HUEGLI TECH SWITZERLAND

MC100

Technical Handbook

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MC100

A product powered by SICES AUTOMAZIONE

Revision

Revision	Date	Page	Remark
00	18/05/2010	102	First release of this document, valid from software 1.01 of MC100
01	01/07/2010		14-15, 18, 39, 52, 87 – 90
02	19/11/2010	103	Valid from software 1.01 of MC100. 3.1, 3.3, 7.1, 4.4.1, 4.5.1, 9.11
03	15/04/2011		Changes in the structure document

Contents

Parameters summary

1. Introduction

1.1 Forward

Warning: before installing and using the device, carefully read this handbook.

1.2 References

[1] SICES EAAM0360xxXA - MC100 parameter tables.

[2] SICES EAAS034101EN - Serial communication and SMS protocol for SICES devices.

[3] SICES EAAS0361xxEN - MC100 Modbus protocol.

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

1.3 Requirements

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

In this document it is not present a description detailed of all the programming parameters: to this purpose see [1]. The document [1] should be considered integral part of this manual.

1.4 Definitions

Throughout this document the words “BLOCK” and “ALARM” are used to indicate an anomaly that makes generation function impossible. The generators are immediately disconnected from the loads/mains (without power transfer), and the engines are stopped with emergency procedure (without cooling cycle).

The words “DISABLE” or “DEACTIVATION” are used to indicate an anomaly that makes generation function impossible. The generators are immediately disconnected from the loads/mains (without power transfer), and the engines are stopped with standard procedure (with cooling cycle).

The word “UNLOAD” is used to indicate an anomaly that makes generation function impossible. The generators are disconnected from the loads/mains with power transfer, and the engines are stopped with standard procedure (with cooling cycle).

The word “WARNING” is used to indicate a warning that requires an operator action but doesn’t require the automatic generators shutdown.

Also the following terms are used:

- **MCB:** mains circuit breaker.
- **MGCB:** main generators circuit breaker.
- **GCB:** generator circuit breaker.

1.5 Symbols

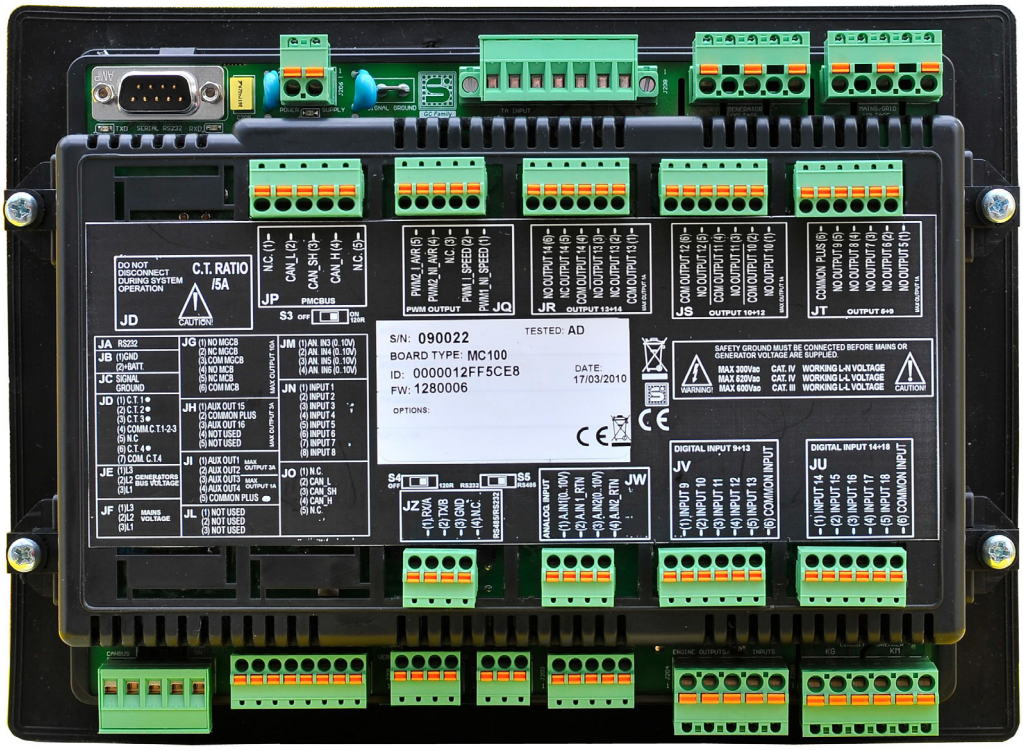
In this document a vertical bar on the right margin or a gray background indicates that the chapter or the paragraph has been amended with respect to the last document's version.

1.6 Software revisions

Throughout this document, the words SOFTWARE and FIRMWARE are used as synonymous if they are referred to the board firmware. Software code version is reported in a format like EB0220181XXYY, where "XX" is the major version number and "YY" is the minor version number. Thus, code EB02201810100 refers to software release 01.00. SW revision is shown on the page "S.06" of the LCD display.

2. Connections

Rear view



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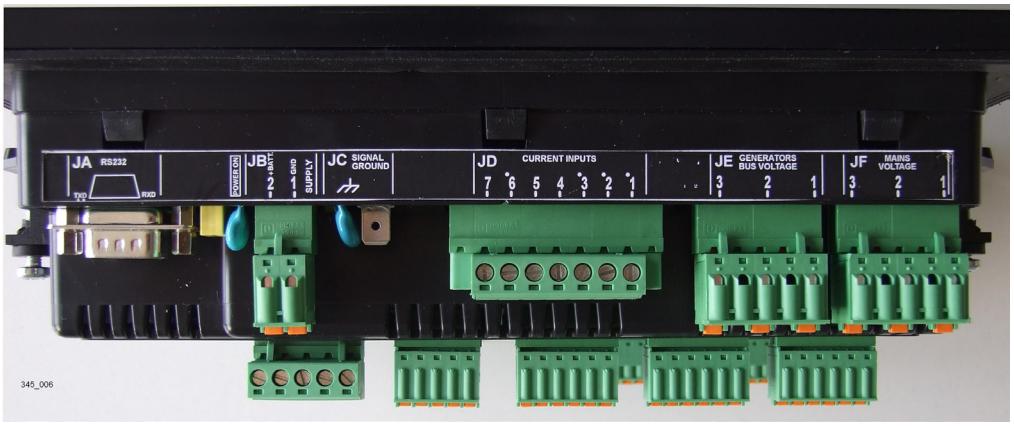
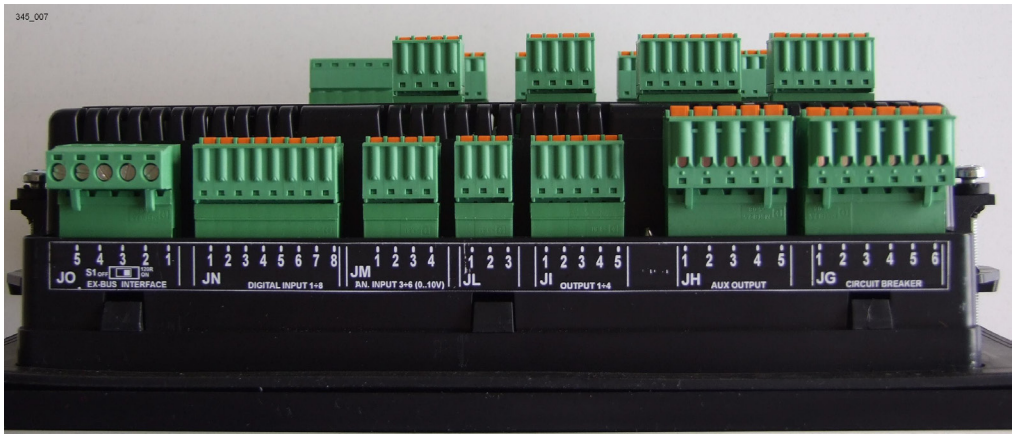
Top view



Bottom view



For the appropriate use of the device, it must be installed in a fixed way in a panel. The connections of the equipment don't have to be accessible without the use of specific keys or utensils. It must not be possible to remove the device without the aid of tools.

2.1 Connection to the mains

It is required to install an external over current protection for each phase of the mains connected to the device. The input impedance of the board, under normal operation condition, is greater than 1 MΩ. A threshold of protection of 1A is suitable.

The connection to the public electric mains is made through the connector JF of the card.

Tri-phase connection:

- Connect phase L1 (or R) to terminal 3 of JF connector.
- Connect phase L2 (or S) to terminal 2 of JF connector.
- Connect phase L3 (or T) to terminal 1 of JF connector.
- No neutral connection is available

Single-phase connection

- Connect phase (L) to terminal 3 of JF connector.
- Connect neutral (N) to terminal 2 of JF connector.
- Terminal 1 of JF connector must be let unconnected.

Parameters P.1201 allows to select the tri-phase/single-phase mode.

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

For CAT.III use, the maximum working voltage is 345Vac (phase-neutral) and 600Vac (phase to phase). Maximum voltage to the protection ground is 600Vac.

Note: MC100 is able to measure phase-to-phase voltages up to 580 Vac.

If working voltages are greater than these values, step-down transformer must be used in order to respect the specified limits. Nominal voltages on primary and secondary side of the voltage transformer are configurable by means P.1203 and P.1204. Voltage transformers having a nominal voltage of 400V on the secondary side are the solution that preserves the best available measurement precision of the board.

The mains frequency measurement is carried out on phase L1 (terminal JF_3).

2.2 Connection to the generator bus

It is required to install an external over current protection for each phase of the generator bus connected to the device. The input impedance of the board, under normal operation condition, is greater than 1 MΩ. A threshold of protection of 1A is suitable.

The connection to the generator bus is made through the connector JE of the card.

Three-phase connection:

- Connect phase L1 to terminal 3 of JE connector.
- Connect phase L2 to terminal 2 of JE connector.
- Connect phase L3 to terminal 1 of JE connector.
- No neutral connection is available

Single phase connection

- Connect phase to terminal 3 of JE connector.
- Connect neutral to terminal 2 of JE connector.
- Terminal 1 of JE connector must be let unconnected.

Parameters P.1101 allows to select the three-phase/single-phase mode.

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

For CAT.III use, the maximum working voltage is 345Vac (phase-neutral) and 600Vac (phase to phase). Maximum voltage to the protection ground is 600Vac.

Note: MC100 is able to measure phase-to-phase voltages up to 580 Vac.

If working voltages are greater than these values, step-down transformer must be used in order to respect the specified limits. Nominal voltages on primary and secondary side of the voltage transformer are configurable by means P.1103 and P.1104. Voltage transformers having a nominal voltage of 400V on the secondary side are the solution that preserves the best available measurement precision of the board.

The generator bus frequency measurement is carried out on phase L1 (terminal JE-3).

2.3 Current transformer connection

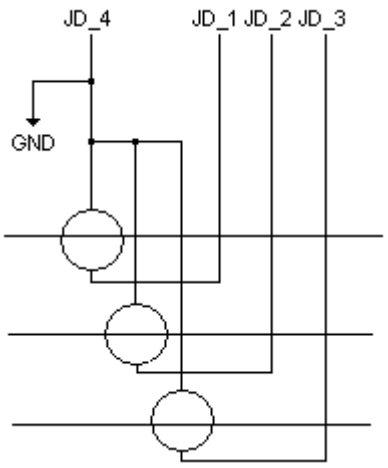
Current transformers (CTs) must be used in order to allow to MC100 controller to measure the AC currents. Use CTs that have a nominal current of 5A on the secondary side. Above 5.4 Aac, the controller input saturates. In any case it will be able to measure, with less precision, up to 15 Aac. Nominal current on primary side of the current transformer is configurable by means P.1302 (nominal current on secondary side is fixed at 5Aac).

If the same CTs have to be used to supply other device in addition to the MC100, this one has to be the last one in the connection chain. Current transformers have to be connected to connector JD:

- Connect to terminal JD-1 one terminal of the phase L1 CT.
- Connect to terminal JD-2 one terminal of the phase L2 CT.
- Connect to terminal JD-3 one terminal of the phase L3 CT.
- Connect to terminal JD-4 a common connection of the remaining terminals of CTs.

The common connection of CTs has to be connected to the negative side of the supply of MC100.

For single phase connection, terminals JD-2 and JD-3 should not be connected.



The CTs can be connected to the mains lines, to the load lines or to the generator bus lines. In parallel to mains applications, it's better to connect them to the mains lines. You use the parameter P.1301 to define where the CTs are connected.

MC100 can work also without current measures. In this case, remember to set parameter P.1302 to zero.

2.4 Connection of the auxiliary current measurement

MC100 allows acquiring a fourth measure of current. For default, the board is configured for the connection of a current transformer (CT) for the measure of the current: if it is required to use a toroid (instead of a CT) it is necessary to ask for the special option in phase of order.

2.4.1 Using a CT

Use a transformer that, at the maximum current to be measured, supplies around 5 Aac on the secondary side. The board measures at the most 5.4 Aac, besides this threshold the measure circuit saturates. If the CT has to be connected to other devices in addition to the MC100, the MC100 has to be the last device of the chain.

- Connect to the terminal JD-6 one terminal of C.T.
- Connect to the terminal JD-7 the connection return of C.T.

The CT return has to be connected also to the negative supply of the controller.

Nominal current on primary side of the current transformer is configurable by means P.1304 (nominal current on secondary side is fixed at 5Aac).

Using parameter P.1303 you can select if the measure is related to voltages on mains lines, load lines or generators lines.

Parameter P.1305 let you select the purpose of this measure.

2.5 Auxiliary supply connection

For CAT.IV application, the negative voltage of the auxiliary supply voltage (GND at terminal JB_1) must be connected to the protective ground. Otherwise ask to SICES redefinition of the operating condition.

In order to supply the MC100 controller, connect the auxiliary supply in the following way:

- Connect negative terminal of the power supply to the terminal JB-1
- Connect positive terminal of the power supply to the terminal JB-2

Inside MC100 controller there is an over current protection on the positive terminal. In any case, if an external over current protection is added, the nominal value should be 2A.

Notice: connect the positive voltage only after the connections are all established. Before connect the positive voltage, open all the panel fuses.

2.6 Generic digital inputs

MC100 is equipped by 18 insulated digital input; they can be accessed through connectors JN, JV and JU. All the 18 inputs are configurable; that means that for each input can be selected any available predefined input function. The following tables list the default configuration of the inputs. For a detail of the available functions refer to [1].

2.6.1 JN Connector

In order to activate these inputs, it is required to connect the terminal to the negative ground of the controller (JB-1).

Terminal	Input	Function
JN-1	INPUT 1	20-MGCB status.
JN-2	INPUT 2	10-MCB status.
JN-3	INPUT 3	72-Emergency stop.
JN-4	INPUT 4	56-Load function enable.
JN-5	INPUT 5	00-Not used.
JN-6	INPUT 6	00-Not used.
JN-7	INPUT 7	00-Not used.
JN-8	INPUT 8	00-Not used.

By means P.1400 it is possible to change from active-low to active-high (or float) the functionality of the inputs. The configuration can be made individually for each input.

2.6.2 JV connector

To use these inputs, you have to connect a DC voltage on terminal JV-6:

- Positive voltage (JB-2) on JV-6. In this case, to activate the inputs, it is required to connect the terminals 1-5 to the negative ground of the controller (JB-1).
- Negative voltage (JB-1) on JV-6. In this case, to activate the inputs, it is required to connect the terminals 1-5 to the positive supply of the controller (JB-2).

Terminal	Input	Function
JV-1	INPUT 9	00-Not used
JV-2	INPUT 10	00-Not used
JV-3	INPUT 11	00-Not used
JV-4	INPUT 12	00-Not used
JV-5	INPUT 13	00-Not used
JV-6	COMMON INPUT	

By means P.1430 it is possible to change from active-low to active-high (or float) the functionality of the inputs. The configuration can be made individually for each input.

2.6.3 JU connector

To use these inputs, you have to connect a DC voltage on terminal JU-6:

- Positive voltage (JB-2) on JU-6. In this case, to activate the inputs, it is required to connect the terminals 1-5 to the negative ground of the controller (JB-1).
- Negative voltage (JB-1) on JU-6. In this case, to activate the inputs, it is required to connect the terminals 1-5 to the positive supply of the controller (JB-2).

Terminal	Input	Function
JU-1	INPUT 14	00-Not used
JU-2	INPUT 15	00-Not used
JU-3	INPUT 16	00-Not used
JU-4	INPUT 17	00-Not used
JU-5	INPUT 18	00-Not used
JU-6	COMMON INPUT	

By means P.1430 it is possible to change from active-low to active-high (or float) the functionality of the inputs. The configuration can be made individually for each input.

2.7 Generic digital outputs

MC100 is equipped by 18 relays; they can be accessed through connectors JG, JI, JT, JS, JR and JH. All the 18 relays are configurable; that means that for each relay can be selected any available predefined output function. The following tables list the default configuration of the outputs. For a detail of the available functions refer to [1].

2.7.1 JG connector

Two relays are provided by this connector. The connector makes available both the free potential contacts. Both the N.C. and N.O. ones share a single COMMON terminal for each relays.

Terminal	Output	Max ampere	Function
JG-1 (N.O.)	MGCB output	10 Ampere	23-MGCB static close command.
JG-2 (N.C)			
JG-3 (COM.)			
JG-4 (N.O.)	MCB output	10 Ampere	13-MCB static close command (reverse command).
JG-5 (N.C.)			
JG-6 (COM.)			

By means P.1600 it is possible to change from active-high to active- low the functionality of the outputs (it is possible to force a relay to be normally energized, and it will be de-energized when its related function is active). The configuration can be made individually for each output.

2.7.2 JI connector

This connector provides connections for 4 relays. If a relay is activated, it makes available the voltage applied to terminal JI-5 (**only positive DC voltages can be connected to terminal JI-5, not negative or GND**).

Terminal	Output	Max ampere	Function
JI-1	Output 1	3 Ampere	0-Not used.
JI-2	Output 2	3 Ampere	0-Not used.
JI-3	Output 3	1 Ampere	0-Not used.
JI-4	Output 4	1 Ampere	0-Not used.
JI-5	Common plus		

By means P.1600 it is possible to change from active-high to active- low the functionality of the outputs (it is possible to force a relay to be normally energized, and it will be de-energized when its related function is active). The configuration can be made individually for each output.

2.7.3 JT connector

This connector provides connections for 5 relays. If a relay is activated, it makes available the voltage applied to terminal JT-6 (**only positive DC voltages can be connected to terminal JT-6, not negative or GND**).

Terminal	Output	Max ampere	Function
JT-1	Output 5	1 Ampere	0-Not used.
JT-2	Output 6	1 Ampere	0-Not used.
JT-3	Output 7	1 Ampere	0-Not used.
JT-4	Output 8	1 Ampere	0-Not used.
JT-5	Output 9	1 Ampere	0-Not used.
JT-6	Common plus		

By means P.1640 it is possible to change from active-high to active- low the functionality of the outputs (it is possible to force a relay to be normally energized, and it will be de-energized when its related function is active). The configuration can be made individually for each output.

2.7.4 JS connector

The six poles JS connector allows wiring three free potential outputs.

Terminal	Output	Max ampere	Function
JS-1 (N.O.) JS-2 (COM.)	Output 10	1 Ampere	0-Not used.
JS-3 (N.O.) JS-4 (COM.)	Output 11	1 Ampere	0-Not used.
JS-5 (N.O.) JS-6 (COM.)	Output 12	1 Ampere	0-Not used.

By means P.1640 it is possible to change from active-high to active- low the functionality of the outputs (it is possible to force a relay to be normally energized, and it will be de-energized when its related function is active). The configuration can be made individually for each output.

2.7.5 JR Connector

Two relays are provided by this connector. The connector makes available both the free potential contacts. Both the N.C. and N.O. ones share a single COMMON terminal for each relays.

Terminal	Output	Max ampere	Function
JR-1 (COM.)	Output 13	1 Ampere	0-Not used.
JR-2 (N.C)			
JR-3 (N.O.)			
JR-4 (COM.)	Output 14	1 Ampere	0-Not used.
JR-5 (N.C.)			
JR-6 (N.O.)			

By means P.1640 it is possible to change from active-high to active- low the functionality of the outputs (it is possible to force a relay to be normally energized, and it will be de-energized when its related function is active). The configuration can be made individually for each output.

2.7.6 JH Connector

This connector provides connections for 2 relays. If a relay is activated, it makes available the voltage applied to terminal JH-2 (**only positive DC voltages can be connected to terminal JH-2, not negative or GND**).

Terminal	Output	Max ampere	Function
JH-1	Output 15	3 Ampere	0-Not used.
JH-2	Common plus		
JH-3	Output 16	3 Ampere	0-Not used.
JH-4	Do not connect		
JH-5	Do not connect		

By means P.1600 it is possible to change from active-high to active- low the functionality of the outputs (it is possible to force a relay to be normally energized, and it will be de-energized when its related function is active). The configuration can be made individually for each output.

2.8 Generic analogue inputs

MC100 is equipped by 6 analogue inputs; they can be accessed through connectors JW and JM. All the analogue inputs are configurable; that means that for each input can be selected any available predefined input function. The following tables list the default configuration of the analogue inputs. For a detail of the available functions refer to [1].

2.8.1 JW connector

This connector offer provision for two analogue input connections. The two analogue inputs allow signals having a dynamic range of 0-10Vdc. Inputs are of differential types, so two signals are available for any of them. In any case, be ware that they are not insulated, thus RTN signals (-) should be connected to a potential near or equal the ground of MC100 supply (JB-1).

Terminal	Input	Function
JW-1 (+)	Analogue input 1.	0-Not used.
JW-2 (-)		
JW-3 (+)	Analogue input 2.	0-Not used.
JW-4 (-)		

2.8.2 JM connector

This connector offer provision for 4 analogue input connections. The analogue inputs allow signals having a dynamic range of 0-10Vdc. Only the positive signal can be connected to the terminals of this connector: the RTN signals (-) should be connected to a potential near or equal the ground of MC100 supply (JB-1). Also these inputs are not insulated.

Terminal	Input	Function
JM-1	Analogue input 3.	0-Not used.
JM-2	Analogue input 4.	0-Not used.
JM-3	Analogue input 5.	0-Not used.
JM-4	Analogue input 6.	0-Not used.

2.9 Serial communication ports

For detailed information, please, refer to the documents [2] and [3].

2.9.1 JA - Main serial communication port

Connector JA allows interfacing an external RS232 device.

Terminal	Function
JA-1	not connected
JA-2	RXD
JA-3	TXD
JA-4	DTR
JA-5	GND
JA-6	DSR
JA-7	RTS
JA-8	not connected
JA-9	not connected

2.9.2 JZ - Additional serial communication port

Connector JZ allows interfacing an external RS232 or RS485 device.

Terminal	Function
JZ-1	RS232 RX – RS485 A
JZ-2	RS232 TX – RS485 B
JZ-3	GND
JZ-4	N.C.

This port can be used as RS232 or RS485 interface. Selector S5 on the rear panel allows configuring the operating mode.

In case the RS485 mode is selected, switch S4 allows connect/disconnect the 120 ohm resistor for termination. RS485 interface is not insulated.

2.10 PMCBUS interface

JP connector provides a CANBUS connection, to be used to interface with the genset controllers for managing all plant operations. This can bus link is called PMCBUS or PMCB.

PMCBUS uses a CAN 2.0B interface working at 250 Kbit/s. Use adequate interface cable and proper termination resistor for reliable communication. If required, switch S3 allows inserting the 120 ohm resistor for termination.

Interface is insulated; please do not refer any terminals of this connector to the panel supply potential.

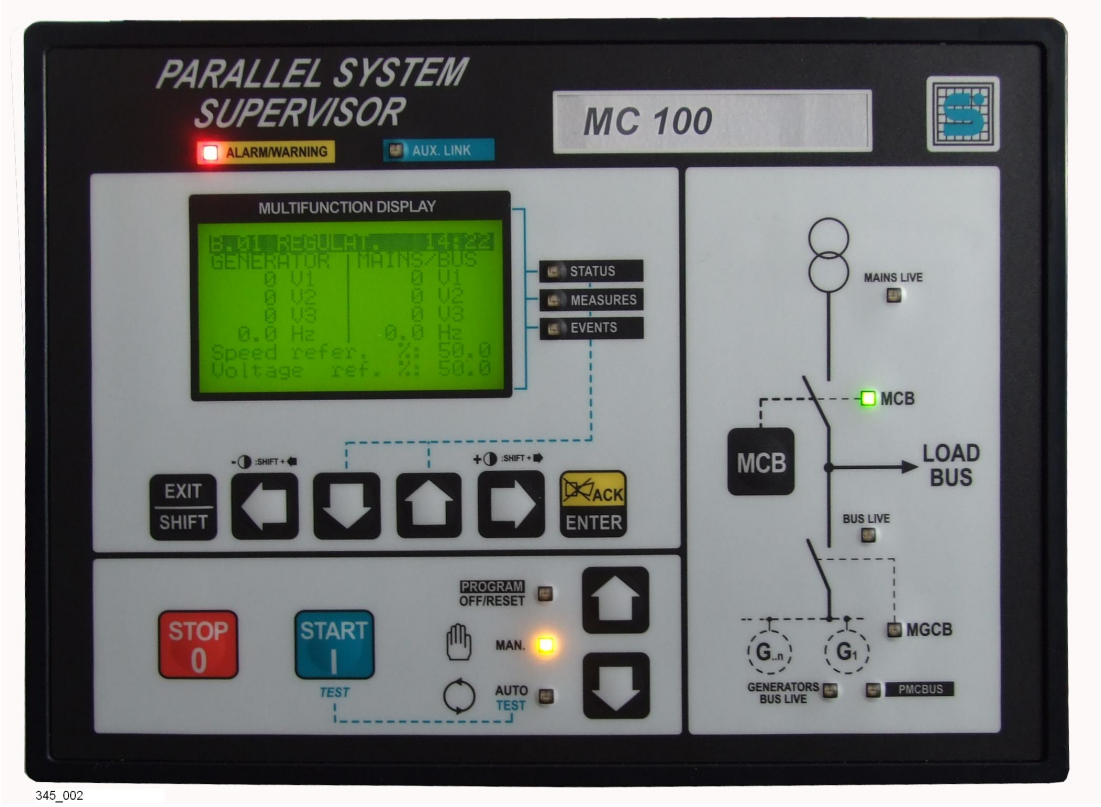
Connector JP and its plug have GOLD PLATED terminals; please do not exchange this connector with JH connector.

2.11 Other connectors

The following connectors cannot be used. Be sure their terminals are left unconnected.

- JL.
- JO.
- JQ.

3. Front panel



3.1 Pushbuttons

Eleven pushbuttons are available for the operator interface. The following table lists their functions.

