller opens the MGCB, avoiding load transfers on both gensets and grid transformers.

Then the generator control devices manage by itself the unload ramp for their generators. The controller waits for the end of the unloading process and then opens the MCB circuit breaker. The unloading process is terminated when:

- In case there are other MC xxx with MGCB closed and this MC400 does not measure the power on the MGCB circuit breaker. In this case, the unload ramp is not carried out.
- In case there are no gensets with GCB closed, the controller stops the unload ramp.
- If the parallel with the grid is not allowed: the unload ramp can last maximum 0.5 seconds.
- If you have configured a maximum duration for the parallel with the grid (parameter P.0890): the unload ramp is immediately stopped after the gensets are in parallel as per the time configured.
- If the power supplied by the gensets “managed by MC xxx” is lower than the threshold set in P.0878 (the power is calculated as sum of the active powers divided by the sum of the nominal powers of all gensets supplying). **The power supplied by the gensets not “managed by MC xxx” is ignored.** In case the controller measures the power on MGCB and there are other MC xxx with MGCB closed, the controller checks that the power on MGCB is lower than P.0878. It is also possible to add a delay by means parameter P.9517: the controller opens MGCB only when the power supplied by the generators reached the setpoint continuously for this delay. The default value for this parameter is zero.

Note: if P.9605 is set to 1, the active power setpoint for the unloading procedure is managed through the SYSTEM BASE LOAD mode. The genset controllers manage this setpoint by themselves, taking care of the ones that are working in different modes; however, the setpoint is probably near to zero and, if there are gensets working in a different mode, it is possible that the system can’t reach it: this is the reason for which, to detect the end of the unload, only the generators “managed by MC xxx” are considered.

- After the time configured with parameter P.0879 is elapsed from the start of the process (this is only a timeout, normally MGCB is opened early for the reaching of power setpoint).

The controller does not change the setpoint for the reactive power (see paragraph below) during the unload ramp. Whatever is the cos(ϕ) required to the controllers, this corresponds in a null value of reactive power when the active power supplied by a genset tends to zero: so, the reactive power unload is indirectly managed by the genset controllers.

7.12 Reactive power management

The controller does not implement any regulations on reactive power. No PI regulators are provided for reactive power: the controller selects the reactive power setpoint for generators, and the voltage and reactive power regulation tasks are performed by each genset controller.

The reactive power setpoint is not expressed as kvar, it is set as a “power factor”, also called cos(Φ).

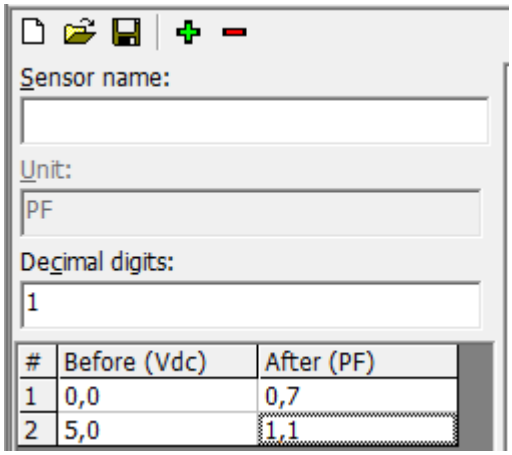
The controller can select the cos(Φ) setpoint for generators through the CAN bus link. This setpoint is used by the genset controllers only when generators are in parallel with grid. When they are in “island mode”, the genset controllers automatically manage reactive power sharing (without MC400) between available generators, as a percentage of their nominal power.

The setpoint sent by MC400 over the CAN bus is the same for all generators: each genset controller will convert this setpoint to kvar (based on current active power of that generator); then it will provide voltage control loop to move generator reactive power to the required kvar.

On MC400, operator selects the setpoint for cos(Φ) using parameter P.0860 (“Reference for system cos(Φ)”). It allows selecting values between “0.7 inductive” and “0.9 capacitive”. The parameter can be modified also in MAN o AUTO modes, and directly from display page M.01. To set a capacitive cos(Φ), the formula “2 - cos(Φ)” must be used. For example, to select a cos(Φ) equal to 0.95c, the real number is 2.00 – 0.95 → 1.05.

Alternatively, it is possible to use a controller analogue input to configure the setpoint. This input can be connected to a potentiometer, or to any external controller that must adjust the cos(Φ) setpoint of the plant. To use the analogue input, do the following:

- Configure an analogue input with the function AIF.2405 (“Setpoint for system power factor”) (parameter P.4001 for analogue input 1).
- Associate a conversion curve to the analogue input, to convert the acquired voltage to a kW setpoint. For example:



After this configuration, by moving the potentiometer between 0 and 5 Vdc the cos(Φ) setpoint varies between 0.70 inductive and 0.90 capacitive (the setpoint is displayed on page M.01 but cannot be modified from the controller panel).
Note: once you have configured an analogue input with the function AIF.2405, the parameter P.0860 is no more used.

Important note:

- P.9506 = 1: only the controllers “managed by MC xxx” use the cos(Φ) setpoint transmitted by MC400. The controllers not “managed by MC xxx” use the proper local setpoint.

- P.9506 = 0: MC400 transmits the cos(Φ) setpoint for the SYSTEM BASE LOAD mode. The genset controllers manage this setpoint by themselves, taking care about the ones that are working in a different mode. In this way, the total system cos(Φ) will be the one required by MC400.

7.13 Commands for gensets

Usually, the controller can start/stop the gensets and eventually force the opening of the GCB circuit breakers through commands on the CAN bus PMCB line. It is possible to also use some digital outputs for this purpose. The controller has the following two functions for the configuration of the digital outputs:

- DOF.1005 (“Request to start”). The controller activates this output each time the intervention of the gensets is required (both in MAN and AUTO). It deactivates this output when the intervention of the gensets is no longer required. It is possible to wire this output on the digital inputs of the gensets controllers to command the start/stop of the engines.
- DOF.3062 (“Ready to supply”). The controller activates this output to signal that it is possible to connect the loads to the gensets. The output activates only in AUTO, TEST and REMOTE START, if there are no “load inhibitions” in the following cases:
    - If there is a MGCB circuit breaker:
        - If MGCB is closed, the output is active.
        - If MGCB is open, the output is active when the nominal power of the gensets with GCB closed is enough to supply the loads.
    - If there is not a MGCB circuit breaker:
        - If at least one GCB is closed, the output is active.
        - if no GCB is closed:
            - If there is a MCB circuit breaker but it is externally managed, and the plant does not consider the parallel with the grid:
                - If MCB is closed: the output activates when all gensets “managed by MC xxx” are started; if there are no gensets “managed by MC xxx”, the output activates when at least one genset is started.
                - If MCB is open, the output is active when the nominal power of the gensets with GCB closed is enough to supply the loads.
            - In other cases, the output activates when the nominal power of the gensets with GCB closed is enough to supply the loads.

Usually, the controller can modify the speed and voltage of the gensets through commands on the CAN bus PMCB line. It is possible to also use some analogue outputs for this purpose. The controller has the following functions for the configuration of the analogue outputs:

- AOF.1000 (“Speed regulator”). The controller manages this output for sending speed commands to the genset controllers. The output can be adjusted by the following parameters:
    - P.0831: if set to zero, the output increases to request an increase of the speed. If set to 1, the output decreases to request an increase of the speed.
    - P.0856: it allows to specify the minimum value for the output (%).
    - P.0857: it allows to specify the maximum value for the output (%).
- AOF.1001 (“Speed regulator (with curve)”). The controller manages this output for sending speed commands to the genset controllers. The output can be adjusted by means a conversion curve.
- AOF.1002 (“Voltage regulator”). The controller manages this output for sending voltage commands to the genset controllers. The output can be adjusted by the following parameters:
    - P.0861: if set to zero, the output increases to request an increase of the voltage. If set to 1, the output decreases to request an increase of the voltage.

- P.0862: it allows to specify the minimum value for the output (%).
- P.0863: it allows to specify the maximum value for the output (%).

- AOF.1003 (“Voltage regulator (with curve)”). The controller manages this output for sending voltage commands to the genset controllers. The output can be adjusted by means a conversion curve.

7.14 Plant types

This paragraph describes all the plant types managed by MC400, selectable by parameter P.0802. The controller manages only plant types with more than one genset; anyhow, it is possible to work (with this plants) even with only one genset. The following notes are valid for all types of plant:

- See paragraph 7 for the list of the conditions, so that a genset controller is considered “managed by MC xxx” (remember that, in any case, the genset controllers should be at least in AUTO to be “managed by MC xxx”).
- The gensets “managed by MC xxx” can be started only if MC400 is not in OFF/RESET and if there are no blocks and/or unloads.
- In MAN, the operator can start/stop the gensets “managed by MC xxx” with the buttons START and STOP. To start/stop the gensets not “managed by MC xxx”, use the related controllers.
- See paragraph 7.9 for a list of the minimum conditions that allow the closing of the MCB circuit breaker.
- See paragraph 7.9 for a list of the minimum conditions that allow the closing of the MGCB circuit breaker.
- See paragraph 7.9 for the description of the manual commands for the circuit breakers.
- See paragraph 7.9 for the anomalies of the circuit breakers opening/closing failure.
- See paragraph 7 for the anomalies of the circuit breakers synchronization failure.

The plants are divided according to the necessary conditions for the automatic intervention of the gensets. From this point of view, there are three types of plant:

- “Island mode” production plant. The term “island mode” indicates the situation in which one or more gensets supply a load, without being in parallel with the grid. The automatic intervention of the plant is always required, independently from the grid status. The parallel with the grid is not allowed.
- “Emergency” plant. The automatic intervention of the gensets is required in case of anomalies of the grid. The parallel with the grid is allowed, even if it is not the normal operation for this type of plant.
- Plant for the production “in parallel with the grid”. The automatic intervention of the plant is required only if the grid is live and in tolerance. The supply in “island mode” is not allowed.

The following table shows a recap of all types of plant, according to what has been said:

P.0802	Production in island mode	AMF	Production in parallel with the grid	Parallel with the grid allowed	Supply in island mode allowed
MPM	X			No	Yes
MSB		X		No	Yes
MSB + MSTP		X	X	Yes	Yes
MPtM			X	Yes	No
MPtM + MSB	X		X	Yes	Yes

The acronyms indicated in the first column will be described in detail below. It is important to understand well the difference between the plants “**MSB + MSTP**” e “**MPtM + MSB**”: they allow, in fact, both the supply in “island mode” and the supply in “parallel with the grid”. The difference consists in the mode in which the automatic intervention of the genset is required:

- The plant “**MSB + MSTP**” is an “emergency” plant and so the gensets will be started (automatically) only in case of grid anomaly. To put the gensets in parallel with the grid, you need to force the start when the grid is live (through the REMOTE START or TEST mode).

- The plant "**MPtM + MSB**" is both a "supply in island" and production "in parallel with the grid" plant. Automatically, the gensets are started when the grid is in tolerance and when it is out of tolerance or off: in the first case, the plant will be "in parallel with the grid", in the second case, it will be "in island mode".

The different types of plant will be described in detail below. Gensets automatic start inhibition

7.14.1 MPM (Multiple Prime Mover)

This type of plant requires the production in "island mode". They are the typical gensets of the building sites, where the operator decides when the gensets must supply or not. The parallel with the grid is not allowed.

Parallel functions	Available
Synchronization for MGCB.	Not available.
Synchronization for MCB.	Not available.
Protections for the parallel with the grid.	Not available.
Management of the active power in parallel with the grid.	Not available.
Management of the power factor in parallel with the grid.	Not available.
Function "transfer to gensets".	Not available.

In this type of plant, the controller ignores the grid and MCB status. It is not possible to close the MGCB circuit breaker with synchronization: this means that the controller does not allow the MGCB closing if, in case of wrong wiring, it detects the simultaneous presence of voltage on both sides of the circuit breaker.

Automatic sequence

The automatic intervention of the genset is required in the following conditions:

- In AUTO: if no "inhibition to start" is active.
- In TEST and REMOTE START: always, ignoring the "inhibition to start".

When there are gensets ready to supply, the controller must decide if closing the MGCB circuit breaker or not (if it exists). The circuit breaker should be always closed, except for the following cases:

- There are active alarms or unloads.
- The stop of the gensets is required.
- There is an active "inhibition to supply the load".

If the opening of MGCB is not required, the controller must decide in which moment to close the circuit breaker: see the description of the parameter P.0806 at paragraph 7.9.3.5.

The logic of normal operation in AUTO (**if the controller manages the MGCB circuit breaker**) will be:

1) **MGCB open, gensets "managed by MC xxx" stopped.** If the automatic intervention of the plant is required, the procedure skips to point 2.

2) **MGCB open, gensets "managed by MC xxx" starting.** If there are no gensets "managed by MC xxx", the procedure skips to point 3. Otherwise, the controller waits that at least one genset "managed by MC xxx" is ready to supply and then the procedure skips to point 3. It is possible to set a maximum duration for the gensets starting with the parameter P.9511. If this parameter is different from zero, and the starting phase lasts more than the value configured, the controller activates the warning W022. During the waiting, in case of alarms or unloads, or if the automatic intervention is no longer required, the procedure skips to point 8.

3) **MGCB opened.** If the gensets must be stopped (alarms or unloads, or if the automatic intervention is no longer required), the procedure skips to point 8. If there are requests of "inhibition to supply the load", the procedure stays at this point. Otherwise, it continues:
   - To point 4, if there is no voltage on loads bus.
   - Stay in this point if there is voltage on the load's bus (rare, as MGCB is opened and MCB does not exist).

4) **MGCB open, waiting for gensets.** The controller checks if the number of gensets with GCB closed and their nominal power correspond to what has been configured in parameter P.0806. If they correspond (or if there are no other genset "managed by MC xxx" that could close their GCB), the procedure skips to point 5. During the waiting, in case of alarms or unloads, or if the automatic intervention is no longer required, the procedure skips to point 8.

5) **Closing without synchronization of MGCB** (three attempts). In case of closing failure, the alarm A014 is activated (MGCB not closed), and the procedure skips to point 8. Otherwise, the procedure continues to point 6.

6) **MGCB closed.** In case of alarms or deactivations, or if there are requests of "inhibition to supply the loads", the procedure skips to point 7. If the automatic intervention of the genset is no longer required, the procedure skips to point 7.

7) **Opening of MGCB** (three attempts): if MGCB opens, the procedure skips to point 3. If MGCB does not open, the alarm A024 is activated (MGCB not closed), and the procedure skips to point 8.

8) **Stopping.** The controller removes the start request for the gensets "managed by MC xxx". If there are other MC xxx requiring the use of the gensets, the procedure ends at point 1. Otherwise, the controller waits for the gensets stopping. It is possible to set a maximum duration for this waiting: if the parameter P.9512 is set to a value different from zero, the controller waits in this status for the time configured. If the gensets do not stop within this time, the controller activates a warning W021, and the procedure ends at point 1. If the automatic intervention of the genset is required again, the procedure continues from point 2.

The logic of normal operation in AUTO (**if the controller does not command the MGCB circuit breaker**) will be:

1) **Gensets "managed by MC xxx" stopped.** If the automatic intervention of the plant is required, the procedure skips to point 2.

2) **Gensets "managed by MC xxx" starting.** If there are no gensets "managed by MC xxx", the procedure skips to point 3. Otherwise, the controller waits that at least one genset "managed by MC xxx" is ready to supply and then the procedure skips to point 3. It is possible to set a maximum duration for the gensets starting with the parameter P.9511. If this parameter is different from zero, and the starting phase lasts more than the value configured, the controller activates the warning W022. During the waiting, in case of alarms or unloads, or if the automatic intervention is no longer required, the procedure skips to point 4.

3) **Supplying**. In case of alarms or deactivations, or if the automatic intervention of the gensets is no longer required, the procedure skips to point 4. If there are requests for "inhibition to supply the loads", the procedure stays in this status: if MGCB is closed, the requests of inhibition are transformed in opening commands of the GCB circuit breakers of the controllers "managed by MC xxx".

