POWER FROM WITHIN

HS315 CONTROLLER

SMARTECH

A DIVISION OF MECC ALTE

TECHNICAL MANUAL

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Revision	Date	Notes
22/03/2017	00	The first version of the manual, drawn-up for version 01.00 of the controller.
30/08/2017	01	Valid from version 01.01 of the controller. 1.1, 2, 3, 3.1, 5, 5.4.5, 5.5.5, 5.6.6, 5.7.3, 5.14, 5.14.2, 5.14.3, 5.15, 7.4.3, 7.5.2, 7.5.3.1, 7.5.3.2, 7.5.4.1, 7.5.4.14, 7.5.4.15, 8.2.2, 8.3.6, 8.5.2, 8.5.3, 8.5.4, 8.5.5, 8.5.7, 8.5.7.1, 8.5.7.2, 8.5.7.3, 8.5.9, 8.5.11, 8.5.12, 9.1, 9.2, 9.56, 9.59, 9.213, 9.226, 9.227, 9.228, 9.237, 9.900, 9.901, 10.2, 10.9, 10.9.1, 10.9.2
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10/03/2018	03	Added paragraph 1,8, 1.9
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11/06/2021	12	Valid for version 1.18 9.1, 9.5.7.1, 10.273
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18/03/2025	26	Valid for version 2.06 1, 6.5, 7.3, 8.5.3.6

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1 Introduction

1.1 Reference documents

[1] Mecc Alte EAAM0584xxXA Parameters table HS315.

[2] Mecc Alte EAAM0458xxEN Software Manual BoardPrg4.xx

[3] Mecc Alte EAAS0341xxEN Serial communication and SMS protocol.

[4] Mecc Alte EAAS0585xxXA Modbus registers HS315.

[5] Mecc Alte EAAP0457xxXA USB driver installation guide

[6] Mecc Alte EAAM0412xx – PLC environment for Mecc Alte devices

[7] Mecc Alte EAAM0867xx Smart Cloud v1.2.0 Manual

1.2 Introduction and prerequisites

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

⚠ WARNING!!!!

All interventions must be carried out only by qualified personnel, because dangerous voltages are present on the terminals of the device; prior to performing any operation, make sure you have opened the circuit breakers and generator set switches, or that you have removed their fuses.

Do not remove or modify any of the connections while the generator set is operating.

Incorrect interventions on the connections can result in disconnection of the users from the auxiliary source, from the plant battery or from the generator.

Before installing and using the device, carefully read this handbook.

The device uses many configurable parameters and it is therefore impossible to describe all their possible combinations and effects.

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.

The devices are supplied with a generic "default" configuration; is the responsibility of the installer to adjust the operating parameters to his/her specific application.

Mecc Alte makes considerable efforts for a continuous improvement and upgrading of its own products; therefore, they are subject to modifications both in hardware and software, without prior notice. Some of the features described in this manual may therefore differ from those present in your device.

1.3 Switch SW1

IMPORTANT! Both the SW1 switches must remain in OFF position.

The SW1 switches are reserved for accessing special features that are not part of the normal operation of the device.

If the device is powered with one of the two switches in ON position, it will not turn on. To restore normal operation, you need to remove the power from the device, turn the switches OFF and power it again.

In case the device does not turn on when powered, the first thing you must do is to check the position of the switches.

1.4 Notes on the configuration of the device parameters.

Although most of the parameters and features can be accessed and configured by directly operating on the device, **some particular features or configurations, due to their nature, can only be set or changed through the Mecc Alte Board Programmer4 PC Software** (hereinafter called "BoardPrg4"), which can be downloaded for free from the Mecc Alte website www.meccalte.com

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

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

BoardPrg4 can be used on all the Mecc Alte devices; connection to the PC can be realized both directly, via the RS232 serial port, USB, or remotely via modem, RS485 serial port or Ethernet network. To use the program, refer to document [2].

1.5 Definitions

In this document, the term "**ALARM**" is used to indicate a fault that prevents the generator set from operating and causes the automatic emergency shutdown of the generator (skipping the cool down phase).

The term "**DE-ACTIVATION**" is used to indicate a fault that prevents the generator set from operating and causes the automatic standard shutdown of the generator (including the cool down phase).

The term "**WARNING**" is used to indicate a fault that requires the intervention of the operator with no need for automatic shutoff of the generator. When the operator acknowledges the fault, if its cause is no more present, the controller automatically resets it.

The term "**LATCHED WARNING**" is used to indicate a fault that requires the intervention of the operator with no need for automatic shutoff of the generator. This fault is different from a "WARNING" because this requires an explicit reset by the operator.

The codes that identify functions for input, output, status or other functions are preceded by the following acronyms:

DIF ("Digital Input Function"): the following is a code for the configuration of the digital inputs.

DOF ("Digital Output Function"): the following is a code for the configuration of the digital outputs.

AIF ("Analogue Input Function"): the following is a code for the configuration of the analogue inputs.

AOF ("Analogue Output Function"): the following is a code for the configuration of the analogue outputs.

AVF (“Analogue Virtual Function”): the following is a code for the configuration of the virtual analogue inputs.

EVT (“Event”): the following is an event code

ST (“Status”): the following code shows the status of a dimension or a condition of the device or of one of its functions.

1.6 Conventions

In this document a vertical bar on the right margin or a grey background indicates that the chapter or the paragraph has been amended respect to the previous document’s version. Changes in the fields of a table are highlighted with a grey background colour.

1.7 Terms and Abbreviations

EDGE *Enhanced Data rates for GSM Evolution (E)*

GNSS *Global Navigation Satellite System*

GPRS *General Packet Radio Service*

GPS *Global Positioning System*

GSM *Global System for Mobile*

IoT *Internet of Things*

IP *Internet Protocol*

LTE *Long Term Evolution*

LTE-M *Long-Term Evolution Machine Type Communications Category M1*

NB-IoT *Narrowband IoT*

RAT *Radio Access Technology*

RF *Radio Frequency*

SIM *Subscriber Identification Module*

SMS *Short Message Service*

1.8 Software revisions

Several parts of this manual refer to the controller's software revisions. These revisions are marked with the assigned Mecc Alte code (shown on the rear panel of the controller). Software code version has the following format: EB0250260XXYY, where "XX" is the main revision number and "YY" is the secondary revision number. Thus, code EB02502600100 refers to the controller's software release "1.00". The software revision is also displayed on page “S.03” of the LCD display.

The software codes available at the release date are:

- EB0250260xxyy: HS315.

1.9 Maintenance and cleaning

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

The cleaning of the front panel can be carried out exclusively with a soft cloth. Do not use abrasive products, detergents or solvents.

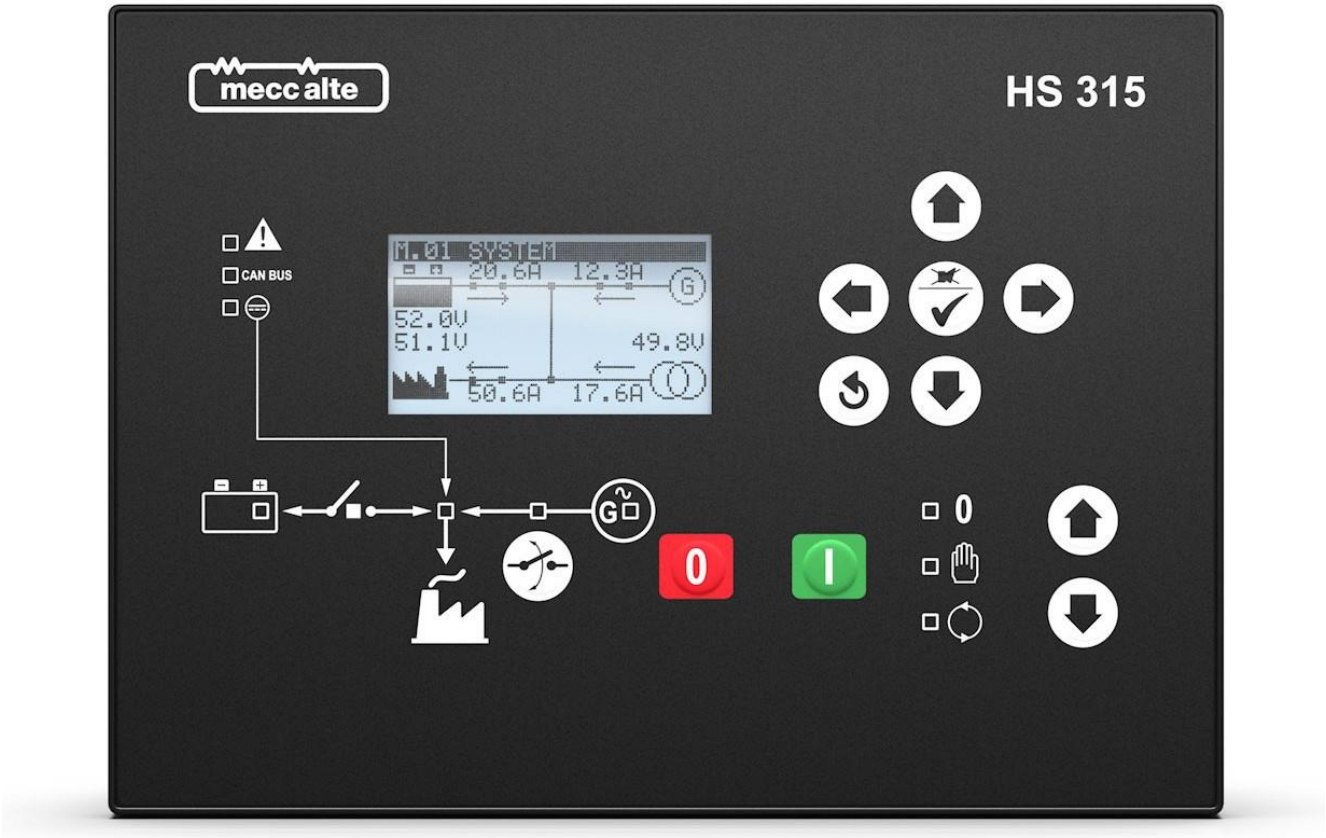
1.10 Information concerning disposal

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

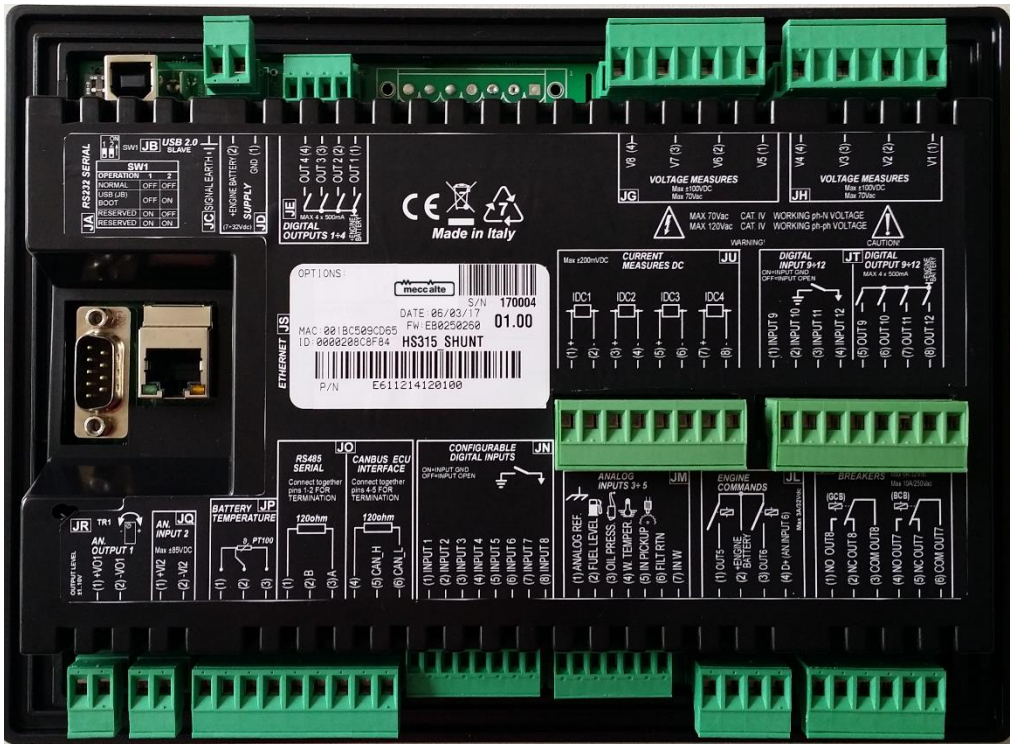
Products bearing the barred wheeled waste container symbol cannot be disposed of with normal urban waste. Old electrical and electronic equipment should be recycled in a facility authorized to process these items and dispose of the components. Contact your local authority for information on where and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