Pushbutton	Function
MODE UP MODE DOWN	They allow changing the operating mode of the device. OFF_RESET, MAN and AUTO mode can be selected. **In order to change the mode, the pushbutton must be kept pressed for at least 0.5 seconds.**
START	**MAN**: can be used to start all the gensets controlled by MC100. **AUTO**: 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 MC100 that are stopped for a low load condition. **TEST**: changes the operating mode from TEST to AUTO. *Pressed at the same time with the STOP pushbutton at the power up, it allows entering the board special functions.*
STOP	**OFF_RESET**: the pushbutton drives the LAMP TEST function. **MAN**: it is used to stop all the gensets controlled by MC100. **AUTO**, **TEST**, **REMOTE START**: it is issued an alarm (A007) and all gensets controlled by MC100 are stopped. *Pressed at the same time with the START pushbutton at the power up, it allows to enter the board special functions.*

Pushbutton	Function
MCB	**MAN**: it is used to manually manage the MCB circuit breaker. *MC100 does not provide directly a pushbutton for MGCB management. It is possible to use a digital input for this purpose (IF_21, IF_22). If no inputs is so configured (and so manual management of MGCB is not possible):* • *If both MCB and MGCB are present on a specific plant and no synchronization has to be done, this pushbutton performs a switchover of the loads between the mains and the generators, instead of opening/closing the MCB.* • *If in a specific plant MCB is not present but MGCB is present, this pushbutton can be used to manage MGCB.*
► ◄	They allow selecting previous and following pages of the LCD display (except in PROGRAM mode). *In PROGRAM mode, they are used to move the cursor while editing character strings.* *Used together with the SHIFT pushbutton they modify the display contrast.* *In some display pages, they can be used to select a different editing field.*
▲ ▼	They allow selecting the multifunction display mode. The following 5 modes are available: PROGRAM, STATUS, MEASURES, PMCB, and EVENTS. *In PROGRAM and EVENTS modes they allow to scroll menus, increase/decrease variables or scroll records.* *Used in combination with the SHIFT button, in PROGRAM mode, it allows scrolling menu by step of 5 rows or increase/decrease variables in ten units' steps.* *They allow scrolling anomalies or statuses if the function is active.*
ENTER /ACK	It is used to acknowledge an anomaly status and to switch off the internal/external horn. *Activates the statuses/anomalies scroll mode.* *Activates the possibility to change set points out of PROGRAM mode.* *It allows entering the program mode. Selects a menu entry or enables/disables the changing mode of a variable; confirm a new value.* *It is used to enter the EVENTS function after selecting the required archive.* *It is used (together with EXIT) to acknowledge non volatile memory errors at board power up.* *If pressed alongside the EXIT pushbutton for at least 5 seconds it executes a clear task, depending on the currently shown information: parameters are reloaded with their default values, history data are cleared, peak values are cleared, cancel the BUS-OFF status of CAN BUS.*
EXIT / SHIFT	While pressed, the first row of the display shows some status information. If you prefer to permanently show this status information, quickly press and release the pushbutton twice (double click). Pressed alongside the ◄► pushbuttons, it changes the multifunction display contrast. *Deactivates the statuses/anomalies scroll mode.* *Deactivates the possibility to change set points out of PROGRAM mode.* *During programming, pressed alongside the ▲▼ pushbuttons, it makes the menu scrolling and the value increase/decrease faster. If used alone, it aborts the current change. If it is kept pressed for at least 2 seconds, the programming mode is leaved retaining the current menu position for further programming access.* *During programming or in EVENTS view, it allows to go up the in the previous menu level or to exit the function.* *In OFF_RESET mode, if pressed alongside the ENTER pushbutton for at least 5 seconds, it executes a clear task that depends on the shown screen of the multifunction display: (see ENTER pushbutton description).* *It is used (together with ENTER) to acknowledge non volatile memory errors at board power up.*

3.2 Signal lamps

14 LED signal lamps are available. If the "OFF_RESET" mode is active, pressing the STOP pushbutton activates the LAMP test.

Signal	Function
OFF_RESET PROGRAM	**Fixed on**: the current operation mode is OFF_RESET. **Flashing (50% on)**: the current display mode is PROGRAMMING.
MAN	**Fixed on**: the current operation mode is MAN.
AUTO / TEST	**Fixed on**: the current operation mode is AUTO. **Flashing (50% on)**: the current operation mode is TEST. **Flashing (90% on)**: the current operation mode is REMOTE START.
MAINS LIVE	**Fixed off**: neither voltages nor frequency are present on the mains. If the device is configured to use an external mains sensor (IF_40), the related digital input is off. **Fixed on**: voltages and frequency are stable inside the operating window. If the device is configured to use an external mains sensor (IF_40), the related digital input is on. **Flashing (50% on)**: transition between the previous statuses. **Flashing (75% on)**: at least one voltage or the frequency is above the high limit of the operating window. **Flashing (25% on)**: at least one voltage or the frequency is below the low limit of the operating window. It can also signal a voltage unbalance on the mains or a wrong phase's rotation.
MCB	**Fixed off**: MCB breaker is open. **Fixed on**: MCB breaker is closed. **Flashing (25% on)**: MCB breaker is open while the command is to close. **Flashing (75% on)**: MCB breaker is closed while the command is to open. **Flashing (50% on)**: synchronization in progress for MCB breaker (blinks with BUS LIVE, alternated).
BUS LIVE	**Fixed on**: voltages on the loads. **Fixed off**: no voltages on the loads. **Flashing (50% on)**: synchronization in progress for MCB or MGCB breaker (blinks with MCB or MGCB, alternated).
MGCB	**Fixed off**: MGCB breaker is open. **Fixed on**: MGCB breaker is closed. **Flashing (25% on)**: MGCB breaker is open while the command is to close. **Flashing (75% on)**: MGCB breaker is closed while the command is to open. **Flashing (50% on)**: synchronization in progress for MGCB breaker (blinks with BUS LIVE, alternated).
GENERATORS BUS LIVE	**Fixed on**: voltages on the generators bus. **Fixed off**: no voltages on the generators bus.
ALARM WARNING	**Fixed off**: no anomalies are active. **Flashing (50% on)**: at least a warning is present. **Fixed on**: at least an alarm or deactivation or unload is present.
AUX. LINK	**Fixed off**: no communication is in progress on the serial ports. **Fixed on**: a link is established on one or both the serial ports. **Flashing (50% on)**: a command received from the serial ports is in execution (for example a REMOTE TEST was activated from serial port).
PMCBUS	**Fixed off**: no genset control devices are connected to the PMCBUS. **Fixed on**: at least one genset control device is connected to the PMCBUS. **Flashing (25% on)**: communication problems over the can bus (ERROR PASSIVE). **Flashing (75% on)**: communication problems over the can bus (BUS OFF).
STATUS	**Fixed on**: the current display mode is the STATUS MODE.
MEASURES	**Fixed on**: currently are shown the electrical measures or the PMCBUS pages.
EVENTS	**Fixed on**: the current display mode is EVENTS MODE.

3.3 Multifunction display

It is a graphical display that has a resolution of 128x64 pixels.

The backlight lamp is managed by the controller that switches it off after a configurable time (P.4502) if no pushbutton is pressed. To switch it on again, press any pushbutton. It is possible to disable this function, setting to zero the parameter P.4502. If the controller temperature is very low, the lamp is switched in any case on in order to warm up the controller and the display. On the contrary, with high temperature, the lamp is switched off after a second.

Display contrast can be adjusted pressing at the same time the SHIFT and ◄ (to decrease) or the SHIFT and ► (to increase) pushbuttons.

MC100 uses two different font types, with different dimensions. The basic font allows a matrix of 21 characters by 8 rows.

Different display modes are available. Each mode has some pages. Using the ▲▼ pushbuttons, it is possible to select the display mode, while the pages of the selected mode can be selected using the ◄► pushbuttons. Some screen mode are menu-based; in this case, pressing the ENTER pushbutton is request in order to enter the mode. After entering the mode, the menus can be scrolled using the ▲▼ pushbuttons.

As general rule, in case the pushbuttons ▲▼and ◄► have to be used to accomplish task inside the page, it will be necessary to press ENTER to enable the function and EXIT or again ENTER to disable/leave the function.

All the multifunctional display's pages have similar structure.

The title bar, shown in reverse mode, is always present on the top row, and contains useful information:

- The "Mode identifier" that consist of 5 different letters that identify the screen mode:
    - "P": programming
    - "S": status
    - "M": electrical measure
    - "B": PMCBUS measures
    - "H": events and history logs
- The "Page identifier" that shows which page is currently shown on the display.
- The "Page title" is a text that describes the current shown page. The title text depends on the selected language. Thus, it will be better to identify the page using also the Mode and Page identifier.
- If some digital inputs are used to select the operating mode of the controller, a small "key" symbol is shown on the far right. See 7.1.
- If any type of inhibition that prevents the automatic start of generators is present, a small lock symbol will be shown on the far right.

Combining Mode and Page identifier allows having unique identification for every page.

By keeping pressed the SHIFT pushbutton, the title bar is replaced by the status bar. It shows cyclically some important statuses of MC100. When SHIFT pushbutton is released, the title bar is shown again.

By quickly pressing and releasing the SHIFT pushbutton twice (double-click), the status bar is permanently shown instead of the title bar (there is no need to keep the SHIFT pushbutton pressed). To go back to the title bar, repeat the double-click procedure or change display page.

Only for some pages, you can show a help text related to the current page on the last row of the display: do that by keeping pressed the SHIFT pushbutton.

3.3.1 Programming

This mode allows showing and modifying the programming parameters. See par 4 for detailed information regarding programming.

3.3.2 Status

This mode consists of 9 pages.

3.3.2.1 S.01 STATUS

Purpose of this page is to report the general status of the plant. It contains:

- Mains status (available, not available, etc.).
- Working mode of the controller (MAN, AUTO, etc.).
- Current status of the working sequence (stopped, supplying, etc.).
- The circuit breakers statues (opened, closed, synchronization etc.).
- If any kind of start inhibition is active.
- If any kind of changeover inhibition is active.

Some pieces of information are shown alongside an elapsing time; for example, during synchronization, the residual time before a warning is raised is shown.

3.3.2.2 S.02 ANOMALIES

This page is automatically shown in case a new anomaly arises. For every anomaly, it is shown:

- A letter that identify the type:
  - “A”: Alarm (block).
  - “D”: Deactivation.
  - “U”: Unload.
  - “W”: Warning.
- A three digit numeric code that uniquely identify the anomaly. This code flash until it is acknowledged pressing the “ENTER” pushbutton.

- A text message, which depends on the selected language and can be, for some anomalies, customized. For this reason, when report an anomaly, please report also the type identifier and the numeric code.

Every anomaly uses one or two rows of the display. The top one is the most recent. If space is not sufficient to show all the pending anomalies, only the most recent ones are shown. In order to see the others, it is required to:

- Press the ENTER pushbutton.
- Use the ▲▼ pushbuttons to scroll the anomalies.
- Press EXIT to leave the mode.

The anomaly “273” (“incoherent parameters”) is special. When activated, the last row of the display is used to better clarify the problem.

3.3.2.3 S.03 PLANT

Digital inputs of the controller can be configured in order to acquire status information. Two categories are available: simple (IF_50) and important (IF_51). It is also possible to assign a text to the input configured in this way. If one of these inputs is activated, the assigned text will be shown. If the input status is of the type important, this page will pop up.

Every status uses one or two row of the display. If no space is available for all the status, only some of them will be shown. In order to see the other, it is required to:

- Press the ENTER pushbutton.
- Use the ▲▼ pushbuttons to scroll the anomalies.
- Press EXIT to leave the mode.

3.3.2.4 S.04 SERIAL COMMUNICATION

This page is used to show the serial ports statuses. In case of functional problems, please, verify the content of this page.

For each serial port, it is always shown the type of connection (direct, PSTN modem or GSM modem) and the related status (at rest, communication in progress etc.).

In case of GSM modem, information related to the radio signal strength and the provider are shown (only for main serial port, JA).

3.3.2.5 S.05 CAN BUS

This page is used to show the can bus communication status for PMCBUS. In case of functional problems, please, verify the content of this page.

If the CAN BUS connection is enabled, this page shows the connection status (ERROR-ACTIVE, ERROR-PASSIVE, BUS-OFF) and the transmission and reception error number. When this page is shown, with the controller in OFF_RESET mode, it is possible to clear the error counter and set the ERROR-ACTIVE status (that is the status for correct communication) pressing at the same time the pushbuttons ENTER and EXIT for at least 5 seconds.

3.3.2.6 S.06 BOARD

This page is dedicated to the controller itself. It contains:

- Date and Time in extended format (flashing if not valid).
- The supply voltage (DC) of the controller.
- The internal temperature of the controller.
- Internal code used for SICES password.
- The unique identification number of the controller (ID CODE)
- The Software type and version of the controller.
- The Software type and version of the internal extension module.

3.3.2.7 S.07 DIGITAL INPUTS

This page shows the status of all the digital inputs of the controller.

The logic statuses of the inputs are shown. Physical statuses can be different depending on the configuration of the inputs.

In the page, a “0” associated to an input means that the input is not active. A “1” means that the input is active.

3.3.2.8 S.08 DIGITAL OUTPUTS

This page shows the status of all the digital outputs of the controller.

The physical statuses of the outputs are shown. Logical statuses can be different depending on the configuration of the outputs.

In the page, a “0” associated to an output means that it is not active. A “1” means that the output is active.

3.3.2.9 S.09 ANALOGUE I/O

This page shows all the analogue measures of the controller (connectors JW and JM). For each input it is shown the voltage value in V.

3.3.3 Electrical measures

In this mode are shown, by means some pages, the electrical measures carried out from the controller.

3.3.3.1 M.01 SYSTEM

This page shows the general outline of the plant. The elements shown here are:

- The mains (not shown for MPM plants - Multiple Prime Mover). The symbol is blinking when the mains is not in thresholds.
- The loads.
- The generators. The symbol is shown in “reverse” mode if some generator is running, blinking when those generators have not been started by the MC100.

- The MCB circuit breaker (not shown for MPM plants - Multiple Prime Mover). If it is configured as “not used”, it is drawn always as “opened”.
- The MGCB circuit breaker. If it is configured as “not used”, it is drawn always as “closed”.
- The GCB breakers of generators.

All circuit breakers are drawn as “opened” or “closed” based on their real status. Only one GCB breaker is drawn:

- If all GCBs are opened, it is drawn as “opened”.
- If at least the GCB of one generator controlled by MC100 is closed, it is drawn as “closed”.
- If the GCBs of all controlled generators are opened, but at least the GCB of one non-controlled generator is closed, it is drawn as “opened”, but with a dashed line on the closure side.

Moreover, active power and power factor measures are shown on all available lines (mains, loads, and generators). For plants that can work in parallel with mains, also active power and power factor set points are available: they can be modified directly here, also with the device in AUTO mode.

3.3.3.2 M.02 MAINS

The screen shows voltage values (phase-to-phase), frequency and the cyclic sequence of the signals connected to the mains three-phase inputs of the controller.

If the controller is configured for single-phase operation, only one phase-to-neutral voltage value is shown. The cyclic sequence status is no more shown.

At the bottom right a symbol identifies that the values are related to the mains measures.

3.3.3.3 M.03 GENERATORS

The screen shows voltage values (phase-to-phase), frequency and the cyclic sequence of the signals connected to the generators bus three-phase inputs of the controller.

If the controller is configured for single-phase operation, only one phase-to-neutral voltage value is shown. The cyclic sequence status is no more shown.

At the bottom right a symbol identifies that the values are related to the generators bus measures.

3.3.3.4 M.04 CURRENTS

The screen shows the three phase current measures (in single-phase mode only the first one is shown, the others show dashes). If it is configured (P.1305 > 0), it is shown also the fourth current (auxiliary current).

The parameter P.1301 selects where the current transformers (CT) are located: on the mains, on the loads, or on the generators bus. At the bottom right the correct symbol (mains, loads, and generators) is shown in order to immediately identify the source for the measures.

3.3.3.5 M.05 POWERS 1

The active powers and power factors are shown, total and phase by phase (dashes only for phase 2 and 3 in single-phase mode). At the bottom right, a symbol identifies the power source (mains, loads or generators).

3.3.3.6 M.06 POWERS 2

The reactive powers and apparent powers are shown, total and phase by phase (dashes only for phase 2 and 3 in single-phase mode). At the bottom right, a symbol identifies the power source (mains, loads or generators).

3.3.4 Parallel management

3.3.4.1 B.01 MAINS PARALLEL

This page is visible only if MC100 is configured to manage the parallel with the mains. First of all, it shows the current status of the mains (present, absent, etc.).

If it is absent, the middle of the display shows the protections that have detected the loss of the mains while generators were in parallel with the mains. Possible values are:

- 27: mains voltages below minimum threshold.
- 59: mains voltages above maximum threshold.
- 81<: mains frequency below minimum threshold.
- 81>: mains frequency above maximum threshold.
- 81R (DF/DT): a rate of change of frequency higher than the configured thresholds has happened.
- VJ (Vector Jump): a vector jump on the mains voltages higher than the configured threshold has happened.

If one of these protections is activated, generators are immediately disconnected from the mains. The tripped protection is shown flashing on the display until the operator “acknowledge” the situation by pressing the ENTER pushbutton. After that, the display shows the tripped protections (not flashing) until the mains is available again.

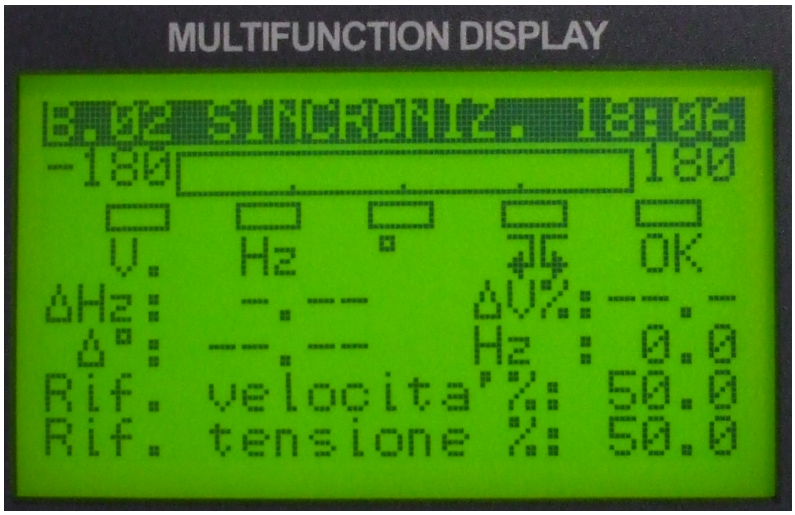
The last two lines of the display show the active power and power factor set points: they can be modified directly here, also with the device in AUTO mode.

If “IMPORT/EXPORT” function is selected, also the powers on the mains, on the loads and on the generators are shown: the operator has thus all the required information to manage the situation.

3.3.4.2 B.02 SYNCHRON.

The screen shows information related to synchronization.

A bar, acting as synchronoscope, is shown. Underneath the bar, four rectangular buttons indicate the status of voltage, frequency, phase and rotation. If they are black the status is correct for the closure; if all four are black, the fifth one (OK) will become black and the closure command will be issued.



Two additional lines on the bottom allow modifying the set points of Speed reference and of Voltage reference.

3.3.4.3 B.03 TOTALS PMCB

The screen shows information related to all the generators connected to the PMCBUS. MC100 calculates the sum of some measures for all the generators and shows the results:

- Active energy (kWh) (sum of active energy counters of all generators).
- Reactive energy (kvarh) (sum of reactive energy counters of all generators).
- Active power (kW) (signed sum of active power of all generators with MGCB closed).
- Reactive power (kvar) (signed sum of reactive power of all generators with MGCB closed).
- Nominal power (the sum of the nominal powers of all generators with MGCB closed).
- Generator bus load (the active power divided by the nominal power of all generators with GCB closed - DPRt).

3.3.4.4 B.04 DEVICES

This page shows a list of all the devices working over the PMCBUS. It's very useful to detect communication problems.

On the top of the page, the list of all MC100 devices is shown, each identified by its PMCBUS address. Note: for MC100 device, PMCBUS address can be different from Modbus address used for serial communication ports. PMCBUS address for MC100 devices is greater or equal to 75. It can be selected by parameter P.3701.

On the bottom of the page, the list of all genset control devices is shown, each identified by its PMCBUS address. The genset control devices have addresses between 1 and 31.

3.3.4.5 B.05 GENERATORS 1

3.3.4.6 B.06 GENERATORS 2

3.3.4.7 B.07 GENERATORS 3

3.3.4.8 B.08 GENERATORS 4

These three pages show some specific information related to each generator connected to the PMCBUS. Each page shows information for up to six generators. The unused pages (because all their generators are not connected to the PMCBUS) are hidden.

One display row per generator is used. Information shown are (from left to right):

- PMCBUS address of the generator. If at this time MC100 is not able to manage this generator, the address is shown in “reverse” mode (for example if the related genset control device is in OFF_RESET mode or has some alarms).
- The active power currently supplied by the generator.
- The reactive power currently supplied by the generator.

In AUTO mode, MC100 starts and stops the generators as required by the loads. Using these pages, the operator can modify this behavior. For each generator, the operator can select one of these operating modes:

- Automatic management (default). MC100 starts/stops the generator as required by load. In this case, a “**blank field**” is shown on the display between PMCBUS address and active power of the selected generator.
- Generator always working. Whatever the load is, this generator must work. In this case, a “**full circle**” is shown on the display between PMCBUS address and active power of the selected generator.
- Generator always stopped. Whatever the load is, this generator must be stopped. In this case, an “**empty circle**” is shown on the display between PMCBUS address and active power of the selected generator.

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

- Press ENTER pushbutton: MC100 will show a caret on the first row.
- By using ▲▼pushbuttons, select the desired generator.
- Change the operating mode for the selected generator using ◄►pushbuttons.
- Press EXIT to exit selection mode.

3.3.4.9 B.09 LOAD FUNCTION

This page, like the next one, is related to the “load function” (the ability of MC100 to start a variable number of generators as required by the loads).

This first page shows the current situation of the load function. The first row shows its status (enabled/disabled).

When the function is enabled, typically only a subset of the generators is working. MC100 uses specific techniques to avoid that always the same generators are working. MC100 provides many rotation techniques (by the operator, every x hours, at a predefined time etc.). The second row shows the currently selected technique. The third row shows the highest priority genset (the one which will never be stopped, named “master”). It is possible to change the master genset directly from this page:

- Press ENTER pushbutton.
- Select the desired genset by ▲▼pushbuttons.
- Confirm by pressing ENTER pushbutton.

The fifth row can show the time remaining before next automatic rotation of generators (depends on the currently selected technique).

Last two rows show a list of generators currently involved in load function. They are shown in base of their priority: first the ones with higher priority, and then the last priority ones. Generators that are currently stopped for a low load situation are shown in reverse.

3.3.4.10 B.10 LOAD FUNCTION 2

This second page, dedicated to load function, shows the powers and the thresholds involved.

The third row shows the threshold (%) above which a new generator must be started. The second row shows the current active power supplied (%): if it is higher than the threshold, it is shown in reverse mode.

The fifth row shows the threshold (%) below which the lower priority generator must be stopped. The fourth row shows the active power (%) that generators should supply if the lower priority ones would be stopped: if is lower than the threshold, it is shown in reverse mode. This power can be shown as dashes if there are no generators to be stopped.

Last row shows the current status of management: it indicates if and when a generator will be started or stopped, if the load function is disabled or frozen, and eventually if the load function is managed by a different MC100 device.

3.3.4.11 B.11 LOAD SHEDDING

This page is related to the “load shedding” function, that allows MC100 to disconnect some loads if generators are unable to supply enough power. This page is hidden if the function is not configured.

It is possible to select up to four digital outputs to be used to connect/disconnect loads from the generators: the rows from the second to the fifth show the status of these outputs. Only configured outputs are shown.

The seventh row shows the status of the function: if and when the next output will be activated (and so a load will be disconnected) or the last activated one will be deactivated (and a load will be connected), if the function is disabled and so on.

The last row shows the actual power (%) related to load shedding thresholds, in reverse mode if an action has to be taken on the loads.

3.3.5 History logs

This mode allows accessing to the history logs of the controller. Please, see par 5 for deeper information.

4. Programming

The board manages a high number of parameters that allow the manufacturer, the installer or the final user to configure it in order to adapt it to the specific requirements of the system. This document does not contain the list of the parameters (even if many of they are quoted in the description of the board functions); the list is available from the document [1], where they're described in detail. Always refer to that document for the most updated information. Here is described the programming general structure and the operating procedure to read and/or modify the parameters.

4.1 General structure

4.1.1 Organization

Each parameter has associated:

- A description, variable with the selected language.
- A numerical code, with four digits (it permits the identification independently of the selected language).
- A level of protection (see next paragraph).

The parameters are grouped in menu, which are organized in a tree structures (a menu can contain others menu). Mixed menu do not exist: a menu cannot contain both parameters and others menu.

To each menu there are associated:

- A description, variable with the selected language.
- A one digit numerical code. In case of secondary menu, the code is composed by the one of the main menu, followed by a dot and by its own code.

4.1.2 Protection

The access to the programming can be conditioned by means of three various levels of PASSWORDS, listed in priority order:

1. Manufacturer password (all parameters can be changed).
2. Installer password (all parameters but not manufacturer ones can be changed).
3. End user password (only end user parameters can be changed).

All parameters can be, in any case, viewed.

Each parameter is associated to a proper access level (in document [1] this association is indicated in column "ACC" with letter "C" in order to indicate the manufacturer, "I" for installer and "U" for end user).

A parameter associated to the manufacturer can be modified only from the manufacturer. A parameter associated to the installer can be modified by manufacturer and installer. A parameter associated to end user can be modified by manufacturer, installer, and end user.

An additional password level is available to prevent incorrect and unintentional plant configuration change that can lead to serious system damage. This is named “SICES”; the parameters that require this password are identified by means a letter “S” in column “ACC” of document [1]. This password can’t be assigned. Read more in the following.

If the operator have to modify a parameter it must first digit the proper password in the parameter P.0000 (menu “1-Security”), so the board can recognize it as “manufacturer”, “installer” or “end user”.

The access code settings remains memorized for about 10 minutes since the end of programming. When this time is elapsed the code is automatically reset to zero and must be reinserted to access programming again.

Any of these three levels can be enabled or disabled individually, setting a password different or equal to zero for the individual level. The three passwords are themselves three board parameters (identified respectively by codes P.0001, P.0002 and P.0003) and they are configurable by the procedure described later. They are placed in the menu “1-Security”. The following examples show all the combinations of the password assignment.

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

All users are “manufacturer”, without entering codes in P.0000. Therefore all the parameters are modifiable from anyone (this is the default mode).

Example 2: P.0001=0 P.0002=0 P.0003=”uuu”

No parameter is modifiable. When user enters the “uuu” code in P.0000 the board consider it “manufacturer” because there is no password for “installer” and “manufacturer”. After entering code all parameters are modifiable.

Example 3: P.0001=0 P.0002=”iii” P.0003=”uuu”

No parameter is modifiable. When user enters “uuu” in P.0000 it can modify only end user associated parameters. If user enters “iii” the board considers it “manufacturer” because there is no password for “manufacturer”. After entering this code all parameters are modifiable.

Example 4: P.0001=”ccc” P.0002=”iii” P.0003=”uuu”

No parameter is modifiable. When user enters “uuu” in P.0000 it can modify only end user associated parameters. If user enters “iii” it can modify parameters associated to “installer” and “end user”. If user enters “ccc” it can modify all parameters.

Example 5: P.0001=”ccc” P.0002=0 P.0003=0

No passwords are associated to end user and installer. Parameters associated to end user and installer are free programmable, without entering code in P.0000. To modify manufacturer associated parameters you have to enter “ccc” in P.0000.