4) **Stopping.** The controller removes the start request for the gensets "managed by MC xxx". If there are other MC xxx requiring the use of the gensets, the procedure ends at point 1. Otherwise, the controller waits for the gensets stopping. It is possible to set a maximum duration for this waiting: if the parameter P.9512 is set to a value different from zero, the controller waits in this status for the time configured. If the gensets do not stop within this time, the controller activates a warning W021, and the procedure ends at point 1. If the automatic intervention of the genset is required again, the procedure continues from point 2.

7.14.2 MSB (Multiple Stand By)

This type of plant requires one or more gensets to carry out the emergency to grid service. The controller starts the gensets if the grid is "out of tolerance" with respect to the time configured; it stops them if the grid is "in tolerance". If configured by means parameter P.9514, the controller can require the intervention of the gensets even in case of closing failure of the MCB circuit breaker. The parallel with the grid is not allowed.

Parallel functions	Available
Synchronization of MGCB.	Not available
Synchronization for MCB.	Not available
Protections for the parallel with the grid.	Not available
Management of the active power in parallel with the grid.	Not available
Management of the power factor in parallel with the grid.	Not available
Function “transfer to gensets”.	Not available

It is not possible to close MCB and MGCB with synchronization: this means that the controller does not allow the circuit breaker closing if the other is closed. Moreover, it does not allow the closing of any circuit breaker if, for a wrong wiring, it detects the simultaneous presence of voltage on both sides of the circuit breaker.

Automatic sequence

The automatic intervention of the gensets is required in the following conditions:

- In AUTO: if no “inhibition to start” is active and if:
  - The grid is “out of tolerance”.
  - The grid is live, but the controller cannot close the MCB circuit breaker (if configured by means parameter P.9514).
- In TEST and REMOTE START: always, ignoring the “inhibition to start”.

When there are gensets ready to supply, the controller must decide if let the gensets supply the load. This should be always done except when:

- There are active alarms or unloads.
- The stop of the gensets is required.
- There is an active “inhibition to supply the loads”.

If the supply of the load from the gensets is required, the controller must decide when to carry out the switch. The controller never closes MGCB before GCB. Parameter P.0806 allows configuring when to close the circuit breaker (see 7.9.3.5).

The logic of normal operation in AUTO (**if MC400 manages both MCB and MGCB circuit breakers**) will be:

1) **MCB closed, MGCB open, gensets “managed by MC xxx” stopped.** If the automatic intervention of the plant is required, the procedure skips to point 2.

2) **MCB closed, MGCB open, gensets “managed by MC xxx” starting.** If there are no gensets “managed by MC xxx”, the procedure skips to point 3. Otherwise, the controller waits that at least one genset “managed by MC xxx” is ready to supply and then the procedure skips to point 3. It is possible to set a maximum duration for the gensets starting with the parameter P.9511. If this parameter is different from zero, and the starting phase lasts more than the value configured, the controller activates the warning W022. During the waiting, in case of alarms or unloads, or if the automatic intervention is no longer required, the procedure skips to point 12.

3) **MCB closed, MGCB open.** If the gensets must be stopped (alarms or unloads, or if the automatic intervention is no longer required), the procedure skips to point 12. If there are requests of “inhibition to supply the loads”, the procedure stays at this point. Otherwise, the procedure continues to point 4.

4) **Gensets wait.** The controller checks if the number of gensets with GCB closed and their nominal power correspond to what has been configured in parameter P.0806. If they correspond (or if there are no other genset “managed by MC xxx” that could close their GCB), the procedure skips to point 5. If the gensets must be stopped (alarms or unloads, or if the automatic intervention is no longer required), the procedure skips to point 12.

5) **MCB opening** (three attempts) In case of opening failure, the alarm A023 is activated (MCB not opened), and the procedure skips to point 12. Otherwise, the procedure continues to point 6.

6) **MCB open, MGCB closed.** The controller waits for the time configured with parameter P.0219, then it continues to point 7. If the gensets must be stopped (alarms or unloads, or if the automatic intervention is no longer required), the procedure skips to point 11. If there is an inhibition to supply the loads, the procedure skips to point 11.

7) **MGCB closing** (three attempts). In case of closing failure, the alarm A014 is activated (MGCB not closed), and the procedure skips to point 11. Otherwise, the procedure continues to point 8.

8) **MCB open, MGCB closed.** In case of alarms or deactivations, or if there are no requests of "inhibition to supply the loads", the procedure skips to point 9. If the automatic intervention of the genset is no longer required, the procedure skips to point 9.

9) **Opening of MGCB** (three attempts): if MGCB opens, the procedure skips to point 10. If MGCB does not open, the alarm A024 is activated (MGCB not opened), and the procedure skips to point 12.

10) **MCB open, MGCB closed.** The controller waits for the time configured with parameter P.0219, then it continues to point 11.

11) **MCB closing** (three attempts) In case of closing failure, the alarm A013 is activated (MCB not closed), and the procedure skips to point 12. Otherwise, the procedure continues to point 3.

12) **Stopping.** The controller removes the start request for the gensets "managed by MC xxx". If there are other MC xxx requiring the use of the gensets, the procedure ends at point 1. Otherwise, the controller waits for the gensets stopping. It is possible to set a maximum duration for this waiting: if the parameter P.9512 is set to a value different from zero, the controller waits in this status for the time configured. If the gensets do not stop within this time, the controller activates a warning W021, and the procedure ends at point 1. If the automatic intervention of the genset is required again, the procedure continues from point 2.

The logic of normal operation in AUTO (**if MC400 manages the MCB circuit breaker only**) will be:

1) **MCB closed, gensets "managed by MC xxx" stopped.** If the automatic intervention of the plant is required, the procedure skips to point 2.

2) **MCB closed, gensets "managed by MC xxx" starting.** If there are no gensets "managed by MC xxx", the procedure skips to point 3. Otherwise, the controller waits that at least one genset "managed by MC xxx" is ready to supply and then the procedure skips to point 3. It is possible to set a maximum duration for the gensets starting with the parameter P.9511. If this parameter is different from zero, and the starting phase lasts more than the value configured, the controller activates the warning W022. During the waiting, in case of alarms or unloads, or if the automatic intervention is no longer required, the procedure skips to point 8.

3) **MCB closed**. If the gensets must be stopped (alarms or unloads, or if the automatic intervention is no longer required), the procedure skips to point 8. If there are requests of "inhibition to supply the loads", the procedure stays at this point. If MGCB is closed, the procedure continues to point 5 to open the MCB circuit breaker immediately (otherwise, the controllers cannot close GCB because the plant does not require the parallel with the grid). Otherwise, the procedure continues to point 4.

4) **Gensets waiting (MGCB open).** The controller checks if the number of gensets with GCB closed and their nominal power correspond to what has been configured in parameter P.0806. If they correspond (or if there are no other genset "managed by MC xxx" that could close their GCB), the procedure skips to point 5. If the external logic closes MGCB, the procedure immediately skips to point 5. If the gensets must be stopped (alarms or unloads, or if the automatic intervention is no longer required), the procedure skips to point 8.

5) **MCB opening** (three attempts) In case of opening failure, the alarm A023 is activated (MCB not opened), and the procedure skips to point 8. Otherwise, the procedure continues to point 6.

6) **MCB open**. In case of alarms or deactivations, or if the automatic intervention of the genset is no longer required, the procedure skips to point 7. If there are requests for "inhibition to supply the loads" and MGCB is closed, the requests of inhibition are transformed in opening commands of the GCB circuit breakers of the controllers "managed by MC xxx".

7) **MCB closing** (three attempts) In case of closing failure, the alarm A012 is activated (MCB not closed), and the procedure skips to point 8. Otherwise, the procedure continues to point 3.

8) **Stopping.** The controller removes the start request for the gensets "managed by MC xxx". If there are other MC xxx requiring the use of the gensets, the procedure ends at point 1. Otherwise, the controller waits for the gensets stopping. It is possible to set a maximum duration for this waiting: if the parameter P.9512 is set to a value different from zero, the controller waits in this status for the time configured. If the gensets do not stop within this time, the controller activates a warning W021, and the procedure ends at point 1. If the automatic intervention of the genset is required again, the procedure continues from point 2.

Note: the described sequences are valid if the parameter P.0248 is set to zero. If it is set to 1, the MCB circuit breaker will be opened as soon as the grid become steadily "out of thresholds", to protect the loads against wrong voltages/frequency.

7.14.3 MSB+MSTP (Multiple Stand By + Multiple Short Time Parallel)

This type of plant is like the previous one: it requires one or more gensets to carry out the emergency service to grid. The controller starts the gensets if the grid is "out of tolerance" with respect to the time configured; it stops them if the grid is "in tolerance". If configured by means parameter P.9514, the controller can require the intervention of the gensets even in case of closing failure of the MCB circuit breaker.

With respect to the MSB plant, the controller allows the parallel with the grid.

Usually, the parallel with the grid is temporary (P.0880=0): it is used to avoid a black-out on the loads during their switch from gensets to grid (when it is back) or from grid to gensets (in case of forced intervention in TEST or REMOTE START). In this case, the maximum duration for the parallel with the grid is 1 second: anyhow, it can be configured with the parameter P.0890. Please read the description of the warning W207 that is related with this parameter.

This type of plant also allows the parallel with the grid (if P.0880 is different from zero). Usually, you use this function to test the gensets (TEST) without disconnecting the loads from the grid. In this case, there is no limit in the parallel duration.

Function	Available
Synchronization of MGCB.	**Available.**
Synchronization for MCB.	**Available.**
Protections for the parallel with the grid.	**Available.**
Management of the active power in parallel with the grid.	**Available.**
Management of the power factor in parallel with the grid.	**Available.**
Function "transfer to gensets".	**Available.**

Automatic sequence

The automatic intervention of the gensets is required in the following conditions:

- In AUTO: if no "inhibition to start" is active and if:
  - The grid is "out of tolerance".
  - The grid is live, but the controller cannot close the MCB circuit breaker (if configured by means parameter P.9514).
- In TEST and REMOTE START: always, ignoring the "inhibition to start".

When there are gensets ready to supply, the controller must decide if let the gensets supply the load. This should be always done except when:

- There are active alarms or unloads.
- The stop of the gensets is required.
- There is an active "inhibition to supply the loads".

If the supply of the loads from the gensets is required, the controller must decide when to carry out the switch. The controller never closes MGCB before GCB. Parameter P.0806 allows configuring when to close the circuit breaker (see 7.9.3.5).

The logic of normal operation in AUTO (**if MC400 manages both circuit breakers**) will be:

1) **MCB closed, MGCB open, gensets "managed by MC xxx" stopped.** If the automatic intervention of the plant is required, the procedure skips to point 2.

2) **MCB closed, MGCB open, gensets "managed by MC xxx" starting.** If there are no gensets "managed by MC xxx", the procedure skips to point 3. Otherwise, the controller waits that at least one genset "managed by MC xxx" is ready to supply and then the procedure skips to point 3. It is possible to set a maximum duration for the gensets starting with the parameter P.9511. If this parameter is different from zero, and the starting phase lasts more than the value configured, the controller activates the warning W022. During the waiting, in case of alarms or unloads, or if the automatic intervention is no longer required, the procedure skips to point 17.

3) **MCB closed, MGCB open.** If the gensets must be stopped (alarms or unloads, or if the automatic intervention is no longer required), the procedure skips to point 17. If there are requests of "inhibition to supply the loads", the procedure waits in this point. Otherwise, it continues:

   - To point 12 if it is possible to close MGCB with the synchronization and the parallel with the grid is allowed (P.0880 > 0).
   - To point 4 in other cases.

4) **MCB closed, MGCB open, genset waiting.** The controller checks if the number of gensets with GCB closed and their nominal power correspond to what has been configured in parameter P.0806. If they correspond (or if there are no other genset "managed by MC xxx" that could close their GCB), the procedure skips to point 5 and it is not possible to close MGCB with synchronization; otherwise, to point 12. If the gensets must be stopped (alarms or unloads, or if the automatic intervention is no longer required), the procedure skips to point 17. If there are inhibitions, the procedure skips to point 3.

5) **MCB opening, MGCB open** (three attempts). In case of opening failure, the alarm A023 is activated (MCB not opened), and the procedure skips to point 17. Otherwise, the procedure continues to point 6.

6) **MCB open, MGCB closed.** If the gensets must be stopped (alarms or unloads, or if the automatic intervention is no longer required), the procedure skips to point 10. If there is an inhibition to supply the loads, the procedure skips to point 10. Otherwise, the controller waits for the time configured with parameter P.0219, then it continues to point 7.

7) **MGCB closing without synchronization** (three attempts). In case of closing failure, the alarm A014 is activated (MGCB not closed), and the procedure skips to point 10. Otherwise, the procedure continues to point 8.

8) **MCB open, MGCB closed.** If there are alarms or unloads, requests of inhibition to supply the loads or the automatic intervention of the gensets is no longer required, the procedure continues:

   - To point 9 if it is not possible to close MCB with synchronization.
   - To point 11 if it is not possible to close MCB with synchronization.

9) **Opening of MGCB, MCB open** (three attempts): if MGCB opens, the procedure skips to point 6. If MGCB does not open, the alarm A024 is activated (MGCB not opened), and the procedure skips to point 17.

10) **MCB closing without synchronization** (three attempts) In case of closing failure, the alarm A013 is activated (MCB not closed), and the procedure skips to point 17. Otherwise, the procedure continues to point 3.

11) **MCB closing with synchronization.** This phase lasts maximum P.0853 seconds. If during this time MCB closes, the procedure skips to point 13. Otherwise, the controller activates the warning W272 ("synchronization failure

on MCB"): the controller will not allow the synchronization for the MCB closing if the operator does not "acknowledge" this warning. The procedure goes back to point 8.

12) **MGCB closing with synchronization** This phase lasts maximum P.0852 seconds. If during this time MGCB closes, the procedure skips to point 13. Otherwise, the controller activates the warning W271 ("synchronization failure on MGCB"): the controller will not allow the synchronization for the MGCB closing if the operator does not "acknowledge" this warning. The procedure goes back to point 3.

13) **MCB closed, MGCB closed** If the gensets must be stopped for an alarm, the procedure skips to point 16. If some unloads are activated, the automatic intervention is no longer required, or some requests of "inhibition to supply the loads" are activated, the procedure continues to point 15. If the parallel with the grid is not allowed (or the maximum time allowed for the parallel with the grid expires), the procedure continues to point 14. If the "transfer to gensets" mode is active, when the gensets reach the power setpoint configured by MC400, the procedure continues to point 14.

14) **MCB opening, MGCB closed** (three attempts). In case of opening failure, the alarm A023 is activated (MCB not opened), and the procedure skips to point 17. Otherwise, the procedure continues to point 8.

15) **MCB closed, MGCB closed, power unload** If the parallel with the grid is not allowed (or the maximum time allowed for the parallel with the grid expires), the procedure continues to point 16. During this phase, the controller establishes a power setpoint equal to 0 kW for the gensets. Then, it controls the active power supplied by the gensets "managed by MC xxx": when it goes under the threshold P.0878, the procedure continues to point 16. In any case, the maximum duration of this phase can be configured with the parameter P.0879: when the time is up, whatever the power supplied by the gensets is, the procedure continues to point 16. If there are not alarms or unloads, the requests of "inhibition to power load" are not activated and the automatic intervention is required, the procedure continues to point 13.

    Note: if P.9605 is set to 1, the active power setpoint for the unloading procedure is managed through the SYSTEM BASE LOAD mode. The genset controllers manage this setpoint by themselves, taking care of the ones that are working in different modes; however, the setpoint is probably near to zero and, if there are gensets working in a different mode, it is possible that the system can't reach it: this is the reason for which, to detect the end of the unload, only the generators "managed by MC xxx" are considered.

16) **Opening of MGCB, MCB closed** (three attempts): if MGCB opens, the procedure skips to point 3. If MGCB does not open, the alarm A024 is activated (MGCB not opened), and the procedure skips to point 17.