2 Views of the device

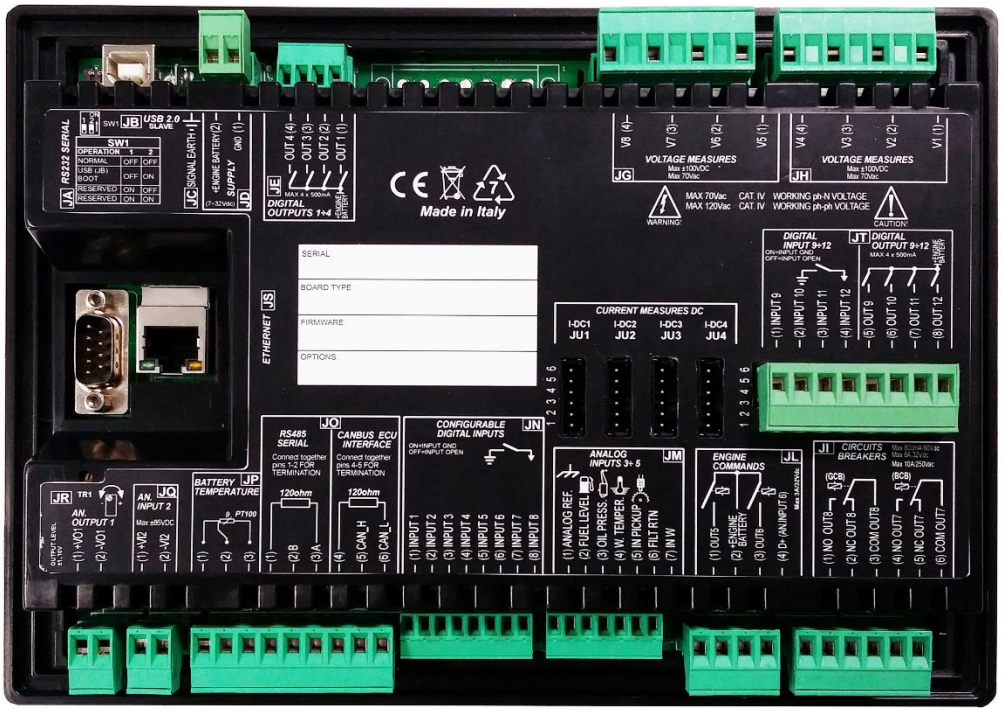
Front view



Rear view (shunt)



Rear view (Hall)



3 Technical features

Supply power voltage +VBATT – JD	
Operation	From 7 to 32Vdc with continuous operation. Protection against polarity reversal with built-in self-resetting fuse. The operation is guaranteed during the engine start up to Vbatt=5VDC for an undefined time. The device identifies the plant operation at 12 or 24V to manage its alarms when powered up and whenever OFF/RESET mode is selected.
Power consumption in stand-by:	For HS315 without options: 330mA @ Vbatt =13.5VDC with LCD backlight lamp 310mA @ Vbatt =13.5VDC without LCD backlight lamp 195mA @ Vbatt =27 VDC with LCD backlight lamp 185mA @ Vbatt =27 VDC without LCD backlight lamp
Maximum power consumption during operation (relays, horn, LCD backlight lamp, digital inputs activated; static outputs not activated)	For HS315 without options: Max 970mA @ 7 VDC 420mA @ 27 VDC 540mA @ 13.5 VDC
Voltage measurement inputs V1-V8 - JG and JH	
Input type	8 AC/DC voltage measurement inputs. Resolution 12bit. DC voltage measurements are referred to the negative power supply of the controller. Measurement of the AC L-N and L-L phases voltages. Measurements of the neutral voltages referred to the device supply negative.
Type of measurement	True RMS measurements (TRMS).
Sampling frequency	10Khz
Input impedance	> 500kohm terminal-GND
Maximum DC voltages applicable	MAX ±105Vdc MAX 74Vac **With common mode voltage respect to GND = 0**
Maximum AC voltages applicable	MAX 150Vac in CAT.III MAX 100Vac in CAT.IV
Analogue input 02 – DC voltage measurement - JQ	
Input type	Differential DC voltage measurement. Resolution 12bit. Not insulated.
Type of measurement	RMS
Sampling frequency	240 SPS
Input impedance	> 300kohm Terminal-GND

Maximum DC voltages applicable	When configured for DC source: MAX ±85Vdc When configured for generic 0...10V: MAX ±21Vdc **With common mode voltage respect to GND = 0**
Maximum common mode voltage respect to GND	When configured for DC source: MAX +20Vdc When configured for generic 0...10V: MAX ±20Vdc
Bidirectional DC current measurement input – JU - SHUNT	
Input type	Four differential analogue inputs for DC voltage measurement, optimized for the connection towards external shunt sensors. Galvanically insulated.
Type of measurement	True RMS measurements (TRMS)
Sampling frequency	10Khz
Input impedance	> 28Kohm
Maximum DC voltages applicable	Max ±200mVdc
Insulation voltage	350Vac
Surge immunity	1KV (class 2) transient 1,2/50µs (EN61000-4-5)
Resolution	12 bits
Measurement accuracy	<0,2% F.S. (excluding the error of the shunt) The measurement accuracy of the DC current depends on the accuracy class of the used shunt. We suggest the use of shunts with accuracy class of 0,5 or better.
Bidirectional DC current measurement input DC – JU - HALL	
Input type	Four differential analogue inputs for DC voltage measurement, optimized for the connection towards external HALL effect sensors. The galvanic insulation is provided by the sensors. No injection leakages.
Type of measurement	True RMS measurements (TRMS)
Sampling frequency	10Khz
Maximum DC currents applicable	Nominal range from 50 to 600A DC.
Insulation voltage	500Vac CAT.III 3KVdc on transient < 60s.
Resolution	12 bits
Measurement accuracy	<1,5% F.S.

Analogue input PT100 - JP	
Input type	Analogue input for the measurement of the plant battery temperature, through PT100. The resistance is calculated by measuring the differential voltage on the sensor, injecting a constant current. PT100 sensors with two or three wires can be used. Not insulated.
Temperature measurement range	From -70°C to +650°C
Resistance measurement range	From 20 Ohm to 330 Ohm (broken wire warning over 333 Ohm).
Sampling time	<300ms
Injected current	0,6mA nominal
Resolution	12 bits
Measurement accuracy	<0,1% F.S. with three wires connection (excluding the error of the sensor)
Digital inputs 01-12 – JN and JT	
Input type	8+4 digital inputs with same supply, internal supply terminal connected to the device positive JD (2) +Vbatt. They are active when the input is connected to the supply negative GND. When they are open, the inputs terminals voltage is like Vbatt.
Activation/deactivation threshold	2,5VDC
Typical current with closed contact	6,3mA @ +Vbatt= 13.5Vdc 12 mA @ +Vbatt= 27Vdc
Input signal delay	It can be adjusted by the related parameter for each input
Digital outputs 01-04 - JE	
Output type	4 independent static outputs to battery positive. The output current is supplied by the positive supply terminal of the device JD (2) +Vbatt. All relay outputs are adjustable by parameter.
Nominal Rated Current	Max 500mAdc for each output. Maximum total continuous current for all activated outputs 500mADC for the full temperature range of the device
Output resistor on status ON	Max 350mΩ
Leakage current on status OFF	Max 5uA@32Vdc
Protections	Internal current limited to about 4A max. on transients >150us. Thermal protection, short circuit, overvoltage and inverted polarity.
Digital outputs 05 and 06 – JL Engine commands	
Output type	2 relays with NO contacts and one positive common terminal. The positive common terminal has the function of input for the emergency stop. The measurement of the voltage on the common input is displayed at page S.16 of the display (EM-S). They can be used as starter motor (START) and fuel solenoid valve (FUEL). All relay outputs are adjustable by parameter.

Rated supply	Max. 3A @ 30Vdc for each output.
Protections	Integrated opening power-surge protection diodes.
Digital outputs 07 and 08 – JI Switch commands	
Output type	2 relays with dry contacts for the contactors. All relay outputs are adjustable by parameter.
Rated supply	Max. 10A @250Vac.

Digital outputs 09-12 - JT	
Output type	4 independent static outputs to battery positive. The output current is supplied by the positive supply terminal of the device JD (2) +Vbatt. All outputs are adjustable by parameter.
Nominal Rated Current	**Valid for HW revision 00:** Max 400mAdc for each output. Total maximum continuous current for all activated outputs $400mA_{DC}$ @ 20°c **The maximum total current decreases with increasing temperature according to the derating curve shown in section 5.5.3**
	Valid for HW revision 01: Max 500mAdc for each output. Maximum total continuous current for all activated outputs $500mA_{DC}$ (full temperature range of the device).
Output resistor on status ON	Max 350mΩ
Leakage current on status OFF	Max 5uA@32Vdc
Protections	Internal current limited to about 4A max. on transients >150us. Thermal protection, short circuit, overvoltage and inverted polarity.
D+ output and analogue input 06 - JL	
Output type	Current output with value automatically switched according to the supply voltage Vbatt. If it is not used for the excitation of the battery charger alternator, it is possible to configure the D+ terminal as analogue input or acquire voltage measurements from 0 to 32Vdc or as additional digital input with +Vbatt activation. The voltage measurement acquired is displayed in the page S.16 of the display.
Excitation current	200mA @ 13.5 Vdc 100mA @ 27 Vdc
Sampling frequency	10kHz
Resolution	12 bits