Example 6: P.0001=0 P.0002=”iii” P.0003=0

Parameters associated to end user are freely programmable, without entering code in P.0000. When user enters “iii” in P.0000 it can modify all parameters because there is no password for “manufacturer”.

Example 7: P.0001=”ccc” P.0002=”iii” P.0003=0

Parameters associated to end user are freely programmable, without entering code in P.0000. When user enters “iii” in P.0000 it can modify parameter associated to “installer” and “end user”. If user enters “ccc” it can modify all parameters.

Example 8: P.0001=”ccc” P.0002=000 P.0003=”uuu”

No parameter is modifiable without entering codes in P.0000. When user enters “uuu” it can modify parameters associated to end user and installer. If user enters “ccc” it can modify all parameters.

Note: all parameter values are always visible, but the modification is possible only if P.0000 contains a password with superior or equal level to that one required by the parameter.

Note: while accessing to programming and setting the password (P.0000), it is possible that parameters P.0001, P.0002, P.0003 and P.0004 will not be immediately visualized. To enable the visualization, go back to previous menu and subsequently come back.

In case the password code has been forgotten, only knowing the password with higher level it is possible recover the access right. Otherwise (or in the case the manufacturer password was lost), it is necessary to use the SICES password supplied with the controller to unlock the programming (see next paragraph).

For this reason, it is not advisable to not set up at least the “manufacturer” password (P.0001): if in fact someone else sets up this password or a lower password (even just unaware) without communicate it, it will not be possible to modify any parameter. Instead, knowing the “manufacturer” password, it will be in any case possible to cancel or modify other passwords.

The general rule imposes that the parameters are modifiable only when the controller is in “OFF_RESET” mode. Some parameters make exception and are modifiable in any operating modes. Generally, if a parameter cannot be modified it will be enclosed between < >, while if it’s modifiable it is enclosed between [ ]: that is valid also for the restrictions due to password. Parameters can always be changed by serial link without any regards to the operating mode of the controller.

4.1.3 SICES password

Some parameters are protected by this special password. Actually two type of SICES password are available: fixed and temporary.

Fixed password is shipped alongside the controller and it is valid forever. Temporary password can be obtained by means the following procedure.

It's supplied from SICES upon request and depends on the board and a random parameter. After its first use, is possible to continue to use it until two hours of operation are elapsed. After this time a new password must be requested to SICES.

At the present moment, it protects the following parameters: P.3001 (Plant type), P.3002 (MGCB mode), P.3004 (MCB mode), P.3006 (operating mode in parallel with mains) and P.3601 (interface breaker).

Scope of SICES password is to prevent altering parameters whose modification could bring serious damages.

To obtain this password, manufacturer has to request it to SICES, by sending e-mail to techelp@sices.it. In the e-mail must be reported the Board and panel S/N (if produced by Sices) with the univocal board identification code and the internal code. These last information are obtained from the S.06 status page.

4.2 Operating procedure

This procedure will describe the keyboard and display use.

4.2.1 Enter the programming mode

Programming procedure is accessible in all the working modes of the board. To enter in programming mode, it is required to act on ▲ and ▼ pushbuttons until the programming screen appear (P.03). Note: if you are inside a screen mode or function that doesn't allow the use of these pushbuttons to change the mode, press few times EXIT and then try again (this can happen during the visualization of the history logs or during particular operations as, for instance, the setting of the active power setpoint).

Press ENTER in order to enter in programming.

At the procedure start, it is automatically shown the menu or the parameter selected before the last exit from programming (the first time you enter it is shown the main menu). That is true if programming was exited changing the controller mode to MAN or AUTO or if the SW aborted automatically the programming after the maximum idle time or if the programming was aborted keeping pressed the EXIT pushbutton for at least two seconds.

4.2.2 Menu selection

In the first line are always indicated: current menu name, selected menu, number of menus. By means the following rows, menu items are visualized (submenus). Selected menu is displayed in REVERSE. The ▲ and ▼ pushbuttons go up and down in cyclical way (then pressing ▲ from the first item you pass to the last one and vice versa).

To enter the selected menu item press ENTER pushbutton. EXIT goes back to previous menu or exits from programming.

4.2.3 Parameters selection

First row shows always the name of the current menu (for example “1-Security”), followed by the indication of the selected parameter and by the number of the menu parameters. Next rows are all utilized to visualize one single parameter. In details:

- Fourth and fifth rows show the univocal parameter code (four decimal digits) followed by the description in the current language.
- Sixth row shows, aligned to the right side, the parameter value, included in square brackets or between < >.
- For some parameters on the eighth row it is shown a value in some way related to the parameter current value. For example, if current parameter is the minimum mains voltage (%), the eighth row shows the corresponding value in Volt, obtained from nominal mains voltage (P.1202) and from the parameter itself (P.3624). Often this additional measure is visualized when the parameter is expressed as percentage related to something else, to show its absolute value.

Use the pushbuttons ▲ and ▼ to scroll through the menu toward the items having respectively higher and lower index, in a cyclical way (pressing ▲ from the first item it passes the last one and vice versa). Normally the selection moves by an item at once; pressing the SHIFT pushbutton together with ▲ and ▼ pushbuttons, the selection moves by three items at once. Pressing the ENTER pushbutton it will be enabled the parameter modify procedure (see next paragraph); press the EXIT pushbutton to exit from the menu (coming back to previous menu).

4.2.4 Parameters modifying

A parameter can be modified if its value is shown enclosed by [ ]. If it is shown enclosed by < >, it can’t be modified due to password level or system status.

Once visualized a parameter, to start modifying it, it is necessary to press the ENTER pushbutton. The square brackets enclosing the value start to flash, indicating that the modify phase is in progress. Press ENTER pushbutton to confirm the new value, press the EXIT pushbutton to abort the modifying and come back to the original value. If a variable is shown enclosed in angle brackets instead of square brackets, it can’t be modified (that can depend on password level or working mode of the controller).

Existing parameter types are:

- Numerical: the value is modifiable by means of the ▲▼, respectively in order to increase it or to decrease it of one unit (if such pushbuttons are pressed alongside the SHIFT pushbutton, the value will be increased or decreased of ten units at a time). The modifying is cyclical: trying to increase the value when it is already at its maximum, it is set to the minimum and vice versa.
- Numerical with selection between a predefined list (for example the number of phases of the mains): same as seen for numerical parameters; the ▲▼ permit to select the next/previous value from predefined list (pressing ▲▼ together with the SHIFT pushbutton, the next/previous value is ten position ahead/back to the current value).
- Numerical with selection from list of number-string items (for example the CT connections); same as the previous type.
- Hour type: same as numerical types, with one exception: the board manages the increase/decrease maintaining valid values (example: increasing from “00.59”, the value goes to “01.00” and not to “00.60”).

- Strings (by example phone numbers): in this case the display shows also a cursor indicating the currently select character in 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 SHIFT is pressed too), whereas ◄► pushbuttons allow selecting the character to modify. Note: it is possible to set the ASCII characters from 32 (space) to 127 (escape). It is not possible to set extended ASCII characters (over 127) and the control characters (from zero to 31).

- Hexadecimal strings (by example the digital output bitmaps): same as for the string parameters but the selectable characters are only "0-9" and "A-F" (only capitals).

4.2.5 Set up limits

The operator has not to worry about verifying that the set up value is acceptable for the board since it is not possible to set up not acceptable values. Obviously, this is true only for a single parameter. Nothing forbids, by example, to invert two thresholds values which for their logic function must be the first lower than the second. These controls are however left to the operator. Operator has the responsibility to verify that the programmed value is acceptable for the system: wrong parameter values may lead to damages.

4.2.6 Exit from programming

There are three ways to leave programming mode:

- Press the EXIT pushbutton n times to go back until main menu appears and then press it again to exit from programming. Coming a next time into programming, it will be show main menu.

- Keeping pressed the EXIT pushbutton for two consecutive seconds from any position: an instantaneous exit from programming will follow and the next programming entry will be exactly in same point.

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

4.2.7 Loading default values

In some situation may be useful to reload parameters factory default values. To do this it is necessary, first at all, entering in the programming mode, and then keep the pushbuttons ENTER and EXIT pressed simultaneously and consecutively for five seconds. A message on the display will confirm to the operator of defaults reload.

Note: the default values will be reloaded only for the parameters for which the access rights are granted.

4.3 Additional notes

This paragraph contains notes of general use on the programming.

There are four main menus used to describe the plant to the device.

- The menu "0-Security" is used to setup the password for all the programming access levels (maker, installer and user). It lets also the operator to digit its password in order to be recognized by the device. Finally, it is used to setup a different password used to limit access to the device from serial ports.

- The menu “1-Hardware” contains all hardware configurations for the device. In details:
    - AC voltage inputs for mains.
    - AC voltage inputs for generators.
    - Current inputs.
    - Digital inputs.
    - Digital outputs.
    - Analogue inputs.
- The menu “3-Sequence” is used to configure the plant type and the working sequences of the device. In details:
    - Plant type.
    - The existence and the management mode for MCB and MGCB breakers.
    - The mains sensor (thresholds and delays).
    - The “loss of mains” protections.
    - The PID parameters for speed and voltage regulation during synchronization (also the windows for synchro-check).
    - The active power and power factor set points for parallel to mains operations...
    - The “load function”.
    - The “load shedding”.
    - Other timings and options for working sequences.
- The menu “4-Auxiliary functions” is used to configure some secondary functions/options:
    - History logs.
    - Serial ports.
    - Periodic test and time intervals during week when the system can work.
    - The maximum device temperature, the screen saver delay and the internal horn command duration.

4.4 Digital input configuration

MC100 is equipped with eighteen digital inputs that are fully configurable (connectors JN, JV and JU). For the connection of the digital input, please, refer to par 2.6.

As default, all the inputs are “active” only when the related terminal is connected to the negative of the supply voltage of the board; they are considered “not active” when the terminal is left open. It is possible to change this behavior (input by input), using parameters P.1400 (for connector JN) and P.1430 (for connectors JV and JU). Each input is identified by one bit in the related parameter (eight bits for P.1400 and ten for P.1430):

- 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 left open (connecting the input to ground will change to “not active” the status).

As default, all the bits are set to 0.

All the inputs are fully configurable. For each input, there are associated three parameters:

- One parameter configures the function.
- One parameter configures the delay time.
- One parameter allows defining a text message to display.

The following table shows for each input the related parameter

Input	Terminal	Function	Delay	Text
INPUT1	JN-1	P.1401	P.1402	P.1403
INPUT2	JN-2	P.1404	P.1405	P.1406
INPUT3	JN-3	P.1407	P.1408	P.1409
INPUT4	JN-4	P.1410	P.1411	P.1412
INPUT5	JN-5	P.1413	P.1414	P.1415
INPUT6	JN-6	P.1416	P.1417	P.1418
INPUT7	JN-7	P.1419	P.1420	P.1421
INPUT8	JN-8	P.1422	P.1423	P.1424
INPUT9	JV-1	P.1431	P.1432	P.1433
INPUT10	JV-2	P.1434	P.1435	P.1436
INPUT11	JV-3	P.1437	P.1438	P.1439
INPUT12	JV-4	P.1440	P.1441	P.1442
INPUT13	JV-5	P.1443	P.1444	P.1445
INPUT14	JU-1	P.1446	P.1447	P.1448
INPUT15	JU-2	P.1449	P.1450	P.1451
INPUT16	JU-3	P.1452	P.1453	P.1454
INPUT17	JU-4	P.1455	P.1456	P.1457
INPUT18	JU-5	P.1458	P.1459	P.1460

4.4.1 Digital input functions

The available functions are the following. Note: the following description refers to “logical” status of digital inputs, not “physical” status (see previous paragraph).

- “0 - Not used”
- “10 - MCB status” (IF_10). The device considers the circuit breaker closed when the input is activated, otherwise the circuit breaker is considered open. It is used for the working sequence and for “not closed” and “not opened” anomalies. It is possible to start the generators and supply the loads when MCB is “not closed”. The delay related to the input is used as timeout for opening and closing commands, before raising anomalies (if a zero delay is configured, the device uses a 2 seconds fixed timeout). The message related to the input is not used.

- “11 - MCB external open request” (IF_11). This input can be used to issue opening command for the circuit breaker (in MAN). The opening command is issued when the input becomes active (then, if it stays activated, the command will not be issued again). It can be used instead of MCB pushbutton. The delay and text parameters are not used here.

- “12 - MCB external close request” (IF_12). This input can be used to issue closure command for the circuit breaker (in MAN). The closure command is issued when the input becomes active (then, if it stays activated, the command will not be issued again). It can be used instead of MCB pushbutton. The delay and text parameters are not used here.

  If no input is configured with function 11 (IF_11), this input is used for both opening and closure commands, depending on circuit breaker status.

- “13 - MCB external synchro request” (IF_13). This function is used only if the circuit breaker is configured as “external synchronizable” (P.3004). It allows an external logic to require synchronization to MC100: the physical closure command will be issued by external logic when MC100 signals “synchronized” status by a digital output (OF_32). The delay and text parameters are not used here.

- “14 - MCB closure acknowledge” (IF_14). This function allows an external logic to prevent or to delay the circuit breaker closure. If this input is configured, MC100 activates an output configured as “ready to close” (OF_14) and waits for external acknowledge. If a delay is configured for this input, after this time MC100 goes on with closure command even without acknowledgement. The text parameter is not used here.

- “15 - MCB opening acknowledge” (IF_15). This function is used only when the opening of the circuit breaker will result in a black-out on the loads and the MGCB circuit breaker is not directly managed by MC100. Before opening MCB, the device activates an output configured as “ready to open” (OF_15), if exists, and waits for external acknowledge. If a delay is configured for this input, after this time MC100 goes on with opening command even without acknowledgement. The text parameter is not used here.

- “20 - MGCB status” (IF_20). The device considers the circuit breaker closed when the input is activated. It is used for the working sequence and for “not closed” and “not opened” anomalies. The delay related to the input is used as timeout for opening and closing commands, before raising anomalies (if a zero delay is configured, the device uses a 2 seconds fixed timeout). The message related to the input is not used.

- “21 - MGCB external open request” (IF_21). This input can be used to issue opening command for the circuit breaker (in MAN). The opening command is issued when the input becomes active (then, if it stays activated, the command will not be issued again). The delay and text parameters are not used here.

- “22 - MGCB external close request” (IF_22). This input can be used to issue closure command for the circuit breaker (in MAN). The closure command is issued when the input becomes active (then, if it stays activated, the command will not be issued again). The delay and text parameters are not used here.

  If no input is configured with function 21 (IF_21), this input is used for both opening and closure commands, depending on circuit breaker status.

- “23 - MGCB external synchro request” (IF_23). This function is used only if the circuit breaker is configured as “external synchronizable” (P.3002). It allows an external logic to require synchronization to MC100: the physical closure command will be issued by external logic when MC100 signals “synchronized” status by a digital output (OF_32). The delay and text parameters are not used here.

- “24 - MGCB closure acknowledge” (IF_24). This function allows an external logic to prevent or to delay the circuit breaker closure. If this input is configured, MC100 activates an output configured as “ready to close” (OF_24) and waits for external acknowledge. If a delay is configured for this input, after this time MC100 goes on with closure command even without acknowledgement. The text parameter is not used here.

- “25 - MGCB opening acknowledge” (IF_25). This function is used only when the opening of the circuit breaker will result in a black-out on the loads, and the MCB circuit breaker is not directly managed by MC100. Before opening MGCB, the device activates an output configured as “ready to open” (OF_25) and waits for external acknowledge. If a delay is configured for this input, after this time MC100 goes on with opening command even without acknowledgement. The text parameter is not used here.

- “30-No voltages on loads” (IF_30). MC100 is not able to directly detect voltages on the loads. It can detect voltages on the mains and on the generators bus, and, based on circuit breakers statuses, it can decide if loads are energized or not. If preferred (and for safety reasons also) it is possible to use this input to tell the device if loads are energized or not. This status is used when a circuit breaker has to be closed to activate synchronization or not. **Note: the loads are considered energized when the input is not activated.** The delay and text parameters are not used here. If MGCB is not present, this function is not necessary.

- “31-No voltages on gensets” (IF_31). MC100 is able (and normally do that) to directly detect voltages on the generators bus. If preferred it is possible to use this input to tell the device if generators bus is energized or not. This status is used when MGCB circuit breaker has to be closed to activate synchronization or not. **Note: the generators bus is considered energized when the input is not activated.** The delay and text parameters are not used here.

- “40 - External mains sensor” (IF_40). Normally MC100 uses its internal mains sensor (JF) to check whether mains is “in tolerance” or not and to detect “loss of mains” during parallel to mains operations. If preferred, this input can be used as an external mains sensor. The timings related to internal mains sensor are used also for the external one (P.3630 e P.3631). The mains is considered “in tolerance” when the input is activated. To select between internal and external sensor, use parameter P.3621. The delay and text parameters are not used here.

  Note: MC100 uses this input to detect both “mains in tolerance” for emergency plants and “loss of mains” for parallel to mains plants. If required, you can connect to this input an approved mains failure protection relays (DK).

- “41 - Start inhibition command” (IF_41). When this input is activated, MC100 never automatically starts the generators, even if required by plant logic. In this situation, the only way to automatically start the generators is to change MC100 operating mode to TEST or to REMOTE START mode. This function uses two specific parameter (P.3801 e P.3802) to add a delay on activation and deactivation of the input. The delay and text parameters are not used here.

- “42 - Remote start command” (IF_42). If operating mode is AUTO or TEST, when this input is activated the operating mode switches to REMOTE START. When the input reverts to deactivated status, the operating mode switch back to AUTO or TEST. In REMOTE START mode, MC100 starts the generators and connects them to the loads even if plant logic doesn’t require that. If a delay is configured for this input, the operating mode switches to REMOTE START after this time is elapsed from input activation (usable for EJP applications). The text parameter is not used here.

- “43 - Remote start enable” (IF_43). If this input is configured, the operating mode of MC100 can switch to REMOTE START only if this input is activated. The delay and text parameters are not used here.

- “44 - Load inhibition command” (IF_44). In AUTO, TEST or REMOTE START modes, when this input is activated MC100 disconnects the generators from the loads (opening MGCB if possible, otherwise forcing generators to open their GCB). **Note: the activation of this input does not result in stopping generators unless required by plant logic.** The delay and text parameters are not used here.

- “45 - Remote test command” (IF_45). In AUTO mode, if generators are not required or are inhibited, when the input is activated the operating mode switches from AUTO to TEST. When the input is deactivated, the mode switches back to AUTO. The delay and text parameters are not used here.

- “46 - Remote OFF-RESET” (IF_46). 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. See 7.1. **Note: when this input become “not active”, if no inputs are configured with functions 47 and 48, the operating mode is forced to the one set before the input activation.**

- “47 - Remote MAN” (IF_47). When this input is active, the operating mode of the controller is forced to MAN, and it is not possible to use the pushbuttons on the front panel to change it. See 7.1.

- “48 - Remote AUTO” (IF_48). When this input is active, the operating mode of the controller is forced to AUTO, and it is not possible to use the pushbuttons on the front panel to change it. See 7.1.

- “50 - Generic status” (IF_50). If the related input is active, the controller will show the text defined by the related parameter on page S.03 of the display. The delay parameter is not used here.

- “51 - Important status” (IF_51). If the related input is active, the controller will show the text defined by the related parameter on page S.03 of the display. The display is also forced to show this page. The delay parameter is not used here.

- “52 - Select configuration 1” (IF_52). When the input <u>becomes</u> active with MC100 in OFF_RESET mode, parameters of alternative configuration 1 are copied into the working parameters. The delay and text parameters are not used here.

- “53 - Select configuration 2” (IF_53). When the input <u>becomes</u> active with MC100 in OFF_RESET mode, parameters of alternative configuration 2 are copied into the working parameters. The delay and text parameters are not used here.

- “54 - Select configuration 3” (IF_54). When the input <u>becomes</u> active with MC100 in OFF_RESET mode, parameters of alternative configuration 3 are copied into the working parameters. The delay and text parameters are not used here.

- “55 - Select configuration 4” (IF_55). When the input <u>becomes</u> active with MC100 in OFF_RESET mode, parameters of alternative configuration 4 are copied into the working parameters. The delay and text parameters are not used here.

- “56 - Load function enable” (IF_56). If this input is <u>configured but not active</u>, the “load function” is disabled. The delay and text parameters are not used here.

- “57 - Import/export” (IF_57). This function is used in parallel to mains applications configured with BASE LOAD power management mode. When this input is active, the power management mode switches to “IMPORT/EXPORT”. The delay and text parameters are not used here.

- “58 - Transfer to gensets” (IF_58). During parallel to mains operations, if this input is active MC100 makes a soft power transfer of loads from the mains to the generators, and then opens the MCB circuit breaker. Normally MC100 needs to acquire mains powers to perform this soft transfer. If not possible, this function can be used also in BASE LOAD mode: the operator must set an active power set point that corresponds to current loads and, when the generators will reach this power the MCB circuit breaker will be opened. The delay and text parameters are not used here.

- “59 - Peak shaving” (IF_59). ***This function is reserved for future. Do not use it.***

- “60 – Load shedding” (IF_60). If this input is configured but not active, the “load shedding” function is disabled. The delay and text parameters are not used here.

- “61- Manual disconnection of part of load” (IF_61). Each time this input become active, the “load shedding” function disconnects one load (if possible). See the “load shedding” description for more details. The delay and text parameters are not used here.

- “62 - Manual re-connection of part of load” (IF_62). Each time this input become active, the “load shedding” function connects one previously disconnected load (if possible). See the “load shedding” description for more details. The delay and text parameters are not used here.

- “63 - Immediate supply” (IF_63). When MC100 starts generators for “island” operations (that means “not in parallel with mains”), normally it waits that all available generators are in parallel to each other, and then closes the MGCB circuit breaker to connect loads to generators. If this input is active, MC100 closes MGCB circuit breaker as soon as the first GCB has been closed. The delay and text parameters are not used here.

- “70 - Alarms acknowledge” (IF_70). When this input becomes active, MC100 executes the same anomalies acknowledge operations as if you pressed the “ACK” pushbutton. The horn is silenced and no anomalies on display page S.02 are still flashing. The warnings that are not even active will be automatically removed. The delay and text parameters are not used here.

- “71 - Alarms reset” (IF_71). When this input becomes active, MC100 executes the same anomalies reset operations as if you switch to OFF_RESET mode. The delay and text parameters are not used here.

- “72 - Emergency stop” (IF_72). This input is used to signal to the control an EMERGENCY STOP. An alarm is issued. SAFETY EMERGENCY STOP CAN’T BE CARRIED OUT BY THE CONTROLLER: be sure that external electromechanical or mechanical parts fulfill the safety requirements. The text parameter is not used here.

- “73 - Warning” (IF_73). If the input is active for the configured delay, a warning is issued: the message shown is the one set by means the related “text” parameter.

- “74 - Unload” (IF_74). If the input is active for the configured delay, an unload is issued: the message shown is the one set by means the related “text” parameter.

- “75 - Alarm” (IF_75). If the input is active for the configured delay, an alarm is issued: the message shown is the one set by means the related “text” parameter.

- “80 - Auxiliary current protection disable” (IF_80). ***This function is reserved for future. Do not use it.***

- “81 - Protections override” (IF_81). ***This function is reserved for future. Do not use it.***

- “82 - Production line open” (IF_82). If this input is active, MC100 activates an alarm and forces generators to open their MGCB circuit breakers. The delay and text parameters are not used here. This function is used in parallel to mains applications where some circuit breaker besides MCB and MGCB: if one of these is opened, the generators must be disconnected from the loads.

4.5 Digital output configuration

MC100 controller has eighteen digital outputs (relays) fully configurable, available on connectors JG, JI, JT, JS, JR and JH. Please see par 2.7 for the list of the available outputs and their connections.

As default, all the relays pick-up when the associated function is active. It is possible to invert the function mode in order to let relays work until the function becomes active, then drop. This can be done by means parameters P.1600 (connectors JI, JH e JG) e P.1640 (connectors JT, JS e JR). These parameters has one bit for associated to each configurable output.

- Bit set to zero means that the output is normally at rest, it pick-ups when the associated function is active
- Bit set to one means that the output is normally working; it drops whenever the associated function is active.

As default parameter is set to 0 (all bits to 0).

To each output are associated 4 parameters.

- A parameter that allows selecting an output function among a list of predefined functions.
- Three parameters that define the OR logic among controller statuses to associate to the output, alternative to the predefined output functions (Output Mapping).

The following table lists the associations between outputs and parameters.

Output	Terminal	Function	Mapping 1	Mapping 2	Mapping 3
1	JI-1	P.1601	P.1602	P.1603	P.1604
2	JI-2	P.1605	P.1606	P.1607	P.1608
3	JI-3	P.1609	P.1610	P.1611	P.1612
4	JI-4	P.1613	P.1614	P.1615	P.1616
5	JT-1	P.1641	P.1642	P.1643	P.1644
6	JT-2	P.1645	P.1646	P.1647	P.1648
7	JT-3	P.1649	P.1650	P.1651	P.1652
8	JT-4	P.1653	P.1654	P.1655	P.1656
9	JT-5	P.1657	P.1658	P.1659	P.1660
10	JS-1_2	P.1661	P.1662	P.1663	P.1664
11	JS-3_4	P.1665	P.1666	P.1667	P.1668
12	JS-5_6	P.1669	P.1670	P.1671	P.1672
13	JR-1_3	P.1673	P.1674	P.1675	P.1676
14	JR-3_6	P.1677	P.1678	P.1679	P.1680
15	JH-1	P.1617	P.1618	P.1619	P.1620
16	JH-3	P.1621	P.1622	P.1623	P.1624
MCB	JH-3	P.1625	P.1626	P.1627	P.1628
MGCB	JH-3	P.1629	P.1630	P.1631	P.1632

4.5.1 Digital output functions

The available functions are the following. Note: the following description refers to “logical” status of digital outputs, not “physical” status (see previous paragraph).