17) **Stopping.** The controller removes the start request for the gensets "managed by MC xxx". If there are other MC xxx requiring the use of the gensets, the procedure ends at point 1. Otherwise, the controller waits for the gensets stopping. It is possible to set a maximum duration for this waiting: if the parameter P.9512 is set to a value different from zero, the controller waits in this status for the time configured. If the gensets do not stop within this time, the controller activates a warning W021, and the procedure ends at point 1. If the automatic intervention of the genset is required again, the procedure continues from point 2.

The logic of automatic normal operation (**if MC400 manages MCB only**) will be:

1) **MCB closed, gensets "managed by MC xxx" stopped.** If the automatic intervention of the plant is required, the procedure skips to point 2.

2) **MCB closed, gensets "managed by MC xxx" starting.** If there are no gensets "managed by MC xxx", the procedure skips to point 3. Otherwise, the controller waits that at least one genset "managed by MC xxx" is ready to supply and then the procedure skips to point 3. It is possible to set a maximum duration for the gensets starting with the parameter P.9511. If this parameter is different from zero, and the starting phase lasts more than the value configured, the controller activates the warning W022. During the waiting, in case of alarms or unloads, or if the automatic intervention is no longer required, the procedure skips to point 9.

3) **MCB closed**. If the gensets must be stopped (alarms or unloads, or if the automatic intervention is no longer required), the procedure skips to point 9. If there are requests for "inhibition to supply the loads", the procedure stays in this status: if MGCB is closed, the requests of inhibition are transformed in opening

commands of the GCB circuit breakers of the controllers “managed by MC xxx”; the gensets will download the power before opening GCB.

MGCB opened. The controller checks if the number of gensets with GCB closed and their nominal power correspond to what has been configured in parameter P.0806. If they correspond (or if there are no other genset “managed by MC xxx” that could close their GCB):

- If there is a digital input to require the synchronization of MGCB, the procedure stays in this status waiting for the request. When the request is active, the procedure skips to point 8.
- If there is no digital input (and MGCB cannot be closed with synchronization), the procedure continues to point 4.

MGCB closed: the controller checks:

- There are gensets with GCB closed. If the parallel with the grid is not allowed (or the maximum time allowed for the parallel with the grid expires), the procedure continues to point 4. If the “transfer to gensets” mode is active, when the gensets reach the power setpoint configured by MC400, the procedure continues to point 4.
- There are no gensets with GCB closed. If there are gensets ready to supply, but the grid is out of tolerance (so, the gensets cannot close their GCB with synchronization), the procedure continues to point 4.

4) **MCB opening** (three attempts). In case of opening failure, the alarm A023 is activated (MCB not opened), and the procedure skips to point 9. Otherwise, the procedure continues to point 5.

5) **MCB open**. The actions depend on the MGCB status.

   MGCB opened. If there are alarms or unloads, requests of “inhibition to supply the loads” or the automatic intervention of the genset is no longer required, the procedure continues to point 6. Otherwise, the procedure stays in this status.

   MGCB closed. If there are alarms or unloads, the procedure skips to point 9. If there are “inhibition to supply the loads”, or the automatic intervention is not required, the controller continues to point 7 if it is possible to use the synchronization for the closing of MCB; otherwise, it waits for MGCB or GCB to open.

6) **MCB closing without synchronization** (three attempts) In case of closing failure, the alarm A013 is activated (MCB not closed), and the procedure skips to point 9. Otherwise, the procedure continues to point 3.

7) **MCB closing with synchronization** This phase lasts maximum P.0853 seconds. If during this time MCB closes, the procedure skips to point 3. Otherwise, the controller activates the warning W272 (“synchronization failure on MCB”): the controller will not allow the synchronization for the MCB closing if the operator does not “acknowledge” this warning. The procedure goes back to point 5.

8) **MGCB closing with synchronization** This phase lasts maximum P.0852 seconds. If during this time MGCB closes, the procedure skips to point 13. Otherwise, the controller activates the warning W271 (“synchronization failure on MGCB”): the controller will not allow the synchronization for the MGCB closing if the operator does not “acknowledge” this warning. The procedure goes back to point 5.

9) Stopping. The controller removes the start request for the gensets “managed by MC xxx”. If there are other MC xxx requiring the use of the gensets, the procedure ends at point 1. Otherwise, the controller waits for the gensets stopping. It is possible to set a maximum duration for this waiting: if the parameter P.9512 is set to a value different from zero, the controller waits in this status for the time configured. If the gensets do not stop within this time, the controller activates a warning W021, and the procedure ends at point 1. If the automatic intervention of the genset is required again, the procedure continues from point 2.

Note: the described sequences are valid if the parameter P.0248 is set to zero. If it is set to 1, the MCB circuit breaker will be opened as soon as the grid become steadily “out of thresholds”, to protect the loads against wrong voltages/frequency.

7.14.4 MPTM (Multiple Parallel to Grid)

This is a plant for the production in parallel with the grid. The controller starts the gensets if the grid status allows the parallel; it disconnects the gensets from the grid if the protections of parallel with the grid are activated (see 7.4.2); it stops the gensets if the grid status does not allow the parallel for P.0899 seconds.

The supply in “island mode” is not allowed: so, if the protections of parallel with the grid are activated, the controller opens the MGCB circuit breaker anyway (if it exists), whatever is the interface controller selected with parameter P.0900. We suggest selecting MGCB as interface controller (P.0900=2).

The parallel with the grid must be continue, so the parameter P.0880 must be set at a value different from zero.

Parallel functions	Available
Synchronization for MGCB.	**Available.**
Synchronization for MCB.	Not available.
Protections for the parallel with the grid.	**Available.**
Management of the active power in parallel with the grid.	**Available.**
Management of the power factor in parallel with the grid.	**Available.**
Function “transfer to gensets”.	Not available.

Automatic sequence

The automatic intervention of the gensets is required in the following conditions:

- In AUTO: if there is no “inhibition to start” and the grid status allows the parallel with the grid.
- In TEST and REMOTE START: always, ignoring the “inhibition to start” and the grid status.

When there are gensets ready to supply, the controller must decide if connect the gensets to the grid. This should be always done except when:

- There are active alarms or unloads.
- The stop of the gensets is required.
- There is an active “inhibition to supply the loads”.

The logic of normal operation in automatic mode (**if the controller manages both circuit breakers and if MGCB is the interface controller**) will be:

1) **MCB closed, MGCB open, gensets “managed by MC xxx” stopped.** If the automatic intervention of the plant is required, the procedure skips to point 2.

2) **MCB closed, MGCB open, gensets “managed by MC xxx” starting.** If there are no gensets “managed by MC xxx”, the procedure skips to point 3. Otherwise, the controller waits that at least one genset “managed by MC xxx” is ready to supply and then the procedure skips to point 3. It is possible to set a maximum duration for the gensets starting with the parameter P.9511. If this parameter is different from zero, and the starting phase lasts more than the value configured, the controller activates the warning W022. During the waiting, in case of alarms or unloads, or if the automatic intervention is no longer required, the procedure skips to point 9.

3) **MCB closed, MGCB open.** If the gensets must be stopped (alarms or unloads, or if the automatic intervention is no longer required), the procedure skips to point 9. If there are requests of “inhibition to supply the loads”, the procedure waits in this point. If the grid is out of tolerance, the procedure waits in this point (after P.0899 seconds, an “inhibition to start” is activated to automatically removes the request of intervention). Otherwise, it continues:

    - To point 4, if you decided to close the MGCB circuit breaker before the GCB one (by means of the parameter P.9513) and if there are no GCB closed.

- To point 5 if it is not possible to close MGCB with synchronization.
- In the other cases, it stays in this status.

4) **MGCB closing without synchronization** (three attempts). In case of closing failure, the alarm A014 is activated (MGCB not closed), and the procedure skips to point 9. Otherwise, the procedure continues to point 6.

5) **MGCB closing with synchronization.** This phase lasts maximum P.0852 seconds. If during this time MGCB closes, the procedure skips to point 6. Otherwise, the controller activates the warning W271 ("synchronization failure on MGCB"): the controller will not allow the synchronization for the MGCB closing if the operator does not "acknowledge" this warning. The procedure goes back to point 3. If during the waiting the grid is out of tolerance, the procedure goes back to point 3.

6) **MCB closed, MGCB closed.** If alarms or the protections for the parallel with the grid are activated, the procedure continues to point 8. If some unloads are activated, the automatic intervention is no longer required, or some requests of "inhibition to supply the loads" are activated, the procedure continues to point 7.

7) **MCB closed, MGCB closed, power unload.** During this phase, the controller selects a power setpoint equal to 0 kW for the gensets. Then, it controls the active power supplied by the gensets "managed by MC xxx" (expressed in percentage): when it goes under the threshold P.0878, the procedure continues to point 8. In any case, the maximum duration of this phase can be configured with the parameter P.0879: when the time is up, whatever the power supplied by the gensets is, the procedure continues to point 8. If there are no alarms or unloads, there are no requests of "inhibition to supply the loads", the grid is permanently in tolerance and the automatic intervention is required, the procedure goes back to point 6.

   Note: if P.9605 is set to 1, the active power setpoint for the unloading procedure is managed through the SYSTEM BASE LOAD mode. The genset controllers manage this setpoint by themselves, taking care of the ones that are working in different modes; however, the setpoint is probably near to zero and, if there are gensets working in a different mode, it is possible that the system can't reach it: this is the reason for which, to detect the end of the unload, only the generators "managed by MC xxx" are considered.

8) **Opening of MGCB, MCB closed** (three attempts): if MGCB opens, the procedure skips to point 3. If MGCB does not open, the alarm A024 is activated (MGCB not opened), and the procedure skips to point 9.

9) **Stopping.** The controller removes the start request for the gensets "managed by MC xxx". If there are other MC xxx requiring the use of the gensets, the procedure ends at point 1. Otherwise, the controller waits for the gensets stopping. It is possible to set a maximum duration for this waiting: if the parameter P.9512 is set to a value different from zero, the controller waits in this status for the time configured. If the gensets do not stop within this time, the controller activates a warning W021, and the procedure ends at point 1. If the automatic intervention of the genset is required again, the procedure continues from point 2.

7.14.5 MPTM+MSB (Multiple Parallel to Mains + Multiple Stand By)

In this type of plant, the gensets can supply both in "island" and in "parallel with the grid" mode. it is like the MSB + MSTP plant. The differences are:

- This plant is not an emergency plant; so, the request of the gensets automatic intervention is not related to the grid status.
- The parallel with the grid must be allowed (P.0880 > 0).

As the supply in island mode is allowed, it is suggested (but not compulsory) to select MCB as interface circuit breaker (P.0900 = 2).

Parallel functions	Available
Synchronization of MGCB.	**Available.**
Synchronization for MCB.	**Available.**
Protections for the parallel with the grid.	**Available.**
Management of the active power in parallel with the grid.	**Available.**
Management of the power factor in parallel with the grid.	**Available.**
Function “transfer to gensets”.	**Available.**

Automatic sequence

The automatic intervention of the gensets is required in the following conditions:

- In AUTO: if no “inhibition to start” is active.
- In TEST and REMOTE START: always, ignoring the “inhibition to start”.

When there are gensets ready to supply, the controller must decide if let the gensets supply the load. This should be always done except when:

- There are active alarms or unloads.
- The stop of the gensets is required.
- There is an active “inhibition to power load”.

See 7.14.3 for an example of operating logic.

7.15 Load function

Note: this description is valid only if the parameter P.9506 is set to one. If it is set to 1, see the document [8].

"Load function" is the ability of MC400 to automatically start/stop the gensets "managed by MC xxx" according to the power required by the load or by the setpoint for the parallel with the grid. The display pages B.07 and B.08 are related to this function.

Note: the gensets controllers have their own "load function", but it is disabled when MC xxx manages them. If, at a precise moment, the gensets "managed by MC xxx" are in parallel with the gensets not "managed by MC xxx", all with the load function enabled, the two managements may conflict.

Load function, if enabled, works on all plant types:

- In parallel with grid, load function starts the correct number of generators to allow the system supplying power as requested by the setpoint, starting/stopping additional generators if setpoint changes. Note: in "BASE LOAD" mode, the setpoint can only be changed by the operator, while in "IMPORT/EXPORT" mode it changes also if some loads are added or removed.
- In "island mode", load function starts the generator as required by current loads, starting/stopping additional generators on changes.

Load function is enabled only in AUTO and REMOTE START modes. So, in MAN or TEST modes generators are never stopped due to load (switching from AUTO or REMOTE START to MAN or TEST the currently started generators are kept running).

In AUTO and REMOTE START modes, load function is normally enabled. It is possible, but not compulsory, to configure an input with the function DIF.2702 "Enables the load function" If this input is configured, load function is disabled when the input is "not active" (logical state). If the input is not configured or if it is "active", load function is enabled.

If a MGCB circuit breaker exists, load function is disabled if this circuit breaker is opened: in this situation, no loads are connected to generators and load function could stop them.

The main purposes of the load function are:
- Start the correct number of generators to supply the required power.
- Grant that all generators will be used, not always the same ones.

7.15.1 Starting/stopping generators to meet power requests

MC400 allows configuring two thresholds (%) related to load function:
- P.0826 - "Activation load threshold".
- P.0828 - "Deactivation load threshold".

The second threshold must be lower than the first one. They should be set to quite the same value; the purpose of difference is only to define a hysteresis, to avoid unnecessary start/stop if active power changes around the thresholds.

MC400 calculates the system total power % dividing the sum of active powers of each generator by the sum of their nominal powers (both are transmitted by the genset controllers over the can bus):

$$DPRt = \frac{\sum_{x=1}^{n} ADP_x}{\sum_{x=1}^{n} MDP_x}$$

n: number of generators with GCB closed.

ADPX: generator x active power.

MDPX: generator x nominal power.

DPRT: System total power %.

Note: these calculations are carried out on all genset supplying, not only on those managed by MC xxx.

When the total percentage power (DPRt) is higher than the threshold P.0826 for the time set with the parameter P.0827 ("Activation load delay"), MC400 must start one new genset "managed by MC xxx".

To decide to stop one genset "managed by MC xxx", MC400 first selects the genset to be stopped (hereinafter identified as genset y) and then it calculates the percentage power ratio % the system will supply if the generator would be stopped.

$$DPRtn = \frac{\sum_{x=1}^{n} ADP_x}{\sum_{x=1}^{n} MDP_x - MDP_y}$$

n: number of generators with GCB closed.

y: generator to be stopped.

X: it indicates any genset, except for the genset y.

ADPX: generator x active power.

MDPX: generator x nominal power.

MDPY: generator y nominal power.

DPRTN: system total power ratio % if generator y is stopped.

Note: these calculations are carried out on all genset supplying, not only on those managed by MC xxx.

When this system total power (DPRTN) is lower than threshold P.0828 for the time set by parameter P.0829 ("Deactivation load delay"), MC400 stops the generator y.

Parameter P.0820 ("Minimum number of gensets started") allows selecting the minimum number of started generators, whatever is the load: MC400 never stops generators (indeed it may start some of them) if currently started generators are less or equal to the desired number. Note that minimum value for this parameter is "1", so at least one generator is always running. **Note: these calculations include all genset supplying, not only on those managed by MC xxx.**

Every time a GCB circuit breaker is opened or closed, MC400 stops checking the power (and so no genset will be started/stopped) for the time set with the parameter P.0830 ("Initial delay"): in this way, the system has time for stabilization.

If automatic genset supply is required when all generators are stopped (for example when grid become "absent" in emergency plants), MC400 always starts all available generators.

Note: by pressing START on MC400, the load function is temporary suspended, by forcing the start of all available gensets "managed by MC xxx". Once all generators are supplying, load function will stop unnecessary ones. This possibility is useful each time the operator knows in advance that an increase of power is needed: he can start all generators and, when all are supplying, new loads can be added or the power setpoint can be increased. In this way, you will have the necessary power whenever you need it, even in AUTO mode and with the load function enabled.