Analogue inputs 03-05 and Vref - JM	
Input type	3 adjustable analogue inputs, which can be used as engine equipment. Adjustable as resistive, voltage, current (with external resistor) and digital inputs. For the resistive sensors, there's an input for the measurement and compensation of the reference potential with respect to the sensor common negative (Vref).
Resistive inputs	Measurement range: 0 – 500Ω with error < 0,2% 0 – 2kΩ with error <1% Injected current: 25mA max. Compensation range (Vref): from -2,7Vdc to 5Vdc
Sampling frequency	10kHz
Resolution	12 bits
Pick-up input for the measurement of the engine speed - JM	
	Filtered for DC currents blocking.
Minimum voltage	1,3Vac @ 3kHz
Maximum voltage	60Vac
Frequency range	1Hz – 10000Hz
"W" inputs for the measurement of the engine speed - JM	
	It uses a pick-up input with internal anti-interference filter to insert by connecting the JM connector pin 7 and 8 to each other.
Analogue output 01- JQ	
Output type	±10Vdc voltage output, galvanically insulated It can be used for the connection to the speed regulator or to the voltage regulator. The output includes a trimmer able to reduce the maximum output voltage, preserving the resolution.
Regulation range	From ±1Vdc to ±10Vdc
Resolution	16 bits
Minimum load impedance	>10 kΩ
Insulation voltage	560Vdc max. 3KVdc on transient < 60s.
Insulation resistance	>1000MΩ @ 500Vdc
RS232 Communication interface - JA	
Interface type	1 RS232 serial port standard TIA/EIA, not insulated on DB connector 9 poles male CANON
Electrical signals	TX. RX, DTR, DSR, RTS, GND

Settings	Baud rate selectable by parameter: 300, 600, 1200, 2400, 4800, **9600***, 19200, 38400, 57600, 115200 bps Parity: **None***, Even, Odd Stop bit: **1***,2 * **Default Setting**
Type of transmission	**Modbus RTU Slave***, Modem AT, Modbus RTU master * **Default Setting**
RS485 Communication interface - JO	
Interface type	1 RS485 serial port standard TIA/EIA, with galvanic insulation. Terminal resistor connectible by connecting to each other terminals 1 and 2 of JO
Electrical signals	DATA+ (A), DATA– (B)
Settings	Baud rate selectable by parameter: 300, 600, 1200, 2400, 4800, **9600***, 19200, 38400, 57600, 115200 bps Parity: **None***, Even, Odd Stop bit: **1***,2 * **Default Setting**
Type of transmission	**Modbus RTU Slave***, Modbus RTU Master * **Default Setting**
Insulation voltage	560Vdc max. 1KVdc on transient < 60s.
USB 2.0 Communication interface - JB	
Interface type	1 USB2.0 serial port not insulated, which can be used in Function mode.
	Connection to PC by Mecc Alte Driver USB Connector type B. Type of transmission Modbus RTU Slave
Maximum distance	6m (20 feet)
CANBUS Communication interface - JO	
Interface type	One CANBUS port with galvanic insulation. 1 RS485 serial port standard TIA/EIA, with galvanic insulation. Terminal resistor connectible by connecting to each other terminals 4 and 5 of di JO.
CanBus0	CANBUS connection with protocol SAE J1939 and MTU for ECU engine control.
Nominal impedance	120Ω
Insulation voltage	560Vdc max. 1KVdc on transient < 60s.
Ethernet Communication interface - JS	
Interface type	1 Ethernet interface 10/100Mbps full-duplex 10T/100Tx Auto HP Auto-Mdix support Compliant IEE802.3/802.3u (Fast Ethernet) Compliant ISO802-3/IEEE802.3 (10BASE-T)
Insulation voltage	1500VRMS

Display	
Display type	Transflective graphic monochrome LCD with backlight illumination with white leds.
Resolution	128 x 64
Pixel Size	0,48 x 0,48 mm
Visual area dimensions	70 x 38 mm

Environmental conditions	
Operating temperature	From -25°C to +60°C
Stock temperature	From -30°C to +80°C
Humidity	IEC 60068-2-30 Db Damp Heat Cyclic 20/55°C @ 95% RH 48 Hours IEC 60068-2-78 Cab Damp Heat steady state 40°C @ 93% RH 48 Hours
Box	
Material	ABS + PC
Size	244(L) x 178(H) x 50(P) mm
Hole size	218x159mm
Weight	600g
Protection degree	IP65 with gasket for the front panel IP20 for the panel interior

3.1 Measurement resolution

Auxiliary source and generator voltages (AC):	1Vrms accuracy <0.5% F.S.
Auxiliary source and generator frequencies (AC):	0.1Hz ±50ppm, 35ppm/C typical
DC Voltages (JG and JH)	50mV
DC Currents	Shunt: 0,1mV Hall MIN. 15mA MAX. 150mA Current value depends on external transducer.
Powers	Min. 0.1 kW (depends on the current transformers ratio)
Engine speed	1 rpm
Oil pressure	0.1bar (below 10bar)
Coolant temperature	0.1°C
Fuel level	0.1%
PT100	0.1°C
Analogue input JQ	<40mV (for DC source) <10mV (for generic measure)
Analogue output JR	0.3 mV/bit

3.2 Additional characteristics of LINK LTE series device (GPRS/EDGE/LTE)

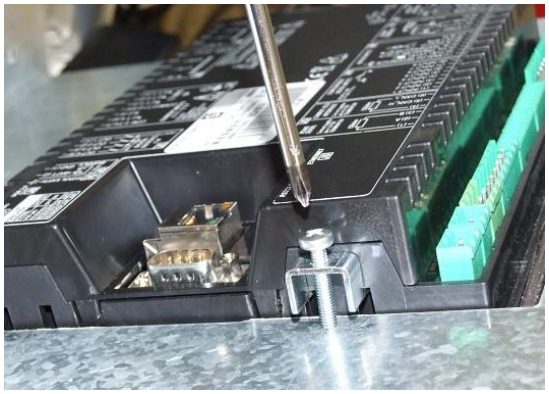
Protocol stack	3GPP Release 13	
Radio Access Technology (RAT)	**LTE Cat. M1** **LTE Cat. NB-IoT** Band: B1/B2/B3/B4/B5/B8/B12/B13/B18/B17/B19/B20/B26/B28/*B39** **B39* Supported only with LTE Category M1	
	GSMGPRS/EDGE Band: 850/900/1800/1900Mhz	
Transmitting power	**GPRS power class**: EGSM900: 4 (2W) DCS1800: 1 (1W)	**EDGE power class:** EGSM900: E2 (0.5W) DCS1800: E1 (0.4W)
	LTE power class: CAT M1 and NB-IoT: 3 (0.25W)	
Data Transmission Throughput	**LTE CAT-M1**: Uplink up to 375kbps (Half duplex) Downlink up to 300kbps (Half duplex) Uplink up to 1Mbps (Full duplex) Downlink up 1Mbps (Full duplex)	**LTE NB-IoT**: Uplink up to 66kbps Downlink up to 34kbps
	EDGE Class: Uplink up to 236.8Kbps Downlink up to 236.8Kbps	**GPRS**: Uplink up to 85.6Kbps Downlink up to 85.6Kbps
Global Navigation Satellite System (GNSS)	**GPS** 1575.42 ± 1.023Mhz	**GLONASS** 1597.52–1605.92Mhz
	Galileo 1575.42 ± 2.046Mhz	**BeiDou** 1561.098 ± 2.046Mhz
	Receiver Type: 16-channel C/A Code	
	Sensitivity GNSS Tracking: -167 dBm (GPS) /-157 dBm (GLONASS) Reacquisition: -157 dBm Cold starts: -148 dBm	
	Stand-alone Time to First Fix (TTFF) Cold start: <35s Hot start: <1s	
	Accuracy in open sky < 2.5m (CEP50)	
Antenna RF (GSM/LTE)	50-ohm nominal characteristic impedance	
Antenna GNSS	50-ohm nominal characteristic impedance The plug of the Link device provides automatically the power supply required (Max 35mA@3,3Vdc).	
Inertial motion sensors features	**3D Accelerometer:** Linear acceleration measurement range: ±2 g/±4 g/±8 g/±16 g Linear acceleration sensitivity FS = ±2 g 1 mg/digit FS = ±4 g 2 mg/digit FS = ±8 g 4 mg/digit FS = ±16g 12 mg/digit **3D Gyroscope:** Angular rate measurement range: ±250/±500/±2000 dps Angular rate sensitivity FS = ±250 dps 8.75 mdps/digit FS = ±500 dps 17.50 mdps/digit FS = ±2000 dps 70 mdps/digit	

4 Installation

4.1 Mounting

The device must be mounted permanently on an electrical panel or cabinet. The back of the device must be accessed only using keys or tools, and only by personnel authorized to perform maintenance operations. The device must be mounted in a way that makes it impossible to remove it without using tools.

The dimensions of the mounting slot are 250x159mm. The device is mounted with four hooks with locking screws: once you have put the device in place, insert the hooks in the side slots and tighten the screws. Be careful not to overtighten the screws to avoid damaging the coupling slots on the casing of the device.



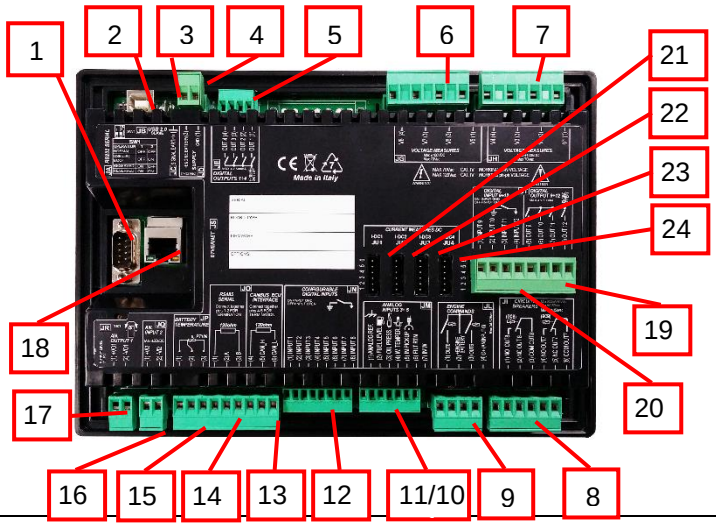
4.2 Wiring

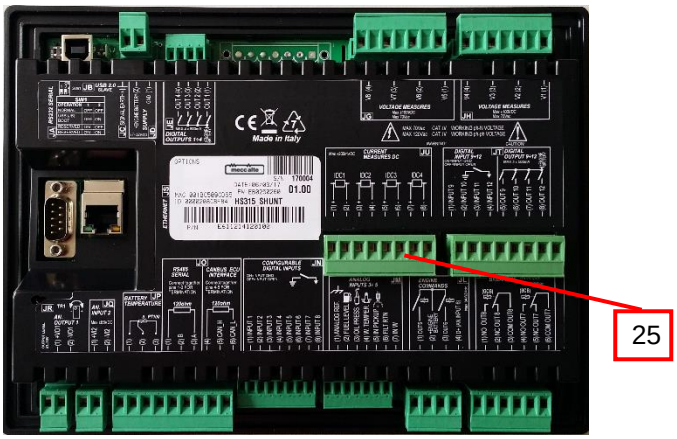
Due to high voltages associated to the measurement circuits of the controller, all the conductive parts of the electrical panel must necessarily be connected to the protective earth by means of permanent connections.

Installing an overcurrent protection device is required for each input terminal for voltage measurement. 1A fuses can be conveniently used.