- “0 - Not used”
- “10 - MCB minimum voltage coil (reverse command)” (OF_10). This output is activated to open the circuit breaker. So a normally closed contact must be used to command the minimum voltage coil of the circuit breaker: in this way, if MC100 is switched off, the circuit breaker will not be opened. Once the circuit breaker is opened, this output switches off (pulse). MC100 grants a minimum 0.5 seconds delay between this output and circuit breaker closure commands.
- “11 - MCB open coil” (OF_11). This output is activated to open the circuit breaker. Once the circuit breaker is opened, this output switches off (pulse).
- “12 - MCB close coil” (OF_12). This output is activated to close the circuit breaker. Once the circuit breaker is closed, this output switches off (pulse).
- “13 - MCB static close command (reverse command)” (OF_13). This output is deactivated to close the circuit breaker. So a normally closed contact must be used to command circuit breaker closure: in this way, if MC100 is switched off, the circuit breaker will be closed. Hints: use an output that has an N.C contact.
- “14 - Ready to close MCB” (OF_14). This output is activated **before** closing the circuit breaker only if one digital input is configured as “MCB closure acknowledge” (IF_14): it is deactivated (and so the circuit breaker will be closed) when that input is active or after the delay configured for the input. Please see the input function 14 on digital input description.
- “15 - Ready to open MCB” (OF_15). This output is activated **before** opening the circuit breaker only if one digital input is configured as “MCB opening acknowledge” (IF_15): it is deactivated (and so the circuit breaker will be opened) when that input is active or after the delay configured for the input. Please see the input function 15 on digital input description.
- “20 - MGCB minimum voltage coil” (OF_20). This output is deactivated to open the circuit breaker. Once the circuit breaker is opened, this output switches on (pulse). MC100 grants a minimum 0.5 seconds delay between this output and circuit breaker closure commands.
- “21 - MGCB open coil” (OF_21). This output is activated to open the circuit breaker. Once the circuit breaker is opened, this output switches off (pulse).
- “22 - MGCB close coil” (OF_22). This output is activated to close the circuit breaker. Once the circuit breaker is closed, this output switches off (pulse).
- “23 - MGCB static close command”. This output is activated to close the circuit breaker.
- “24 - Ready to close MGCB” (OF_23). This output is activated **before** closing the circuit breaker only if one digital input is configured as “MGCB closure acknowledge” (IF_24): it is deactivated (and so the circuit breaker will be closed) when that input is active or after the delay configured for the input. Please see the input function 24 on digital input description.
- “25 - Ready to open MGCB” (OF_24). This output is activated **before** opening the circuit breaker only if one digital input is configured as “MGCB opening acknowledge” (IF_25): it is deactivated (and so the circuit breaker will be opened) when that input is active or after the delay configured for the input. Please see the input function 25 on digital input description.
- “30 - MCB synchronization in progress” (OF_30). This output is active during the synchronization on MCB. It can be used to enable/supply an external synchronizer.

- “31 - MGCB synchronization in progress” (OF_31). This output is active during the synchronization on MGCB. It can be used to enable/supply an external synchronizer.
- “32 - Synchronized” (OF_32). This output is active during synchronization only, when voltages, frequencies and phases differences between mains and generators are inside the configure windows, with the same rotation sense. It can be used when one of the circuit breakers is managed externally, but is useful to use the synchro-check function of MC100.
- “33 - Mains present” (OF_33). This output is managed by the “mains sensor” management (checked with the thresholds set by menu 3.6.1). The output is activated if mains is “in tolerance” for the configured time.
- “34 - Mains present (from both internal/external loss of mains protection)” (OF_34). This output is managed by the “loss of mains” protection for parallel to mains operations. The function works also if no parallel to mains operations are in progress, so the output always represents the mains status (checked with the thresholds set by menu 3.6.0).
- “35 - Generators live” (OF_35). The output is active when MC100 detects voltages on the generators bus by its sensor (JE).
- “36 - Load live” (OF_36). The output is active when MC100 detects voltages on the loads. This status can be acquired by a digital input (see input function 30 on digital input description - IF_30) or calculated from mains voltages, generators voltages and circuit breakers statuses.
- “37 - Start required” (OF_37). This output is active when MC100 needs to start generators.
- “38 - Ready to supply” (OF_38). This output is active when loads can be connected to generators.
- “40 - External horn” (OF_40). This output function allows to connect an external horn (or a lamp) that will be driven in parallel to the internal horn.
- “41 - Alarms reset command” (OF_41). When the controller start a reset cycle (usually changing the operator mode to OFF_RESET), the output is activated for one second. It allows, for example, resetting external devices.
- “50 - Load-shedding 1” (OF_50). 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.
- “51 - Load-shedding 2” (OF_51). 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.
- “52 - Load-shedding 3” (OF_52). 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.
- “53 - Load-shedding 4” (OF_53). 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.
- “60 - Bit-mapped” (OF_60). Setting the output with this function, allows to define an OR function of one or more status among a maximum of 192 status. See beginning of the paragraph.

- “61 - Device fault” (OF_61). It is possible to configure with this function only the outputs from 5 to 14. The output is always activated: it is not activated only for an internal fault of the controller. It can be used to signal the fault of the controller. See 9.11.

4.6 Analogue input configuration

MC100 controller has six analogue inputs fully configurable, available on connectors JW and JM. Please see par 2.8 for the list of the available analogue inputs and their connections.

To each input are associated three parameters.

- A parameter that allows selecting an input function among a list of predefined functions.
- Two parameters to select a minimum and a maximum voltage for the input.

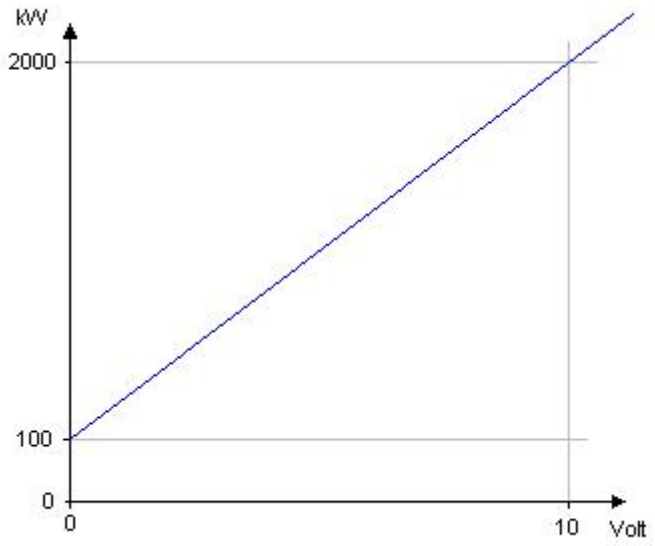
The following table shows the relations between analogue inputs and parameters:

Input	Terminal	Function	Minimum voltage	Maximum voltage
1	JW-1_2	P.1841	P.1842	P.1843
2	JW-3_4	P.1851	P.1852	P.1853
3	JM_1	P.1801	P.1802	P.1803
4	JM_2	P.1811	P.1812	P.1813
5	JM_3	P.1821	P.1822	P.1823
6	JM_4	P.1831	P.1832	P.1833

All possible functions that can be configured for analogue inputs provide two additional parameters to allow conversion of acquired voltage to the desired measure. For example, suppose to have a 0-10V signal to be used as active power set point: at 0V setpoint must be 100 kW, at 10V must be 2000 kW.

- P.1841 = 30
- P.1842 = 0.0%
- P.1843 = 100.0%
- P.3521 = 100
- P.3522 = 2000

MC100 will continuously convert the acquired voltage in a kW value according to the following relation:



4.6.1 Analogue input functions

The available functions are the following. The table shows the conversion parameter for each predefined function.

Function	Conversion parameter	Conversion parameter	Unit
10 - External synchronizer	P.3315	P.3316	%
11 - External MCB synchronizer	P.3315	P.3316	%
12 - External MGCB synchronizer	P.3315	P.3316	%
20 - Speed reference	P.3202	P.3203	%
21 - Voltage reference	P.3102	P.3103	%
30 - Power reference	P.3521	P.3522	kW
31 - Power Factor reference	P.3401	P.3402	-
32 - Import/export reference	P.3531	P.3532	kW
40 - Power on mains	P.3534	P.3535	kW

- “0 - Not used”.
- “10 - External MCB synchronizer” (AIF_10). Used to acquire an external synchronizer signal for closing the MCB circuit breaker only.
- “11- External MGCB synchronizer” (AIF_11). Used to acquire an external synchronizer signal for closing the MGCB circuit breaker only.
- “12- External synchronizer” (AIF_12). Used to acquire an external synchronizer signal for closing the MCB or MGCB circuit breaker.
- “20 - Speed reference” (AIF_20). Used only during manual synchronization to acquire a potentiometer for manual speed regulation of generators.
- “21 - Voltage reference” (AIF_21). Used only during manual synchronization to acquire a potentiometer for manual voltage regulation of generators.
- “30 - Power reference” (AIF_30). Used to acquire external active power set point, for BASE LOAD function in parallel with mains applications. Typically it acquires a potentiometer.
- “31 - Power Factor reference” (AIF_31). Used to acquire external power factor set point, in parallel with mains applications. Typically it acquires a potentiometer.

- “32 - Import/export reference” (AIF_32). Used to acquire external active power set point, for IMPORT/EXPORT function in parallel with mains applications. This set point is not the power that generators should supply: it is the power that should be measured on the mains. Typically it acquires a potentiometer.
- “40 – Power on mains” (AIF_40). Used to acquire the active power measure on the mains from an external instrument. If the CTs of MC100 are connected on the mains, this measure is available directly by MC100 and so this external signal is not used.

5. Event logs

During his working the board effects some periodical or on-event recordings; they are partially configurable with programming parameters. The board manages four types of archive:

- **Events**: when an event (previously configured) occurs, the board adds a record in this archive. The full capacity is of 100 records. If the archive is full and a new event occurs, the less recent is overwritten (so there are always the last 100 events). For each event, the following data are recorded:
    - A numerical code that identifies it.
    - The date/time when the event occurred.
    - The operating mode of the device.
    - The mains status and the generators bus status.
    - MCB and MGCB commands and statuses.
    - All digital inputs statuses.
    - Current active anomalies (if more than 4, the last 4).

  If the event is an anomaly, some analogue measurements are recorded too, linked to the event. The setting of what event must be recorded is possible by means of P.4101 parameter. For possible settings, see [1]. It is possible to record changes of:
    - The operating mode of the device.
    - MCB and MGCB commands.
    - MCB and MGCB statuses.
    - Mains status.
    - Generators bar status.
    - Activation of “loss of mains” protections.
    - Start inhibitions.
    - Load inhibitions.
    - Load functions.
    - Load shedding.

The following table lists all possible event codes.

Code	Version	Description
1000	1.02	Reset.
1001	1.00	New power on.
1002	1.00	Parameters default value has been reloaded.
1003	1.00	Clock not valid (but needed for some function).
1004	1.00	Date/time modified.
1011	1.00	OFF_RESET
1012	1.00	MAN
1013	1.00	AUTO
1014	1.00	TEST
1015	1.00	REMOTE START
1021	1.00	MGCB closure command.
1022	1.00	MGCB opening command.
1023	1.00	MGCB closed.
1024	1.00	MGCB opened.
1031	1.00	MCB closure command.
1032	1.00	MCB opening command.
1033	1.00	MCB closed.
1034	1.00	MCB open.
1041	1.00	Mains absent.
1042	1.00	Mains out of thresholds.
1043	1.00	Mains present (in thresholds).
1051	1.00	Generators bus absent.
1053	1.00	Generators bus present.
1061	1.00	Loss of mains: minimum voltage.
1062	1.00	Loss of mains: maximum voltage.
1063	1.00	Loss of mains: minimum frequency.
1064	1.00	Loss of mains: maximum frequency.
1065	1.00	PPR: DF/DT (Rate Of Change Of Frequency).
1066	1.00	PPR: Vector Jump.
1071	1.00	Start inhibition activated.
1072	1.00	Start inhibition deactivated.

1073	1.00	Load inhibition activated.
1074	1.00	Load inhibition deactivated.
1081	1.00	Load function: new MASTER.
1082	1.00	Load shedding: load 1 disconnected.
1083	1.00	Load shedding: load 1 connected.
1084	1.00	Load shedding: load 2 disconnected.
1085	1.00	Load shedding: load 2 connected.
1086	1.00	Load shedding: load 3 disconnected.
1087	1.00	Load shedding: load 3 connected.
1088	1.00	Load shedding: load 4 disconnected.
1089	1.00	Load shedding: load 4 connected.
1101	1.00	Manual start command.
1102	1.00	Automatic start command.
1103	1.00	Start command due to MCB not closed.
1104	1.00	TEST mode requested by pushbutton.
1105	1.00	TEST mode requested by digital input.
1106	1.00	TEST mode requested by clock/calendar.
1107	1.00	TEST mode requested by serial port (JA).
1108	1.00	TEST mode requested by serial port (JZ).
1109	1.00	TEST mode requested by SMS.
1110	1.00	REMOTE START mode requested by digital input.
1111	1.00	REMOTE START mode requested by serial port (JA).
1112	1.00	REMOTE START mode requested by serial port (JZ).
1113	1.00	REMOTE START mode requested by SMS.
1121	1.00	Stop command for OFF_RESET.
1122	1.00	Manual stop command by pushbutton.
1123	1.00	Manual stop command by serial port (JA).
1124	1.00	Manual stop command by serial port (JZ).
1125	1.00	Manual stop command by SMS.
1126	1.00	Automatic stop command for alarms.
1127	1.00	Automatic stop command for any MGCB not opened.
1128	1.00	Automatic stop command for mains absent.
1129	1.00	Automatic stop command.

All the anomalies are recorded using the own failure code, summed with:

- 2000: for warnings.
- 3000: for unloads.
- 5000: for alarms.

- **Fast trend:** with a configurable frequency by means of parameter P.4102 (time step increment in seconds), the board records the following analogue measurements:
  - Mains phase-to-phase voltages and frequency.
  - Generators bus phase-to-phase voltages and frequency.
  - Currents (auxiliary current also).
  - Active, reactive and apparent powers and the power factor.
  - Power supply voltage of MC100.
  - Six analogue inputs voltages.
  - Nominal power of all generators with MGCB closed (sum).
  - Active power of all generators with MGCB closed (sum).
  - Reactive power of all generators with MGCB closed (sum).

  Each record has date/time associated. This archive has a capacity of 30 records that, with the predefined time step increment (60 seconds) covers a period of half an hour. Each subsequent recording overwrites the oldest one.

- **Slow trend**: with a time step increment configurable by means of P.4103 (minutes) the board records the same measurements seen at previous point. Each record has associated its date/time. This archive has a capacity of 48 recordings that, with the predefined time step increment (30 minutes) covers a period of one day. Each subsequent recording overwrites the oldest one.

- **Peaks**: the board effects a series of recordings of the maximum and minimum peaks for some significant measurements:
  - Board temperature: the maximum and minimum peaks of the internal temperature are recorded with its time/date
  - Total active power: it is recorded the maximum peak, with its associated date/time.
  - Currents: for each phase it is recorded the maximum current value, with its date/hour and with the power factor for that phase (not for auxiliary current).

5.1 Entering the archives

These archives can be accessed in any function mode and status of the controller. In order to select the function, use the buttons ▲ and ▼ under the display in order to show the HISTORY ARCHIVE (H.01) base page. REMARKS: if inside a function that doesn't allow changing the display mode, press EXIT pushbutton one or more time in order to leave the function (for example if inside PROGRAMMING).

Once the page H.01 is shown, press ENTER in order to activate the mode, page H.03 will be shown, containing a menu for all the archives type.

5.2 Exit from archives visualization

There are two ways to exit from archive visualization:

- Press the EXIT pushbutton n times to come back until page H.01
- Changing the operation 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.

5.3 Archive selection

Second row shows always the numerical indication of the selected entry and the number of available entries in the menu. Subsequent rows are used to show the list of available archive types. Selected entry is shown in reverse. Using the pushbuttons ▲ and ▼, it is possible to scroll the menu in cyclic mode (once reached the last or the first one, the scroll continues with the first or the last one).

Then, pressing ENTER the archive is accessed; from this page, press EXIT to go back to page H.01.

Note: a “lock” icon is shown on the second row if recording to history logs is currently disabled (for example in OFF_RESET mode).

5.4 Events page

Second row identifies which event in the whole list of records is shown. REMARK: the most recent one has the higher identify number. Using the ▲ and ▼ pushbuttons it is possible to scan all the event records.

Each event is shown by means at least three pages; if the event is one of the last 16 ones, they are shown by means eight pages. It is possible to scroll among the pages by means the ◄► pushbuttons.

Fourth row of all event pages shows recording date and time. On the right, left and right arrows (or only one of them) are shown to indicate that other pages can be accessed for this record.

Other rows show information depending on the shown page:

- On the first page, it is shown a numeric code of the event and its description.
- On the second page, it is shown the function mode of the controller in addition to the mains and generators bus statuses.
- On the third page, MGCB and MCB statuses are shown.
- For page 4, 5, 6, 7 and 8, please refer to next paragraph.

5.5 Pages for fast/slow analogue records

Second row shows which record is displayed respect to the total number of records. REMARK: the most recent one has the higher identify number. Using the ▲ and ▼ pushbuttons it is possible to scan all the records.

Fourth row of all pages shows recording date and time. On the right, left and right arrows (or only one of them) are shown to indicate that other pages can be accessed for this record.

Other rows show information depending on the shown page:

- On the first page, phase to phase voltages and frequency related to the mains are shown.
- On the second page, phase to phase voltages and frequency related to the generators bus are shown.
- On the third page are shown measures related to current, powers (kW, kvar and KVA), and the power factor and load type.
- On the fourth page the power supply voltage and the fourth current measure are shown.
- The fifth page shows total powers (kW and kvar) supplied by generators.

5.6 Peak pages

Second row shows which record is displayed respect to the total number of records. The available records are 6. Only one page is used to show the records, thus use the ▲ and ▼ pushbuttons to scan the records.

Fourth row shows a description of the peak record shown:

- Maximum power
- Maximum current (L1)
- Maximum current (L2)
- Maximum current (L3)
- Minimum board temperature
- Maximum board temperature

On the sixth row date and time of record are shown. On the seventh row it is shown the recorded measure (power, current etc.). On the eighth row can be shown a meaningful reference measure:

- Together the maximum currents, are recorded the power factor values.

6. Special procedures

Besides to the normal working sequence, MC100 includes special procedures which must to be activated in a particular way. Some of them are reserved to S.I.C.E.S. s.r.l. and then are not described in this document. Some other instead can be used also by the installer or by the end user.

While these special procedures are in execution, the normal working sequence is not executed and the gensets are not available. It is then appropriate executing these special procedures in phase of plant installing or start up. If these procedures have to be executed in a second time, be sure to supply the loads from another source before starting.

Here the list of special procedures implemented by MC100. The ones in italics and underlined are reserved to S.I.C.E.S. s.r.l.

- *"RESERVED"*
- *"TEST": board self test*
- *"CALIBRAT.": measurements inputs calibration.*
- **"LANGUAGE": language selection**

The required operations to activate the special procedures are common for all, and are described forward. REMARK: all special operations are protected with password. In this document, the passwords are disclosed only for the procedures available to the operator. It is not possible to modify these passwords: avoid then to disclose them to operators not interested to special operations.

Before activate one of the special procedure, be sure that the generators can't be started.

6.1 Special procedure activation

During this phase all the outputs are deactivated and load is transferred to the mains.

It is required to follow these steps:

1) Disconnect the supply from the board (remove JB connector or open the fuse in the panel).
2) Now supply the board, keeping pressed together the START and STOP pushbuttons. In this phase, the multifunctional display shows question marks. The two pushbuttons must be kept pressed until the question marks disappear. Note: if the pushbuttons are released too soon, the board will start to work with its normal working sequence.
3) On third row appears enclosed between square brackets the name of a special procedure. Release the START and STOP pushbuttons and press ENTER: the square brackets start to flash.
4) Select the request procedure using ▲ and ▼ pushbuttons (until its name appears into the brackets). Then confirm with ENTER pushbutton. The square brackets stop to flash.
5) In the fifth row, it is now necessary to set a password. This password is different for each special procedure (see next paragraphs). Press ENTER to start the password setting (brackets start to flash).
6) Use the ▲ and ▼ pushbuttons to increase or decrease the number into the squares (Note: pressing the SHIFT pushbutton together to ▲ or ▼ makes the numbers increase or decrease faster).
7) When into the brackets there is the desired number, confirm it by pressing ENTER pushbutton. If the password is correct the selected special procedure starts (described later on), otherwise the board shows an error message and automatically comes back to step 1.

Note: it is possible to abort this procedure in every moment, by removing the supply from the board. In each case, at the special procedure end, it is necessary to remove and provide again the supply to the board to come back to the normal working sequence.

6.2 “LANGUAGE”: language selection

MC100 allows selecting the language to use for any text of the multifunctional display. Default language is English. To select the desired language, follow at first the procedure described in 6.1, using **“1”** as password. The board records the selected language in a non-volatile memory. Normally, then, this procedure has to be executed only one time. At the end of the procedure described in 6.1, the display shows the currently selected language enclosed in square brackets. To modify the language:

1) Press ENTER pushbutton. Square brackets start to flash.
2) Select the desired language (in the square brackets) using ▲ and ▼ pushbuttons. Note: the text in the first three rows adapts itself to the selected language.
3) Confirm with ENTER pushbutton: brackets stop flashing.

Now it is possible to remove and restore the supply to the board and work with new language.

7. Working sequences

7.1 Board modes

MC100 operating modes are five:

- OFF_RESET: gensets are not working (or they are stopping), anomalies are all reset and it is possible to enter to the programming to modify parameters. MGCB and MCB are at rest allowing load connection to the mains (for some kind of plants not both breakers are present).
- MAN: gensets starting and load connection to the generators are made by operator (the board does not manage them automatically). The gensets stopping and the load connection to the mains are normally made by the operator; since protections are active, the board may in all cases connect the load to mains if the generators are not in tolerance and in the same way can stop the generators if an anomaly requiring it occurs. It is allowed to access programming but only few parameters can be changed.
- AUTO: the gensets starting and stopping and the load changeover are managed by the board (the operator cannot intervene). All the protections are enabled. It is allowed to access programming but only few parameters can be changed.
- TEST: this working mode is almost identical to AUTO mode. It differs by the fact that the generators are in all the cases started (automatically) also with mains present. By parameter P.4301, it is possible to choose if the board has or has not to connect the load to generators. The board will pass automatically from TEST to AUTO if the conditions for an automatic gensets intervention are verified. It is allowed to access programming but only few parameters can be changed.
- REMOTE START: this working mode is almost identical to AUTO. It differs by the fact that the generators are in every case (automatically) started also with mains and inhibits input presence, and the load is then connected to gensets. This mode has priority to TEST mode (it can interrupt TEST or substitute itself to the periodical test) and also to AUTO mode. The operator cannot changeover the load manually. It is allowed to access programming but only few parameters can be changed.

First three modes can be selected by using the UP/DOWN pushbuttons on the front panel. Alternatively, it is possible to use three digital inputs of the controller configured with the following functions:

- 46 “Remote OFF” (IF_46).
- 47 “Remote MAN” (IF_47).
- 48 “Remote AUTO” (IF_48).

When one of these inputs is active, the operating mode is forced, and it is no more possible to use the pushbuttons to change it (the first row of the display shows a “key” symbol to warn the operator about this situation). When no one of these inputs is active, it is again possible to use the pushbuttons to change the operating mode. If more than one input is active at the same time, the input configured to force the OFF-RESET mode has high priority, followed by the one which forces the MAN mode and last by the input which forces the AUTO mode. It is also possible to use only one or two inputs. For example, It’s possible to use only one input to force the AUTO mode: when the input is active, the controller is forced in AUTO mode, when the input is not active the controller remains in AUTO, but the pushbuttons can be used to select a different mode. **If it is used only one input to force the OFF-RESET mode, the controller acts in a different way: when the input is active the controller is forced in OFF-RESET, when the input become not active the operating mode goes back to the mode active before the input activation.**

In order to activate the TEST mode, the operating mode must be in advance set to AUTO. If in test mode, the AUTO/TEST indicator flashes at a duty of 50%. If no start requests are pending, it is possible to activate the TEST mode in one of the following ways:

- Pressing the START pushbutton. The mode change is immediate. To return to AUTO mode, press again the START pushbutton.
- Set properly parameters P.4302, P.4303 and P.4304 (periodical test). They permit to program weekly time slots during which the generators has to run in TEST mode (to maintain them efficient). In this case, the passage to TEST is automatic in the scheduled days and hour. The board comes back to AUTO mode at the end of the configured TEST time interval.
- Through an adequate SMS command message (see the document describing the use of RS232 port). To utilize this possibility it is necessary that parameter P.4304 is different from zero (it is the TEST duration). In this case the board enters TEST mode as soon as received the SMS message and comes back to AUTO mode after the time P.4304
- By means of a command from a PC connected to one of the serial ports. The board passes to TEST as soon as received the command, comes back when receive the opposite command or when it consider lost the serial connection (60 seconds without messages).
- Activating a digital input configured with the “remote test command” function (input function code 45 – IF45). Controller switch from AUTO to TEST activating this input and switch back to AUTO deactivating it.

To active the REMOTE START mode, the board must be in AUTO or in TEST mode. If a digital input is configure as “remote start enable” (input function code 43 – IF_43), this input must be active in order to allow entering REMOTE START mode. If in REMOTE START mode, the AUTO/TEST indicator flashes at a duty of 90%. This mode can be activated in one of the following modes:

- By means a digital input configured with the “remote start command” function (input function code 42 – IF42). If input is active, the REMOTE START mode is entered and it is leaved deactivating the input.
- By means a SMS. In this case, the controller switch to REMOTE START as soon it receives the message, and switch back to AUTO receiving a message with the opposite command.
- By means command sent from a remote PC connected to one of the serial ports. It switches to REMOTE START upon reception of the command and switch back to AUTO after receiving the opposite command (**it remains in REMOTE START in case of communication failure**).

7.2 Plant types

This paragraph describes all the plant types managed by MC100, selectable by parameter P.3001.

- MPM (Multiple Prime Mover). In this plant, mains and MCB circuit breaker don’t exist. MGCB circuit breaker is optional. Generators can supply in “island mode” only. MC100 doesn’t start generators only if some “start inhibition” is present.
- MSB (Multiple Stand By). It is an emergency plant, without synchronizations on circuit breakers. Mains and MCB circuit breaker always exist, MGCB circuit breaker is optional. MC100 starts the generators and connects loads to them when the mains is missing. When mains becomes present again, loads are connected to mains and generators are stopped.
- MSB+MSTP (Multiple Stand By + Multiple Short Time Parallel). It’s an emergency plant like the previous one, but with the possibility of synchronizations (to avoid black-outs on the loads). Even if synchronization is available, normally it is not possible to stay in parallel with mains for more than one second.
- MPTM (Multiple Parallel To Mains). This plant allows only supplying in parallel to mains. The mains and the MCB circuit breaker always exist, MGCB circuit breaker is optional. Generators are started only if mains is present (if no “start inhibition” is activated). If mains misses during the parallel, generators are disconnected from mains and loads by opening MGCB (or GCB if MGCB is not present): generators stay running for the time configured with parameter P.3810 (waiting for mains coming back), then they are stopped. Normally, MGCB is used as “interface device” (see 7.3.2.11). When possible, synchronization is used to close the circuit breakers.
- MPTM+MSB (Multiple Parallel To Mains + Multiple Stand By). This plant allows both “parallel to mains” and “island mode” supplying. Generators are always started (if no “start inhibition” is present). Normally, synchronization is used to close the circuit breakers (if not configured in a different way). Normally, MGCB is used as “interface device” (see 7.3.2.11).

7.3 Mains

MC100 acquires mains voltages and frequency, for three main purposes:

- “AMF”. MC100 must detect all anomalies about the mains in order to start the generators and make them supply the loads. In the same way, MC100 detects when mains voltages and frequency are back to their operating values to connect loads to mains and stop the generators.
- “Loss of mains protection”. MC100 must detect the “loss of mains” **while** generators are in parallel with mains, in order to disconnect them from the mains

(generator can in this case supply loads or not depending on plant configuration). In the same way, when generators are disconnected from the mains, MC100 detects when mains voltages and frequency are back to their operating values in order to put generators in parallel with mains again.