7.15.2 Selecting generators

The gensets "not managed by MC xxx" are always "excluded" from the load function.

Normally, instead, all generators “managed by MC xxx” participate in load function. It is possible to manual exclude some “managed” generators from load function (forcing them always stopped or always running). This manual operation must be performed on display pages from B.02 to B.05, which show details about each generator (see description in 6.5.4.2). Note: the manually excluded generators list is not saved on non-volatile memory. At power on, all “managed” generators are included in load function.

Note: MC400 can stop all generators involved in load function. This happens when at least P.0820 “not managed” generators are running, and there is no power request for other gensets.

The logics described below work only on gensets that, at a given time, are included in the load function (and so implicitly “managed by MC xxx”).

To ensure that all generators are used (not always the same ones), MC400 assigns a priority to them:

- Low priority generators are started for last and stopped for first.
- High priority generators are started for first and stopped for last.
- The highest priority generator, at a given time, is called “master”.

MC400 implements three different techniques for assigning priorities to generators, selectable by parameter P.0822 (“Load function mode”).

7.15.2.1 Manual “master” genset selection

Set “1” in parameter P.0822 to select this mode.

In this mode, the operator manually selects the “master” genset using parameter P.0823 (“Master genset address”). Other gensets priorities are automatically assigned depending on addresses. Suppose generators 1 to 8 are present on the plant. Suppose also that generators 3, 4 and 7 are excluded from load function (see previous paragraph). The remaining gensets are:

1, 2, 5, 6, 8.

If the operator selects the genset “5” as “master”, the priority list will be:

5, 6, 8, 1, 2.

If the operator selects the genset “8” as “master”, the priority list will be:

8, 1, 2, 5, 6.

If the operator selects the genset “1” as “master”, the priority list will be:

1, 2, 5, 6, 8.

The priority list is made by following the order address of gensets (increase order) starting from the “master” up to the highest one; then starting from the lowest to the one preceding the “master”.

7.15.2.2 Automatic “master” generator selection at fixed time

Set “2” in parameter P.0822 to select this mode.

In this mode, the operator can always manually select the “master” genset using parameter P.0823. At the time configured by the parameter P.0824 (“Master genset change time”), however, MC400 will select a new “master”. The new “master” selected is the one following the old “master” in the priority list (obviously among the gensets included in the load function).

Let us suppose that the priority list set in P.0823 is “5,6,7,1,2”; the new “master” genset will be the genset “6”.

You can assign priorities to the following gensets as described above.

In this mode, the “rotation” of generators happens once a day.

7.15.2.3 Automatic “master” generator selection every x hour

Set “3” in parameter P.0822 to select this mode.

In this mode, the operator can always manually select the “master” genset using parameter P.0823. After the number of hours configured with parameter P.0825 “Master genset batch hours”, MC400 will select a new “master”. The new “master” is the one following the old “master” in the priority list (obviously among the generators included in load function).

Let us suppose that the priority list set in P.0823 is “5,6,7,1,2”; the new “master” genset will be the genset “6”.

You can assign priorities to the following gensets as described above.

In this mode, the “rotation” of generators happens every x hour.

7.15.2.4 Actions on “master” change

When a new “master” is selected, a new priority list is built. At that moment, it is possible that some lower priority generators are running, while some high priority generators are stopped. In this case, MC400 grants that first the high priority generators will be started and loaded, and then the low priority ones will be stopped. In this way, there will be no problems on power supply.

7.15.2.5 Events

The controller records the event EVT.1291 when the master genset is changed (if configured with the bit 8 of the parameter P.0441).

7.16 Load shedding

The purpose of “load shedding” function is to manage some digital outputs of MC400, to connect/disconnect part of loads from the generators, when generators cannot supply all loads. Display page B.09 is related to this function.

This function is normally enabled; it is disabled in the following situations:

- If the controller is in MAN or OFF/RESET mode.
- In parallel to grid operations (the eventually extra loads are supplied by grid).
- If a digital input is configured with the function DIF.2721 “Enable load shedding” and the input is “not active” (logical status). If the input is not configured, or if it is “active”, the function is enabled.
- If no digital outputs of MC400 are configured for “load shedding”. Four functions are available for digital outputs configuration:
  - DOF.2251 (“Load-shedding 1”).
  - DOF.2252 (“Load-shedding 2”).
  - DOF.2253 (“Load-shedding 3”).
  - DOF.2254 (“Load-shedding 4”).

It is possible to manage up to four groups of loads. Remember that the same function (DOF.2251 - DOF.2254) can be assigned to more than one output: in this way, a single logical group of loads can be connected/disconnected from the gensets by using more than one circuit breaker at the same time.

Outputs are “active” when MC400 needs to disconnect loads from generators, they are “not active” when loads can be re-connected.

If less than four outputs are used, configure them continuously starting with function DOF.2251. For example, if you would like to use two outputs, configure them with the functions DOF.2251 and DOF.2252. If you accidentally use the functions DOF.2251 and DOF.2253, only the first output configured with the function DOF.2251 will be used. If you use the functions DOF.2252 and DOF.2253, no output will be associated to the function “load shedding” (because the function DOF.2251 is missing).

Loads must be assigned to outputs depending on their priority:

- The output configured with the function DOF.2251 should be used for lowest priority loads: it is the first activated (to disconnect a load) and the last deactivated (to re-connect a load).
- The output configured with the function DOF.2254 should be used for highest priority loads: it is the last activated (to disconnect a load) and the first deactivated (to connect a load).

If “load shedding” function is disabled and some of its digital outputs are configured, these outputs are “not active” to avoid disconnection of loads.

7.16.1 All loads management

Normally MC400 can connect or disconnect one group of loads at a time. There are some situations, however, where all loads are connected or disconnected at the same time. Loads are all disconnected (independently by actual power) when:

- In “island mode”, in the moment the MGCB circuit breaker closes.
- In “island mode”, if the MGCB circuit breaker does not exist or it is closed but no GCB are closed, in the moment the first GCB circuit breaker closes.
- When passing from “parallel to grid” to “island mode” (at the opening time of MCB).

In the same way, all outputs are deactivated at the same time when:

- Each time loads are separated from generators by any circuit breakers.

7.16.2 Single load management

MC400 provides two thresholds (%) related to “load shedding”:

- P.1181 - “Load disconnect threshold”.
- P.1183 - “Load re-connect threshold”.

The second threshold must be lower than the first one. P.1181 threshold must be set at the maximum allowed power per generator (%). P.1183 threshold must be calculated depending on loads connected/disconnected, to avoid that when a load is connected the total power becomes greater than P.1181 and so load is disconnected again, and so on.

MC400 calculates the system total power % by dividing the sum of active powers supplied by all the gensets (included the ones not “managed by MC xxx”) by the sum of their nominal powers (both pieces of information are transmitted by the gensets controllers on CAN bus):

$$DPRt = \frac{\sum_{x=1}^{n} ADP_x}{\sum_{x=1}^{n} MDP_x}$$

n: number of generators with GCB closed.

ADP: generator x active power.

MDP: generator x nominal power.

DPRt: System total power %.

When the system total power (DPRt) is higher than the threshold P.1181 for the time set by parameter P.1182 (“Load disconnect delay”), MC400 disconnects the lowest priority loads (see above for load priorities).

MC400 can be configured to re-connect the loads automatically or manually. This choice is available by parameter P.1186 (“Load re-connect mode”):

- 0 – “Automatic”. MC400 checks system power before allowing loads connection. The system total power (%) must be less than the P.1183 threshold, for the time set by parameter P.1184 (“Load re-connect delay”).
- 1 – “Manual”. Note: this option needs for a digital input configured for “load connection command” (see in the following).

Each time a group of loads is connected/disconnected from generators, MC400 stops monitoring the power (and so no other loads can be connected/disconnected) for the time set by parameter P.1185 (“Initial delay”), to allow system stabilization.

7.16.3 Manual commands

MC400 allows configuring two digital inputs to be used for “load shedding” manual commands. Functions to be used for the input’s configuration are:

- DIF.2251 (“Manual disconnection of loads”).
- DIF.2252 (“Manual disconnection of loads”).

Note: these inputs are managed both in MAN and AUTO modes.

Both inputs work on activation and not on the state of the input (the function related to the input is executed once when input state changes form “not active” to “active” – logical state).

The activation of input configured as DIF.2251 will result in the disconnection of the lowest priority load (the next activation will disconnect the next load and so on until all loads are disconnected).

The activation of input configured as DIF.2252 will result in the re-connection of the highest priority load (the next activation will re-connect the next load and so on until all loads are connected).

7.16.4 Notes about “load shedding”.

If “not-motorized” circuit breakers are used to connect/disconnect loads, MC400 cannot automatically re-connect loads. In this case parameter P.1186 must be set to “0”: when MC400 detects that a group of loads can be re-connected, it automatically deactivates its output, and the circuit breaker is no more forced “open”. The operator can then manually close the circuit breaker.

7.16.5 Events

If it is configured with the bit 7 of the parameter P.0441, the controller records the following events related to the unload function:

- EVT.1301: load #1 has been disconnected.
- EVT.1302: load #1 has been connected.
- EVT.1303: load #2 has been disconnected.
- EVT.1304: load #2 has been connected.
- EVT.1305: load #3 has been disconnected.
- EVT.1306: load #3 has been connected.
- EVT.1307: load #4 has been disconnected.
- EVT.1308: load #4 has been connected.

7.17 “Peak shaving/lopping”

These names identify the function available in MC400 that allows to monitor the active power on the loads; when it becomes greater than a threshold, MC400 starts the generators and connects them to the loads: the loads will be partly or totally supplied by the generators (MCB opening is also available). When the active power on the loads falls below a second threshold, MC400 connects the loads to the grid, transfers the loads from the generators to the grid and stops the generators.

The function must be enabled by means parameter P.1171 (different from zero).

Moreover, it is possible to use a digital input (physical or virtual) to dynamically enable this function: use the function DIF.2722 for configuring the digital input. If such an input exists, it must be activated (logic status) to enable the “peak shaving/lopping” function.

The “peak shaving/lopping” function monitors the active power on the loads; the controller, this, must be able to measure this power (or to calculate it, see 7.8.4). If this measure is not available, the function is disabled.

Finally, the thresholds P.1172 and P.1174 must be carefully configured (the second one must be greater than the first one), otherwise the “peak shaving/lopping” function is disabled,

If the function is enabled, MC400 starts the generator if the active power on the loads is higher than the threshold P.1172 consecutively for the time P.1173. In the same way, MC400 stops the generator if the active power on the loads is lower than the threshold P.1174 consecutively for the time P.1175.

The page B.10 shows details for this function (the page is visible only if the function is enabled).

7.17.1 Power management

Once the gensets have been started and the MGCB has been closed, MC400 actions depend on the “active power management” configuration (P.0880, see 7.11).

7.17.1.1 SYSTEM BASE LOAD (“peak lopping”)

In this case, MC400 keeps the generators in parallel to the grid. The generators will provide a fixed power (as set by parameter P.0858 or acquired by means an analogue input configured as AIF.2307); the remaining part of the loads will be supplied by the grid. Attention: if the SYSTEM BASE LOAD setpoint should be greater than the loads, the generators will export active power on the grid.

7.17.1.2 SYSTEM IMPORT EXPORT (“peak shaving”)

In this case, MC400 keeps the generators in parallel to the grid. A fixed power will be imported from the grid to supply the loads (setpoint set by parameter P.0859 or acquired by means an analogue input configured as AIF.2309); this setpoint could also be 0. The remaining part of the loads will be supplied by the generators. In this case, if the power on the loads should be less than the setpoint, the generators will supply 0 kW.

7.17.1.3 Transfer to the generators

In this case, MC400 does not keep the generators in parallel to the grid. After closing MGCB, MC400 will transfer the loads from the grid to the generators (see 7.11.3) and then it will open MCB circuit breaker.

7.17.2 Events

If it is configured with the bit 6 of the parameter P.0441, the controller records the following events related to the “peak shaving/lopping” function:

- EVT.1331: “peak shaving/lopping” function requires the starting of the generators.
- EVT.1332: “peak shaving/lopping” function does not require the starting of the generators.

8 Anomalies

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

We define three typologies of anomaly:

- **Warnings**: these anomalies do not require stopping the generators. They point out to 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 require stopping the generators. As they do not create problems for the loads and the gensets, in parallel operations opening of the power connection is preferably performed after power unloading. This is performed by unloading ramp. However, it is not possible to restart the generators until the anomaly has not been acknowledged.
- **Alarms**: these anomalies require stopping the generators. They create hazards for the loads and/or for the generators. For this reason, the controller opens immediately the MGCB circuit breaker (without discharging the power from the generator), and stops the generators with standard procedure, i.e. with the cooling cycle. It is not possible to restart the generators until the anomaly is acknowledged.

An alarm can be activated if no other alarms are already active (there are some exceptions, which will be listed below). Unloads and warnings can be present.

For activating unloads, alarms or other unloads should not be present. Some other warnings can be active.

For activating a warning, alarms or unloads should not be present. Some other warnings can be active.

When an anomaly activates, the controller performs the following:

- It activates the internal horn and, if configured, also the external one. To this purpose, it is possible to configure an output of the controller with function DOF.3152 (“External horn”). The output is controlled together with the internal acoustic signalling; the aim is to use a more powerful signalling or a lamp.
- Prompts the page S.02 ANOMALIES on the multifunction display. This page shows the fault numeric code and the current language text related to the anomaly. The numeric code flashes to indicate that the anomaly has not been recognized by the operator yet.
- It activates the flashing of the “ALARM” light, if the anomaly belongs to the warning category, or it switches that light fixed on in case of unloads and alarms.
- If the anomaly is not a warning, it disconnects the generators from users or from the parallel bars (with or without power discharge) and it stops the generators (with or without cooling cycle).

The following operations can be carried out on an anomaly:

- **Silence** the horn.
- **Acknowledge** it: this informs the controller that the operator has acknowledged the event.
- **Reset:** this informs the controller that the anomaly is no longer active.

The multifunction display shows the anomaly until the operator “acknowledges” it, even if the relevant cause is no longer present (sequence ISA2C). The controller automatically resets all the acknowledged warnings when their cause is no longer active.

8.1 Silence the horn

The horn can be silenced in three ways:

- Pressing the ACK/ENTER pushbutton. **This operation does not acknowledge the anomaly, which continues to flash on the display**.

- With a digital input configured with DIF.2002 function (“Command for alarm acknowledgement”). The acoustic signalling is silenced when the input passes from “not active” to “active”.
- Using a Modbus command. These commands can be disabled in different ways (see 5.11). To send the command it is necessary to write in sequence (within 5 seconds):
  - HOLDING REGISTER 101: write the password configured with the parameter P.0004.
  - HOLDING REGISTER 102: enter the value “51”.

The management of the hooter is anyway linked to the value of P.0491 parameter (“Horn duration”).

- If set to zero, the horn will be never activated.
- If set to 999, the horn will be activated when a new anomaly arises and deactivated through the above-described procedure.
- If set to a value between 1 and 998, the horn will be activated when a new anomaly arises and deactivated through the described procedure above, or when the configured time has elapsed.

Silencing the horn does not mean to acknowledge the anomaly: it remains, in effect, flashing on page S.02 ANOMALIES.

8.2 Acknowledge the anomaly.

The anomaly (sequence ISA2C) can be identified in three ways:

- By pressing the ACK/ENTER button on the board panel. If you push this key when the horn is on, it stops the horn: it should be pressed a second time to “recognize” the anomaly.
- With a digital input configured with DIF.2002 function (“Command for alarm acknowledgement”). It is acknowledged when the input passes from “not active” to “active”.
- Using a Modbus command. These commands can be disabled in different ways (see 5.11). To send the command it is necessary to write in sequence (within 5 seconds):
  - HOLDING REGISTER 101: write the password configured with the parameter P.0004.
  - HOLDING REGISTER 102: enter the value “52”. NB: this control also silences the horn if it is active.