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

5 Connections and IN/OUT configuration

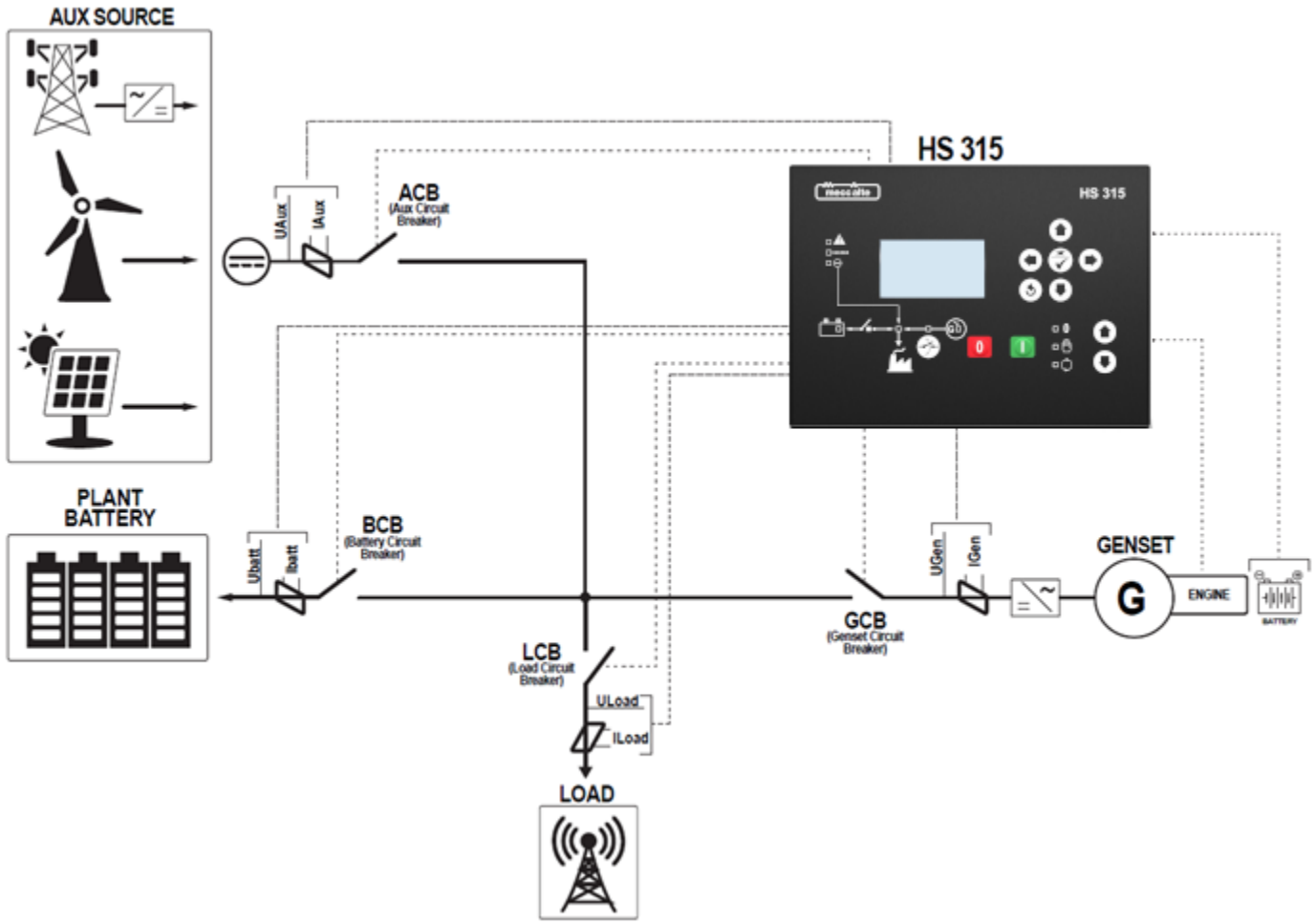




No.	NAME	DESCRIPTION	CONNECTOR
1	**JA**	Interface RS232	9 Poles Male Canon
2	**JB**	USB	USB B
3	**JC**	Signal Earth	Faston
4	**JD**	Power supply	2 polesx2.5mm^2 Screw terminal
5	**JE**	Digital outputs	4 poles x1.5mm ^{2} Screw terminal
6	**JG**	AC voltages for generator or DC voltages	4 poles x2.5mm^2 Screw terminal
7	**JH**	AC voltages for auxiliary source or DC voltages	4 poles x2.5mm^2 Screw terminal
8	**JI**	Digital outputs (mainly for circuit breakers)	6 poles x2.5mm^2 Screw terminal
9	**JL**	Digital outputs (mainly fir engine commands) and +D input	4 poles x2.5mm^2 Screw terminal
10	**JM**	Pick-Up / W	7 poles x1.5mm ^{2} Screw terminal
11		Engine tools	
12	**JN**	Digital inputs	8 poles x1.5mm ^{2} Screw terminal
13	**JO**	ECU Can-bus J1939	6 poles x2.5mm ^{2} Screw terminal
14		RS485 Interface	
15	**JP**	Plant battery temperature input	3 poles x2.5mm ^{2} Screw terminal
16	**JQ**	Auxiliary DC voltage input	2 poles x2.5mm ^{2} Screw terminal
17	**JR**	Analogue output for AVR / speed governor	2 poles x2.5mm ^{2} Screw terminal
18	**JS**	Ethernet	RJ45
19	**JT**	Digital inputs	8 poles x2.5mm 2 Screw terminal
20		Digital outputs	
21	**JU1 (Hall)**	DC current input	AMP MODU2 – 6 poles
22	**JU2 (Hall)**	DC current input	AMP MODU2 – 6 poles

23	**JU3 (Hall)**	DC current input	AMP MODU2 – 6 poles
24	**JU4 (Hall)**	DC current input	AMP MODU2 – 6 poles
25	**JU (Shunt)**	DC current inputs 1…4	8 poles x2.5mm 2 Screw terminal

5.1 Basic Diagram

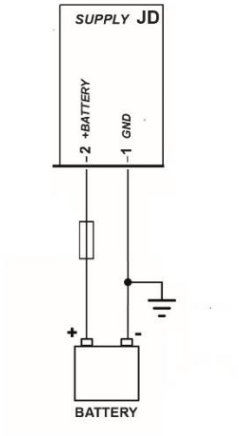


5.2 Functional earth (JC)

The connection to the functional earth JC is mandatory, to guarantee the proper operation of the device and compliance with the EU Electromagnetic Compatibility Directive.

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

5.3 Device (JD) supply



The **JD** connector is the supply connector: connect an uninterruptible power supply (usually the engine starter battery) to the **1-GND** terminal (minus) and to the **2-+BATT** terminal (plus).

The minus terminal **1-GND** is the reference and the common return of the digital inputs, of the outputs and of the current and voltage measurements. **It must be connected to the protective earth.** Systems requiring isolation between battery minus and protective earth are nonetheless usable, but they may generate operating problems and could require special precautions, such as the use of insulating voltage transformers for the auxiliary source and the generator voltage (AC) measurements.

Although the device is protected by a built-in self-resetting fuse, it is recommended that you use a fuse for the protection of the positive line **2-+BATT**. of supply.

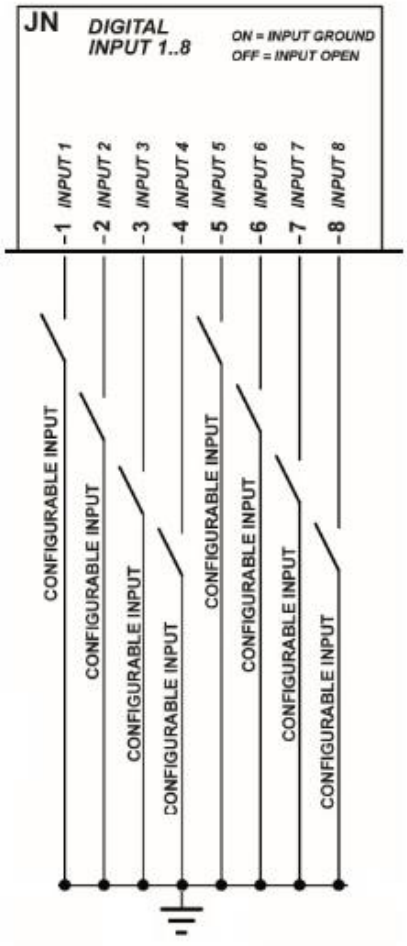
All the current delivered by the SSR outputs flows through the positive input 2-+BATT., therefore you need to pay attention to the dimensioning of the fuse.

The device automatically recognizes when it is powered if the generator set battery nominal voltage is 12 or 24V for managing the related logics and alarms. The recognition also takes place every time you switch to mode **OFF/RESET**.

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

5.4 Digital inputs

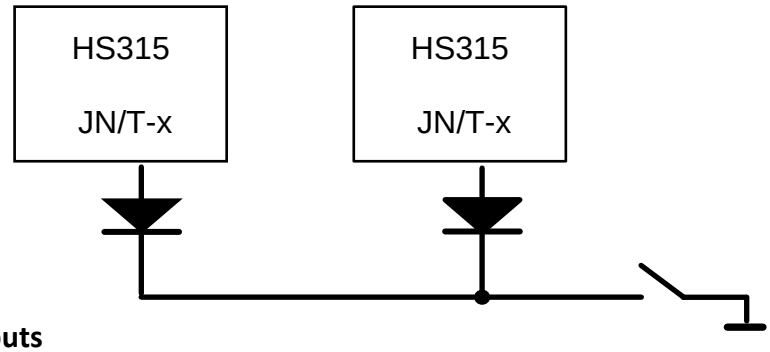
5.4.1 JN and JT digital inputs



HS315 has 12 digital inputs, which can be activated by connecting them to GND. When left floating, the input brings itself to +Vbatt. Avoid situations where intermediate or undefined voltage levels can occur.

Eight of the twelve inputs are located in the connector JN that is totally dedicated to these inputs (see the picture). The remaining 4 inputs are in the connector JT, using 4 of the 8 available terminals.

The same command signal of an input can be shared by several different devices (for instance one signal that goes to two HS315). In this case it is recommended to separate the inputs with diodes, as shown in the figure below. This is to prevent the false activation of the input when one of the devices is being turned off.



5.4.2 Virtual digital inputs

In addition to the 12 digital physical inputs and the 32 of the DITEL modules, the controller also operates 16 virtual digital inputs. The same are operated by the controller just as if they were physical inputs (with no limitation), but the status of the virtual inputs is not acquired from the hardware, but it is determined through the software. In fact, every digital input can have an AND/OR logic associated, which determines its status (see par. 0).

A practical example of use. Suppose you want to activate a warning if the auxiliary source voltage exceeds the tolerance thresholds. Let us use the virtual digital input #1 (as example).

- Using the BoardPrg4 software we associate an AND/OR logic configured as AND to the virtual digital input #1, with the following list of conditions:
  - ST.060 (“GCB Status”)
  - ST.017 (“Auxiliary source absent or out of tolerance”).
- The virtual digital input will therefore be active when the GCB is closed and the auxiliary source is out of tolerance.
- Let us set the DIF.4001 function (“Generic warning”) within the P.2151 parameter.
- Let us set the desired delay (for example 0.5 s) within the P.2152 parameter.

Let us set the alarm message (for example “auxiliary source voltage warning”) within the P.2153 parameter.