- For synchronization purpose. See description of this function in its dedicated paragraph.

MC100 uses three different sets of parameters for these purposes.

For connection to MC100, please refer to par 2.1.

7.3.1 AMF

These parameters have an influence on mains management, for starting/stopping gensets in case on anomalies on mains. They are accessible by menu 1.0, 1.2 and 3.6.1.

- P.1001: nominal frequency. All frequency-related thresholds are expressed in percentage respect to this parameter.
- P.1201: set it to 3 if mains is three-phases and 1 if single-phase.
- P.1202: 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. All voltages-related thresholds are expressed in percentage respect this parameter.
- P.1203: if VTs (voltage transformers) are used, this is their primary voltage value (in volts).
- P.1204: if VTs (voltage transformers) are used, this is their secondary voltage value (in volts).
- P.3621: internal/external mains sensor selection.
- P.3622: minimum mains voltages threshold (percentage respect to P.1202); under this value mains is considered absent.
- P.3623: hysteresis applied to all the thresholds related to mains voltages and frequency (percentage).
- P.3624: low mains voltages threshold (percentage respect to P.1202); under this value mains is considered anomalous.
- P.3625: high mains voltages threshold (percentage respect to P.1202); over this value mains is considered anomalous.
- P.3626: low mains frequency threshold (percentage respect to P.1001); under this value mains is considered anomalous.
- P.3627: high mains frequency threshold (percentage respect to P.1001); over this value mains is considered anomalous.
- P.3628: voltages unbalance threshold (percentage respect to P.1202); over this value mains is considered anomalous. Used in three-phase systems only.
- P.3629: required phase sequence. If different from this setting, mains is considered anomalous. Used in three-phase system only. No delays are provided for this check.

7.3.1.1 Internal mains sensor

To use the MC100's internal mains sensor, P.3621 must be set to 0.

Let us see a practical example upon how thresholds work, with default values for the parameters we have seen.

- Voltages.

  Consider a three-phase system (P.1201 = 3) with 400 V nominal voltages (P.1202) and without VT (P.1203 and P.1204 = 0).

  Default thresholds are:

  1. P.3622 = 17.5% = 70 V (voltages presence threshold).
  2. P.3623 = 2.5% = 10 V (hysteresis).
  3. P.3624 = 80.0% = 320 V (low voltages threshold).
  4. P.3625 = 110.0% = 440 V (high voltages threshold).
  5. P.3628 = 10.0% = 40 V (voltages unbalance threshold).

  Considering these values we can detect the following bands:

0	V	
		Band A: **absent**
70	V	
		Band B: hysteresis
80 (70 + 10)	V	
		Band C: **low**
320	V	
		Band D: hysteresis
330 (320+10)	V	
		Band E: **in tolerance**
430 (440-10)	V	
		Band F: hysteresis
440	V	
		Band G: **high**
xxx	V	

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

  Such statuses are managed for each phase.

- Frequency.

  Consider a system with 50 Hz nominal frequency (P.1001).

  Default thresholds are:

  1. P.3623 = 2.5% = 1.25 Hz (hysteresis).
  2. P.3626 = 90.0% = 45 Hz (low frequency threshold).
  3. P.3627 = 110.0% = 55 Hz (high frequency threshold).

  Considering these values we can detect the following bands:

0	V	
		Band C: **low**
45	V	
		Band D: hysteresis
46.25 (45+1.25)	V	
		Band E: **in tolerance**
53.75 (55-1.25)	V	
		Band F: hysteresis
55	V	
		Band G: **high**
xxx	V	

If the frequency is in the D or F bands, board maintains its previous status (hysteresis). For example, if frequency was in E band and now is in D band, it is considered in any case “in tolerance”. If instead frequency was in C band and now is in D band, it is considered “low”.

In order to diagnose the mains “global” status, the following algorithms are utilized, shown in their computing order:

- If *frequency and all voltages* are in the “Absent” status, also global status is “Absent”.
- If *frequency and all voltages* are in the “In tolerance” status, also global status is “In tolerance”.
- If *frequency or at least one voltage* is in the “High” status, also global status is “High”.
- If no one of the previous conditions is verified, the global status is “Low”.

If previous tests say mains is “in tolerance”, the following test are also performed:

- Voltages unbalance. This control is performed only if parameter P.3628 is different from zero. If the difference between two phase-to-phase voltages is above this threshold (40 V in the example), the global status is “Low”, even if it is “In tolerance” from previous tests.
- Phase’s sequence. This control is performed only if parameter P.3629 is different from zero. If current phase’s sequence is different from the one configured with P.3629, the global status is “Low”, even if it is “in tolerance” from previous tests.

7.3.1.2 External mains sensor

To use an external mains sensor, P.3621 must be set to 1.

The external mains sensor must be connected to a digital input configured as “40 – external mains sensor” (IF_40). Mains is “in tolerance” when this input is “active” (logical state), is “Absent” when the input is “not active”.

7.3.1.3 Use of mains status for plant management

For automatic gensets management purpose, the mains behavior can be described in three steps:

- Steady out of tolerance: the mains global status was different from “In tolerance” consecutively for the time configured in P.3630 (if at least one generator is ready to supply a time of 2 second is used). In AUTO mode, MC100 provides to start generators and to transfer the loads to genset.
- Steady present: the mains global status was “In tolerance” consecutively for the time set by P.3631 (if not in AUTO mode, a time of 0.1 seconds is used). In

AUTO mode, the board provides to transfer the load to mains and to stop the generators.

- Transitory: between the passages from the previous two steps

Mains status is shown by means the signal lamp MAINS LIVE (see par 3.2).

7.3.1.4 Remote signals

Mains status can set/reset an output configured with function 33 (OF_33). Output will be set when mains is “in tolerance” for the configured delay.

7.3.2 “Loss of mains” protection

MC100 uses six different techniques to detect the “loss of mains” during parallel to mains operations, in order to disconnect generators from the mains. Next paragraphs describe these techniques, reporting for each the relevant parameters. Descriptions may refer to parameters P.1001, P.1201 e P.1202, already described in the previous paragraph.

7.3.2.1 Loss of mains detection from voltages

At the “loss of mains” time, voltages on generators can decrease or increase, depends on how loads change. The two following protections detect exactly these conditions. Parameter P.3603 is common to both protections: it is the hysteresis (percentage of P.1202) applied to all voltages-related thresholds.

If both protections are enabled, please check the following:

(P.3604 + P.3603) < (P.3606 - P.3603)

7.3.2.2 Low voltages (27)

This protection detects the “loss of mains” from a decrease of voltages. It is configured by the following parameters (menu 3.6.0):

- P.3604: low voltages threshold (percentage of a P.1202), under which mains is considered “fault”.
- P.3605: delay related with low voltages threshold.

This protection can be disabled by setting parameter P.3605 to zero.

If the protection is enabled, mains is “fault” if at least one voltage is below the P.3604 threshold continuously for the P.3605 delay. Mains is “in tolerance” if all voltages are above the P.3604 + P.3603 threshold (hysteresis), except it is detected “fault” by another protection.

7.3.2.3 High voltages (59)

This protection detects the “loss of mains” from an increase of voltages. It is configured by the following parameters (menu 3.6.0):

- P.3606: high voltages threshold (percentage of a P.1202), over which mains is considered “fault”.
- P.3607: delay related with high voltages threshold.

This protection can be disabled by setting parameter P.3607 to zero.

If the protection is enabled, mains is “fault” if at least one voltage is above the P.3606 threshold continuously for the P.3607 delay. Mains is “in tolerance” if all voltages are below the P.3606 - P.3603 threshold (hysteresis), except it is detected “fault” by another protection.

7.3.2.4 Loss of mains detection from frequency

At the “loss of mains” time, frequency on generators can decrease or increase, depends on how loads change. The two following protections detect exactly these conditions. Parameter P.3608 is common to both protections: it is the hysteresis (percentage of P.1001) applied to all frequency-related thresholds.

If both protections are enabled, please check the following:

(P.3609 + P.3608) < (P.3611 - P.3608)

7.3.2.5 Low frequency (81<)

This protection detects the “loss of mains” from a decrease of frequency. It is configured by the following parameters (menu 3.6.0):

- P.3609: low frequency threshold (percentage of a P.1001), under which mains is considered “fault”.
- P.3610: delay related with low frequency threshold.

This protection can be disabled by setting parameter P.3610 to zero.

If the protection is enabled, mains is “fault” if frequency is below the P.3609 threshold continuously for the P.3610 delay. Mains is “in tolerance” if frequency is above the P.3609 + P.3608 threshold (hysteresis), except it is detected “fault” by another protection.

7.3.2.6 High frequency (81>)

This protection detects the “loss of mains” from an increase of frequency. It is configured by the following parameters (menu 3.6.0):

- P.3611: high frequency threshold (percentage of a P.1001), over which mains is considered “fault”.
- P.3612: delay related with high frequency threshold.

This protection can be disabled by setting parameter P.3612 to zero.

If the protection is enabled, mains is “fault” if frequency is above the P.3611 threshold continuously for the P.3612 delay. Mains is “in tolerance” if frequency is below the P.3611 - P.3608 threshold (hysteresis), except it is detected “fault” by another protection.

7.3.2.7 Rate of change of frequency (ROCOF or 81R or DF/DT)

This protection detects the “loss of mains” from an increase or a decrease of frequency that must last in the time. In other words, a single change in frequency does not trip this protection; in order to trip it, the increase or decrease of frequency must stay over the threshold continuously for the configured time. It is configured by the following parameters (menu 3.6.0):

- P.3613: DF/DT mode. Allow selecting only increase of frequency, only decrease or both.
- P.3614: DF/DT thresholds. Allow setting a threshold (Hz/s) for the protection.

- P.3615: delay related with DF/DT threshold.

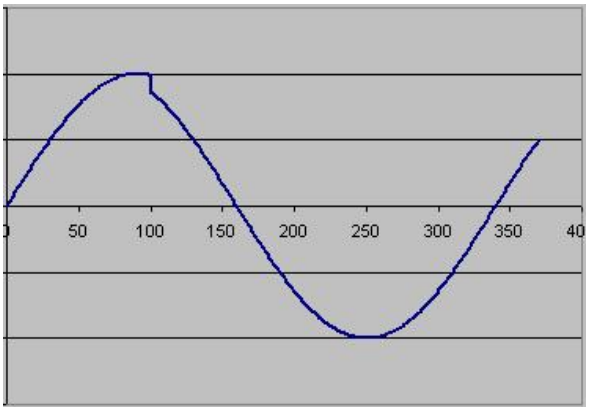
This protection can be disabled by setting parameter P.3615 to zero.

If the protection is enabled, mains is "fault" if MC100 detects a constant increase (or decrease) of frequency higher than P.3614 threshold, continuously for the P.3615 delay.

Note: when this protection trips, mains is disconnected from generators. No more voltages and frequency will be present on JF sensor, so no more change of frequency can be detected: it is necessary to enable at least the minimum voltage (27) or minimum frequency (81<) protections to be able to detect the "loss of mains" after generators have been disconnected from mains.

7.3.2.8 Vector jump (or Vector Shift)

This protection works on the effects that the "loss of mains" has on the generators voltages: exactly in the time of the "loss of mains" it is possible (for one period) to have a smaller or a greater voltage period.



We identify as "positive phase jump" the situation where the "loss of mains" corresponds to one longer period of generators voltages (so a "negative phase jump" corresponds to one smaller period, like in the previous example).

This protection is configured by the following parameters (menu 3.6.0):

- P.3616: vector jump mode. Allows enabling positive phase jumps, or negative phase jumps or both.
- P.3617: vector jump threshold. Allow setting the maximum allowed phase jump in normal conditions.

This protection can be disabled by setting parameter P.3617 to zero.

If the protection is enabled, mains is "fault" if MC100 detects a "phase jump" (in the configured direction) higher than the P.3617 threshold.

Note: this protection has no delays because phase jump happens once. For this reason it is necessary to enable at least the minimum voltage (27) or minimum frequency (81<) protections to be able to detect the "loss of mains" after generators have been disconnected from mains.

7.3.2.9 Timings

The following table shows the maximum trip time of each protection. The time has been measured from the “loss of mains” moment to when the configured relays of MC100 opened. (OF_34). The only time to be added is the opening time of the circuit breaker that disconnects generators from mains (called interface device)

Protection	Worst case (s)	Typical (s)
27	0.124	0.100
59	0.122	0.100
81<	0.105	0.070
81>	0.083	0.070
81R (DF/DT)	0.142	0.080
Vector jump	0.055	0.040

Note: these times are measured in the worst conditions (for example with changes in voltages and frequency a little bit out of thresholds). With higher changes in voltages and frequency, protections trip faster.

7.3.2.10 Use of external protections

In some cases, the “loss of mains” protection of MC100 could be not suitable. For example, for Italy market we need a “certified protections relay”. If you cannot use (or don’t want to use) MC100 to detect “loss of mains”, a digital input can be configured to acquire an external protection relay (code “40 – External mains sensor” - IF_40). In this case, mains is “present” when the input is active (logical status).

7.3.2.11 Actions related to “loss of mains”

When a “loss of mains” situation is detected (from mains sensor or external contact), this situation is maintained (independently from real mains status) for at least the P.3602 time. This allows, in all situations, to have commands for circuit breakers not shorter than this time.

In the automatic working sequence, the parallel to mains is allowed again after the P.3631 delay is elapsed with mains stably “present”. In manual mode no delay is managed: parallel to mains is allowed as soon as mains is present (after P.3602 time).

Normally only the outputs assigned to circuit breakers commands are used to manage the “loss of mains” situation. If needed, it is possible to configure one digital output to signal the “loss of mains” conditions: MC100 *deactivates* this output when the “loss of mains” situation is detected (so when mains is present the output is activated). This output must be configured with code “34” (OF_34).

When MC100 detects the “loss of mains”, generators must be disconnected from mains as soon as possible. Mains, in fact, could back in any moment, and it probably will not be synchronized to generators yet. In the plant configuration, two circuit breakers must be identified:

- The "**interface device**": it's the circuit breaker to be opened as soon as possible in case of "loss of mains", to disconnect generators from mains.
- The "**safety device**": if the "interface device" will not open in 0.5 seconds from the "loss of mains", this circuit breaker will be opened.

The "interface device" choice can be influenced by many factors:

- MCB circuit breaker should be used if generators have to work also for the "emergency service" (there are local loads to be supplied from generators when mains is absent).
- MGCB circuit breaker should be used when there are no local loads.
- As an alternative to MGCB (or when MGCB does not exist), generator's GCB breakers can be used.

The choice can be influenced also by practical problems. For example the best circuit breaker (for "interface device" actions) could be "not managed" directly by MC100: in this case, it would be better not to select it as "interface device". MC100 allows selecting the "interface device" by its parameter P.3601.

Note: it is possible (even if not suggested) to select as "interface device" a circuit breaker not managed by MC100 (but its status must be acquired by MC100); in this case MC100 will open only the "safety device" if the external circuit breaker will not open in 0.5 seconds from the "loss of mains".

Note: if you select GCB as "interface device", it is preferable to hard-wire the "loss of mains" information to all genset controllers. This information is normally transferred from MC100 to genset controller via can bus; in this case such communication introduces unnecessary delays, that it is better to avoid. Moreover, the hard-wiring protects also from communication malfunctions (broken wires for example).

Note: it also possible to select no circuit breaker as "interface device". In this case, the fast disconnection of generators from mains has to be done externally. The controller will continue detecting the "loss of mains" but only for managing the working sequence: for example, if a plant is configured to work only in parallel to mains, generators will be in any case disconnected from the mains (but in this case circuit breakers opening time could be longer).

The controller uses all available circuit breakers as "safety device". In some situation this may result in an unnecessary opening/closure of a circuit breaker, but this is an emergency situation, and controller gives priority to safety.

7.3.2.11.1 MCB as interface device

MCB *will not be opened* in case of "loss of mains", even if configured as "interface device", when:

- The MGCB circuit breaker exists and is opened.
- The MGCB circuit breaker does not exist, but no generators have GCB closed and no generators are "ready to load".

7.3.2.11.2 MGCB as interface device

MGCB *will not be opened* in case of "loss of mains", even if configured as "interface device", when:

- MCB circuit breaker is directly managed by MC100 and is actually opened.

7.3.2.11.3 GCB as interface device

GCB *will not be opened* in case of “loss of mains”, even if configured as “interface device”, when:

- MCB circuit breaker is actually opened.

7.4 Generator bus voltage detection

MC100 needs to know if there are voltages on generators bus in order to enable or not synchronization when it has to close a circuit breaker. The following terms are used:

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

MC100 normally uses its three-phase sensor (JE) to detect voltages on generators bus. For information about connection of the generator, please refer to par 2.2. The following parameters are used to configure the sensor:

- P.1001: nominal frequency.
- P.1101: set it to 3 if three-phases and 1 if single-phase.
- P.1102: 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. All voltages-related thresholds are expressed in percentage respect this parameter.
- P.1103: if VTs (voltage transformers) are used, this is their primary voltage value (in volts).
- P.1104: if VTs (voltage transformers) are used, this is their secondary voltage value (in volts).

No other parameters are used to configure this function: MC100 uses a fixed threshold (9% of nominal voltage) with a 2% hysteresis.

Generators bus is considered “dead” if all voltages (P.1101) are below the 9% threshold, it is “live” if at least one voltage is above 11% (9 + 2). 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 44 V.

If preferred it is possible to use one digital input (configured as “31 - No voltages on generators” – IF_31) to acquire this information. Generator bus is “live” if this input is “*not active*” logical state).

Note: if you configure a digital input with code “31” the internal sensor is no more used to detect voltages on generators bus.

MC100 can manage an output (configured as “35 - generators live” – OF_35) to signal the presence of voltages on generators: the output is activated when generators bus is “live”.

7.5 Load bus voltage detection

MC100 needs to know if there are voltages on loads bus in order to enable or not synchronization when it has to close a circuit breaker. The following terms are used:

- "Dead" bus: no voltages on loads bus.
- "Live" bus: voltages on loads bus.

MC100 is not able to directly detect voltages on the loads (except when MGCB is not used or always closed). It can detect voltages on the mains and on the generators bus, and, based on circuit breakers statuses, it can decide if loads are energized or not. If preferred (and for safety reasons also) it is possible to use one digital input (configured as "30 - No voltages on loads" – IF_30) to acquire this information. Loads bus is "live" if this input is "*not active*" (logical state).

MC100 can manage an output (configured as "36 - load live" – OF_36) to signal the presence of loads: the output is activated when loads are "live".

7.6 Synchronization

Synchronization is used when a circuit breaker has to 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 mains, in order to allow a safe closure of the circuit breaker.
- Voltages and frequency regulations, in order to minimize differences in voltages, frequency and phase.

MC100 can handle both functions, but, if needed, allows one or both to be managed externally.

7.6.1 Synchro-check

Before issuing the closure command for a circuit breaker, this function checks for differences in voltages, frequency, phase and phase sequences, between the opposite sides of the circuit breaker. If differences are inside configured thresholds, the circuit breaker can be safety closed, otherwise it cannot be closed.

MC100 performs these checks if:

- It directly manages frequency and phase regulations (see 7.6.2).
- Frequency and phase regulations are managed externally, but parameter P.3310 explicitly configures MC100 to manage synchro-check.

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

MC100 does not perform these checks if frequency and phase regulations are managed externally, and parameter P.3310 explicitly configures MC100 to not manage synchro-check. In this case, the circuit breaker closure command is immediately issued by MC100; an external synchro-check must be provided to inhibit the circuit breaker closure if not synchronized.

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

Parameter P.3310 allows forcing the use of the MC100's synchro-check with externally managed frequency and phase regulations (its value is ignored if MC100 manages regulation processes). It allows separate settings for MCB and MGCB synchronizations. As default, MC100 synchro-check is always to be used.

MC100 performs six different checks before allowing the circuit breaker closure: only when all checks are correct, the circuit breaker will be closed.

7.6.1.1 Voltages in tolerance

Voltages (both mains and generators ones) must be inside configured thresholds. For example, if we have 200 V on both mains 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.3306: minimum voltages threshold (%).
- P.3307: maximum voltages threshold (%).

These thresholds are percentage (of P.1202 for mains voltages, of P.1102 for generator voltages).

Each voltage measure (see P.1101 e P.1201) 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 B.02 by an empty rectangle – see 3.3.4.2).

7.6.1.2 Voltage differences

If all voltages are inside the configured thresholds, MC100 calculates the differences between generators and mains voltages (L1 of generators – L1 of mains and so on) and converts them as percentage of generator voltages. The circuit breaker can be closed only if all differences (%) are below the threshold configured by parameter P.3301 (with a fixed hysteresis of 1%).

The voltages status (the results of this check and of the previous one) is shown on the display page B.02, by the first small rectangle from the left (the one identified by the "V." label, see 3.3.4.2):

- Empty rectangle: voltages <u>or</u> voltage differences are out of thresholds.
- Full rectangle: voltages <u>and</u> voltage differences are inside thresholds.

MC100 can perform this check also when mains and generators have different nominal voltages: this happens when there are voltage transformers on the plant. In this case, MC100 remove the voltage transformer ratio from measures, in order to make them comparable.

If mains is single-phase and generators are three-phase (or vice-versa), the check is performed on phase L1 only.

7.6.1.3 Frequency in tolerance

Frequencies (both mains and generators ones) must be inside configured thresholds. For example, if we have 40 Hz on both mains 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.3308: minimum frequency threshold (%).
- P.3309: maximum frequency threshold (%).

These thresholds are percentage of P.1001.

Mains 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 B.02 by an empty rectangle – see 3.3.4.2).

7.6.1.4 Frequency difference

If both frequencies are inside the configured thresholds, MC100 calculates the differences between them. The circuit breaker can be closed only if the difference (Hz) is below the threshold configured by parameter P.3303 (with a fixed hysteresis of 0.1 Hz).

The frequency status (the results of this check and of the previous one) is shown on the display page B.02, by the second small rectangle from the left (the one identified by the "Hz" label, see 3.3.4.2):

- Empty rectangle: frequencies <u>or</u> frequency differences are out of thresholds.
- Full rectangle: frequencies <u>and</u> frequency differences are inside thresholds.

7.6.1.5 Phase difference

MC100 must evaluate the phase difference between mains and generators, and allow closing the circuit breaker only when this difference is below the threshold configured by parameter P.3302 (with a fixed hysteresis of 1 degree). P.3302 allows setting the maximum phase difference in degrees

The results of this check is shown on the display page B.02, by the third small rectangle from the left (the one identified by the "°" label, see 3.3.4.2):

- Empty rectangle: phase difference is out of thresholds.
- Full rectangle: phase difference is inside thresholds.

If voltage transformers are used, these transformers can introduce phase errors between their primary and secondary sides. So it is possible that synchronizing on their primary side, we have a phase error on the secondary side. Normally, circuit breaker is on the primary side of the transformers, while MC100 is connected on the secondary side. If MC100 regulates for 0° on secondary side, voltages on the circuit breaker may be not synchronized. Parameter P.3305 allows setting a fixed phase offset. If different from zero, MC100 regulates for x° on the secondary side, in order to have 0° on primary side. Parameter P.3305 has sign, allowing offset compensation in both directions.

7.6.1.6 Phases sequence

Only for three-phase plants, MC100 check for the same phases sequence on generators and mains. The circuit breaker can be closed only if the same phases sequence is detected. No parameters are provided for this check.

The results of this check is shown on the display page B.02, by the forth small rectangle from the left (the one identified by two arrows, see 3.3.4.2):

- Empty rectangle: different phase sequences.
- Full rectangle: same phase sequences.

7.6.1.7 Closure enable

MC100 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.3304. When the “synchronized” status is detected, the circuit breaker closure is enabled.

Once closure has been enabled, this condition lasts for at least 0.4 seconds, even if the “synchronized” status is no more present. In the same way, when MC100 disables the closure, it can’t be enable again for at least one second.

The “closure enable” condition is shown on the display page B.02, by the fifth small rectangle from the left (the one identified by two arrows, see 3.3.4.2):

- Empty rectangle: closure not allowed.
- Full rectangle: closure allowed.

Note: circuit breaker closure is enabled only when MC100 first detects a “not synchronized” status and then a “synchronized status”. This protects the plants from wiring errors. If MC100 directly manages frequency and phase regulations, it automatically forces generators to go in a “not synchronized” status first, and then in a “synchronized” status.

If MC100 directly manages the circuit breaker, the “closure enable” status results in the closure command for the circuit breaker. If the circuit breaker is externally managed, it is possible to configure a digital output to signal the “closure enable” status. This output will be activated *during synchronization only*, when MC100 activates the internal “closure enable” status. The output must be configured with the code “32 – Synchronized” (OF_32).

7.6.2 Voltages, frequency and phase regulations

To synchronize generators with mains, it is needed to work on:

- On generator voltages, to make them equal to mains: this avoids current circulation (reactive) when the circuit breaker will be closed. Normally generators voltages should be a little bit higher than mains voltages: in this case, when circuit breaker will be closed, reactive currents will be supplied by the generators and not imported.
- On generators frequency, to minimize differences on phase and frequency from mains.

MC100 can manage both voltage and frequency regulations on generators, by the can bus link. Thus, it is able to minimize differences in voltages, frequency and phase between mains and generators, to allow a safe closure of the circuit breaker.

It is not mandatory using MC100 for this function: if preferred (or if it is needed because, for example, mains voltages are not acquired by MC100), an external analogue synchronizer can be used (GAC or other).

7.6.2.1 Using external synchronizer

Analogue synchronizers act on generator frequency by a command signal. Each synchronizer has its own signal type. MC100 can handle only 0-10 Vdc signals. Some synchronizers have different 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 MC100.
- Up/Down. These synchronizers use two digital outputs to request an increase or a decrease of speed. Not managed by MC100.

Inside the 0-10 Vdc range, MC100 is fully configurable: for example MC100 can acquire a 3 to 6 Vdc signal and convert it to -4 to +4 Hz change on generators frequency. MC100 can be also configured to decrease generators frequency when the synchronizer signal increases (and vice-versa).

In order to use an external synchronizer, an analogue input of MC100 must be correctly configured. For example, suppose to use analogue input 1 for managing an external GAC synchronized (see paragraph 4.6 for parameters related to analogue inputs):

- P.1841 - “Analogue input 1 function”. This parameter allows selecting the analogue input function. For external synchronizers, three functions are available:
    - “10” (AIF_10) if external synchronizer has to be used for MCB synchronization only (MGCB synchronization is handled by MC100).
    - “11” (AIF_11) if external synchronizer has to be used for MGCB synchronization only (MCB synchronization is handled by MC100).
    - “12” (AIF_12) if external synchronizer has to be used for both MCB and MGCB synchronization.
- 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%.

Now we need to configure the conversion between the voltage acquired by the analogue input and the change of speed for generators. Frequency 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). GAC synchronizer decreases its command signal to speed-up generators. So:

- P.3315 - “Synchronization reference at minimum input voltage”. Setting this parameter to 100 % the generators frequency will be 4 Hz over the nominal frequency with 0V on GAC command (maximum speed required by GAC).
- P.3316 - “Synchronization reference at maximum input voltage”. Setting this parameter to 0 % the generators frequency will be 4 Hz less than the nominal frequency with 10V on GAC command (minimum speed required by GAC).