When the anomaly has been acknowledged, it stops flashing on page S.02 ANOMALIES. After being identified, if it is a warning, it is automatically cancelled if the cause is no more present.

Otherwise, if the cause disappears before the anomaly has been acknowledged, it remains on the display.

8.3 Cancel the anomaly.

An anomaly can be cancelled only when the cause that activated it is no more present.

The controller automatically resets all the acknowledged warnings when their cause is no longer active.

On the contrary, to cancel unloads and alarms, it is necessary to follow one of the below procedures:

- By moving the key switch on OFF/RESET position.
- Using a digital input configured with the feature DIF.2001 - “Command for resetting alarms”. When the input becomes “active”, the controller carries out a reset of all faults.
- Using a Modbus command. These commands can be disabled in different ways (see 5.11). To send the command it is necessary to write in sequence (within 5 seconds):
  - HOLDING REGISTER 101: write the password configured with the parameter P.0004.
  - HOLDING REGISTER 102: enter the value “53”.
- By using an “SMS” command (see document [3]).

8.4 Events and signalling

Each anomaly is registered (with its own code) in the event log.

Some functions are available for the configuration of the digital outputs related to the anomalies:

- DOF.3151 (“Reset of anomalies”). The controller activates this output for one second when the internal sequence for the cancellation of anomalies is carried out. With this procedure, it is also possible to reset externally managed anomalies.
- DOF.3152 (“External horn”). This output is activated and deactivated along with the internal horn. It can be used to control a more powerful horn and/or a lamp.
- DOF.3154 (“Acknowledge of the anomalies”). The controller activates this output for one second when the internal sequence of faults acknowledgement is carried out. This procedure can be used to acknowledge also some faults managed by other devices externally.
- DOF.4001: the output will be activated if at least a warning is active.
- DOF.4002: the output will be activated if at least an unload is active.
- DOF.4004: the output will be activated if at least an alarm is active.
- DOF.4005: the output will be activated if at least an alarm or an unload is active.
- DOF.4035: the output will be activated if at least an anomaly linked to circuit breakers is active. What follows is the list of anomalies that activate this output:
  - 013 (“MCB not closed”).
  - 014 (“GCB not closed”).
  - 023 (“MCB not open”).
  - 024 (“GCB not open”).

The board makes available the following internal statuses, related to anomalies, for AND/OR logics:

- ST.006: the output will be activated for a second after a command of faults acknowledgement.
- ST.007: the output will be activated for a second after a command of faults reset.
- ST.008: Warnings cumulative.
- ST.009: Unload cumulative.
- ST.011: Alarm cumulative.
- ST.012: Non-acknowledged warnings cumulative.
- ST.013: Non-acknowledged unloads cumulative.
- ST.015: Non-acknowledged alarms cumulative.

8.5 OVERRIDE of protections

WARNING: the use of this function can cause serious damages to the generators. 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 capacity of the controller of temporarily disabling (in particular conditions, and on specific request) a series of protections. The OVERRIDE function, when is activated, turns a set of alarms and unloads into simple “warnings”: in this way, the board indicates, anyway, the presence of problems, but does not reduce the supplying capacity of the generators. In some situations, in fact, supply to users is put before the preservation of the engines. You should consider, for example, hospitals: there are situations in which it is preferable to damage the engines, and supply power for the longest period possible, rather than safeguarding the engines, but leaving operating rooms without light.

The board manages the protections OVERRIDE request through digital inputs. Use the following function to configure the digital inputs:

- DIF.2063 (“Full protections Override”).

The OVERRIDE function turns into "warnings" a specific group of alarms/unloads. The document [1] has a table indicating all the controller anomalies: the column “OVER” indicates, for each anomaly, if it is subject to the OVERRIDE functions.

Besides what indicated in the table, the OVERRIDE function also affects "generic" anomalies connected to analogue and digital inputs. The following functions for the configuration of digital inputs activate anomalies that are subject to protections OVERRIDE too:

- DIF.4062 - “Unload (subject to OVERRIDE)”.
- DIF.4064 - “Alarm (subject to OVERRIDE)”.

As to protections activated through thresholds on analogue measures, it is possible to subject these anomalies to protections OVERRIDE through the bit 15 of the threshold configuration parameter (P.4005 for the first threshold on the first analogue input).

The board will show a message on “S.01” page when the OVERRIDE function is activated.

The board records an event each time an OVERRIDE request is activated (EVT.1082). Moreover, it records an event among the records, whenever the OVERRIDE request ceases (EVT.1083).

8.6 Anomalies connected to digital inputs

The board manages a considerable number of digital inputs, by also considering the expansion modules (DITEL) that it can manage. Every input can be used to activate anomalies. These anomalies are divided into two kinds:

- **Specific.** They are configured with functions DIF.4261 and following. The board knows the modes through which these anomalies should be managed, and already has some default error messages (that cannot be configured) connected to each anomaly.

- **Generic**. They are configured through DIF.4001 through DIF.4064 functions. As to these anomalies, the operator should configure the message that will be shown on the display. Moreover, by using the appropriate functions, the board will be instructed regarding the way it should manage the anomaly.

Specific anomalies will be described in the following paragraphs: in the description, the parameters relevant to the digital input #1 (P.2001, P.2002 e P.2003) will be always referred to. The document [1] has a table that shows the parameters to be used for every digital input.

What stated above is true also for generic anomalies. They will not be described in the following paragraphs, because they will be infinite repetitions of the same description for each input. On the contrary, they are described here, by indicating parameters for input #1 of the controller.

The board assigns numeric codes 701 through 806 to generic anomalies linked to digital inputs (the document [1] has a table that shows the code for each input). By utilizing the parameter that configures the function (P.2001), it is possible to select the type of anomaly (warning, unload or alarm) and to define the conditions for the anomaly management. Warning: by setting the delay to “0”, the anomaly is disabled. In the list below, the functions for the configuration of digital inputs, used to manage generic anomalies, are indicated. They are grouped three by three: the three functions for each group define the type of anomaly (see document [1] for the list of functions).

- DIF.4001, DIF.4002, DIF.4004. The board will activate this anomaly if the digital input is uninterruptedly active for the configured (P.2002) time span.

- DIF.4005, DIF.4008. The board will activate this anomaly if the digital input is uninterruptedly active for the configured (P.2002) time span. An anomaly of the same type is also activated by all the genset controllers connected through the CAN bus link.

- DIF.4021, DIF.4022, DIF.4024. The board will activate this anomaly if the digital input is uninterruptedly active for the configured (P.2002) time span. These anomalies force the opening of the MCB circuit breaker.

- DIF.4062, DIF.4064. The board will activate this anomaly if the digital input is uninterruptedly active for the configured (P.2002) time span. The anomaly is subject to the engine protections OVERRIDE and to total OVERRIDE, too (see 8.5).

8.7 Anomalies connected to analogue inputs

The board can manage a high number of analogue inputs, also considering those acquired by DIGRIN, DITHERM and DIVIT expansion modules.

For each analogue input, it allows setting two thresholds on the acquired measure, and each threshold can activate an anomaly. These are generic anomalies since the controller does not know how to manage them and has not default warning messages. They will not be described in the following paragraphs, because they will be infinite repetitions of the same description for each analogue input. On the contrary, they are described here, by indicating parameters for input 1.

The controller assigns numeric codes 301 through 554 to generic anomalies linked to analogue inputs (the document [1] has a table that shows the code of each input).

First, the operator should configure the error message that will be shown on the board display when the anomaly is activated. It should use P.4002 parameter, the only one 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.

For each analogue input, there are six parameters available for the management of thresholds, three for each threshold (P.4003, P.4004 and P.4005 for the first threshold of the first analogue input; P.4006, P.4007 and P.4008 for the second threshold of the first analogue input).

Besides the threshold value (P.4003 or P.4006) and the delay to be managed (P.4004 or P.4007), the operator must configure the operations connected to the threshold (P.4005 o P.4008). The parameter that configures the actions is managed through bits (every bit enables/disables a function connected to the threshold). For the description of these parameters, see 5.6.2.

Warning: by setting the delay to “0”, the anomaly is not disabled.

8.8 Faults list.

NOTE: as it is not possible to define either which digital or analogue inputs (of the controller or on additional modules) will be used or which function they are going to perform, refer to the following list as an example of the first configurable input. The presence of symbol (*) or the indication “or equivalent for the other inputs” aside a parameter indicates that it varies according to the configured input.

From this point on, words **enabling** and **activation** will be utilized:

- Enabling an anomaly means that the minimum necessary conditions that the controller should verify to observe the provoking cause.

- Activating an anomaly means the verification of the provoking cause, after the enabling has happened.

005 - At least one GCB is not opened

Typology: **Warning**
Related parameters: **P.0805**
To disable: **-**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

MC400 activates this anomaly when it detects (from information sent over CAN bus PMCB) that at least one genset is in a “GCB not opened” condition (GCB closed while an opening command is active). In this situation, the parameter P.0805 selects the actions on the MGCB circuit breaker:

- “0”. This setting forces an MGCB opening (and obviously avoids next MGCB closures).
- “1”. This setting avoids MGCB closures (but does not force MGCB opening if already closed).
- “2”. Use this setting when you want that the “GCB not open” condition is not involved in the MGCB management.

Note: the gensets controllers have its own equivalent parameter to configure actions on GCB.

007 – Manual STOP pressed in automatic mode

Typology: **Alarm**
Related parameters: **P.0495**
To disable: **Bit 0 of P.0495=1**
Enabled if: **AUTO, TEST, REMOTE START.**

The protection is enabled if bit 0 of parameter P.0495 is set to 0. It is activated when pressing the STOP button on MC400, or if a stop command is received from Modbus.

008 - Power required for supply not reached

Typology: **Warning**
Related parameters: **P.0806**
To disable: **P.0806 = 0 o P.0806 = 30000**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

This anomaly is enabled only if MGCB circuit breaker exists, and if it is managed by MC400. Moreover, it is enabled only when generators must supply in “island” mode. MC400 activates this anomaly before MGCB closure, if all available generators are supplying but the sum of their nominal powers is lower than the power requested with parameter P.0806. It signals that generators may be unable to supply all loads. Values “0” and “30000” of P.0806 are special; they disable this anomaly. The value “0” configures MC400 to close MGCB as soon as one GCB is closed; the value “30000” forces MC400 to wait for all available generators are supplying (whatever their power is).

013 - MCB not closed

Typology: **Warning**
Related parameters: **P.2001 (or equivalent for other inputs)**
To disable: **P.2001 <> DIF.3002**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

MC400 activates this anomaly after three consecutive closing commands without results (in MAN after the first attempt). It cannot be directly disabled: it can be disabled only by not configuring an input to acquire the circuit breaker status (but this is possible only in certain situations).

014 - MGCB not closed

Typology: **Warning / alarm**
Related parameters: **P.2001 (or equivalent for other inputs)**
To disable: **P.2001 <> DIF.3003**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

MC400 activates this anomaly after three closing commands of the circuit breaker without result (in MAN mode after the first attempt): it is a warning in MAN mode and an alarm in the other modes. It cannot be directly disabled: it can

be disabled only by not configuring an input to acquire the circuit breaker status (but this is possible only in certain situations).

016 – Maximum current (#1)

Typology:	**Warning / unload / alarm**
Related parameters:	**P.9502 P.9521 P.9522 P.9523 P.9524**
To disable:	**P.9502 = 0 o P.9522 = 0 o P.9523 = 0**
Enabled if:	**MAN, AUTO, TEST, REMOTE START.**

MC400 activates this anomaly when at least one of the grid currents is higher than the configured threshold.

The threshold (P.9521) is a percentage of the nominal current of the system, set by parameter P.9502. The threshold can be configured between 0% and 999%, with 0.1% resolution.

The delay (P.9522) of the protection can be set between 0 and 4000 seconds, with 0.1 seconds' resolution. If the delay is set to zero, the protection is disabled: so, the minimum delay is 0.1 seconds.

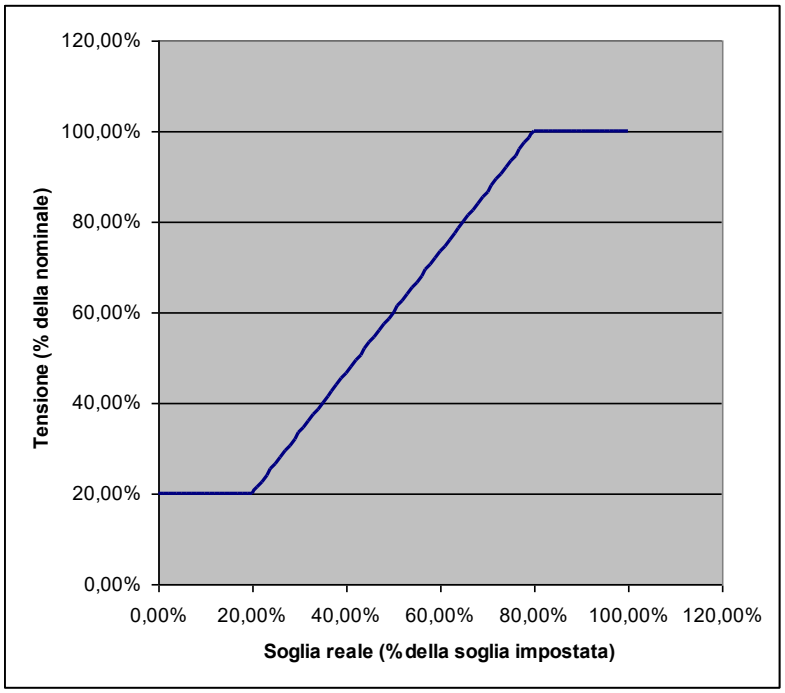
Parameter P.9524 selects the typology:

- 1: Warning.
- 2: Unload.
- 4: Alarm.
- 8: Alarm sent also to all gensets.
- 9: Warning, forces MCB open.
- 10: Unload, forces MCB open.
- 12: Alarm, forces MCB open.

The protection can work in four different ways, as selected by parameter P.9523:

1) This value selects a "fixed time" protection. The anomaly is activated when at least one current is higher than the threshold P.9521 for the time P.9522. Note: the check is made both on instantaneous and average current values; if one or both is higher than the threshold the protection can be activated.

2) This value selects the same protection of the previous one: the only difference is that the real threshold is decreased respect to the configured one if the voltages are lower than the nominal.



3) This value selects a time-related maximum current protection (it activates so much more quickly how much higher is the overload). The used curve is named EXTREMELY INVERSE and implements an I2t function.

We define a maximum current threshold (P.9521), and the maximum time the generator can work with this current (P.9522). If the current is lower than the defined threshold, the protection is not activated. If the current becomes greater than the threshold, the protection is activated with a time inversely proportional with the entity of the over current. To correctly set the thresholds, follow the following steps:

- You must set the nominal current of the system (P.9502).
- Configure the maximum current threshold by the P.9521 parameter, as a percentage of the nominal current.
- Configure the intervention time for the protection in the P.9522 parameter: the protection will be activated exactly after the time you've configured if the current is constantly equals to the P.9521 threshold multiplied by $\sqrt{2}$.