5.4.3 Analogue inputs used as digital

If not used as measurement inputs, you can also use, as digital inputs, the analogue inputs JM, JQ and, with different methods, also terminal JL-4 (see related chapters).

5.4.4 Digital inputs on expansion modules

You can also increase the number of digital inputs by adding two optional DITEL 16 IN modules connected to the HS315 via CAN-BUS, up to a total number of 32 additional digital inputs (refer to par. 5.6.2).

5.4.5 Configuration of the digital inputs

By default, all the digital inputs on the HS315 are considered “active” when the related terminal is connected to the supply minus of the controller; they are considered “not active” when the related terminal is not connected to anything. The logic state of the input can be reversed with respect to the physical state by ticking the “Reversed polarity” box on the input configuration page on BoardPrg4. The box is only visible if the function selected is other than DIF.0000 – “Not used”.

You can also reverse the logic state (still individually for each input), by operating directly on the controller, using the parameters P.2000 (for inputs 1...12 found on the controller), P.2100 (for the analogue inputs when the same are used as digital), P.2200 and P.2250 for the 32 optional inputs of the two DITEL expansions.

Those parameters have a bit for each input:

- 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).

Bit mapping of parameter P.2000 is:

BIT	Value	Hexadecimal	Input
0	1	0001	Input 01 (JN-1)
1	2	0002	Input 02 (JN-2)
2	4	0004	Input 03 (JN-3)
3	8	0008	Input 04 (JN-4)
4	16	0010	Input 05 (JN-5)
5	32	0020	Input 06 (JN-6)
6	64	0040	Input 07 (JN-7)
7	128	0080	Input 08 (JN-8)
8	256	0100	Input 09 (JT-1)
9	512	0200	Input 10 (JT-2)
10	1024	0400	Input 11 (JT-3)
11	2048	0800	Input 12 (JT-4)

Bit mapping of parameter P.2100 is:

BIT	Value	Hexadecimal	Input
0	1	0001	Input 13 (JQ)
1	2	0002	Input 14 (JM-3)
2	4	0004	Input 15 (JM-4)
3	8	0008	Input 16 (JM-2)
4	16	0010	Input 17 (JL-4)

Bit mapping of parameters P.2200 and P.2250 is:

BIT	Value	Hexadecimal	Input
0	1	0001	Input 01
1	2	0002	Input 02
2	4	0004	Input 03
3	8	0008	Input 04
4	16	0010	Input 05
5	32	0020	Input 06
6	64	0040	Input 07
7	128	0080	Input 08
8	256	0100	Input 09
9	512	0200	Input 10
10	1024	0400	Input 11
11	2048	0800	Input 12
12	4096	1000	Input 13
13	8192	2000	Input 14
14	16384	4000	Input 15
15	32768	8000	Input 16

Thus, if you want to revert the logic of an input, you must add its bit in the related parameter. For example, to revert inputs 3 and 4 of the controller, you must set P.2000 =12 (0x000C) (4+8); to revert inputs 5 and 10 of the second DITEL module (16 IN + 16 OUT) you must set P.2250=1056 (0x0420) (32+1024).

As default, all the bits are set to 0.

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

- One parameter which configures its function (P.2001 for input 1).
- One parameter which configures any delay (P.2002 for input 1).
- One parameter allows to define a text message to display. (P.2003 for input 1).

See document [1] for the parameters list.

All inputs, whether we are talking about the ones on the HS315, the ones on the DITEL expansion or the virtual ones, are managed the same way.

The parameters which configure the delay and the message for an input are used by the controller only for certain features of the inputs. The table below shows when they are used.

NOTE: in BoardPrg4 the boxes for the delay and for the message are always displayed, even if they are not used by the controller.

The identification codes of the inputs' functions starting with 3xxx concern operating states, those that start with 4xxx trigger alarms (alarms, deactivations, warnings).

Function of the xx input.	Name	Delay	Message	Description
DIF.0000	Not used.			Input not used.
DIF.0101	Used by PLC			Input used by the internal PLC logic
DIF.1001	Request for GCB closure.			Only acts in MAN mode and is equivalent to pressing the GCB button to close the GCB circuit breaker. If there is no input with the function DIF.1002, it acts as “toggle”: it controls the opening of the breaker when the same is closed and vice versa
DIF.1002	Request for GCB opening.			Only acts in MAN mode and is equivalent to pressing the GCB button to open the GCB circuit breaker.
DIF.1031	Request for ACB closure.			Only acts in MAN mode to close the ACB circuit breaker. If there is no input with the function DIF.1032, it acts as “toggle”: it controls the opening of the breaker when the same is closed and vice versa
DIF.1032	Request for ACB opening.			Only acts in MAN mode to open the ACB circuit breaker.
DIF.1061	Request for BCB closure.			Only acts in MAN mode to close the BCB circuit breaker. If there is no input with the function DIF.1062, it acts as “toggle”: it controls the opening of the breaker when the same is closed and vice versa
DIF.1062	Request for BCB opening.			Only acts in MAN mode to open the BCB circuit breaker.
DIF.1091	Request for LCB closure.			Only acts in MAN mode to close the LCB circuit breaker. If there is no input with the function DIF.1092, it acts as “toggle”: it controls the opening of the breaker when the same is closed and vice versa
DIF.1092	Request for LCB opening.			Only acts in MAN mode to open the LCB circuit breaker.
DIF.2001	Command for resetting alarms.			When the input becomes active, the controller executes a reset of all anomalies. That is equivalent to press the buttons SHIFT+ACK on the controller.
DIF.2002	Command for alarm acknowledgment.			When the input becomes active, the controller executes an acknowledgment of all anomalies (the horn stops and the anomalies stop blinking on the display). That is equivalent to press the button ACK on the controller.
DIF.2029	TEST without load (pulse).			When the input becomes active with the controller in AUTO, the controller carries out a test start of the engine without load for the time configured in P.0420. If the input activates again during the test, it immediately stops.

DIF.2030	TEST with load (pulse).			When the input becomes active with the controller in AUTO, the controller carries out a test start of the engine with load for the time configured in P.0420. If the input activates again during the test, it immediately stops.
DIF.2031	Request for TEST mode.			If the input is active, the controller status changes from AUTO to TEST (controller should be at rest in AUTO mode). When it becomes inactive, the status changes back to AUTO.
DIF.2032	Request for REMOTE START mode.	YES		If the input is active, the controller status changes from AUTO to REMOTE START (controller should be at rest in AUTO mode). When it becomes inactive, the status changes back to AUTO.
DIF.2033	Manual START command.			When the input becomes active (only in mode MAN) the controller makes a start attempt (only one) the same way an automatic start is performed, i.e., it controls the starter motor until starting is accomplished or failed.
DIF.2034	Manual STOP command.			When the input becomes active (in MAN mode) the controller stops the engine. This is equivalent to pressing the STOP button.
DIF.2061	Request for idle speed.			When this input is “active”, the controller disables the minimum frequency and minimum voltage protections of the generator, because it assumes that the engine is running at a speed lower than the usual. If the opening and closing command for GCB are configured, the controller opens the GCB. In the case of certain CAN-BUS engines, the controller also controls the reduced rotational speed of the engine
DIF.2062	Override engine's protections.			When the input is “active”, all the protections for the engine, which normally act as alarms or deactivation become mere warnings
DIF.2063	Full override of protections.			When the input is activated, all the protections (except for few, see [1]) which involve alarms or deactivations become warnings.
DIF.2064	Override generator’s protections.			When the input is “active”, all the protections for the generator, which normally act as alarms or deactivation become mere warnings
DIF.2071	Inhibit DPF regeneration.			When the input is "active", the controller "prevents" the regeneration of the particulate filter to the engine ECU. See par. 8.5.5.12.
DIF.2072	Force DPF regeneration.			When the input is "active", the controller requires the regeneration of the particulate filter to the engine ECU. See par. 8.5.5.12.
DIF.2073	Consent for DPF regeneration			If this input exists, the controller authorizes the regeneration of the particulate filter only when the input is active. If it does not exist, the controller authorizes regeneration when GCB is open. See par. 8.5.5.12.
DIF.2241	Fuel pump in MAN-OFF mode.			When the input is active, the mode of the fuel pump is forced into “Manual-OFF”.
DIF.2242	Fuel pump in MAN-ON mode.			When the input is active, the mode of the fuel pump is forced into “Manual-ON”.
DIF.2243	Fuel pump in AUTO mode.			When the input is active, the mode of the fuel pump is forced into “Automatic”.
DIF.2271	Remote OFF.			When this input is active, the operation mode of the controller is forced into OFF-RESET and you cannot use the buttons on the panel to change it. **NB: when this input is deactivated, if there are no inputs configured with the functions DIF.2272 and DIF.2273, the operation mode returns to what it was prior to the activation of the input**
DIF.2272	Remote MAN.			When this input is active, the operation mode of the controller is forced into MAN and you cannot use the buttons on the panel to change it.
DIF.2273	Remote AUTO.			When this input is active, the operation mode of the controller is forced into AUTO and you cannot use the buttons on the panel to change it.
DIF.2321	Full charge.			When this input is active during a charge cycle, the controller performs a full charge (thus using the setpoints of the menu 2.5.2 instead of the ones of the menu 2.5.3).
DIF.2501	Inhibition of start.			When the input is “active”, the automatic start of the engine is inhibited. The “REMOTE START” mode is not influenced by this function.
DIF.2502	Inhibition of supply.			In automatic mode, when this input is “active”, the controller opens GCB (but only if it can be re-closed, thus if a closure command is configured).
DIF.2701	Enables remote start requests.			If this function is defined for one input, “REMOTE START” function is inhibited if the input is not active.