In the previous example, the GAC synchronizer is able to change generators frequency of +/- 4 Hz. With P.3315 = 75% e P.3316 = 25%, the maximum change of frequency should be +/- 2 Hz. By setting the two parameters in an asymmetric way, it is possible to compensate electrical offsets (GAC should give a 5 V signal to request the nominal frequency, it may be 5.1 or 4.9 Volts).

Note: actually no support is provided for external voltage regulator connected to MC100.

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 “11” and “12”. For each input is possible to setup minimum and maximum voltages, **but parameters used to convert voltages to % are common to both inputs, so external synchronizers must be of the same type.**

7.6.2.2 Using internal synchronizer

7.6.2.2.1 Phase regulation

MC100 regulates the generators frequency in order to minimize the phase difference between generators and mains. For regulation purpose only, no checks are done on frequency difference: when phase difference is stably minimized, also the frequency difference is zero.

A PI regulator is used to manage generator frequency. It works on phase difference, and can be configured with the following parameters:

- P.3311 - “Gain for phase control loop”.
- P.3312 - “Integrative factor for phase control loop”.

These parameters have to be adapted to get the best response from the system. They have the same functions of trimmers on analogue synchronizers.

First parameter configures the system response to instantaneous error: for a given error, the change in regulation command is directly proportional to this parameter. As higher is the parameter, as higher is the change in regulation command. If this parameter is set too high, generators frequency may become unstable (some oscillations on frequency may start and can result in alarms for over/under frequency on generator control devices).

The second parameter configures the system response to errors lasting in time: for a given error, the correction will continuously grow in the time until the error will begin to reduce. If this parameter is too high, the regulation can generate overshoots and ringing: if the system requires an increase, frequency may first become higher than needed, and then decrease to desired value (very slow changes).

Practical procedure to setup these parameters is:

- Start with very low values for both (for example 0.1).
- Progressively increase the first parameter (“P”) until the system become unstable: the correct value for this parameter is one/half of the value that starts the instability.
- Set “P” to half the maximum value found in the previous point, then increase “I” (the second parameter) until you get the best performances from the system (in this case the maximum precision and stability in phase regulation).

PI parameters can be changed even in AUTO mode, so it is possible to adjust them during synchronization.

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.3302 to zero.

7.6.2.2.2 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.3313 - “Voltage matching gain”.
- P.3314 - “Voltage matching integrative factor”.

If both parameters are “0”, no voltage regulation is available during synchronization.

7.6.3 Digital inputs for synchronization

MC100 allows configuring digital inputs with two special functions related to synchronization:

- 13 - “MCB external synchro request” (IF_13).
- 23 - “MGCB external synchro request” (IF_23).

These inputs must be used when the related circuit breaker is not managed by MC100, but you want to use PI regulators of MC100 for synchronization. When the input is “active” (logical state), if all necessary conditions for synchronization are present, MC100 starts the synchronization process and signals it to external devices using up to three digital outputs (see next paragraph).

7.6.4 Digital outputs for synchronization

MC100 allows configuring digital outputs with three special functions related to synchronization:

- 30 - “MCB synchronization in progress” (OF_30). It is used when MCB is managed by MC100 but an external synchronizer has to be used. When MC100 starts synchronization process, this output become “active” and can be used to supply/enable the external synchronizer. When synchronization ends, the output become “not active”.
- 31 - “MGCB synchronization in progress” (OF_31). It is used when MGCB is managed by MC100 but an external synchronizer has to be used. When MC100 starts synchronization process, this output become “active” and can be used to supply/enable the external synchronizer. When synchronization ends, the output become “not active”.
- 32 - “Synchronized” (OF_32). This output can be used with externally managed circuit breakers, when the synchro-check of MC100 must be used. This output can be “active” *only during synchronization process*, when MC100 detects the “synchronized” status between mains and generators. Outside synchronization process, or when generators are not synchronized with mains, 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).

7.6.5 Manual synchronization

MC100 allows, in MAN mode, to manually synchronize generators to mains. The user has to manually regulate voltages and frequency until the “synchronized” status is detected (this check is always done by MC100).

MC100 provides two parameters that allow voltages and frequency regulations on the generators:

- P.3101 - “Voltage reference”.
- P.3201 - “Speed reference”.

Both are expressed as percentage (between 0 and 100%). The first allows changing generators voltages of +/-15 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 B.02 (provided for synchronization). It is possible to simplify the procedure using two potentiometers instead of the parameters. To do that, you must:

- Voltages
  - Configure an analogue input with code 21 – “Voltage reference” (AIF_21) (parameter P.1841 for analogue input 1).
  - Configure the minimum and maximum voltage acquired by the input from the potentiometer (parameters P.1842 e P.1843 for analogue input 1). Normally 0% and 100% are used.
  - Configure the generators voltages corresponding to minimum and maximum voltage acquired by the input:
    - P.3102 – “Voltage reference at minimum input voltage”. Normally 0% is used.
    - P.3103 – “Voltage reference at maximum input voltage”. Normally 100% is used.

  After these configurations, you can change the voltage reference between 0 and 100% by moving the potentiometer (the current voltage reference is shown on page B.02), and consequently you are able to change generators voltages using the potentiometer. **Note: once you have configured an analogue input with code 21, parameter P.3101 is no more used.**

- Frequency
  - Configure an analogue input with code 20 – “Speed reference” (AIF_20) (parameter P.1841 for analogue input 1).
  - Configure the minimum and maximum voltage acquired by the input from the potentiometer (parameters P.1842 e P.1843 for analogue input 1). Normally 0% and 100% are used.
  - Configure the generators frequency corresponding to minimum and maximum voltage acquired by the input:
    - P.3202 – “Speed reference at minimum input voltage”. Normally 0% is used.

- P.3203 – “Speed reference at maximum input voltage”. Normally 100% is used.

After these configurations, you can change the speed reference between 0 and 100% by moving the potentiometer (the current speed reference is shown on page B.02), and consequently you are able to change generators frequency using the potentiometer. **Note: once you have configured an analogue input with code 20, parameter P.3201 is no more used.**

Manual synchronization procedure is:

- Start the generators.
- Select the page B.02 on the display (this can also be done by a manual closure command – MCB pushbutton or digital inputs configured for MCB/MGCB closure commands).
- Synchronize generators to mains modifying the values of P.3101 and P.3201, that are shown on page B.02 (or equivalent potentiometers id configured).
- When MC100 detects the “synchronized” status, give a second manual closure command: the circuit breaker will be closed.

7.6.6 Notes about synchronization

When using internal synchronizer, MC100 continuously acts to synchronize generators with mains. If the “synchronized” status persists for 10 seconds and the circuit breaker doesn’t close, MC100 changes generators frequency to force a “not synchronized” status, then starts to synchronize again. This is done to avoid problems when using external synchro-checks in addition to MC100’s one: it is possible that some external synchro-check doesn’t allow closure because it has never seen a “not synchronized” status.

MC100 allows configuring the maximum duration of synchronizations for the two circuit breakers:

- P.3806: MGCB synchronization maximum time.
- P.3809: MCB synchronization maximum time.

MC100 checks for synchronization timeout only if related parameter is different from zero; in this case an anomaly is activated:

- W272 - MCB synchronization failure. It is always a warning. MC100 can decide to close MCB without synchronization (opening MGCB or GCB), depending on plant type and on configuration.
- X271 - MGCB synchronization failure. If MGCB is directly managed from MC100, it is an alarm, otherwise it is a warning.

7.7 Measuring active power on mains

In many applications it is useful to know how many kW are circulating over the connection between the plant and the mains. For AMF applications, for example, this information is useful for monitoring the loads, even when they are supplied by mains (it is then possible to implement functions like peak-shaving). For parallel to mains applications, it is useful to control power supplied by generator in order to import/export a fixed quantity from mains, independently from current loads.

The following rules are used:

- **Positive active power: the power is imported from mains (there are local loads).**
- **Negative active power: the power is exported to mains (there are generators in parallel with mains).**

MC100 has two direct methods to acquire this measure, plus another indirect one.

7.7.1 Method 1

The best method is to allow MC100 direct measuring the currents (and so the powers) on the mains. The following is needed:

- Set parameter P.1301 to “1” to indicate to MC100 that current transformers (CTs) are located on the mains.
- Connect CTs to MC100, and also mains voltages.
- Check for proper values for CTs ratio (P.1302), VTs ratio (P.1203 and P.1204), number of phases (P.1201), nominal voltage (P.1202) and nominal frequency (P.1001).

Now MC100 continuously measures the powers on mains.

7.7.2 Method 2

It is possible to connect an external instrument to an analogue input of MC100, in order to acquire a signal proportional to the active power on mains. The following is needed:

- Configure an analogue input with code 40 – “Power on mains” (AIF_40) (parameter P.1841 for analogue input 1).
- Configure the minimum and maximum voltage acquired by the input (parameters P.1842 e P.1843 for analogue input 1). Normally 0% e 100% are used.
- Configure the powers on mains related to minimum and maximum voltage acquired by the input:
  - P.3534 – “Power on mains related to minimum input voltage”.
  - P.3535 – “Power on mains related to maximum input voltage”.

  These parameters represent powers (kW) and can be set up to +/- 30 MW. Powers on mains is signed information (positive if imported): one of these parameters should be negative.

For example, if the external instrument has a 0-5 V signal representing power from -1000.. +1000 kW, parameters must be set as in the following:

- P.1841 = 40.
- P.1842 = 0.0%.
- P.1843 = 50.0%.
- P.3534 = -1000.
- P.3535 = 1000.

Note: once you have configured an analogue input with code 40, the mains active power measure is acquired from it, also if MC100 is able to directly measure this power.

7.7.3 Method 3

If the previous methods cannot be used, MC100 can calculate the power on mains subtracting the loads from the power supplied by generators (with sign). MC100 needs to know both loads and generators powers. The only way is to connect CTs on the loads (P.1301 = 2). In this way MC100 directly measures powers on loads, while generators powers are calculated by summing (with sign) the power of each generators, as received by can bus link.

7.8 Active power management

MC100 does not implement any regulations on active power. No PI regulators are provided for active power: MC100 select the power setpoint for generators, and the power regulation task is performed by each generator control device.

MC100 is able to select the active power setpoint for generators through the can bus link. This setpoint is used by the generator control devices *only* when generators are in parallel with mains. When they are in “island mode”, generator control devices automatically manage load sharing (without MC100) between available generators, as a percentage of their nominal power.

MC100 sends the active power setpoint through the can bus as a percentage. This setpoint is the same for all generators: each generator control device will convert this percentage to kW, multiplying it by its nominal power; then it will provide active power control loop to move generator power to the setpoint.

On MC100, operator selects the setpoint directly as kW, not as percentage. MC100 converts from kW to %, using available generators and their nominal powers.

Let’s see a practical example: suppose to have three generators (200 kW, 300 kW and 700 kW). Suppose also that actual power setpoint is 900 kW.

- MC100 calculates the total nominal power of available generators (200 + 300 + 700 = 1200 kW).
- Then converts the power setpoint as a percentage of the total nominal power (900 / 1200 = 75 %).
- This value is transmitted over the can bus.
- Genset 1 receives the setpoint (%) and converts it to kW by multiplying it by its nominal power (0.75 * 200 kW = 150 kW).
- Genset 2 receives the setpoint (%) and converts it to kW by multiplying by it by its nominal power (0.75 * 300 kW = 225 kW).

- Genset 3 receives the setpoint (%) and converts it to kW by multiplying by it by its nominal power (0.75 * 700 kW = 525 kW).

As you can see, the total power required from generators will be 150 + 225 + 525 = 900 kW, the same value set by operator on MC100. At the same time, all generators are supplying 75% of their nominal power, so are all used in the same way.

Note: the operator can select a setpoint greater than the total generator nominal power (for example the setpoint is selected when three generators are available, but one generator now is stopped for alarms). To avoid problems, the setpoint over can bus is limited to 100%.

There are three different operating modes when working in parallel with mains, described in the following.

Note: genset control devices have their own parameter to select the operating mode while in parallel with mains. When controlled by MC100, however, the operating mode is the one select on MC100.

7.8.1 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.3006 to “1”.

In this mode, the operator selects the power setpoint for the plant using parameter P.3523, 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 pages M.01 and B.01.

If preferred, the setpoint can be modified using an analogue input (typically a potentiometer). To use the analogue input, do the following:

- Configure an analogue input with code 30 – “Power reference” (AIF_30) (parameter P.1841 for analogue input 1).
- Configure the minimum and maximum voltage acquired by the input (parameters P.1842 e P.1843 for analogue input 1). Normally 0% and 100% are used.
- Configure the set points related to minimum and maximum voltage acquired by the input:
  - P.3521 – “Power related to minimum input voltage for BASE LOAD”. Typically 0 kW is used.
  - P.3522 – “Power related to maximum input voltage for BASE LOAD”. Set here the maximum setpoint you need.

After that, the power setpoint can be changed using the potentiometer (the setpoint is shown on pages M.01 e B.01). **Note: once you have configured an analogue input with code 30, parameter P.3523 is no more used.**

7.8.2 IMPORT/EXPORT

This term is used to indicate the working mode where the power setpoint is not for generators, but for mains. The setpoint for generators is calculated from selected setpoint and current power on mains. It is mandatory that MC100 is able to measure the power on mains (see 7.7).

To select this mode, set parameter P.3006 to “2”. Otherwise you can set this parameter to “1” (“BASE LOAD”) and use a digital input to switch the working mode between “BASE

LOAD” and “IMPORT/EXPORT”. The digital input must be configured as 57 – “Import/export” (IF_57): when the input is “active” (logical state) the working mode is “IMPORT/EXPORT”, when “not active” the working mode is “BASE LOAD”.

Operator can select power setpoint on mains by using parameter P.3533, directly as kW. It allows setting values up to +/-30 MW. A positive value means that the plant should import power from mains, while a negative value indicates that power should be exported to mains. A setpoint equal to zero selects no power transfers over mains: generators should supply only local loads. This parameter can be modified even in MAN and AUTO modes and directly from display pages M.01 and B.01.

It is also possible to use an analogue input as setpoint (normally connected to a potentiometer).

To use the analogue input, do the following:

- Configure an analogue input with code 32 – “Import/export reference” (AIF_32) (parameter P.1841 for analogue input 1).
- Configure the minimum and maximum voltage acquired by the input (parameters P.1842 e P.1843 for analogue input 1). Normally 0% and 100% are used.
- Configure the power set points for mains related to minimum and maximum voltage acquired by the input:
  - P.3531 – “Power reference for "IMPORT/EXPORT" related to minimum input voltage”.
  - P.3532 – “Power reference for "IMPORT/EXPORT" related to maximum input voltage”.

  One of these parameters must be negative if power export to mains must be available. One of these parameters must be positive if import from mains must be available.

After that, the power setpoint on mains can be changed using the potentiometer (the setpoint is shown on pages M.01 e B.01). **Note: once you have configured an analogue input with code 30, parameter P.3533 is no more used.**

7.8.3 Transfer to generators

This term is used to indicate a transitory working mode where the power has to be transferred from mains to generators: after that the MCB will be opened and the load will be supplied only by generators.

To select this mode, set parameter P.3006 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”. The digital input must be configured as 58 – “Transfer to gensets” (IF_58): when the input is “active” (logical state) the working mode is “Transfer to generators”, when “not active” the working mode is the previous one.

This working mode is different if MC100 acquires the power on mains or not (see 7.7):

- MC100 acquires the power on mains. Power setpoint for generators is calculated as in “IMPORT/EXPORT” mode, assuming 0 kW setpoint on mains. When generators reach the setpoint no power is flowing on the mains: the MCB circuit breaker can be opened without load transients on generators.
- MC100 does not acquire the power on mains. The operator must provide a power setpoint (by parameter P.3523 or equivalent analogue input, see 7.8.1) equal to actual loads. 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 are not able to reach the setpoint (because too loads are applied) MCB circuit breaker will never be opened.

This transitory operating mode ends when generators reach the setpoint or after the configured timeout is elapsed (the timeout is used only if generators have enough power to reach the setpoint). The timeout is set using parameter P.3812 (“Unload ramp max duration”).

7.8.4 Load function

“Load function” is the ability of MC100 to automatically start/stop generators as required by loads or by active power setpoint. Display pages B.09 and B.10 are related to this function (see 3.3.4.9).

Note: generator control devices have their own “load function”, but it is disabled when the generators are controlled by MC100.

Load function, if enabled, works on all plant types:

- In parallel with mains, 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. If needed, a digital input can be configured with function 56 – “Load function enable” (IF_56). 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.

7.8.4.1 Starting/stopping generators to meet power requests

MC100 allows configuring two thresholds (%) related to load function:

- P.3505 - “Activation load threshold”.
- P.3507 - “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.

MC100 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 generator control devices 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.

ADP: generator x active power.

MDP: generator x nominal power.

DPRt: System total power ratio %.

When the system total power (DPRt) is higher than the threshold P.3505 for the time set by parameter P.3506 (“Activation load delay”), MC100 must start other generators. It is possible to select starting one genset or all available gensets by parameter P.3511 (“Gensets starting mode”).

- P.3511 = 0. Only one generator is started when system total power is higher than activation threshold. This configuration avoids unnecessary starts/stops (and unnecessary commands on GCB circuit breakers), but has two problems when used in “island mode”:
    - Suppose that generator to be started has problems, so, after n cranks, its control device activates an alarm. MC100 will detect this situation and will select another generator to be started, but much time is elapsed from activation request, and currently started generators may be not able to supply the loads (maximum power or maximum currents alarms may be activated by generator control devices).
    - Even if the selected generator starts without problems, its power may be lower than required by the increase on loads.

- P.3511 = 1. All available generators are started when system total power is higher than activation threshold. In a second time, unnecessary generators will be stopped. This solution avoids problems described in the previous point, but it results in unnecessary starts/stops and unnecessary circuit breaker commands.

In order to decide to stop one generator, MC100 first selects the generator to be stopped (in the following identified as generator y) and then calculates the total power ratio % the system will supply when the generator y will 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.

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.

When this system total power (DPRtn) is lower than threshold P.3507 for the time set by parameter P.3508 (“Deactivation load delay”), MC100 stops the generator y.

Parameter P.3510 (“Minimum number of working gensets”) allows selecting the minimum number of started generators, whatever is the load: MC100 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.

Every time a GCB circuit breaker is opened or closed, MC100 stops checking powers (and so no generator will be started/stopped) for the time set by parameter P.3509 (“Initial delay”): this time is provided to allow system stabilization.

If automatic genset supply is required when all generators are stopped (for example when mains become “absent” in emergency plants), MC100 always starts <u>all</u> available generators.

Note: by pressing START pushbutton on MC100, load function is temporary suspended and all available generators are started. 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 starts all generators and, when all are supplying, new loads can be safety added or the setpoint can be safety increased, remaining in AUTO mode and with load function enabled.

7.8.4.2 Selecting generators

MC100 can “manage” a generator only when its control device is in AUTO mode, with no alarms and with the “start inhibition” contact closed. In all other situations, generators are not “managed” by MC100; they could be always stopped (in case of alarms for example) or always running (if “start inhibition” contact is opened for example): in both cases, these generators are excluded from load function.

Normally, instead, all generators "managed" by MC100 are involved 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 has to be performed on display pages from B.05 to B.08, which show details about each generator (see description in 3.3.4.5). **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: MC100 can stop <u>all</u> generators involved in load function. This happens when at least P.3510 "not managed" generators are running, and there is no power request for other gensets.

The techniques described in the following work only on generators that, at a given time, are included in load function.

To ensure that all generators are used (not always the same ones), MC100 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".

Actually MC100 implements three different techniques for assigning priorities to generators, selectable by parameter P.3501 ("Load function mode").

7.8.4.3 Manual "master" generator selection

Set "1" in parameter P.3501 to select this mode.

In this mode, the operator manually selects the "master" genset using parameter P.3502 ("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 operator selects generator "5" as "master", the priority list will be:

5, 6, 8, 1, 2.

If operator selects generator "8" as "master", the priority list will be:

8, 1, 2, 5, 6.

If operator selects generator "1" as "master", the priority list will be:

1, 2, 5, 6, 8.

The priority list is built by following natural address order of generators (increase order) starting from the "master" to the highest one; then starting from the lowest to the one preceding the "master".

7.8.4.4 Automatic "master" generator selection at fixed time

Set "2" in parameter P.3501 to select this mode.

In this mode, the operator can always manually select the "master" genset using parameter P.3502. At the time configured by parameter P.3503 ("Master genset change time"), however, MC100 will select a new "master". The new "master" is the one following the old "master" in the priority list (obviously between the generators included in load function).

Suppose the old priority list is "5,6,7,1,2"; at the configured time, the new "master" genset will be the generator "6".

See previous paragraph for assigning priorities to other generators, once the "master" is selected.

In this mode, the "rotation" of generators happens once a day.

7.8.4.5 Automatic "master" generator selection every x hours

Set "3" in parameter P.3501 to select this mode.

In this mode, the operator can always manually select the "master" genset using parameter P.3502. After the configured number of hours is elapsed from last "master" change (P.3504 - "Master genset batch hours"), MC100 will select a new "master". The new "master" is the one following the old "master" in the priority list (obviously between the generators included in load function).

Suppose the old priority list is "5,6,7,1,2"; at the configured time, the new "master" genset will be the generator "6".

See previous paragraph for assigning priorities to other generators, once the "master" is selected.

In this mode, the "rotation" of generators happens every x hour.

7.8.4.6 Actions on "master" change

When a new "master" is selected, a new priority list is built. At this time, it is possible that some lower priority generators are running, while some high priority generators are stopped. In this case, MC100 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.

7.8.5 Load shedding

The purpose of "load shedding" function is to manage some digital outputs of MC100, in order to connect/disconnect part of loads from the generators, when generators are not able to supply all loads. Display page B.11 is related to this function (see 3.3.4.11).

This function is normally enabled; it is disabled in the following situations:

- MC100 is in MAN or OFF_RESET mode.
- In parallel to mains operations (the eventually extra loads are supplied by mains).
- If a digital input is configured as 60 - "Load shedding" (IF_60) and the input is "not active" (logical state). If the input is not configured, or if it is "active", the function is enabled.

- If no digital outputs of MC100 are configured for “load shedding”. Four functions are available for digital outputs configuration:
  - 50 – “Load-shedding 1” (OF_50).
  - 51 – “Load-shedding 2” (OF_51).
  - 52 – “Load-shedding 3” (OF_52).
  - 53 – “Load-shedding 4” (OF_53).

It is possible to manage up to four groups of loads. Remember that the same output function can be assigned to more then one physical output: in this way, a single logical group of loads can be connected/disconnected from generators using many circuit breakers, all commanded at the same time.

Outputs are “active” when MC100 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 50. For example, if only two outputs are needed, use functions 50 and 51 for them. If you use functions 50 and 52, only the first output will be managed by “load shedding”. If you use functions 51 and 52, no outputs will be managed by “load shedding” because function “50” is missing.

Loads must be assigned to outputs depending on their priority:

- The output configured with function “50” should be used for lowest priority loads: it is the first activated (to disconnect loads from generators) and the last deactivated (to re-connect loads to generators).
- The output configured with function “53” should be used for highest priority loads: it is the last activated (to disconnect loads from generators) and the first deactivated (to connect loads to generators).

If “load shedding” function is disabled and some of its digital outputs are configured, these outputs are “not active” in order to avoid disconnection of loads.

7.8.5.1 All loads management

Normally MC100 is able to 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”, at the closure time of MGCB circuit breaker.
- In “island mode”, at the closure time of the first GCB circuit breaker, if MGCB does not exist or if it was closed when first GCB has to be closed.
- When passing from “parallel to mains” 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.

7.8.5.2 Single load management

In “island mode” it could be possible that “load shedding” and “load function” have to work together. If some loads are removed, “load function” stops the unnecessary generators, if all generators are running and loads increase, “load shedding” disconnects some loads. It is important to select what MC100 has to do if not all available generators are running, and loads increase in a way that “load shedding” needs to disconnect some loads. Two options are available by parameter P.3557 - “Load disconnect mode”:

- “0 – Wait for load function”. In this case “load shedding” is disabled until all available generators are running. Only after that, loads can be disconnected from generators. This option avoids unnecessary loads connection/disconnection (important when the operator is involved to re-connect the loads); if “load function” takes a long time to start the next generator, however, this could result in “maximum power” or “maximum current” alarms on currently running generators.
- “1 - Immediate”. In this case loads immediately are disconnected, even if not all available generators are running. “Load function” will then start necessary generators, and when enough power is available, loads will be re-connected. This option avoids “maximum power” and “maximum current” alarms: however, some unnecessary disconnection of loads may happen, and this could be a problem if the operator is involved for re-connecting the loads.

MC100 provides two thresholds (%) related to “load shedding”:

- P.3551 - “Load disconnect threshold”.
- P.3553 - “Load re-connect threshold”.

<u>The second threshold must be lower than the first one</u>. P.3551 threshold must be set at the maximum allowed power per generator (%). P.3553 threshold must be carefully calculated depending on loads connected/disconnected, to avoid that when a load is connected the total power becomes greater than P.3551 and so load is disconnected again, and so on.

MC100 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 generator control devices 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.

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.3551 for the time set by parameter P.3552 (“Load disconnect delay”), MC100 disconnects the lowest priority loads (see above for load priorities).

MC100 can be configured to automatically or manually re-connect the loads. This choice is available by parameter P.3556 (“Load re-connect mode”):

- 0 – “Automatic”. MC100 checks system power before allowing loads connection. The system total power (%) must be less than the P.3553 threshold, for the time set by parameter P.3554 (“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, MC100 stops monitoring the power (and so no other loads can be connected/disconnected) for the time set by parameter P.3555 (“Initial delay”), to allow system stabilization.

7.8.5.3 Manual commands

MC100 allows configuring two digital inputs to be used for “load shedding” manual command. Functions to be used for the inputs configuration are:

- 61- “Manual disconnection of part of load” (IF_61).
- 62 - “Manual re-connection of part of load” (IF_62).

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 “61” will result in the disconnection of the lowest priority loads (next activation will disconnect the next loads and so on until all loads are disconnected).

The activation of input configured as “62” will result in the re-connection of the highest priority loads (next activation will re-connect the next loads and so on until all loads are connected).

7.8.5.4 Notes about “load shedding”

If “not-motorized” circuit breakers are used to connect/disconnect loads, MC100 is not able to automatically re-connect loads. In this case parameter P.3556 must be set to “0”: when MC100 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.

7.9 Reactive power management

MC100 does not implement any regulations on reactive power. No PI regulators are provided for reactive power: MC100 select the reactive power setpoint for generators, and the voltage and reactive power regulation task is performed by each generator control device.

The reactive power setpoint is not expressed as kvar, it is set as a “power factor”, called also cos(Φ).

MC100 is able to select the cos(Φ) setpoint for generators through the can bus link. This setpoint is used by the generator control devices *only* when generators are in parallel with mains. When they are in "island mode", generator control devices automatically manage reactive power sharing (without MC100) between available generators, as a percentage of their nominal power.

The setpoint sent by MC100 over the can bus is the same for all generators: each generator control device 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 MC100, operator selects the setpoint for cos(Φ) using parameter P.3403 ("cos(Φ) regulation reference"). 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 pages M.01 and B.01.