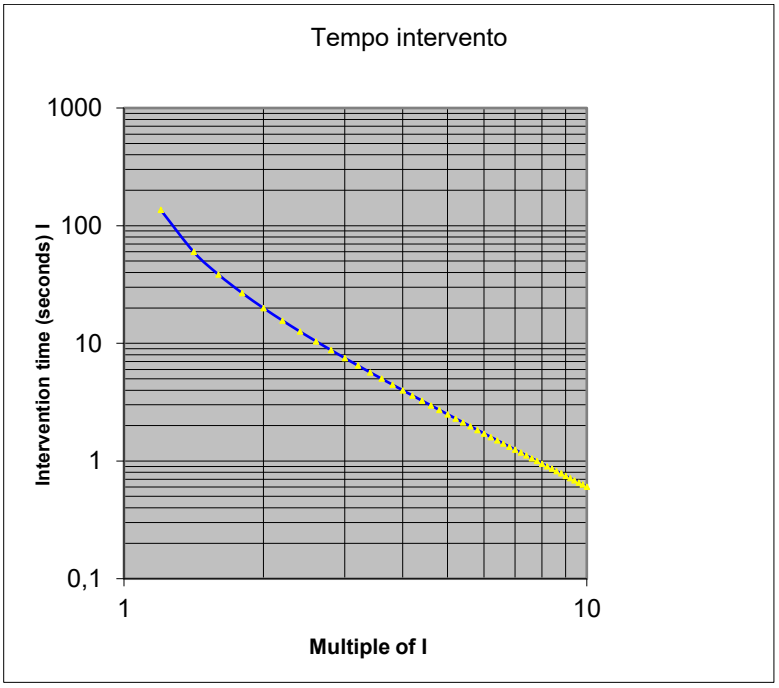
To calculate the intervention time for a preferred current, please use the following formula:

$$t_I = \frac{P.9522}{\left(\frac{I}{P.9521}\right)^2 - 1}$$

"I" is the current in the circuit.

You must keep in mind that the board calculates the integral value of the current in the time, so all the current samples over the threshold concur to determine the intervention time, with their instantaneous weight as defined in the previous formula. The only way to verify exactly this formula is thus to switch instantaneously from a normal load situation to an overload situation.

The following graph shows the used curve, with P.9522 set to 60 seconds ("I" is the maximum current):



4) This value selects the same protection of the previous one: the only difference is that the real threshold is decreased respect to the configured one if the voltages are lower than the nominal (see description for value 2).

017 – Maximum current (#2)

Typology:	**Warning / unload / alarm**
Related parameters:	**P.9502 P.9525 P.9526 P.9527 P.9528**
To disable:	**P.9502 = 0 o P.9526 = 0 o P.9527 = 0**
Enabled if:	**MAN, AUTO, TEST, REMOTE START.**

The same as anomaly “016”, with the parameter listed above.

021 – Time-out for stopping generators

Typology:	**Warning**
Related parameters:	**P.9512**
To disable:	**P.9512 = 0**
Enabled if:	**MAN, AUTO, TEST, REMOTE START.**

This anomaly is activated when at least one genset managed by MC400 is still running after the delay set in the parameter P.9512 from the stop command.

022 – Time-out for starting generators

Typology:	**Warning**
Related parameters:	**P.9511**
To disable:	**P.9511 = 0**
Enabled if:	**MAN, AUTO, TEST, REMOTE START.**

This anomaly is activated when none of the gensets managed by MC400 is running after the delay set in the parameter P.9511 from the start command.

023 – MCB opening failure

Typology: **Warning / alarm**
Related parameters: **P.2001 (or equivalent for other inputs)**
To disable: **P.2001 <> DIF.3002**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

MC400 activates this anomaly in the following situations:

- If MC400 manages the circuit breaker, but it is closed by an external logic (not in MAN mode). The anomaly is set only if the “static command” is used to manage the circuit breaker. In this case the controller activates an alarm with a delay of 0.5 seconds.
- After three opening commands of the circuit breaker without result (only one attempt in MAN mode): in this case, it is a warning in MAN mode and an alarm in the other modes.

It cannot be directly disabled: it can be disabled only by not configuring an input to acquire the circuit breaker status (but this is possible only in certain situations).

024 – MGCB opening failure

Typology: **Warning / alarm**
Related parameters: **P.2001 (or equivalent for other inputs)**
To disable: **P.2001 <> DIF.3003**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

MC400 activates this anomaly in the following situations:

- If MC400 manages the circuit breaker, but it is closed by an external logic (not in MAN mode). The anomaly is set only if the “static command” is used to manage the circuit breaker. In this case the controller activates an alarm with a delay of 0.5 seconds.
- After three opening commands of the circuit breaker without result (only one attempt in MAN mode): in this case, it is a warning in MAN mode and an alarm in the other modes.

It cannot be directly disabled: it can be disabled only by not configuring an input to acquire the circuit breaker status (but this is possible only in certain situations).

037 – Low power supply voltage

Typology: **Warning**
Related parameters: **P.0362 P.0363**
To disable: **P.0363 = 0**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

MC400 activates this anomaly when power supply voltage drops down under the threshold P.0362 for the time set with parameter P.0363. Note: the threshold P.0362 is expressed as a percentage of the supply rated voltage, which is configurable, but it is automatically selected by the controller between 12 and 24 Vdc. Selection is made when the controller is powered and every time it is forced in OFF/RESET mode. A nominal voltage of 12 V is selected if power supply voltage is lower than 17 V.

038 – High power supply voltage

Typology: **Warning**
Related parameters: **P.0364 P.0365**
To disable: **P.0365 = 0**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

MC400 activates this anomaly when power supply voltage grows up over the threshold P.0364 for the time set with parameter P.0365. Note: the threshold P.0364 is expressed as a percentage of the supply rated voltage, which is configurable, but it is automatically selected by the controller between 12 and 24 Vdc. Selection is made when the controller is powered and every time it is forced in OFF/RESET mode. A nominal voltage of 12 V is selected if power supply voltage is lower than 17 V.

045 – Maximum auxiliary current

Type:	**Alarm**
Related parameters:	**P.0108 P.0135 P.0131 P.0367 P.0368**
To disable:	**P.0368 = 0**
Enabled in:	**MAN, AUTO, TEST, REMOTE START**

The protection is enabled if a valid current measure is configured. Both P.0108 and P.0135 should be different from zero, and P.0131 should be set to 1 or 2. Moreover, the protection can be disabled through a digital input configured through DIF.2704 function (“disable protections on the fourth current”): if the digital input exists and is activated, the protection will be disabled.

The protection will be activated if, per the previous conditions, the measure of current stays above P.0367 threshold uninterruptedly for the time P.0368.

048 – Emergency stop

Type:	**Alarm**
Related parameters:	**P.0361**
To disable:	**-**
Enabled in:	**MAN, AUTO, TEST, REMOTE START**

The protection is always enabled.

It will be activated if, per the previous conditions, the input dedicated to the emergency stop (JJ 2) remains idle, continuously for the configured time (P.0361).

Note: this anomaly can be activated also with an already active shutdown.

057 – Clock not valid

Type:	**Warning**
Related parameters:	**P.0420 P.0421 P.0422 P.0423 P.0426**
To disable:	**-**
Enabled in:	**MAN, AUTO, TEST, REMOTE START**

The protection is always enabled.

It is activated if the controller recognizes the clock status as not valid and the functions related to the clock, such as the weekly test (P.0418), the time to enable operations (P.0421, P.0422, P.0423) or the time to force intervention (P.0426) have been configured.

To deactivate it, you need to set the clock.

062 – Faulty CAN bus 0 link

Type:	**Warning**
Related parameters:	**P.0141 P.0142 P.0143 P.0144**
To disable:	**-**
Enabled in:	**MAN, AUTO, TEST, REMOTE START**

The protection is enabled if the CAN bus is activated (P.0141 or P.0142 or P.0143 or P.0144 <> 0).

It activates if the internal CAN controller switches to BUS-OFF status due to bus communication errors.

200 – CAN bus PMCB faulty connection

Typology: **Warning**
Related parameters: **-**
To disable: **-**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

This anomaly is activated each time the CAN bus internal interface of the controller switches to the BUS-OFF status. Normally the “BUS-OFF” condition is related to wiring problems (short circuits between CAN-H and CAN-L lines, for example).

201 – Duplicated address over the PMCB

Typology: **Warning**
Related parameters: **P.9501**
To disable: **-**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

This anomaly is activated when two or more MC xxx devices are connected to the same can bus line, and they have the same address for PMCB (parameter P.9501).

202 – Wrong number of generators over the PMCB

Typology: **Warning**
Related parameters: **P.0803**
To disable: **P.0803 = 0**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

MC400 activates this anomaly if the number of genset controllers communicating over the can bus PMCB is different from what configured by parameter P.0803. In this case, parameter P.0804 can be used to inhibit MGCB closure (but not to force its opening). By setting the parameter P.0803 to “0”, you disable this command.

207 – Maximum time in parallel to the grid.

Typology: **Warning**
Related parameters: **P.0890**
To disable: **P.0890 = 0**
Enabled if: **MAN, AUTO, TEST, AVVIAMENTO REMOTO.**

MC400 activates this anomaly if P.0890 has been set to a value different from zero, and the duration of the parallel to the grid was longer than this parameter. MC400 opens the MGCB circuit breaker and does not allow its closure until the operator acknowledges this warning. MC400 can activate this warning even when the function “transfer to gensets” is enabled, if at the end of the configured delay the power is not yet transferred to the gensets (because the nominal power of the gensets is not enough for the loads): in this case, if the power on the loads would decrease (or if new gensets became available), MC400 will close again MGCB circuit breaker even if the warning has not been acknowledged.

The parameter P.0897 is a bit-field parameter, allowing the operator to select in which conditions MCB opening as to be allowed at the end of configured time:

- Bit 0: in MAN mode.
- Bit 1: in AUTO mode.
- Bit 2: in TEST mode.
- Bit 3: in REMOTE START mode.
- Bit 7: in case of failure in opening MGCB.

252 – CAN bus (EXBUS) expansion modules missing

Type: **Warning**
Related parameters: **P.0141 P.0142 P.0143 P.0144**
To disable: **P.0141=0** and **P.0142=0** and **P.0143=0** and **P.0144=0**
Enabled in: **MAN, AUTO, TEST, REMOTE START**

The protection is enabled if the CAN bus is activated (P.0141 or P.0142 or P.0143 or P.0144 different from zero).

It will be activated when one or more boards configured with the previous parameters is not communicating on the CAN bus. On page S.02, by selecting this early warning, the board shows which module is not communicating.

253 – CAN bus (EXBUS) missing measure

Type: **Warning**
Related parameters: **P.0141 P.0142 P.0143 P.0144**
To disable: **P.0142=0** and **P.0143=0**
Enabled in: **MAN, AUTO, TEST, REMOTE START**

The protection is enabled if the CAN bus for the expansion modules is activated (P.0141 or P.0142 or P.0143 or P.0144 different from zero).

It will be activated when the controller does not receive an analogue measure from the CAN bus. The board verifies the sole presence of the utilized analogue measures (those that have a function different from zero in P.4001 parameter or equivalent ones for the other analogue inputs). On S.02 page, by selecting this early warning, the board indicates which channel of which module is not carrying out the measurement.

254 – CAN bus (EXBUS) duplicate address

Type: **Warning**
Related parameters: **P.0141 P.0142 P.0143 P.0144**
To disable: **P.0141=0** e **P.0142=0** e **P.0143=0** e **P.0144=0**
Enabled in: **MAN, AUTO, TEST, REMOTE START**

The protection is enabled if the CAN bus for the expansion modules is activated (P.0141 or P.0142 or P.0143 or P.0144 different from zero).

It will be activated if two or more expansion modules are configured with the same address. On S.02 page, by selecting this early warning, the board indicates which module has the duplicated address.

255 – Disconnected CAN bus sensor (EXBUS)

Type: **Warning**
Related parameters: **P.0142 P.0143**
To disable: **P.0142=0** and **P.0143=0**
Enabled in: **MAN, AUTO, TEST, REMOTE START**

The protection is enabled if the CAN bus for the expansion modules is activated (P.0141 or P.0142 or P.0143 or P.0144 different from zero).

It will be activated when a DIGRIN, DITHERM or DIVIT module reports the status of “disconnected sector”. On S.02 page, by selecting this early warning, the board indicates which channel of which module has a disconnected sensor.

271 – MGCB synchronization failure

Typology: **Warning / alarm**
Related parameters: **P.0852**
To disable: **P.0852 = 0**

Enabled if: **AUTO, TEST, REMOTE START.**

This anomaly is activated only during automatic synchronization, for MGCB closure. If the circuit breaker is not closed after the P.0852 delay, MC400 activates the anomaly: it is a warning in MAN mode, an alarm in all other modes.

272 – MCB synchronization failure

Typology: **Warning**
Related parameters: **P.0853**
To disable: **P.0853 = 0**
Enabled if: **AUTO, TEST, REMOTE START.**

This anomaly is activated only during automatic synchronization, for MCB closure. If the circuit breaker is not closed after the P.0852 delay, MC400 activates the anomaly.

273 – Incoherent parameters

Typology: **Warning / alarm**
Related parameters: **-**
To disable: **-**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

MC400 activates this anomaly to signal a “wrong configuration” of parameters. In the “S.02” display page, a detailed description shows the real cause of the anomaly. Potential causes are:

- The parameters which require the “Mecc Alte” password have never been set after the first factory configuration. It is an alarm.
- Selected plant type (P.0802) is different from “MPM”, and the MCB circuit breaker is configured as “not managed” (P.0855). It is an alarm.
- MCB circuit breaker is configured as “external” (P.0855), and no digital input is configured to acquire its status (function DIF.3002). It is an alarm.
- MCB circuit breaker is managed by MC400 without static commands, and no digital input is configured to acquire its status (function DIF.3002). It is an alarm.
- MCB circuit breaker is configured as “external synchronizable” (P.0855), and no digital input is configured to acquire external synchronization requests (function DIF.1034). It is an alarm.
- MGCB circuit breaker is configured as “external” (P.0854), and no digital input is configured to acquire its status (function DIF.3003). It is an alarm.
- MGCB circuit breaker is managed by MC400 without static commands, and no digital input is configured to acquire its status (function DIF.3003). It is an alarm.
- MGCB circuit breaker is configured as “external synchronizable” (P.0854), and no digital input is configured to acquire external synchronization requests (function DIF.1004). It is an alarm.
- The parameter P.9506 is programmed to zero, but in the plant is present at least one controller that does not support MC200 mode. Function available by GC400 starting from version 02.00; but not by the MC100. It is a warning.

274 – Production line open

Typology: **Alarm**
Related parameters: **P.2001 (or equivalent for other inputs)**
To disable: **P.2001 <> DIF.4261**

Enabled if: **MAN, AUTO, TEST, REMOTE START.**

MC400 activates this anomaly if the digital input configured with the function DIF.4261 (“production line open”) is activated (even for a small time). **Note: this alarm forces the opening of all generator circuit breakers GCB; this function is directly managed by the genset controllers after receiving a proper message over the PMCB bus.**

275 – Interface controller not opened

Typology: **Alarm**
Related parameters: **P.0900**
To disable: **P.0900 = 0**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

This anomaly is used only for parallel to grid operations. MC400 activates it when the circuit breaker configured as “interface controller” (P.0900) does not open in 0.5 seconds from the “loss of grid”**.** Set P.0900 to zero do disable this control: **ensure some external logic can disconnect generators from grid in case of loss of grid.**

279 – Inconsistent bar voltage

Type: **Warning/Alarm**
Parameters connected: **-**
To disable: **Bit 7, P.0807**
Enabled in: **MAN, AUTO, TEST, REMOTE START**

The board will activate this warning before closing MGCB, if it notices a divergence between the effective presence of voltage on parallel bars and what it expects per the statuses of the switches, grid and any other generator control boards connected on PMCB. The anomaly is activated only if there is not voltage on bars when, on the contrary, it should be present. For example, if at least a generator has closed GCB, there should be voltage on parallel bars: if the board does not 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 an alarm (only in case of automatic procedures) after 60 seconds if the board needs to close the MGCB.

281 – Maximum power exported to the grid.

Typology: **Warning / alarm**
Related parameters: **P.0384, P.0385, P.0386**
To disable: **P.0385 = 0**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

This anomaly is activated when the active power measured on the grid is negative (exported) and is greater (absolute value) than the threshold P.0384 continuously for the time P.0385. The action related to the protection can be configured by P.0386:

- 1 – Warning. The controller activates the warning but keeps the generators in parallel to the grid,
- 4 – Alarm. The controller activates the alarm, opens MGCB (when present), forces the genset controllers to open their GCB and to stop the engines with the standard procedure (with the cool down cycle).
- – Warning (MCB). If this value is selected, when the protection trips the controller opens MCB and keeps the gensets running for supply the load in island mode. The controller will try to close MCB only after the warning has been acknowledged. Note: using this value, the protection works in OFF/RESET mode also (it opens MCB). In this way, the grid is protected against manual parallel performed on the genset controllers when MC400 is in OFF/RESET mode.