DIF.2705	Disables protections on analogue measures.			When this input is “activated”, the thresholds set on analogue measures having bit 13 ON in the third configuration parameter (see par. 5.6.2) do not trigger the relevant protections.
DIF.2706	Enables the commands by the serial ports.			If this input is not active, the controls sent via Modbus HOLDING REGISTER 101 and 102 are not accepted.
DIF.2709	Consent to start.			In case of a request for automatic starting, the board activates its internal sequence to start the engine, but it does not activate any actual control until this input (if it exists) is activated (it can be used, for example, to manage pre-ventilation).
DIF.2761	Generator current regulation forcing			Used to force the controller using an analogue input as “generator current setpoint” during the charge process.
DIF.2762	Generator voltage regulation forcing			Used to start the generator and supply the loads at a fixed voltage, disconnecting the battery.
DIF.2763	The BMS are powered			Used to disable communication alarms in case the external BMSs are not powered.
DIF.3001	Status of GCB circuit breaker.	YES		It is used to detect the actual status of the KM/MCB circuit breaker. In case of discordance between status and command, a signalling will outline it.
DIF.3002	Status of ACB circuit breaker.	YES		It is used to detect the actual status of the KM/MCB circuit breaker. In case of discordance between status and command, a signalling will outline it.
DIF.3003	Status of BCB circuit breaker.	YES		It is used to detect the actual status of the KM/MCB circuit breaker. In case of discordance between status and command, a signalling will outline it.
DIF.3004	Status of LCB circuit breaker.	YES		It is used to detect the actual status of the KM/MCB circuit breaker. In case of discordance between status and command, a signalling will outline it.
DIF.3011	Trip of GCB circuit breaker.	YES		Connect to this input the “tripped” contact of circuit breaker. If the input is “active”, an alarm (block) with a fixed description (language-dependant) is activated.
DIF.3012	Trip of ACB circuit breaker.	YES		Connect to this input the “tripped” contact of circuit breaker. If the input is “active”, an alarm (block) with a fixed description (language-dependant) is activated.
DIF.3013	Trip of BCB circuit breaker.	YES		Connect to this input the “tripped” contact of circuit breaker. If the input is “active”, an alarm (block) with a fixed description (language-dependant) is activated.
DIF.3014	Trip of LCB circuit breaker.	YES		Connect to this input the “tripped” contact of circuit breaker. If the input is “active”, an alarm (block) with a fixed description (language-dependant) is activated.
DIF.3101	External sensor for auxiliary source.			When the input is “active” the auxiliary source is considered to be “in tolerance”
DIF.3201	Generic status (page 1).		YES	If the related input is active, the controller will show the text defined by the related text parameter on page S.08 of the display.
DIF.3202	Important status (page 1).		YES	If this input is “active”, the controller displays the text set in the related parameters associated to the input on page S.08, which is displayed immediately
DIF.3203	Generic status (page 2).		YES	If the related input is active, the controller will show the text defined by the related text parameter on page S.09 of the display.
DIF.3204	Important status (page 2).		YES	If this input is “active”, the controller displays the text set in the related parameters associated to the input on page S.09, which is displayed immediately
DIF.3205	Generic status (page 3).		YES	If the related input is active, the controller will show the text defined by the related text parameter on page S.10 of the display.
DIF.3206	Important status (page 3).		YES	If this input is “active”, the controller displays the text set in the related parameters associated to the input on page S.10, which is displayed immediately
DIF.3301	Level for starting fuel pump.			If the input is “active” the fuel pump is started (see par.9.7.13).
DIF.3302	Level for stopping fuel pump.			If the input is “active” the fuel pump is stopped (see par. 9.7.13)
DIF.3311	Level for starting AdBlue pump.			If the input is “active” the AdBlue pump is started (see par. 9.7.14).
DIF.3312	Level for stopping AdBlue pump.			If the input is “active” the AdBlue pump is stopped (see par. 9.7.14)
DIF.4001	Generic warning.	YES	YES	If the input is “active”, a warning is issued: the message shown is the one set by means the related “text” parameter.
DIF.4002	Generic warning latched.	YES	YES	If the input is “active”, a latched warning is issued (it requires an explicit reset): the message shown is the one set by means the related “text” parameter.

DIF.4003	Generic deactivation.	YES	YES	If the input is “active”, a deactivation command is issued: the message shown is the one set by means of the related parameters.
DIF.4004	Generic alarm.	YES	YES	If the input is “active”, an alarm (block) is issued: the message shown is the one set by means the related “text” parameter.
DIF.4011	Warning (after oil delay).	YES	YES	If the input is active, a warning is issued if the time set by means P.0216 is elapsed from the engine running detection. The message shown is the one set by means the related “text” parameter.
DIF.4012	Warning latched (after oil delay).	YES	YES	If the input is active, a latched warning is issued (it requires an explicit reset) if the time set by means P.0216 is elapsed from the engine running detection. The message shown is the one set by means the related “text” parameter.
DIF.4013	Deactivation (after oil delay).	YES	YES	When the input is “active”, if the time set by means of the P.0216 parameter from engine start has elapsed, a deactivation command is issued: the message shown is the one set by means of the related parameters. If the DIF.2062 – “Override engine protections”, or the DIF.2063 - “Complete Protections Override” functions are active, a warning is issued instead of a deactivation. See par. 11.1 and 11.1.2
DIF.4014	Alarm (after oil delay).	YES	YES	If the input is active, an alarm (block) is issued if the time set by means P.0216 is elapsed from the engine running detection. The message shown is the one set by means the related “text” parameter. If the DIF.2062 – “Override engine protections”, or the DIF.2063 - “Complete Protections Override” functions are active, a warning is issued instead of an alarm (block). See par. 11.1 and 11.1.2
DIF.4021	Warning (when GCB is closed).	YES	YES	If the input is "active" and the GCB is closed, a warning is issued. The message shown is the one set by means the related text parameter.
DIF.4022	Warning latched (when GCB is closed).	YES	YES	If the input is "active" and the GCB is closed, a latched warning is issued (it requires an explicit reset). The message shown is the one set by means the related text parameter.
DIF.4023	Deactivation (when GCB is closed).	YES	YES	If the input is "active" and the GCB is closed, a deactivation command is issued: the message shown is the one set by means of the related parameters.
DIF.4024	Alarm (when GCB is closed).	YES	YES	If the input is "active" and the GCB is closed, an alarm (block) is activated. The message shown is the one set by means of the related parameters.
DIF.4031	Warning (when FUEL is active).	YES	YES	If the input is active and the output command for the fuel solenoid is active (JL_03), a warning is issued. The message shown is the one set by means the related “text” parameter.
DIF.4032	Warning latched (when FUEL is active).	YES	YES	If the input is active and the output command for the fuel solenoid is active (JL_03), a latched warning is issued (it requires an explicit reset). The message shown is the one set by means the related “text” parameter.
DIF.4033	Deactivation (when FUEL is active).	YES	YES	If the input is active and the output command for the fuel solenoid is also active (JL_03), a deactivation is issued: the message shown is the one set by means of the related parameters.
DIF.4034	Alarm (when FUEL is active).	YES	YES	If the input is active and the output command for the fuel solenoid is active (JL_03), an alarm (block) is issued. The message shown is the one set by means the related “text” parameter.
DIF.4041	Warning (when GAS is active).	YES	YES	If the input is “active” and the command of an output set as DOF.1004 – “Gas valve” is also active, a warning is issued: the message shown is the one set by means of the related parameters.
DIF.4042	Warning latched (when GAS is active).	YES	YES	If the input is “active” and the command of an output set as DOF.1004 – “Gas valve” is also active, a latched warning is issued (it requires an explicit reset): the message shown is the one set by means of the related parameters.
DIF.4043	Deactivation (when GAS is active).	YES	YES	If the input is “active” and the command of an output set as DOF.1004 – “Gas valve” is also active, a deactivation is issued: the message shown is the one set by means of the related parameters.
DIF.4044	Alarm (when GAS is active).	YES	YES	If the input is “active” and the command of an output set as DOF.1004 – “Gas valve” is also active, an alarm (block) is issued: the message shown is the one set by means of the related parameters.
DIF.4051	Warning (stops fuel pump).	YES	YES	If the input is active, a warning is issued: the message shown is the one set by means the related “text” parameter. The controller blocks the fuel pump if this input is “active”

DIF.4052	Warning latched (stops fuel pump).	YES	YES	If the input is active, a latched warning is issued (it requires an explicit reset): the message shown is the one set by means the related “text” parameter. The controller blocks the fuel pump if this input is “active”
DIF.4053	Deactivation (stops fuel pump).	YES	YES	If the input is active, a deactivation is issued: the message shown is the one set by means the related “text” parameter. The controller blocks the fuel pump if this input is “active”
DIF.4054	Alarm (stops fuel pump).	YES	YES	If the input is active, an alarm (block) is issued: the message shown is the one set by means the related “text” parameter. The controller blocks the fuel pump if this input is “active”
DIF.4062	Warning latched (subject to override).	YES	YES	If the input is “active”, normally latched warning is issued (it requires an explicit reset). If the “override engine protections” function is enabled, a warning is issued. The message shown is the one set by means of the related parameters.
DIF.4063	Deactivation (subject to override).	YES	YES	If the input is “active”, normally a deactivation is activated. If the “override engine protections” function is enabled, a warning is issued. The message shown is the one set by means of the related parameters.
DIF.4064	Alarm (subject to override).	YES	YES	If the input is “active”, normally an alarm (block) is activated. If the “override engine protections” function is enabled, a warning is issued. The message shown is the one set by means of the related parameters.
DIF.4211	Minimum fuel level	YES		If the input is “active”, an alarm (block) with a fixed description (language-dependant) is activated. This function can be also used for the “Fuel pump management” (see par. 9.7.13).
DIF.4212	Low fuel level	YES		If the input is “active”, a warning with a fixed description (language-dependant) is activated. This function can be also used for the “Fuel pump management” (see par. 9.7.13).
DIF.4213	High fuel level	YES		If the input is “active”, a warning with a fixed description (language-dependant) is activated. This function can be also used for the “Fuel pump management” (see par. 9.7.13).
DIF.4221	Minimum oil pressure	YES		When the input is “active”, if the time set by means of the P.0216 parameter from engine start has elapsed, a fixed description (language-dependant) alarm (block) is activated.
DIF.4222	Low oil pressure	YES		When the input is “active”, if the time set by means of the P.0216 parameter from engine start has elapsed, a fixed description (language-dependant) warning is activated.
DIF.4231	High coolant temperature	YES		When the input is “active”, if the time set by means of the P.0216 parameter from engine start has elapsed, a fixed description (language-dependant) warning is activated.
DIF.4232	Maximum coolant temperature	YES		When the input is “active”, if the time set by means of the P.0216 parameter from engine start has elapsed, a fixed description (language-dependant) warning is activated.
DIF.4251	Over speed	YES		If the input is “active”, an alarm (block) with a fixed description (language-dependant) is activated.

By default, the functions of the inputs on the controller are the following:

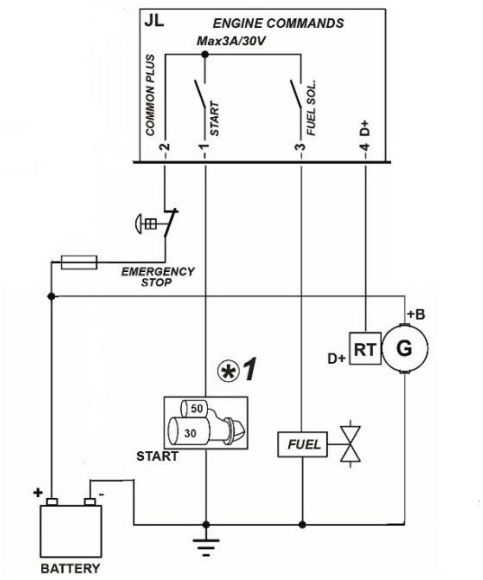
Terminal	**Function**
JN-1	DIF.3001 – “Status of GCB circuit breaker”
JN-2	DIF.3011 – “Trip of GCB circuit breaker”
JN-3	DIF.3006 – “Status of BCB circuit breaker”
JN-4	DIF.3016 – “Trip of BCB circuit breaker”
JN-5	DIF.3007 – “Status of LCB circuit breaker”
JN-6	DIF.3017 – “Trip of LCB circuit breaker”
JN-7	DIF.0000 – “Not used”
JN-8	DIF.2501 – “Inhibition of start”
JT-1	DIF.0000 – “Not used
JT-2	DIF.0000 – “Not used
JT-3	DIF.0000 – “Not used
JT-4	DIF.0000 – “Not used

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

- DIF.0101 - “Used by PLC”. It is possible to use the digital inputs of the controller only for the PLC logics, without the controller normal operation sequence using them. In these cases, it is possible to leave the inputs configured with the function DIF.0000 (“Not used”). Therefore, there’s the risk to reuse the input for other purposes, as it seems to be available: for this reason, there is the DIF.0101 function (to indicate the input used, even if not directly by the controller).