If preferred, the setpoint can be modified using an analogue input (typically a potentiometer). To use the analogue input, do the following:

- Configure an analogue input with code 31 – "Power Factor reference" (AIF_31) (parameter P.1841 for analogue input 1).
- Configure the minimum and maximum voltage acquired by the input (parameters P.1842 e P.1843 for analogue input 1). Normally 0% and 100% are used.
- Configure the set points related to minimum and maximum voltage acquired by the input:
  - P.3401 - "Cos(Φ) related to minimum input voltage". Typically "0.7 inductive" is selected.
  - P.3402 - "Cos(Φ) related to minimum input voltage". Typically "0.9 capacitive" is selected.

After that, the Cos(Φ) setpoint can be changed using the potentiometer (the setpoint is shown on pages M.01 e B.01). **Note: once you have configured an analogue input with code 30, parameter P.3403 is no more used.**

Note: generator control devices have their own setpoint for cos(Φ); when used together with MC100, the setpoint used is the one received from MC100.

7.10 Circuit breakers

MC100 is able to manage both "Mains Circuit Breaker" (MCB) and "Main Generators Circuit Breaker" (MGCB).

MGCB circuit breaker is optional for all kinds of plant:

- If it exists, the related lamp shows its status.
- If it does not exist, MC100 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 MCB is configured as “not managed”, MC100 signals a wrong configuration by warning W237 and 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 MC100 or by external devices. If they are managed by external devices, their status must be wired to MC100 (if not, MC100 again signals a wrong configuration by warning W273).

Synchronization can be enabled or disabled for each circuit breaker: if disabled the circuit breaker can only be closed without synchronization.

Finally, it is possible to select the power source for both circuit breakers. In this way MC100 avoids rising alarms or warnings if the breaker is opened with closure command, if power source is missing.

7.10.1 Configuration

Parameter P.3002 (“MGCB mode”) and parameter P.3004 (“MCB mode”) are used for circuit breakers configuration. The available values (for both) are:

- 0 – “Not managed”. See notes on previous paragraph.
- 1 – “Not synchronizable”. The circuit breaker exists and it is commanded by MC100. It can be closed only without synchronization.
- 2 – “Synchronizable”. The circuit breaker exists and it is commanded by MC100. It can be closed with or without synchronization, depending on plant status.
- 3 – “External not synchronizable”. The circuit breaker exists and it is commanded by external devices, MC100 acquires its status. MC100 never performs synchronization on this circuit breaker.
- 4 – “External synchronizable”. The circuit breaker exists and it is commanded by external devices, MC100 acquires its status. External device can request MC100 to perform synchronization, for a safe closure of the circuit breaker.

MC100 manages each combination of these parameters, except for P.3004 that can be set to “0” only for “MPM” (Multiple Prime Mover) plants.

Parameter P.3003 (“MGCB supplied by generators?”) is used for MGCB circuit breaker only, and allows the following configurations:

- “0”. Circuit breaker can be closed only when voltages are present on generators bus. When no voltages are present, MC100 never activates alarms or warnings for “circuit breaker not closed” situations. Also it never tries to close the circuit breaker, even if a wrong configuration is made with parameter P.3804, to force MGCB closure before any GCB closure. *Note: MC100 doesn’t open the circuit breaker if power source is missing, it only agrees with possible opening of the circuit breaker.*
- “1”. Circuit breaker can be always closed. MC100 can activate alarms or warnings for “circuit breaker not closed” situations.

Parameter P.3005 (“MCB supplied by mains?”) is used for MCB circuit breaker only, and allows the following configurations:

- "0". Circuit breaker can be closed only when voltages are present on mains. When no voltages are present, MC100 never activates alarms or warnings for "circuit breaker not closed" situations. Also it never tries to close the circuit breaker, except when the automatic start of generators is not required. *Note: MC100 doesn't open the circuit breaker if power source is missing, it only agrees with possible opening of the circuit breaker.*
- "1". Circuit breaker can be always closed. MC100 can activate alarms or warnings for "circuit breaker not closed" situations.

7.10.2 Digital outputs for commands

MC100 manages up to four different commands for each circuit breaker:

- **Minimum voltage coil**. It is a temporary command, that allows to open the circuit breaker (and avoids its closure), but cannot be used to close it. This command works in opposite ways for the two circuit breakers:
  - MCB. Output is "**active**" to open the circuit breaker. Use a normally closed contact of this relay: in this way, when MC100 is not powered, no opening commands are pending on the circuit breaker.
  - MGCB. Output is "**not active**" to open the circuit breaker. Use a normally open contact of this relay: in this way, when MC100 is not powered, the circuit breaker is always forced to be opened.

  MC100 uses this command each time the circuit breaker has to be opened. As soon as the circuit breaker opens, however, the output goes back to its normal status: in this way MC100 is ready for closure requests (a minimum time between "minimum voltage coil" and closure commands is required).

  Use the following functions to configure the outputs:

  - 10 – "MCB minimum voltage coil (reverse command)" (OF_10).
  - 20 – "MGCB minimum voltage coil" (OF_20).
- **Opening command**. It is a temporary command, that allows to open the circuit breaker (and avoids its closure), but cannot be used to close it. This command works always with a "positive logic": the output is "activated" when the circuit breaker is closed and need to be opened: as soon as circuit breaker opens (or if MC100 aborts opening operation), the output goes back to "not active" status.

  Use the following functions to configure the outputs:

  - 11 – "MCB open coil" (OF_11).
  - 21 – "MGCB open coil" (OF_21).
- **Closure command**. It is a temporary command that allows closing the circuit breaker, but cannot be used to open it. This command works always with a "positive logic": the output is "activated" when the circuit breaker is opened and need to be closed: as soon as circuit breaker closes (or if MC100 aborts closure operation), the output goes back to "not active" status.

Use the following functions to configure the outputs:

- 12 – “12-MCB close coil” (OF_12).
- 22 – “MGCB close coil” (OF_22).

- **Static command**. MC100 uses this command to both open and close the circuit breaker. It works in a different ways for the two circuit breakers:
  - MCB. MC100 “activates” the output when circuit breaker has to be opened, “deactivates” the output when circuit breaker has to be closed (whatever is the real status of the circuit breaker). Use a normally closed contact of this relay: in this way, when MC100 is not powered, a closure command for the circuit breaker is always present.
  - MGCB. MC100 “activates” the output when circuit breaker has to be closed, “deactivates” the output when circuit breaker has to be opened (whatever is the real status of the circuit breaker). Use a normally opened contact of this relay: in this way, when MC100 is not powered, an opening command for the circuit breaker is always present.

  Use the following functions to configure the outputs:

  - 13 – “MCB static close command (reverse command)” (OF_13).
  - 23 – “MGCB static close command” (OF_23).

It is possible to use only a sub-set of these commands. The possibilities are:

- Only the static command.
- The static 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 command, during each phases 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 command	Closure command	Static command
Closed	X			X
Opened	X			
Opening		X		
Closing	X		X	X

The “closed” and “opened” conditions in the table differ only for the “static command”. Let’s examine both situations:

- “Static command” not used. MC100 uses the same commands when circuit breaker is both “opened” and “closed”. In this situation, MC100 can safely follow external changes in circuit breaker status; it does not activate anomalies if circuit breaker is externally opened or closed, and, in AUTO mode, MC100 will re-close or re-open the circuit breaker as required by plant status.
- “Static command used”. MC100 uses different commands when circuit breaker is opened respect to when it is closed. If the circuit breaker status changes, MC100 should change some of its commands to follow the new status. This operation is very dangerous:
  - If circuit breaker status changes from “closed” to “opened”, MC100 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, MC100 will re-close the circuit breaker if required by plant status.
  - If circuit breaker status changes from “opened” to “closed”, MC100 cannot follow the new status, because an uncontrolled closure command may be issued. There are no problems if circuit breaker is really closed. If, instead, the “closed” status is a “wrong” information (due to disturbs, broken wires and so on), the circuit breaker will be closed by MC100 without checking for synchronizations. **For these reasons, in these situations MC100 always activates an alarm in automatic modes. In MAN mode, no alarms are activated: MC100 follows the external status changes only if the new status persists for one second.**

7.10.2.1 Minimum delays between commands

MC100 grants that the following delays between commands are respected:

- One second between minimum voltage coil and any closure commands.
- The delay configured by parameter P.3808 (“Breakers holding time”) (if set to zero 0.5 seconds are used) between an opening command and the next closure command.
- The delay configured by parameter P.3808 (“Breakers holding time”) (if set to zero 0.2 seconds are used) between a closure command and the next opening command.
- The delay configured by parameter P.3807 (“Breakers 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.

Finally, the two circuit breakers are never closed at the same time

7.10.3 Digital inputs for statuses

MC100 allows configuring its digital inputs to acquire the circuit breakers statuses. The real status of a circuit breaker must be wired to MC100 in the following cases:

- The circuit breaker is managed by an external device.
- The circuit breaker is managed by MC100, but only temporary commands are used.

In all other cases, it is possible to work without wiring the real status: MC100 uses its closure command also as status. **In "parallel to mains" applications, cautions should be used when the breaker status is not connected to MC100, because it is possible to have power reverse or over-speed problems if the status is not coherent with the command.**

The circuit breaker is "closed" when the digital input is "active (logical state).

Use the following functions to configure the outputs:

- 10 – "MCB status" (IF_12).
- 20 – "MGCB status" (IF_22).

If the circuit breaker status is wired to an input of MC100, it is a good practice to setup also a delay for that input: MC100 uses this delay as maximum waiting time during closure/opening of the circuit breaker. For example, if MCB status is wired to digital input 8, parameters must be set as:

- P.1422 ("Input 8 function") = 10
- P.1423 ("Input 8 delay") = 4.0

In this way, MC100 will wait for maximum four seconds during opening and closure commands. If the delay is set to zero, MC100 uses a fixed 5 seconds delay.

If the real status of the circuit breaker is wired, MC100 can perform some additional functions:

- Each time the circuit breaker has to be closed or opened, MC100 will try to set commands up to three times, if circuit breaker doesn't move. A fixed delay of two seconds is used between two consecutive try.
- MC100 activates the "not closed" or "not opened" anomalies if circuit breaker doesn't move as required.

7.10.4 Outputs related to circuit breakers statuses

MC100 allows configuring its digital outputs for signaling statues related to circuit breakers. The following list is a summary of the functions used to configure digital outputs for these purposes. For a complete description, see 4.5.1.

- "14 - Ready to close MCB" (OF_14).
- "15 - Ready to open MCB" (OF_15).
- "24 - Ready to close MGCB" (OF_24).
- "25 - Ready to open MGCB" (OF_25).
- "30 - MCB synchronization in progress" (OF_30).

- “31 - MGCB synchronization in progress” (OF_31).
- “32 - Synchronized” (OF_32).

7.10.5 Inputs related to external commands for circuit breakers

MC100 allows configuring its digital inputs to acquire external commands related to circuit breakers. The following list is a summary of the functions used to configure digital inputs for these purposes. For a complete description, see 4.4.1.

- “11 - MCB external open request” (IF_11).
- “12 - MCB external close request” (IF_12).
- “13 - MCB external synchro request” (IF_13).
- “14 - MCB closure acknowledge” (IF_14).
- “15 - MCB opening acknowledge” (IF_15).
- “21 - MGCB external open request” (IF_21).
- “22 - MGCB external close request” (IF_22).
- “23 - MGCB external synchro request” (IF_23).
- “24 - MGCB closure acknowledge” (IF_24).
- “25 - MGCB opening acknowledge” (IF_25).

7.10.6 Change-over logic

- **OFF_RESET.** MC100 ensures that generators are disconnected form mains and loads. If MGCB circuit breaker exists, MC100 opens it. Moreover, the circuit breakers (GCB) of all controlled generators are opened.

  When all generators are disconnected from mains and loads, if MCB circuit breakers exists and is controlled by MC100, MC100 closes it (in OFF_RESET mode MCB can only be closed without synchronization).

- **MAN**. Switching from any other mode to MAN, no commands are issued to circuit breakers, so they don’t change status. The operator can manually open/close the circuit breakers. If no synchro-check conditions are detected, MC100 doesn’t allow closure: in this case, the operator must manually synchronize generators to mains before closing the circuit breaker (see 7.6 for notes on synchronization and 4.4.1 for digital input configurations, to use them as manual circuit breaker commands).

- **AUTO**. If automatic gensets start is not required, MC100 manages the circuit breakers exactly as in OFF_RESET mode.

If generators have to start, circuit breakers management depends on plant configuration:

- MGCB. If the circuit breaker exists and is managed by MC100, MC100 closes it with different timings, depending on conditions and plant configuration:

  - Parallel to mains. Normally MC100 closes MGCB (without synchronization) before generator's GCB. This is the best solution, because avoids multiple generators synchronization. This cannot be done if:

    - For any reason, at least one GCB is already closed when MC100 has to close MGCB.
    - MGCB is supplied by generators bus (P.3003).
    - The operator has selected to close GCB before MGCB by parameter P.3804.

    If MGCB cannot be closed without synchronization, MC100 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", MC100 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).

  - Island mode. In this case MC100 will never close MGCB before GCB; MGCB is always closed without synchronization. Parameter P.3805 allows configuring the timings for MGCB closure:

    - P.3805 = 0. MC100 closes MGCB when at least one GCB is closed ("Immediate supply").
    - P.3805 = 30000. MC100 waits that the GCB of all managed generators are closed and then closes MGCB. In this case, the nominal power of generators is not checked.
    - In any other cases, MC100 waits that the sum of nominal powers of all generators with GCB closed is greater then the selected value, and then closes MGCB. *Note: if all managed generators have GCB closed and the sum of nominal powers is lower than the selected value, MC100 activates a warning (W008) and then closes MGCB.*

    It is also possible to force the MGCB closure just after the first GCB has been closed, by using a digital input configured as "63 - Immediate supply" (IF_63), whatever is the value set in parameter P.3805.

- MCB. If this circuit breaker exists and is managed by MC100, MC100 normally keep it closed. MC100 opens it only in some cases, depending on plant configuration.

  - For "parallel to mains" applications, MCB is opened only if configured as "interface device" and a "loss of mains" happens.

- For plants that cannot work in parallel with mains, MCB is opened before MGCB closure (or GCB closure if MGCB does not exist), to manage load change-over between mains and generators. In the same way, MCB is closed after MGCB has been opened (or GCB if MGCB does not exist); if configured as “synchronizable”, MC100 will try to close it with synchronization, before opening MGCB.

- **TEST**. In this mode circuit breakers are managed as in AUTO mode; keep in mind that in TEST mode loads are connected to generators only if parameter P.4301 is different from zero.
- **REMOTE START**. In this mode circuit breakers are managed as in AUTO mode; keep in mind that in this mode generators are always forced to supply, whatever other automatic requests are (mains presence, for instance).

7.10.7 Unloading

When generators are supplying in parallel to mains and the MGCB circuit breaker has to be opened, MC100 first commands the unloading process to generators (if neither alarms nor deactivations are activated). Then the generator control devices manage by itself the unload ramp for their generators. MC100 waits for the end of the unloading process and then opens the MCB circuit breaker. The unloading process is terminated when:

- The system total power (%) is lower than the threshold set by parameter P.3811 (total power (%) is calculates as the sum of active powers divided by the sum of nominal powers of all generators).
- After the time configured with parameter P.3812 is elapsed from the start of the process.

8. Anomalies

This chapter describes all the anomalies managed by the board. Some of these act as protections for the loads or for the generators. There is also signaling of particular events in the management of the plant. Before describing them in detail, it is opportune to give some definitions.

We define four typologies of anomaly:

- Warnings: these anomalies don’t require the arrest of the generators. They point out to situations that are not dangerous at the moment, but the operator must take some action because, if ignored, they could degenerate in one of the following categories.
- Unloads: these anomalies require the arrest of the generators. They are dangerous for the loads but not immediately for the generators. For this reason the power is gradually transferred from the generators to the mains, until the GCB circuit breakers are opened. Then the generators can be stopped with the standard procedure (with the cooling cycle). However, it is not possible to restart the generators until someone takes care of the anomaly.

- Deactivations: these anomalies require the arrest of the generators. They are dangerous for the loads but not immediately for the generators. For this reason the MGCB circuit breaker are immediately opened (or GCB if MGCB does not exist) and generators can be stopped with the standard procedure (with the cooling cycle). However, it is not possible to restart the generators until someone takes care of the anomaly. This kind of anomalies are not directly managed by MC100.

- Alarms: these anomalies require the arrest of the generators. They are dangerous for the loads and/or for the generators. For this reason the generators must be stopped immediately, without the cooling cycle. It is not possible to restart the generators until someone takes care of the anomaly.

When an anomaly is activated, the board performs the following actions:

a) It activates the internal horn and, if configured, also the external one (function “40 – external horn” – OF_40).

b) It forces the multifunction display on the S.02. This page shows the fault numeric code and the current language text related to the anomaly.

c) If the anomaly is a **warning**, the “ALARM/WARNING” lamp starts blinking; in other cases the lamp is switched fixed ON.

d) If the anomaly is an **unload** or a **deactivation** or an **alarm**, the loads will be connected to the mains and the generators will be stopped (with or without the cooling cycle).

The operator can take two actions about an anomaly:

a) Acknowledge: this indicates to the board that the operator has taken action about the situation.

b) Reset: it tells to the board that the anomaly is not more active.

The operator can acknowledge the anomaly (ISA2C sequence) by pressing the ACK pushbutton. It is also possible to use a digital input for this purpose (configured with function “70 - alarms acknowledge” – IF_70). This operation also stops the internal and the external horns. The multifunction display shows the anomaly up to when the operator doesn't acknowledge or reset it, even if its cause is not still present.

The board automatically reset all the acknowledged **warnings** when their cause is not still active. In order to reset **unloads**, **deactivations** and **alarms**, the operator must change the operating mode to OFF_RESET (obviously it must be switched back to MAN or AUTO in order to use the gensets again). It is also possible to use a digital input for this purpose (configured with function “71 - alarms reset” – IF_71).

With this procedure, it is also possible to reset externally managed anomalies. In fact, you can configure one of the board digital outputs (function “41 - alarms reset command” – OF_41) to activate for one second when the internal reset procedure is performed. Remember that this one second pulse is generated only for the reset procedure, not for the acknowledge one.

The horn management is however related to the P.4501parameter:

- 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 will be deactivated when the operator press the ACK pushbutton.
- If set to any value between 1 and 998, the horn will be activated when a new anomaly arises, and will be stopped both for pressing the ACK pushbutton or after P.4501 seconds from activation.

An **alarm** can be activated only if no other **alarms** are already active. An **alarm** can be activated if some **unloads**, **deactivations** or **warnings** are active.

A **deactivation** can be activated only if no **alarms** and **deactivations** are already active. Instead, some **warnings** or **unloads** can be active.

An **unload** can be activated only if no **alarms**, **deactivations** and **unloads** are already active. Instead, some **warnings** can be active.

A **warning** can be activated only if no **alarms, deactivations, unload** are already active. Instead, some **warnings** can be active.

Here follows a detailed description of each anomaly.

8.1.1.1 005 - At least one GCB is not opened

Typology:	**Warning**
Related parameters	**P.3704**
To disable:	**-**
Enabled if:	**MAN, AUTO, TEST, REMOTE START.**

MC100 activates this anomaly when detects (from information sent over can bus PMCB) that at least one generator is in a “GCB not open” condition (GCB closed while an opening command is active). In this situation, parameter P.3704 selects actions on MGCB circuit breaker:

- “0”. This setting forces an MGCB opening (and obviously avoids next MGCB closures.
- “1”. This setting avoids MGCB closures (but doesn’t 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: generator control devices have its own equivalent parameter to configure actions on GCB.

8.1.1.2 007 – Manual stop pressed in automatic mode

Typology: **Alarm**
Related parameters **-**
To disable: **-**
Enabled if: **AUTO, TEST, REMOTE START.**

This anomaly is activated when, in AUTO, TEST or REMOTE START modes the operator presses the STOP pushbutton, or if a stop command is received from the serial ports or by an SMS.

8.1.1.3 008 - Power required for supply not reached

Typology: **Warning**
Related parameters **P.3805**
To disable: **P.3805 = 0 o P.3805 = 30000**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

This anomaly is enabled only if MGCB circuit breaker exists, and if it is managed by MC100. Moreover, it is enabled only when generators have to supply in “island” mode. MC100 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.3805. It signals that generators may be unable to supply all loads. Values “0” and “30000” of P.3805 are special; they disable this anomaly. The value “0” configures MC100 to close MGCB as soon as one GCB is closed; the value “30000” forces MC100 to wait for all available generators are supplying (whatever their power is).

8.1.1.4 013 - MCB breaker not closed

Typology: **Warning / alarm**
Related parameters **P.1401 (or equivalent for inputs 2-18)**
To disable: **P.1401 <> 10**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

MC100 activates this anomaly after three consecutive closure commands: it is a warning in MAN mode, an alarm in 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, see 7.10.3).

8.1.1.5 014 - MGCB breaker not closed

Typology: **Warning / alarm**
Related parameters **P.1401 (or equivalent for inputs 2-18)**
To disable: **P.1401 <> 20**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

MC100 activates this anomaly after three consecutive closure commands: it is a warning in MAN mode, an alarm in 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, see 7.10.3).

8.1.1.6 016 – Maximum current (#1)

Typology: **Warning / unload / alarm**
Related parameters: **P.1306 P.3901 P.3902 P.3903 P.3904**
To disable: **P. 1306 = 0 o P.3902 = 0 o P.3903 = 0**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

MC100 activates this anomaly when at least one current is higher than the configured threshold.

The threshold (P.3901) is a percentage of the nominal current of the system, set by parameter P.1306. The threshold can be configured between 0% and 999%, with 0.1% resolution.

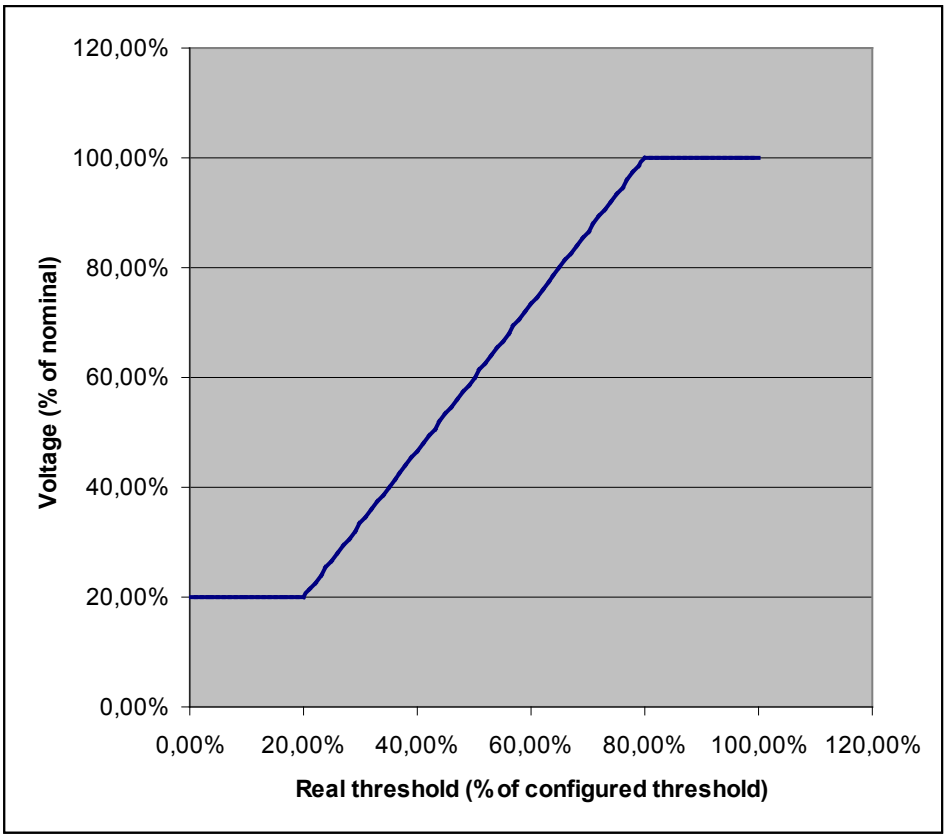
The delay (P.3902) of the protection can be set between 0 and 4000 seconds, with 0.1 seconds resolution. If the delay is set to zero, the protection is disabled: so the minimum delay is 0.1 seconds.

Parameter P.3904 selects the typology:

73. Warning.
74. Unload.
75. Alarm.

The protection can work in four different ways, as selected by parameter P.3903:

1. This value selects a “fixed time” protection. The anomaly is activated when at least one current is higher than the threshold P.3901 for the time P.3902. 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.3901), and the maximum time the generator can work with this current (P.3902). If the current is lower than the defined threshold, the protection is not activated. If the current become greater than the threshold, the protection is activated with a time inversely proportional with the entity of the over current. In order to correctly set the thresholds, follow the following steps:

   - You must set the nominal current of the system (P.1306).
   - Configure the maximum current threshold by the P.3901 parameter, as a percentage of the nominal current.
   - Configure the intervention time for the protection in the P.3902 parameter: the protection will be activated exactly after the time you've configured if the current is constantly equals to the P.3901 threshold multiplied by $\sqrt{2}$.

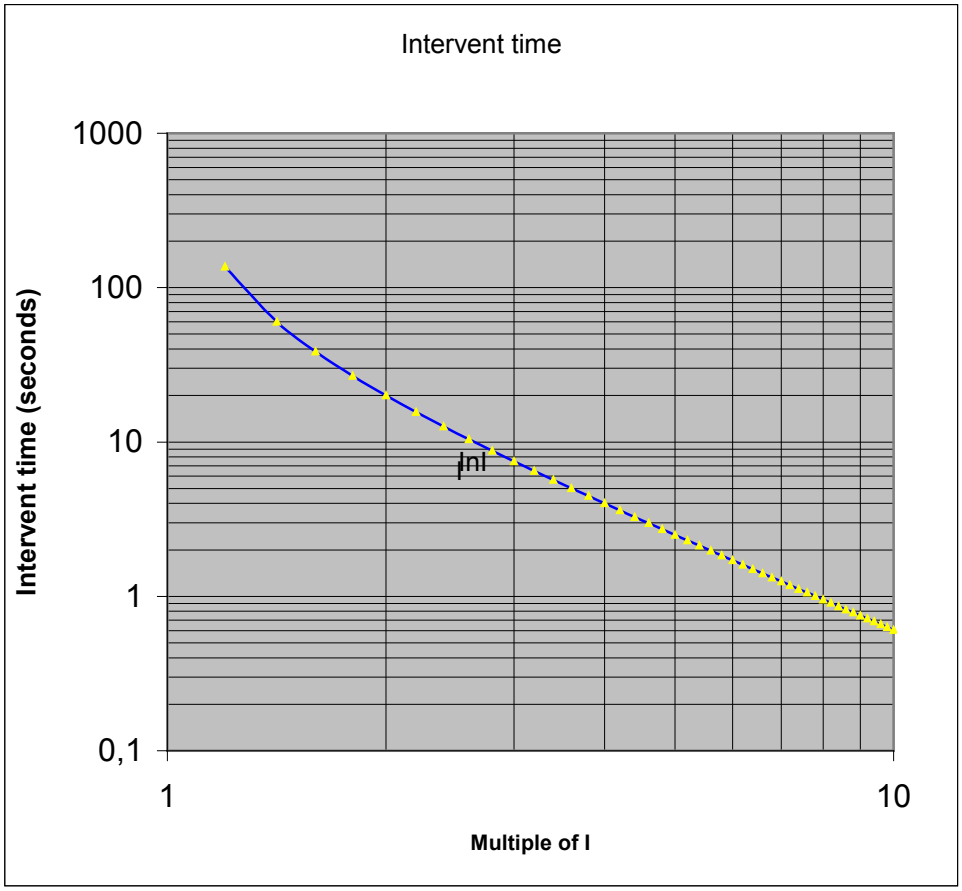
   In order to calculate the intervention time for a preferred current, please use the following formula:

$$t_I = \frac{P.3902}{\left(\frac{I}{P.3091}\right)^2 - 1}$$

   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 over load situation.