301...432 - Generic anomalies linked to analogue inputs

See 8.6.

701...774 - Generic anomalies linked to digital inputs

See 8.7.

9 Other functions

9.1 Loads protection from grid breaker damages.

This function is used for “emergency” plants (MSB or MSB+MSTP). Normally, in case of grid live, the controller connects the load to the grid. For stand-by application, MCB must be usually closed to connect the loads to the grid. Using this function is possible to automatically start the gensets and supply the loads in case of MCB failure.

To use this function, carry out following configuration:

- MCB feedback must be connected to a digital input of the controller.
- Set parameter P.9514 to 1.

With such configuration, MCB status is continuously monitored. When MCB is commanded closed but remains opened for more than the programmed time (grid should be present if MCB is supplied by grid – P.0847), the following actions are carried out:

- It tries to close the MCB circuit breaker.
- In case if failure, warning W013 is issued.
- All available engines are started.
- Loads are connected to generators.

Now, the loads will not be switched automatically on the grid until the operator “acknowledges” the warning W013. After this operation, the controller will try again to close MCB: if it does not close, the warning will be issued again, and the load will stay switched on gensets.

In MAN mode (or with start inhibitions activated) the function is disabled; it is also disabled if a “inhibition to start” is activated,

The controller starts the generators (if P.9514 is set to 1) even when is activated the generic warning related to a digital input configured with the functions DIF.4021, DIF.4022, DIF.4024 (these anomalies force the opening of MCB). Even in this case, the controller will try to close MCB (and then will stop the generators) only when the operator will acknowledge and reset that warning.

9.2 Clock

The board is provided with a hardware clock. It is shown in detail on page S.03. It is possible to set the clock through 4.7.1 menu or serial ports. It is used for several functions:

- History logs recordings.
- TEST weekly planning.
- Weekly planning of time intervals in which the gensets can start automatically.
- Weekly plan of periods in which the gensets automatic activation must be forced.

The clock is equipped with a rechargeable battery and can work for some months even if the controller is not supplied. After a long time in which the controller is not used (no supply), even if the clock reactivates immediately when the supply comes back, a few hours are necessary to guarantee to full recharge of the internal battery.

9.2.1 Clock automatic update.

In case the controller has an Ethernet connection, the clock can be automatically updated through the connection towards a NTP server (see par. 5.11.4). The controller registers the event “EVT.1076 - Date and hour modified” in the history log, but only if the difference between the new time received and the current one is higher than one minute.

The server TNP (questioned by the controller every 5 minutes) gives the date and hour of the reference time zone (that is UCT "Universal Coordinated Time") from which the controller can calculate and update the internal calendar considering its own time zone and eventual daylight-saving time. To this purpose, the follow parameters are available:

- P.0408: Daylight saving offset (1=15 min.; 4=1 hour). The setting limits are from 0 to 48 and allow to manage the offset to be added/subtracted for the daylight-saving time.
- P.0409: Daylight saving time.
    - "0-No" daylight saving time not in use.
    - "1-Yes" daylight saving time in use (it adds P.0408 to the one received).
    - "2-Automatic (only Europe)": It is only valid for Europe, as since 2002 has been unified (it activates ate 01.00 of the last Sunday of March and deactivates at 01.00 of the last Sunday of October).
- P.0410: Time zone (1=15 min.; 4=1 hour). The setting limits are from -47 to + 48 and allow to manage all time zones of the Earth by hour quarts.

9.2.2 Weekly planning for TEST.

The starting test plans is made on weekly base. That is, it is possible to indicate in which days of the week the generators must be started in test and in which not.

The parameters related to this function are the following:

- **P.0418**: allows to specify in which days of week the TEST will be performed. It is a bit-configurable parameter; each bit of the parameter corresponds to a day of the week. The value you must set for the parameter is the sum of the value field of the following table for the days needed.

Bit	Hexadecimal value	Day
0	01	Sunday
1	02	Monday
2	04	Tuesday
3	08	Wednesday
4	10	Thursday
5	20	Friday
6	40	Saturday

  For example, if you want to perform the TEST only on Monday and Thursday, you must set 12 (10+02).

- **P.0419**: allows to set start time for the TEST (Hours and minutes).
- **P.0420**: allows to configure the TEST duration (in minutes).

P.0420 allows to configure the TEST duration (in minutes). This is because the same parameter is used also for the TEST activated by an SMS command.

9.2.3 Weekly planning for working days.

In some applications, it is useful to inhibit the automatic intervention of the gensets for grid failure in hours or days where the grid is not used. For example, if a factory is closed on Sunday, the gensets should never start in this day for grid failure (because it consumes unnecessary fuel). With this function, you can select in which days and in which time intervals the gensets can start automatically. The planning is made on a weekly basis: therefore, it is possible to plan in which days the generator must operate. Besides days, it is possible to set a single auto operation enable time slot common to all selected days.

The parameters related to this function are the following:

- **P.0421:** allows to specify in which days of week the gensets can start automatically. It is a bit-configurable parameter; each bit of the parameter corresponds to a day of the week. The value you must set for the parameter is the sum of the value field of the following table for the days needed.

Bit	Hexadecimal value	Day
0	01	Sunday
1	02	Monday
2	04	Tuesday
3	08	Wednesday
4	10	Thursday
5	20	Friday
6	40	Saturday

- **P.0422:** allows to configure the start of the time interval during which the gensets can start automatically (in hours and minutes).

- **P.0423**: allows to configure the end of the time interval during which the gensets can start automatically (in hours and minutes).

Usually, P.0422 will be set to a value lower than P.0423. On the contrary, if it contains a higher value, the controller infers that the time interval is set across midnight: in this case, the time set with P.0422 refers to the days selected with P.0421, while the time set with P.0423 refers to the following days.

For example, in case an automatic gensets start is required only Monday through Friday, between 08:00 and 18:00, you must set:

- P.0421 = 3E (02+04+08+10+20)
- P.0422 = 08:00
- P.0423 = 18:00

9.2.4 Weekly planning of intervention forcing.

The planning of intervention forcing is performed weekly. That is, it is possible to indicate on which days of the week the generators must intervene, even if the status of the system does not require the intervention. Besides the days, it is possible to specify from what time to what time the intervention should be forced. This time interval is common to all the days selected.

The parameters related to this function are the following:

- **P.0426**: it allows specifying on which days of the week the intervention of the generators must be forced. It is a bit-configurable parameter; each bit of the parameter corresponds to a day of the week. The value to be set for the parameter is the sum of the value fields in the following table related to the days needed.

Bit	Hexadecimal value	Day
0	01	Sunday
1	02	Monday
2	04	Tuesday
3	08	Wednesday
4	10	Thursday
5	20	Friday
6	40	Saturday

  For example, to configure the forcing of the intervention only on Monday and Thursday, it is necessary to set 12 (10+02).

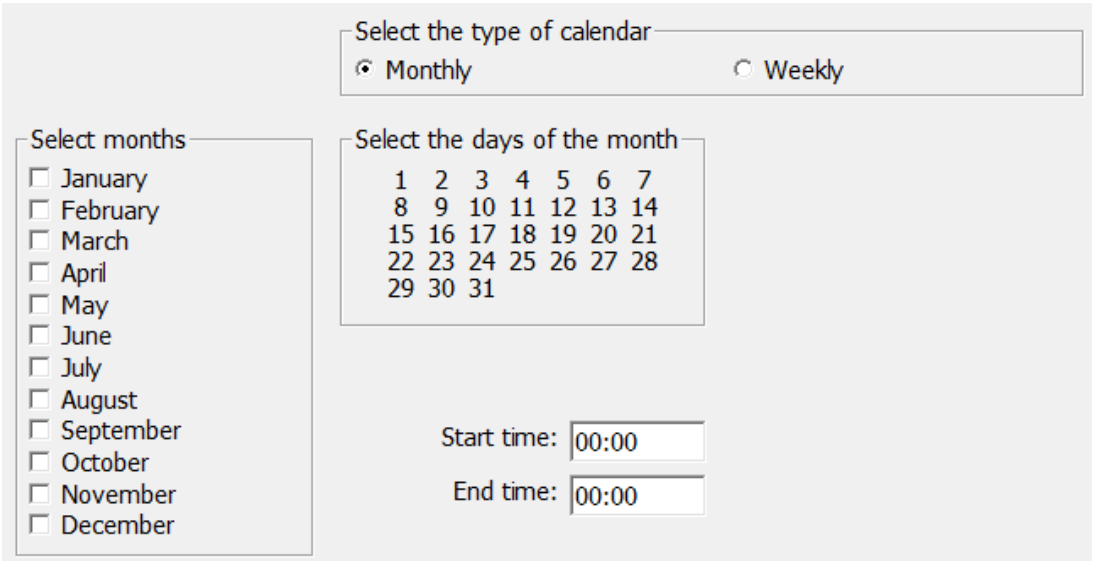
- **P.0427**: it allows setting the starting time of the forcing (in hours and minutes).

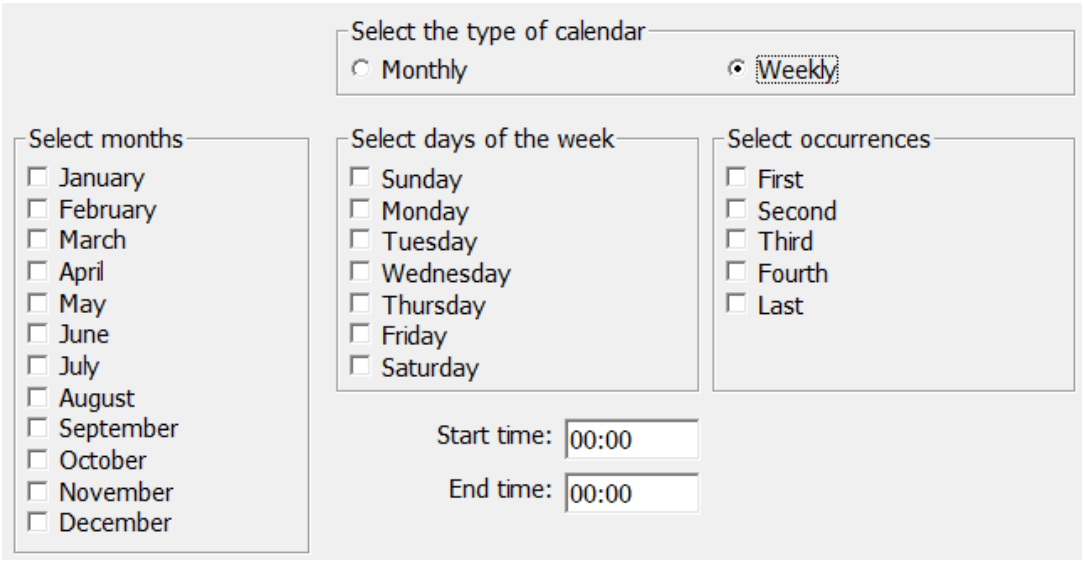
- **P.0428**: it allows setting the ending time of the forcing (in hours and minutes).

9.2.5 Configurable calendars

The controller provides 16 calendars fully configurable. They allow to select 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”).

Each calendar can be individually selected as “monthly” or “weekly”:





Using BoardPrg3 software, it is quite easy to select whether a calendar is “weekly” or “monthly”. If you want to use the parameters of the controller, you must act on the parameter P.1900. It is a bit-field parameter; one bit is provided for each calendar:

BIT	Value	Hexadecimal	Calendar
0	1	0001	Calendar 1
1	2	0002	Calendar 2
2	4	0004	Calendar 3
3	8	0008	Calendar 4
4	16	0010	Calendar 5
5	32	0020	Calendar 6
6	64	0040	Calendar 7
7	128	0080	Calendar 8
8	256	0100	Calendar 9
9	512	0200	Calendar 10
10	1024	0400	Calendar 11
11	2048	0800	Calendar 12
12	4096	1000	Calendar 13
13	8192	2000	Calendar 14
14	16384	4000	Calendar 15
15	32768	8000	Calendar 16

The parameter must be set with the sum of the values for all the calendars that must be selected as “weekly” (in hexadecimal notation). In fact, a bit set to “1” selects the “weekly” mode.

Both calendar types allow to select in which months the controller activates the internal bit (at least one month must be selected, it is even possible to select all months). Using the parameters of the controller, this selection is done by means parameter P.1901 (for the calendar 1 or equivalent for other calendars). This is also a bit-field parameter:

BIT	Value	Hexadecimal	Month
0	1	0001	January
1	2	0002	February
2	4	0004	March
3	8	0008	April
4	16	0010	May
5	32	0020	June
6	64	0040	July
7	128	0080	August
8	256	0100	September
9	512	0200	October
10	1024	0400	November
11	2048	0800	December

The parameter must be set with the sum of the values of the required months (in hexadecimal notation).

For “monthly” calendars, is then possible to select the days of the month for the activation of the internal bit (at least one day must be selected, it is even possible to select all days). Using the parameters of the controller, this selection is done by means parameter P.1902 (for the calendar 1 or equivalent for other calendars). This is also a bit-field parameter:

BIT	Value	Hexadecimal	Day of month
0	1	00000001	1
1	2	00000002	2
2	4	00000004	3
3	8	00000008	4
4	16	00000010	5
5	32	00000020	6
6	64	00000040	7
7	128	00000080	8
8	256	00000100	9
9	512	00000200	10
10	1024	00000400	11
11	2048	00000800	12
12	4096	00001000	13
13	8192	00002000	14
14	16384	00004000	15
15	32768	00008000	16
16	65536	000100000	17
17	131072	00020000	18
18	262144	00040000	19
19	524288	00080000	20
20	1048576	00100000	21
21	2097152	00200000	22
22	4194304	00400000	23
23	8388608	00800000	24
24	16777216	01000000	25
25	33554432	02000000	26
26	67108864	04000000	27
27	134217728	08000000	28
28	268435456	10000000	29
29	536870912	20000000	30
30	1073741824	40000000	31

The parameter must be set with the sum of the values of the required days (in hexadecimal notation).

For “weekly” calendars, is then possible to select the days of the week for the activation of the internal bit (at least one day must be selected, it is even possible to select all days). Using the parameters of the controller, this selection is done by means parameter P.1902 (for the calendar 1 or equivalent for other calendars). This is also a bit-field parameter:

BIT	Value	Hexadecimal	Day of week
16	65536	00010000	Sunday
17	131072	00020000	Monday
18	262144	00040000	Tuesday
19	524288	00080000	Wednesday
20	1048576	00100000	Thursday
21	2097152	00200000	Friday
22	4194304	00400000	Saturday

The parameter must be set with the sum of the values of the required days (in hexadecimal notation).