5.5 Digital outputs

5.5.1 Engine commands (JL)



Basic diagram for switching off when de-energizing

The **JL** connector is configured by default for connecting the starter motor (**START**), fuel solenoid valve (**FUEL SOLENOID**); although not configured by default, there is also an output for energizing/controlling the operation of the battery recharge alternator (**+D**). Unless used to configure the engine (for example engines with CAN-BUS), the two outputs can be reconfigured from parameter for other purposes and terminal +D may be used as digital input or additional voltage measurement input.

The status of the START and FUEL outputs is displayed on page S.13 (0 = output inactive, 1 = output active)

In detail:

5.5.1.1 JL-2 COMMON PLUS Common positive

Common positive input for the START and FUEL outputs. It must be connected to the starter battery and must be fuse protected, with a capacity suitable for the current to be delivered, through a contact of the emergency button, i.e., this connection must be interrupted when the emergency button is pressed (NOTE: this does not apply to systems with arrest while energized). Several emergency buttons may be used by series connecting them to each other.

If no voltage is present (i.e., when pressing the emergency button) in the operating modes (MAN, AUTO, TEST, etc.) the device causes the A048 emergency stop blockage. You cannot configure HS315 to disable the emergency stop blockage.

The voltage to the JL-2 terminal is measured to the purpose of managing the relevant alarm and is displayed on page S.16, under entry EM-S.

Caution: do not use the terminal as common minus for the two relay outputs. Within the outputs there are damper diodes for opening over voltages that would be conducted and immediately damaged.

5.5.1.2 JL-1 START Command for the engine starter motor

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

with particularly inductive loads (remote control switches, electromagnets, etc.) it is advisable to use a damper diode for opening over voltages.

Caution: for currents above the rated use an external relaunch relay.

The controller activates this command when motor start is required and deactivates it automatically within 200-300ms from the instant when it recognizes the motor started state.

If this command is not necessary (for example with CAN-BUS interface engines), the output can be configured for other purposes by means of the parameter P.3005, refer to par. 5.5.3 and [1].

5.5.1.3 JL-3 FUEL SOLENOID Fuel solenoid command

Positive relay output, with a capacity of 3A @30VDC. Integrated internal diode for damping opening over voltages. This terminal shows the battery voltage present on connector JL-2; although one is already present inside, with particularly inductive loads (remote control switches, electromagnets, etc.) it is advisable to use a damper diode for opening over voltages.

Caution: for currents above the rated use an external relaunch relay.

The output is configured by default to control the fuel interception solenoid valve with de-energizing arrest systems (see below); if not used for this purpose (for example in the case of engines with CAN-BUS interface), it can be reconfigured to serve other purposes by means of the parameter P.3006, refer to par. 5.5.3 and [1].

Two different ways to stop the engine are implemented in HS315.

Drop-down stop system

With this system (most widely used and default configuration of the HS315) the engine is started by delivering power to the solenoid valve, which opens/closes the fuel flow and is turned off by cutting the power.

So, the controller activates the JL-3 FUEL SOLENOID output prior to starting the engine (at least a delay of 200 ms is provided between the activation of this command and the activation of the command for the starter motor). It deactivates it when the engine must be turned off. If the engine is stopped by other means, it is possible to delay the deactivation of this command through parameter P.0234.

Pick-up stop system

This system is used when the engine requires an explicit command to stop. It is mainly used for safety reasons: in case of arrest during de-energizing, in fact, if you accidentally disconnect the wire connected to the JH-3 terminal, the engine stops. Instead, in case of shut-off while energizing, the engine does not stop until it receives the explicit arrest command.

By default, digital output JE-1 is configured for the command of arrest during energizing. You can configure any output (**while observing the warning below**) to give the shutdown command by setting the relevant parameters (refer to par. 5.5.3 and [1]).

WARNING! The series connection of the emergency stop button to terminal JL-2 DOES NOT WORK WITH SYSTEMS OF ARREST DURING ENERGIZING because you would get the opposite effect, i.e., cutting the power to the stop valve, even if the HS315 activates the **A048 Emergency stop alarm** and the output configured as stop command anyway. For these systems, in case you need to guarantee the operation of the emergency pushbutton irrespective of the operation of the HS315, it must have a double contact: one NC connected in series to the JL-3, as shown before, to cut the power to the starter motor and one NO between battery plus and valve/stop command with no intermediate fuses which, when activated, delivers positive voltage to the stop valve by bypassing the HS315 command.

5.5.1.4 JL-4 +D: energizing and checking the operation of the recharge alternator

NOTE: To configure the JL-4 for the +D connection at recharge alternator energizing you need to configure the parameter P.4041 with the value AIF.1300 – "Signal +D". The output is configured by default as AIF.0000 – "Unused".

When the controller starts the engine, the JL-4 terminal supplies the necessary power for energizing the battery recharge alternator.

With engine and alternator stopped, the alternator +D terminal is practically a short circuit to the battery minus and the voltage at its ends is close to 0V. During and after engine starting, as well as under normal operating conditions, with the revolution of the recharge alternator, the +D voltage rises to the value of the battery voltage. When the engine stops, or even if only the recharge alternator stops because of the breakage of the drive belt, the +D voltage returns to 0V. The same thing happens in case of malfunction of the alternator.

The current delivered with the alternator stationary is limited internally and is 200mA for 12V systems and 100mA for 24V systems through an automatic threshold on the value of the battery voltage. The transition point between the two power levels occurs at approximately Vbatt = 19VDC.

The energizing command is activated together with the engine start command.

During the engine start cycle, up to when the engine is no longer acknowledged as started with a method whatsoever (voltage, frequency, rpm, +D voltage, oil pressure), the command is kept active for 30s continuously and then is deactivated/activated every 5s (5s ON followed by 5s OFF) until the starting sequence ends. When the engine is acknowledged as started, the command is kept active for 5 more seconds and then is released.

HS315 also uses the JL-4 to measure the +D voltage of the recharge alternator, both during engine start and during its operation. It is displayed in the S.16 page, under item D+.

The voltage measure can be used for two purposes:

- Engine running/stop detection. Set parameters P.0230 and P.0231 to zero to disable this function.
- Usually, the recharge alternator is driven by the drive shaft through a drive belt. Normally, the drive belt also drives other mechanical components of the engine, for example the cooling fan of the radiator. If during engine operation the +D voltage of the recharge alternator drops below 0V or if it does not rise after start, once the P.0349 time is up, it is assumed that the belt is broken or at least that there is a malfunction and the HS315 activates an anomaly that can be configured with the parameter P.0357 (as warning, deactivation or lock) to protect the engine from the lack of operation of the mechanical parts driven by the belt. Set parameter P.0349 to zero to disable this function.

5.5.2 Dry contacts relays JI

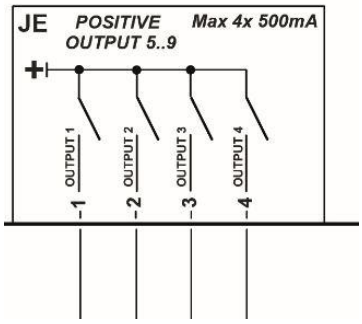
The controller provides two 10A@250Vac dry contact relays. They can be used for the opening/closure commands for the circuit breakers. On the JI connector there is a changeover dry contact for each of the two relays.

Terminal	Function
JI-1	Normally open contact, of the output 08.
JI-2	Normally closed contact, of the output 08.
JI-3	Common contact of the output 08.
JI-4	Normally open contact, of the output 07.
JI-5	Normally closed contact, of the output 07.
JI-6	Common contact of the output 07.

You must use the normally opened contact for GCB circuit breaker, and the normally closed contact for BCB, LCB and ACB circuit breakers: that way, even if the controller is not powered, the loads remain still connected to the auxiliary source and to the plant battery.

If the outputs are not used for the circuit breakers commands, they can be associated to different functions (see par. 5.5.3).

5.5.3 Auxiliary outputs (JE and JT)



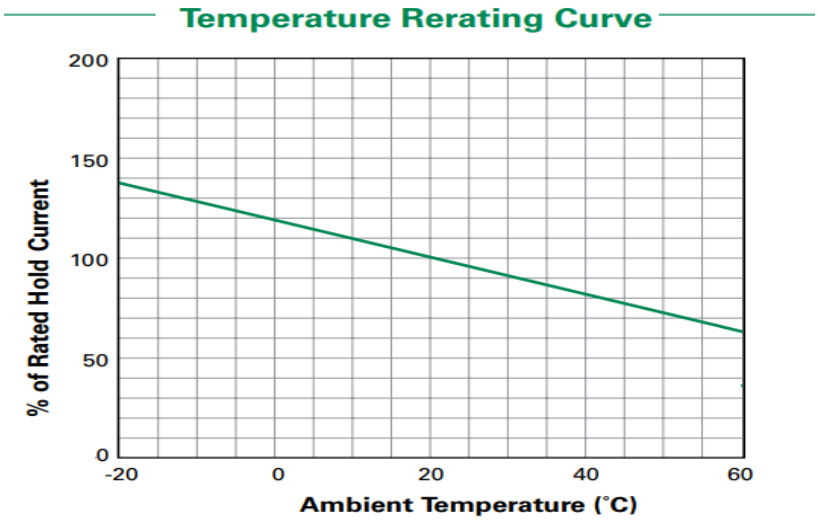
The device operates 8 digital outputs, entirely programmable:

- 4 are available by means connector JE, dedicated for this function.
- 4 are in connector JT, using 4 of the 8 available terminals.

When activated, they bring themselves to the positive supply voltage on the JD supply terminal.

The nominal capacity of each output on the **JE** connector is 500 mA and the total maximum continuous current for all four activated outputs is 500mAdc.

- **HW 00 revision of the controller**: the nominal capacity of each output on the **JT** connector is 400 mA @ 20°c; the total maximum continuous current for all four activated outputs decreases with increasing temperature according to the derating curve shown below.



- **HW 01 revision of the controller**: the nominal capacity of each output on the **JT** connector is 500 mA; maximum total continuous current for all four activated outputs is 500mA for the full temperature range of the device.

REMARK: the total supplied current from the 8 outputs (JE+JT connectors) can't be greater than 1A@50°c.

The outputs are independent and protected individually from overloads, short circuits, polarity reversal and overheating. The overload protection cuts in to limit the current spikes to an instantaneous value of 4A, to allow the activation of loads that require a transient inrush current greater than the rated. If this condition persists, after 150us the thermal protection cuts in progressively, until the output is turned off.

With inductive loads (power relays, electromagnetic actuators), although some are already present inside, it is advisable to use diodes for damping opening over voltages.

All the current delivered by the outputs must be made available through the **JD 2-+BATT; make sure that any safety fuse on the supply plus has a capacity and response time suitable to power and protect both the outputs and the HS315 under any condition of use.**

5.5.4 Digital outputs on expansion modules

The digital outputs of the controller can be extended by adding two DITEL 16 IN modules (connected to HS315 by Can Bus), each of them in charge of up to two DITEL 8 OUT relay modules, up to a total of 32 additional outputs.

5.5.5 Configuration of digital outputs

Each output is completely configurable individually.

By default, all the outputs are activated when their function requires it (for example the fuel pump output starts operating when the pump must be activated).