The following graph shows the used curve, with P.3902 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).

8.1.1.7 017 – Maximum current (#2)

Typology:	**Warning / unload / alarm**
Related parameters:	**P.1306 P.3906 P.3907 P.3908 P.3909**
To disable:	**P. 1306 = 0 o P.3907 = 0 o P.3908 = 0**
Enabled if:	**MAN, AUTO, TEST, REMOTE START.**

The same as anomaly “016”, with the parameter listed above.

8.1.1.8 021 – Timeout for stopping generators

Typology: **Warning**
Related parameters **P.3813**
To disable: **P.3813 = 0**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

This anomaly is activated when at least on generator controlled by MC100 is still running after the delay set by parameter P.3813 from the stop command.

8.1.1.9 022 – Timeout for starting generators

Typology: **Warning**
Related parameters **P.3803**
To disable: **P.3803 = 0**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

This anomaly is activated when no generators (between the ones controlled by MC100) is running after the delay set by parameter P.3803 from the start command.

8.1.1.10 023 - MCB breaker not opened

Typology: **Warning / alarm**
Related parameters **P.1401 (or equivalent for inputs 2-18)**
To disable: **P.1401 <> 10**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

MC100 activates this anomaly in the following situations:

- If the circuit breaker is managed by MC100 and an external logic closes it (not in MAN mode). The anomaly is set only if the “static command” is used to manage the circuit breaker (see 7.10.2). It’s an alarm.
- After three consecutive opening commands: it is a warning in MAN mode, an alarm in 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, see 7.10.3).

8.1.1.11 024 - MGCB breaker not opened

Typology:	**Warning / alarm**
Related parameters	**P.1401 (or equivalent for inputs 2-18)**
To disable:	**P.1401 <> 20**
Enabled if:	**MAN, AUTO, TEST, REMOTE START.**

MC100 activates this anomaly in the following situations:

- If the circuit breaker is managed by MC100 and an external logic closes it (not in MAN mode). The anomaly is set only if the “static command” is used to manage the circuit breaker (see 7.10.2). It’s an alarm.
- After three consecutive closure commands: it is a warning in MAN mode, an alarm in 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, see 7.10.3).

8.1.1.12 037 – Low power supply voltage

Typology:	**Warning**
Related parameters	**P.4021 P.4022**
To disable:	**P.4022 = 0**
Enabled if:	**MAN, AUTO, TEST, REMOTE START.**

MC100 activates this anomaly when power supply voltage drops down under the threshold P.4021 for the time set with parameter P.4022. Note: the threshold P.4021 is a percentage of nominal power supply voltage; this value cannot be programmed, but is automatically detected by MC100 between 12 and 24 V. MC100 selects the nominal voltage at power on and each time the operator select the OFF_RESET mode. A nominal voltage of 12 V is selected if power supply voltage is lower than 17 V.

8.1.1.13 038 – High power supply voltage

Typology:	**Warning**
Related parameters	**P.4023 P.4024**
To disable:	**P.4024 = 0**
Enabled if:	**MAN, AUTO, TEST, REMOTE START.**

MC100 activates this anomaly when power supply voltage grows up over the threshold P.4023 for the time set with parameter P.4024. Note: the threshold P.4023 is a percentage of nominal power supply voltage; this value cannot be programmed, but is automatically detected by MC100 between 12 and 24 V. MC100 selects the nominal voltage at power on and each time the operator select the OFF_RESET mode. A nominal voltage of 12 V is selected if power supply voltage is lower than 17 V.

8.1.1.14 048 – Emergency stop

Typology:	**Alarm**
Related parameters	**P.1401 P1402 (or equivalent for inputs 2-18)**
To disable:	**P.1401 <> 72**
Enabled if:	**MAN, AUTO, TEST, REMOTE START.**

MC100 activates this anomaly when the input configured as “72 – emergency stop” (IF_72) is ***not active*** consequently for the input-related time. **For safety reasons, keep the related time not greater than one or two seconds.**

8.1.1.15 051 – High internal board temperature

Typology:	**Warning**
Related parameters	**P.4011**
To disable:	**P.4011 = 99**
Enabled if:	**MAN, AUTO, TEST, REMOTE START.**

MC100 activates this anomaly when its internal temperature is greater than the threshold P.4011, even for a very little time.

8.1.1.16 101 – From input # 1.

8.1.1.17 102 – From input # 2.

8.1.1.18 103 – From input # 3.

8.1.1.19 104 – From input # 4.

8.1.1.20 105 – From input # 5.

8.1.1.21 106 – From input # 6.

8.1.1.22 107 – From input # 7.

8.1.1.23 108 – From input # 8.

8.1.1.24 109 – From input # 9.

8.1.1.25 110 – From input # 10.

8.1.1.26 111 – From input # 11.

8.1.1.27 112 – From input # 12.

8.1.1.28 113 – From input # 13.

8.1.1.29 114 – From input # 14.

8.1.1.30 115 – From input # 15.

8.1.1.31 116 – From input # 16.

8.1.1.32 117 – From input # 17.

8.1.1.33 118 – From input # 18.

These anomalies are identical; they differ only for the related input. The following description is common for all these anomalies, but refers to parameters related to input 1(P.1401, P.1402 e P.1403). Consider the parameters related to your used input.

Typology:	**Configurable**
Related parameters	**P.1401 P.1402 P.1403**
To disable:	**P.1401 <> (73, 74, 75)**
Enabled if:	**MAN, AUTO, TEST, REMOTE START.**

Parameter P.1401 configures the kind of anomaly. The following codes are available:

- “73 – Warning” (IF_73).
- “74 – Unload” (IF_74).
- “75 – Alarm” (IF_75).

MC100 activates the anomaly when the configured input is activated consecutively for the configured time (P.1402). The message for the anomaly is the one configured for the input P.1403.

8.1.1.34 200 – PMCB CANBUS link fault

Typology:	**Warning**
Related parameters	**-**
To disable:	**-**
Enabled if:	**MAN, AUTO, TEST, REMOTE START.**

It’s activated when the internal CAN controller switch to BUS-OFF status because of bus communication errors. Normally this condition is related to wiring problems (short circuits between CAN-H and CAN-L lines, for example).

8.1.1.35 201 – Duplicated address over the PMCB

Typology:	**Warning**
Related parameters	**P.3701**
To disable:	**-**
Enabled if:	**MAN, AUTO, TEST, REMOTE START.**

This anomaly is activated when two or more MC100 devices are connected to the same can bus line, and they have the same address for PMCB (parameter P.3701).

8.1.1.36 202 – Wrong number of generators over the PMCB

Typology:	**Warning**
Related parameters	**P.3702**
To disable:	**P.3702 = 0**
Enabled if:	**MAN, AUTO, TEST, REMOTE START.**

MC100 activates this anomaly if the number of generator control devices communicating over the can bus PMCB is different from what configured by parameter P.3702. In this case, parameter P.3703 can be used to inhibit MGCB closure (but not to force its opening).

8.1.1.37 271 – MGCB synchronization failure

Typology: **Warning / alarm**
Related parameters **P.3806**
To disable: **P.3806 = 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.3806 delay, MC100 activates the anomaly: it's a warning in MAN mode, an alarm in all other modes.

8.1.1.38 272 – MCB synchronization failure

Typology: **Warning**
Related parameters **P.3809**
To disable: **P.3809 = 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.3806 delay, MC100 activates the anomaly.

8.1.1.39 273 – Incoherent parameters

Typology: **Warning / alarm**
Related parameters **-**
To disable: **-**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

MC100 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. Possible causes are:

- The parameter which require the "SICES" password (see 4.1.3) are never been set after the first factory configuration. It's an alarm.
- Selected plant type (P.3001) is different from "MPM", and the MCB circuit breaker is configured as "not managed" (P.3004). It's an alarm.
- MCB circuit breaker is configured as "external" (P.3004) and no digital input is configured to acquire its status (function "10 - MCB status" – IF_10). It's an alarm.
- MCB circuit breaker is managed by MC100 without static commands, and no digital input is configured to acquire its status (function "10 - MCB status" – IF_10). It's an alarm.
- MCB circuit breaker is configured as "external synchronizable" (P.3004), and no digital input is configured to acquire external synchronization requests (function "13 - MCB external synchro request" – IF_13). It's an alarm.
- MGCB circuit breaker is configured as "external" (P.3002) and no digital input is configured to acquire its status (function "20 - MGCB status" – IF_20). It's an alarm.
- MGCB circuit breaker is managed by MC100 without static commands, and no digital input is configured to acquire its status (function "20 - MGCB status" – IF_20). It's an alarm.

- MGCB circuit breaker is configured as “external synchronizable” (P.3002), and no digital input is configured to acquire external synchronization requests (function “23 - MGCB external synchro request” – IF_23). It’s an alarm.

8.1.1.40 274 – Production line open

Typology: **Alarm**
Related parameters **P.1401**
To disable: **P.1401 <> 82**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

MC100 activates this anomaly if the digital input configured as “82 – production line open” is activated (even for a very 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.**

8.1.1.41 275 – Interface device not opened

Typology: **Alarm**
Related parameters **P.3601**
To disable: **P.3601 = 0**
Enabled if: **MAN, AUTO, TEST, REMOTE START.**

This anomaly is used only for parallel to mains operations. MC100 activates it when the circuit breaker configured as “interface device” (P.3601) does not open in 0.5 seconds from the “loss of mains”. Set P.3601 to zero do disable this control: **ensure some external logic is able to disconnect generators from mains in case of loss of mains.**

9. Other functions

9.1 Automatic start inhibitions for generators

There are some conditions (with MC100 in AUTO mode) that avoid the automatic start of generators (and also result in stopping the generators), whatever is the plant status. **Note: these inhibitions don’t work in TEST or REMOTE START modes.**

If one of these inhibitions is activated, a “lock” symbol is shown on first line of the display. MC100 can automatically start generators only if all these inhibitions are not activated.

In the following, a description is provided for each:

- If one digital input configured as “41 - start inhibition command” (IF_41) is activated. This function doesn’t use the delay associated to the input (parameter P.1402 or equivalent). Instead, there are two dedicated parameters:
  - P.3801: it’s the delay between input activation and start inhibition activation. This time is used in AUTO mode only.
  - P.3802: it’s the delay between input deactivation and start inhibition deactivation. This time is used only if no generators are “ready to load”; otherwise a two seconds delay is used (if at least one generator has its own GCB closed, no delay is used).
- If MC100 is configured to open MCGB in case of “GCB not opened” conditions (parameter P.3704), and the “GCB not opened” conditions persists for the time configured by parameter P.3810. This inhibition will be removed when the “GCB not opened” condition will be removed.

- For parallel to mains applications (MPTM) where generators cannot supply load without mains, when mains is missing for the time set by parameter P.3810. This inhibition is removed when mains is present.

- In predefined time intervals. Using parameters P.4401, P.4402 and P.4403 it is possible to define weekly time intervals, inside which generators can be automatically started. Parameter P.4401 allows selecting the days of week in which automatic start is permitted; P.4402 selects the start of the time interval (referred to days selected with P.4401), while P.4403 selects the end of the time interval (referred to days selected with P.4401 if P.4403 is greater than P.4402, to the next days in other cases – across the midnight). Check the following table for values available for parameter P.4401.

Bit	Value	Day
0	1	Sunday
1	2	Monday
2	4	Tuesday
3	8	Wednesday
4	16	Thursday
5	32	Friday
6	64	Saturday

9.2 Load inhibitions for generators (automatic modes)

There are some conditions (with MC100 in AUTO mode) that prevent the automatic connection of generators to loads/mains (and also result in disconnecting the generators), whatever is the plant status.

MC100 can automatically connect generators to loads/mains only if all these inhibitions are not activated.

Note: these inhibitions work also in TEST and REMOTE START modes.

In the followings, a description is provided for each:

- If one digital input configured as “44 - load inhibition command” (IF_44) is activated. For this function, no delays are provided.

- If MC100 is configured to open MCGB in case of “GCB not opened” conditions (parameter P.3704). No delays are provided: generators are disconnected from loads/mains as soon as the “GCB not opened” condition happens. This inhibition will be removed when the “GCB not opened” condition is solved.

- For parallel to mains applications (MPTM) where generators cannot supply load without mains, when mains is missing. No delays are provided: generators are disconnected from loads/mains as soon as the mains is missing. This inhibition will be removed when mains will be present again.

- With a command from the serial ports or by the SMS. This inhibition is active for 30 seconds from the reception of the command. To keep the inhibition active, a new command must be received before 30 seconds from the previous one. It is also possible to remove this inhibition with the opposite command from the serial ports.

- If no generator has the GCB closed, and MGCB is supplied by generator bus (P.3003). This inhibition will be removed when the first GCB closes.

- In TEST mode, if P.4301 is configured to avoid MGCB closure in TEST mode.

9.3 TEST mode

If MC100 is in AUTO mode and the automatic start of gensets is not required, it is possible to switch to TEST mode. In this mode gensets are started for a period of time, in order to keep them efficient. It is also possible to connect the loads to the generators during the test, using parameter P.4301.

- P.4301 = 0. Loads are never connected to generators.
    - MGCB exists: MGCB is left opened, while GCB of gensets are closed.
    - MGCB does not exist: GCB of the gensets are left opened.
- P.4301 = 1. Loads are connected to generators. GCB of gensets are closed, and also the MGCB (if exists).

Note: if the automatic gensets start is required during test, MC100 switches back to AUTO mode; when the gensets will be no more required, MC100 will switch again to TEST mode only if the request for TEST is already present.

TEST mode can be activated in different ways:

- By pressing the START pushbutton: TEST mode will remain activated until the same pushbutton will be pressed again. **Note: this request is removed when the automatic start of gensets is required (so MC100 will not switch to TEST when generators will be no more required).**
- If a digital input configured as “45 - remote test command” (IF_45) is activated. TEST mode ends when this input become “not activated”.
- In the configured days and timings. The planning for the TEST of the engines is made weekly. Thus it is possible to select in which days the engines must be started for TEST. Attention: the periodic TEST is not related in any way with the manual or automatic use of the engines. It is possible that the engines have been used only a few minutes before, but the planned TEST will be performed any way. It is also possible to select a time interval (start and end hours) for the test. This time interval is common to all the days selected.

The parameters related to this function are:

- **P.4302**: lets you specify the days of week in which the TEST mode has to be activated. It is a bit-configurable parameter; each bit of the parameter corresponds to a day of 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	Value	Day of week
0	1	Sunday
1	2	Monday
2	4	Tuesday
3	8	Wednesday
4	16	Thursday
5	32	Friday
6	64	Saturday

  For example, if you want to perform the TEST only on Monday and Thursday, you must set 18 (16+2).

- **P.4303**: lets you set start time for the TEST (Hours and minutes).
- **P.4304**: lets you configured the TEST duration (in minutes).

By P.4304 you configure duration instead of a time for the end of TEST. This is because the same parameter is used also for the TEST activated by an SMS command.

- By a command received from the serial ports. TEST mode ends when the opposite command is received, or even if the communication ends on that serial port. **Note: this request is removed when the automatic start of gensets is required (so MC100 will not switch to TEST when generators will be no more required).**
- By a short message (SMS). TEST mode ends when the time set with parameter P.4304 is elapsed, or if a new message with the opposite command is received. **Note: this request is removed when the automatic start of gensets is required (so MC100 will not switch to TEST when generators will be no more required).**

9.4 Protection against MCB failures

For stand-by application, MCB must be usually closed in order to connect the loads to the mains. In case of breaker, changeover or power contactor failure, and subsequent opening, the loads can remain unsupplied. Using this function is possible to automatically start the gensets and supply the loads in case of MCB failure.

In order to use this function, carry out following configuration:

- MCB status feedback must be connected to a digital input of the controller.
- Set parameter P.3814 to 1.

With such configuration, MCB status is continuously monitored. When MCB is commanded closed but remains opened for more than the programmed time (mains has to be present if MCB is supplied by mains – P.3005), the following actions are carried out:

- Warning W013 is issued.
- All available engines are started.
- Loads are connected to generators.

At this point, loads will remain indefinitely connected to the generators. In order to restore the normal operating condition, proceed in the following way:

- Set the operating mode to MAN.
- Acknowledge the warning.
- Manually command the changeover to mains.
- Set again the mode to AUTO.

If the loads are successfully transferred to the mains, W013 warning will be reset and gensets will be stopped; otherwise W013 will be issued again and the load transferred again to the generators.

In MAN mode (or with start inhibitions activated) the function is disabled.

9.5 Alternative configuration set

It is possible to use some digital inputs, properly configured, to allow changing system configuration without directly changing programming parameters. MC100 manages 4 alternative parameter sets that can be copied in the working parameter set. Copying is activated by digital input (functions 52, 53, 54, 55; each function is dedicated to one of the four sets). Only a subset of the parameters is changed, the other remains unmodified.

Parameters modified by the alternative set are the followings:

- P.1001 - “Generators/mains nominal frequency”.
- P.1101 - “Generators number of phases”.
- P.1102 - “Generators nominal voltage”.
- P.1103 - “Generators VT primary voltage”.
- P.1104 - “Generators VT secondary voltage”.
- P.1201 - “Mains number of phases”.
- P.1202 - “Mains nominal voltage”.
- P.1203 - “Mains VT primary voltage”.
- P.1204 - “Mains VT secondary voltage”.
- P.1302 - “CT primary”.
- P.1304 - “Auxiliary CT primary.

It is possible to change the configuration by means the following input digital functions:

- “52 - Select configuration 1” (IF_52). When the input becomes active, parameters of alternative configuration set 1 are copied in the working configuration.
- “53 - Select configuration 2” (IF_53). When the input becomes active, parameters of alternative configuration set 2 are copied in the working configuration.
- “54 - Select configuration 3” (IF_54). When the input becomes active, parameters of alternative configuration set 3 are copied in the working configuration.
- “55 - Select configuration 4” (IF_55). When the input becomes active, parameters of alternative configuration set 4 are copied in the working configuration.

Remark: copying an alternative set in working configuration causes the lost of the previous loaded parameters. The only way to restore them without manual reprogramming is to configure the same parameters in another alternative set.

This function is useful for multi voltage/frequency systems, allowing a fast configuration change without direct controller reprogramming.

Remark: the load of an alternative set are enabled only if the controller is in OFF-RESET mode.

Alternative sets can be configured only by BOARDPRG software.

9.6 EJP function

Note: MC100 board is not able to detect EJP signals on the mains. In order to use this function, an external detector device should be used. The detector should provide two output signals consistent with the MC100 EJP functionality.

The EJP function allows starting the engines and warming them before mains faults, so when it will happen, loads can be immediately changed-over to genset, reducing to the minimum the time the loads stay unsupplied (or better the gensets can be placed in parallel to the mains a little time before the mains fault, so load are continuously supplied). EJP is used also to signal the beginning of more expansive fare band for the energy; some users prefer to generate the energy by ourselves during that band. EJP is a French specification and regulation.

The system uses two signal supplied by the mains supplier:

A. A signal activated well in advance with respect to the mains fault or fare change.

B. A signal activated just before mains fault or fare change.

What is desired is to start the engines in some advance (configurable) in respect to “B” signal; load however is changed-over only when “B” is activated. The board can do this, but the following rules have to be followed:

- “A” and “B” signals must stay active until mains comes back (or high fare ends).
- Both signals must be connected with relays with exchanging contacts.
- The time between “A” and “B” signals activation must be known.

To use this function the board has to be configured in the following way:

- Configure one digital input as “42 - remote start command” (IF_42). Moreover, for this input it has to be configured the desired delay between “A” signal activation

and the engines start (in seconds, in parameter P.1402 or equivalents). If, by example, we want to warm the engines for five minutes and "A" signal will be activated 30 minutes before "B", the P.1402 delay will be 1500 seconds that is 25 minutes (it is possible to set delays up to 6000 seconds that is 100 minutes).

- Configure one digital input to acquire the "44 - Load inhibition command" (IF_44).

Then connect the **N.O**. contact of the relay on "A" signal to first configured input and **N.C.** contact of "B" signal relay to second input. **REMARK: the "Load inhibition command" function prevents to connect the loads also if the generators are automatically started for other reasons such as AMF. To avoid this problem, use a logic that prevents to activate this input if the generators are not started by "REMOTE START" function.**

When both signals are inactive, the board has not the "remote start" request and so stays at rest in AUTO mode. The "load inhibition command" is ignored.

When "A" signal is activated, both board inputs will be active. The board will not pass immediately to "REMOTE START" mode, but will do it only after the time configured in P.1402 (or equivalents). So in this phase, too the "load inhibition command" is ignored. In this phase, window S.01 shows the remaining time before cranking.

After the configured time from "A" signal activation, the board passes in "REMOTE START" mode and proceeds to start the engines. In this phase, the "load inhibition command" is no more ignored, and being it active (connected on N.C. relay contact), it will prevent the loads changeover on genset.

When "B" signal is activated, the "load inhibition command" input is deactivated, allowing so the load changeover on genset.

When the function ends, both "A" and "B" signals are deactivated. Therefore, the board comes back in AUTO mode, and being mains present, it provides to stop the engines.

9.7 Output mapping

By means output function "60 – Bit-mapped" (OF_60) is possible to configure a digital output to be activated when at least one of selected status (among a list of 192) is active. Thus this function implements a logical OR operation on all the selected status (it is possible select up to 192 statuses). The statuses are split in three blocks of 64 each. Each block is described by a parameter that consists of a hexadecimal string of 16 characters. Each character represent 4 binary digit (thus 4x16 = 64 bits). Each output has thus 3 parameters for output mapping. Setting to one a bit will include the related status in the check for that output. If any of the status that has the related bit set to one becomes active, the output becomes active.

- First 128 statuses are associated mainly to controller anomalies. **Remark: output is activated when the selected anomaly is activated not when the related input is active (in OFF-RESET, inputs can be all active but no anomalies are activated and neither the mapped outputs associated).**
- Last 64 statuses are general status of the controller, engine, generator etc.

9.8 Counters

The board manages internally the following counters:

1. Active energy (kWh) of generators, clearable: it counts only the supplied energy, it does not count in case of power reverse.

2. Active energy (kWh) of generators, total: it counts only the supplied energy, it does not count in case of power reverse.
3. Reactive energy (kvarh) of generators, clearable; it counts the absolute value.
4. Reactive energy (kvarh) of generators, total; it counts the absolute value.
5. Mains Active energy (kWh), clearable.
6. Mains Active energy (kWh), total.
7. Mains Reactive energy (kvarh), clearable; it counts the absolute value.
8. Mains Reactive energy (kvarh), total; it counts the absolute value.
9. Board absolute supply time (hours).

These counters are not visible on board frontal panel. All are however readable by means of serial ports (with the Modbus protocol). Some of these counters can be reset by means of the serial ports (on previous list these are identified as “clearable”). All these counters are saved in a non-volatile memory and so they maintain their value also removing supply from the board. 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 in the same time) in the following conditions:

- Each time the operating mode is switched to OFF_RESET.
- For each board supply hour.

Furthermore, counters are saved when they are reset (singularly or globally) from serial ports. Beware that some counters have a decimal part (example the minutes-counters associated to hours-counters), which is saved in non-volatile memory too. Removing supply to the board in an uncontrolled way, there is the risk to loose just this decimal part. It is however sufficient switch the operating mode to OFF_RESET to force the board to save data, before removing the supply.

9.9 Clock

The board is provided with a hardware clock. The date/time is shown in the S.06 page of the multifunction display and on the top right of any screen. Time and date are programmable through the menu 4.0.0 of the program function or trough the serial ports. Clock is used for many functions:

- History logs recordings (see 5).
- Weekly planning of the start of the engine for TEST (see 9.3).
- Weekly planning of time intervals in which the gensets must not automatically be started (see 9.1).

9.10 Thermometer

The board is provided with a thermometer used to measure the internal temperature. The measure is shown on S.06 page of the multifunction display. It is used for many functions:

- It is used for automatic compensation of the multifunction display contrast on changes of the ambient temperature. Without this regulation, if you set the

contrast on summer, the reading of the display in winter should be not possible or much difficult.

- The display becomes slower in showing information at very low temperatures. By using the thermometer, when the temperature falls under a very low threshold, the board switches on the backlight lamp of the display, and this contributes to warm it up and to improve its performances.
- The electronic components inside the board have an extended working temperature range. Despite this, it is possible in critical ambient conditions that temperature goes out of this range. The board uses the thermometer to activate a warning if the ambient temperature becomes greater than a configurable threshold. This is useful for alerting the operator, but is also possible to use one board configurable output for activate an external cooling system (by using the bit-mapping function you can configure one output to follow the state of the high internal temperature warning).
- For diagnosis purpose, the board stores in its history logs the most high and low temperature measured, by using also the internal clock. With this function, it is possible to examine in a second time the board working conditions, checking if it is necessary to install external warming/cooling systems, in order to improve the operating conditions.

9.11 Fault signaling

It is possible to configure the outputs from 5 to 14 with the function “61 – Device fault” (OF_61). The output is always activated: it can be not active only due to an internal fault of the controller. It can be use to signal a fault of the controller.

10. Installation

For a proper use of the device, it must be mounted in a fixed way onto a panel or cabinet. The rear panel of the device must not be accessible without using tools or keys. It must be impossible to remove the controller without tools.

DUE TO THE HIGH VOLTAGE CONNECTED TO THE MEASURE INPUTS, ALL THE CONDUCTIVE PARTS OF THE CABINET MUST BE CONNECTED TO SAFETY GROUND.

Protection ground must be permanently connected where required.

The external installation of over current protections is required for each mains and generators phase. The board input impedance of each mains and generators lines, in normal operating conditions, is greater then 1 MΩ. Over current protections of 1A threshold are suitable.

The safety heart connection wire, where used, must be at least equal in section as the wires used to cable the mains and generator voltage line to the board. The section of the wire must be conform to the over current protections value used.

For CAT.IV application, the max applicable voltage is 300Vac (phase-to-neutral) and 520Vac (phase-to-phase). The maximum voltage relative to safety ground is 300 Vac.

For CAT.III application, the max applicable voltage is 345Vac (phase-to-neutral) and 600Vac (phase-to-phase). The maximum voltage relative to safety ground is 600 Vac.

Note: MC100 is able to measure phase-to-phase voltages up to 580 Vac.

Controller can operate in CAT.IV and CATIII condition if the negative supply of the controller and generator's neutral line are connected to the safety ground. In other cases, please, check with SICES the actual operating conditions.

10.1 Panel cut-out

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