Selecting a day of the week (Sunday for example), it is then possible to select if all “Sundays” in the month must be used or only some of them. Using the parameters of the controller, this selection is done by means parameter P.1902 (for the calendar 1 or equivalent for other calendars). This is also a bit-field parameter:

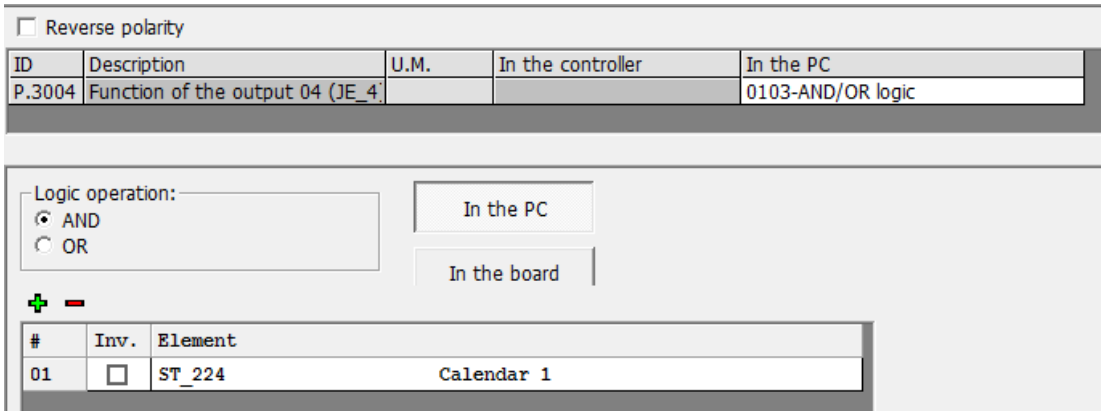
BIT	Value	Hexadecimal	Occurrence
0	1	00000001	First occurrence
1	2	00000002	Second occurrence
2	4	00000004	Third occurrence
3	8	00000008	Forth occurrence
4	16	00000010	Last occurrence

The parameter must be set with the sum of the values of the required occurrences (in hexadecimal notation). **Note: for "weekly" calendars, the days of week and their occurrences in the month are selected by the same parameter, using different bits.**

If the "occurrence" bits are all "0", then the selected days of week will be managed in any week of the month; otherwise, they will be managed for the selected occurrences only. The "last" option is useful because, depending on the month and on the year, a certain day of the week can be present 4 or 5 times in a month: using the "last" option you can do an action exactly in the last occurrence in 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.

Finally, for both "weekly" and "monthly" calendars, it is possible to select a timeslot (valid for all selected days). The controller will activate the internal bit only inside the selected timeslot. Using the parameters of the controller, the timeslot can be selected by means P.1903 and P.1904 (for the calendar 1 or equivalent for other calendars). If those parameters are set with the same values, 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 the selected one.

Using the AND/OR logics, it is possible to activate a digital output into selected days and timeslot (selected using a calendar):



This is an example for the configuration of the daylight save time for Italy, using calendars 15 and 16:

- Calendar 15.
  - Select "weekly" (bit 14 of P.1900 = "1").
  - Last Sunday of October:
    - Select "October" (P.1957 = "0200").
    - Select "Sunday", "Last" (P.1958 = "00010010").
  - The activation should happen at 02:00:
    - Select "2:00" as start time (P.1959).
    - Select "2:01" as end time (P.1960).

- Calendar 16.
  - Select "weekly" (bit 15 of P.1900 = "1").
  - Last Sunday of March:
    - Select "March" (P.1961 = "0004").

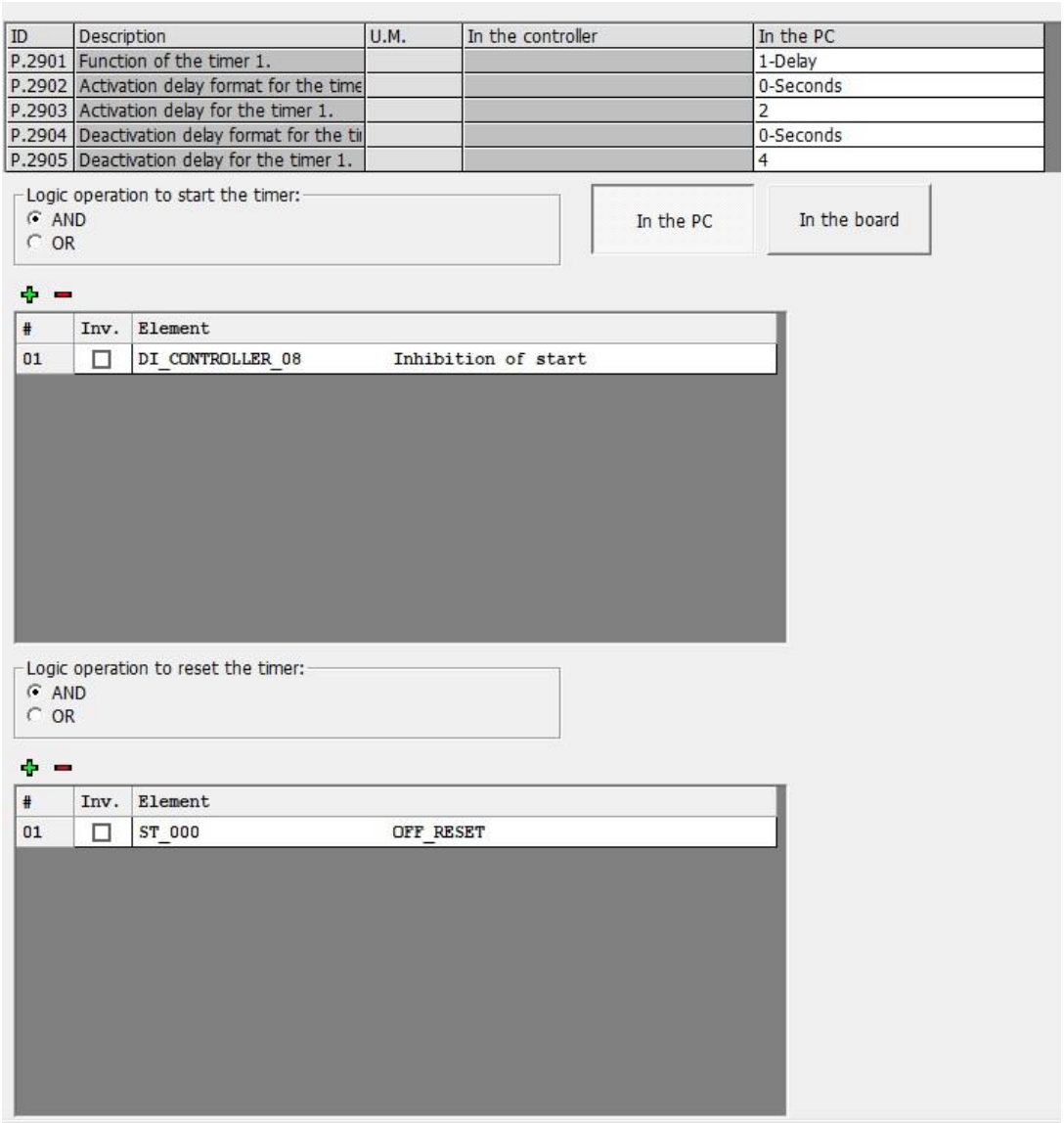
- Select “Sunday”, “Last” (P.1962 = “00010010”).
- The activation should happen at 03:00:
  - Select “3:00” as start time (P.1963).
  - Select “3:01” as end time (P.1964).

9.2.6 Configurable timers

The controller provides 4 generic timers fully configurable, that can be used inside 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.

For each timer it is possible to select (by means an AND/OR logic) an “activation condition” that starts the timer. In the same way, it is possible (but not mandatory) to select (by means an AND/OR logic) a “reset condition” that resets the timer. When the “reset condition” is true, the internal bit of the timer is forced to “0”.



Moreover, each 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.

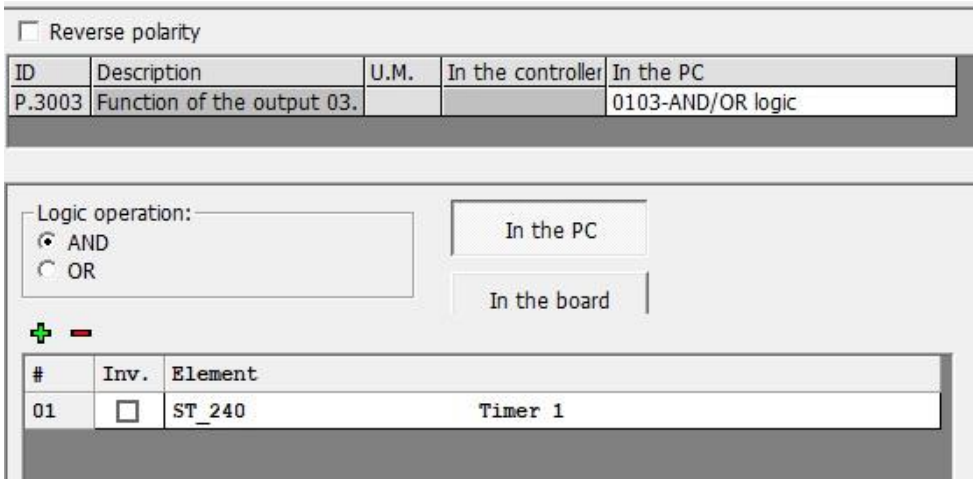
- P.2905: Deactivation delay for the timer 1.

In addition to the function, two delays are configurable for any timer; for each of them it is possible to select the time base ("0 – Seconds", "1 – Minutes", "2 – Hours") and the delay value.

Each timer can work in four different modes, selectable by means parameter P.2901 (for the timer 1 or equivalent for the other timers):

- 0 – Not used. In this case the internal bit related to the timer is always reset.
- 1 – Delay.
  - The internal bit is reset while the "reset condition" is true.
  - The internal bit is set with the delay P.2902 – P.2903 from when the "activation condition" becomes true.
  - The internal bit is reset with the delay P.2904 – P.2905 from when the "activation condition" becomes false.
- 2 – Pulse.
  - The internal bit is reset while the "reset condition" is true.
  - The internal bit is set for the time configured with P.2902 – P.2903 each time the "activation condition" changes from false to true.
  - The internal bit is set for the time configured with P.2904 – P.2905 each time the "activation condition" changes from true to false.
- 3 – Free run
  - The internal bit is reset while the "reset condition" is true.
  - The internal bit is reset while the "activation condition" is false.
  - While the "activation condition" is true, the internal bit is managed as a square wave: it is set for the time configured with P.2902 – P.2903, then it is reset for the time configured with P.2904 – P.2905, and so on.
- 4 – Set/Reset
  - The internal bit is reset while the "reset condition" is true.
  - The internal bit is set if the "activation condition" is true and the "reset condition" is false.
  - The internal bit keeps its previous status if the "activation condition" is false and the "reset condition" is false.

The following example manages a digital output related to the internal bit of the timer 1:



9.3 Counters

The controller manages internally the following counters:

- Working time with MGCB closed (hours) counter (resettable to zero)
- Working time with MGCB closed (hours) counter (total)

- Active energy counter (kWh) exported by the generators (resettable to zero).
- Active energy counter (kWh) exported by the generators (total).
- Reactive energy counter (kvarh) exported by the generators (resettable to zero).
- Reactive energy counter (kvarh) exported by the generators (total).

- Active energy counter (kWh) imported by the generators (resettable to zero).
- Active energy counter (kWh) imported by the generators (total).
- Reactive energy counter (kvarh) imported by the generators (resettable to zero).
- Reactive energy counter (kvarh) imported by the generators (total).

- Active energy counter (kWh) exported on the grid (resettable to zero).
- Active energy counter (kWh) exported on the grid (total).
- Reactive energy counter (kvarh) exported on the grid (resettable to zero).
- Reactive energy counter (kvarh) exported on the grid (total).

- Active energy counter (kWh) imported from the grid (resettable to zero).
- Active energy counter (kWh) imported from the grid (total).
- Reactive energy counter (kvarh) imported from the grid (resettable to zero).
- Reactive energy counter (kvarh) imported from the grid (total).

- Controller total power supply time (hours) counter

All these counters and meters are displayed on the controller's front panel. However, all can be read via the serial port (with the ModBus protocol). Some of these counters can be reset by the operator following a proper procedure, or via the serial port (they are marked in the list with “resettable to zero”). All these counters are saved in a non-volatile memory; therefore, they store their values also when the controller is powered off. Since non-volatile memories “consume” themselves writing in them, it is necessary to reduce at the minimum the number of writings. For this reason, a counter is not immediately saved as its value changes, and it is then important to know when values are saved and how to be sure that they are saved before removing supply from the board.

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

- Each time the working hours counter (with MGCB closed) is increased (both total and partial, also if the gensets have been started for instance six times for ten minutes each time).

- Each time the operating mode is switched to OFF_RESET.

- Each time a “parallel to the pains” protection trips.

- For each hour of working of the controller.

Furthermore, counters are saved when they are reset to zero (individually or globally) via front panel or serial port. 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 will need to switch the key to OFF-RESET to force the controller to save data, before switching off the power.

9.3.1 Counters reset

The reset procedure is common to all counters, but it works only on some of them based on the page shown on the multifunctional viewer. See in par.6.5.3.9 the description of the displayed page containing the counter to be reset.

9.4 Alternative parameters configurations.

You can use certain properly configured digital inputs to change the configuration of the system without changing the programming parameters. In fact, the controller manages internally four groups of alternative parameters that can be “copied” in the operating parameters on request (through a dedicated digital input).

Alternative configurations can be programmed only using the BoardPrg3xx.

You cannot program or modify the configurations from the controller.

The parameters present in each alternative group are the following:

- P.0101: Generators voltages wiring.
- P.0102: Generators bus nominal voltage
- P.0103: Primary of generators bus voltmeter transformers.
- P.0104: Secondary generators bus voltmeter transformers.
- P.0119: Grid voltages wiring.
- P.0116: P.0116: nominal voltage.
- P.0117: Primary of grid voltmeter transformers.
- P.0118: Secondary of grid voltmeter transformers.
- P.0105: Generator nominal frequency.
- P.0124: Connection of current transformers
- P.0107: Primary of the current transformer.
- P.0139: Secondary of current transformer.
- P.0109: Transformer type for auxiliary current.
- P.0130: Auxiliary current connection.
- P.0108: Primary of the current transformer or toroid ratio for auxiliary power.
- P.0135: Secondary of current transformer or toroid ratio for auxiliary current
- P.0131: Auxiliary current use.

It is possible to change the configuration by means the following input digital functions:

- DIF.2151 – “Select configuration 1”. When the input becomes "active", parameters of alternative configuration set 1 are copied in the working configuration.
- DIF.2152 – “Select configuration 2”. When the input becomes "active", parameters of alternative configuration set 2 are copied in the working configuration.
- DIF.2153 – “Select configuration 3”. When the input becomes "active", parameters of alternative configuration set 3 are copied in the working configuration.
- DIF.2154 – “Select configuration 4”. When the input becomes "active", parameters of alternative configuration set 4 are copied in the working configuration.

Remark: copying an alternative set into working configuration causes the loss of the previous loaded parameters. The only way to restore them is to save them in another alternative configuration and recall it.

This function is usually used with multi-voltage and/or multi-frequency panel: cabling the cams in a panel selector on the inputs of the controller it is possible to switch manually voltages and frequency without using the parameter of the controller.

NB. The change of parameters happens only with the controller in OFF_RESET.

9.5 Non-volatile memory

The controller has a non-volatile memory inside (with no need to be supplied), used to store different information as parameters, counters or other. The memory is divided into different zones. When the controller is powered, it performs

a check on the data stored in each area: if even just one area is incorrect, it displays an error message. This message contains a numeric code (hexadecimal note); each bit if this code corresponds to a non-valid memory zone. A chart follows with the zones and relative bits.

Area	Version	Bit	Value	Description
1	1.00	1	0001	Coefficients for the calibration of the measuring inputs of the controller.
2	1.00	2	0002	Different information (selected languages, lcd display contrast, maintenance request).
3	1.00	3	0004	Counters
4	1.00	4	0008	History log of the maximum peaks.
5	1.00	5	0010	Parameters alternative configurations.
6	1.00	6	0020	Parameter:
7	1.00	7	0040	Parameters in text form (E.g. Configurable messages connected to inputs)

If for example the value between brackets was “0004”, this means that the only counter zone is not valid. If the value was “0041”, this means that the parameters zones (0040) and the calibration zones (0001) are not valid.

If a zone is not valid, the normal operation sequences are not performed until when the operator does not press ACK/ENTER + ESC/SHIFT: it is, in effect, necessary that the situation is clear also because it might cause malfunctions (e.g. If the non-valid zone was the one of the parameters). Only when the operator presses ACK/ENTER + ESC/SHIFT, the controller recharges the default data for the data stored in non-valid zones: this means that if you turn off the controller without pressing ACK/ENTER + ESC/SHIFT, in a subsequent start there will be a signalling of not valid memory.

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