Using the BoradPrg3, you can reverse the activation by simply ticking the “reverse polarity” box on top of the configuration page of every single output.

By operating directly on the controller, you can reverse anyway the logic of the outputs (still individually for each output) including by means of the parameters P.3000 for the outputs on the controller (a total of 12 bits), P.3200 (16 bits) for the two DITEL 8 OUT additional modules connected to the first DITEL 16 IN controller and P.3250 (16 bits) for the two DITEL 8 OUT additional modules connected to the second DITEL 16 IN:

- A zero-bit means that the output is normally on standby and starts operating when the related feature requires it.
- A one-bit means that the output is normally operating and goes on standby when the related function requires it.
- The logical status of the digital outputs is displayed on page S.13 (0 = output inactive, 1 = output active).

The mapping of the outputs on the controller is:

BIT	Value	Hexadecimal	Output
0	1	0001	Output 1
1	2	0002	Output 2
2	4	0004	Output 3
3	8	0008	Output 4
4	16	0010	Output 5 (JL-1)
5	32	0020	Output 6 (JL-3)
6	64	0040	Output 7 (JI-4)
7	128	0080	Output 8 (JI-1)
8	256	0100	Output 9
9	512	0200	Output 10
10	1024	0400	Output 11
11	2048	0800	Output 12

While the mapping of the outputs on the two DITEL 8 OUT modules is:

BIT	Value	Hexadecimal	Output
0	1	0001	Output 1
1	2	0002	Output 2
2	4	0004	Output 3
3	8	0008	Output 4
4	16	0010	Output 5
5	32	0020	Output 6

6	64	0040	Output 7
7	128	0080	Output 8
8	256	0100	Output 9
9	512	0200	Output 10
10	1024	0400	Output 11
11	2048	0800	Output 12
12	4096	1000	Output 13
13	8192	2000	Output 14
14	16384	4000	Output 15
15	32768	8000	Output 16

Basically, if you want to reverse the logic of an output you need to add the corresponding value into its parameter.

for example, if you want to invert outputs 3 and 4 on the controller you must set P.3000 =12 (0x000C) (i.e., 4+8); if you want to invert outputs 5 and 10 of the second DITEL gen-set (16 IN + 16 OUT) you must set P.3250=1056 (0x0420) (i.e., 32+1024)

As default, all the bits are set to 0.

The digital outputs can be used directly as command for devices outside the controller, or for reporting certain operating conditions.

See below the outputs configurable on the digital outputs:

Code	**Description.**	**Note**
DOF.0000	Not used.	
DOF.0101	Used by PLC	Output used by the internal PLC logic
DOF.0102	Managed by serial ports.	The controller does not control the output with its own internal logics, but with the controls it receives through the serial ports.
DOF.0103	AND/OR logics.	The status of the output is the result of the combination of the AND/OR logics. See par. 0
DOF.1001	Preheating of glow plugs.	Command for glow plugs preheating for Diesel engines; see par. 9.7.6
DOF.1002	Enable for engine control unit.	Command for ECU enabling; see par. 9.7.6
DOF.1003	Fuel solenoid.	Command for the fuel interception solenoid; see par. 9.7.6
DOF.1004	Gas solenoid.	Command for activating the gas valve (for gas engines); see par. 9.7.6
DOF.1005	Command to start the engine.	Command for the starter motor; see par. 9.7.6
DOF.1006	Stop solenoid.	Command for engine stop with arrest when energized; see par.5.5.1.3 and par. 9.7.6
DOF.1007	Command for idle speed.	Some engines are provided with an output to reduce the rotational speed; see par. 9.7.6
DOF.1008	Selects battery 1.	Select battery 1 to start the engine; see par. 9.7.6
DOF.1009	Selects battery 2.	Select battery 2 to start the engine; see par. 9.7.6
DOF.1031	Coolant preheating.	Thermostat command for coolant pre-heating; see 9.7.6
DOF.1032	Fuel pump.	Fuel pump activation command.
DOF.1033	Command for pre-lubrication.	Command to activate the pre-lubrication pumps before starting the engine; see par. 9.7.6
DOF.1034	Solenoid for fuel pump.	Command to activate the fuel interception solenoid on the fuel pump line; see par. 9.7.6
DOF.1035	Inhibit DPF regeneration.	Command to inhibit the regeneration of the particulate filter; see par. 8.5.5.12.
DOF.1036	Force DPF regeneration.	Command to force the regeneration of the particulate filter; see par. 8.5.5.12.
DOF.1037	AdBlue pump.	Fuel pump activation command; see par. 9.7.14.
DOF.1038	Solenoid for AdBlue pump.	Command to activate the fuel interception solenoid on the fuel pump line; see par. 9.7.14.
DOF.2001	ACB (NC) under voltage coil.	See par. 9.8.1
DOF.2002	ACB opening coil.	See par. 9.8.1
DOF.2003	ACB closing coil.	See par. 9.8.1
DOF.2004	ACB stable opening command.	See par. 9.8.1
DOF.2031	GCB under voltage coil.	See par. 9.8.1
DOF.2032	GCB opening coil.	See par. 9.8.1
DOF.2033	GCB closing coil.	See par. 9.8.1
DOF.2034	GCB stable closing command	See par. 9.8.1
DOF.2041	BCB (NC) under voltage coil.	See par. 9.8.1
DOF.2042	BCB opening coil.	See par. 9.8.1
DOF.2043	BCB closing coil.	See par. 9.8.1
DOF.2044	BCB stable opening command.	See par. 9.8.1
DOF.2051	LCB (NC) under voltage coil.	See par. 9.8.1

DOF.2052	LCB opening coil.	See par. 9.8.1
DOF.2053	LCB closing coil.	See par. 9.8.1
DOF.2054	LCB stable opening command.	See par. 9.8.1
DOF.2261	Secondary LCB #1 command	See par. 9.4.3.
DOF.2262	Secondary LCB #2 command	See par. 9.4.3
DOF.2263	Secondary LCB #3 command	See par. 9.4.3
DOF.2264	Secondary LCB #4 command	See par. 9.4.3
DOF.2265	Secondary LCB #5 command	See par. 9.4.3
DOF.2266	Secondary LCB #6 command	See par. 9.4.3
DOF.2267	Secondary LCB #7 command	See par. 9.4.3
DOF.2268	Secondary LCB #8 command	See par. 9.4.3
DOF.3001	Off/reset.	It is activated when the controller is in OFF/RESET mode.
DOF.3002	Manual.	It is activated when the controller is in MAN mode.
DOF.3003	Automatic.	It is activated when the controller is in AUTO mode.
DOF.3004	Test.	It is activated when the controller is in TEST mode.
DOF.3005	Remote start.	It is activated when the controller is in REMOTE START mode.
DOF.3011	Not in Off/reset.	it is activated when the controller is **not** in OFF/RESET mode.
DOF.3012	One of the automatic modes.	It is activated when the controller is in one of the automatic operation modes, that is AUTO, TEST or REMOTE START.
DOF.3032	Generator in tolerance.	It is active when the generator parameters are in the normal operation window
DOF.3033	Auxiliary source in tolerance.	It is active when the auxiliary source parameters are within the “auxiliary source presence” window
DOF.3061	Engine running.	Active after detection of the engine running status, even when it is started manually.
DOF.3062	Ready to supply.	The output will be activated if the engine is in motion and if the “delay before supplying” (P.0218) has been performed.
DOF.3151	Reset of the anomalies.	It is activated when the controller goes in RESET mode.
DOF.3152	External horn.	It is activated together with the internal siren.
DOF.3153	Lamp test.	It is activated with the controller in OFF/RESET mode by pressing the STOP button.
DOF.3154	Acknowledge of the anomalies.	The controller activates this output for one second when the internal sequence of faults acknowledgement is carried out.
DOF.3155	Reset of the modem	The controller activates this output for two seconds when the internal sequence to reset the modem is carried out.
DOF.4001	Warnings.	It is activated in the presence of warnings and latched warnings.
DOF.4003	Deactivations.	It is activated in the presence of deactivations.
DOF.4004	Alarms	It is activated in the presence of blocks (alarms)
DOF.4005	Alarms and deactivations.	It is activated in the presence of blocks (alarms) and deactivations.
DOF.4031	Anomalies of the generator.	It is activated in the presence of faults of the generator, i.e.: 001: Minimum generator's voltage. 002: Maximum generator's voltage. 003: Minimum generator's frequency. 004: Maximum generator's frequency. 006: Maximum generator current (51). 008: Operating conditions not reached. 011: Reverse current on the generator. 015: Trip on GCB circuit breaker. 016: Maximum generator current (50). 056: Low generator's voltage. 058: Low generator's frequency. 059: High generator's voltage. 060: High generator's frequency. 237: Generator status not available.
DOF.4032	Anomalies of the engine.	It is activated in the presence of faults of the engine, i.e.: 005: Engine's battery charger failure (from D+). 021: Engine not stopped. 022: Engine not started.

		031: High coolant temperature (from contact). 032: High coolant temperature (from measure). 033: Maximum coolant temperature (from contact). 034: Maximum coolant temperature (from measure). 035: Maximum oil temperature (from measure). 037: Low battery voltage (from measure). 038: High battery voltage (from measure). 039: Service required (1st counter). 040: Service required (2nd counter). 041: Minimum oil pressure (from contact). 042: Minimum oil pressure (from measure). 043: Low oil pressure (from contact). 044: Low oil pressure (from measure). 049: Maximum power. 050: Service required (counter of days). 054: High oil temperature (from measure). 062: CANBUS 0 (engine): BUS-OFF. 065: Low coolant temperature (from measure). 096: Magnetic pickup failure 098: CANBUS 0 (engine): timeout without data. 105: Engine's battery charger failure (from CANBUS). 132: High coolant temperature (from CANBUS). 134: Maximum coolant temperature (from CANBUS). 135: Minimum coolant level (from CANBUS). 136: Low coolant level (from CANBUS). 137: Low battery voltage (from CANBUS). 142: Minimum oil pressure (from CANBUS). 144: Low oil pressure (from CANBUS). 158: High oil temperature (from CANBUS). 159: Maximum oil temperature (from CANBUS). 198: Warnings - Yellow lamp (from CANBUS). 199: Alarms - Red lamp (from CANBUS).
DOF.4033	Anomalies of speed regulator.	It is activated in case of faults in the engine rotational speed, i.e.: 003: Minimum generator's frequency. 004: Maximum generator's frequency. 017: Maximum speed (from digital input). 018: Maximum speed (from measure). 019: Maximum speed (from Hz). 058: Low generator's frequency. 060: High generator's voltage. 118: Maximum speed (from CANBUS).
DOF.4034	Anomalies of the fuel.	It is activated in case of faults in the fuel level, i.e.: 025: Minimum fuel level (from contact).

		026: Minimum fuel level (from measure). 027: Low fuel level (from contact). 028: Low fuel level (from measure). 029: High fuel level (from contact). 030: High fuel level (from measure). 160: Water in fuel (from CANBUS).
DOF.4035	Anomalies of circuit breakers.	It is activated in case of faults of the GCB and MCB breakers, i.e.: 013: ACB not closed. 014: GCB not closed. 023: ACB not opened. 024: GCB not opened. 113: BCB not closed. 114: LCB not closed. 123: BCB not opened. 124: LCB not opened.

The factory-set default functions of the JE outputs on the controller are:

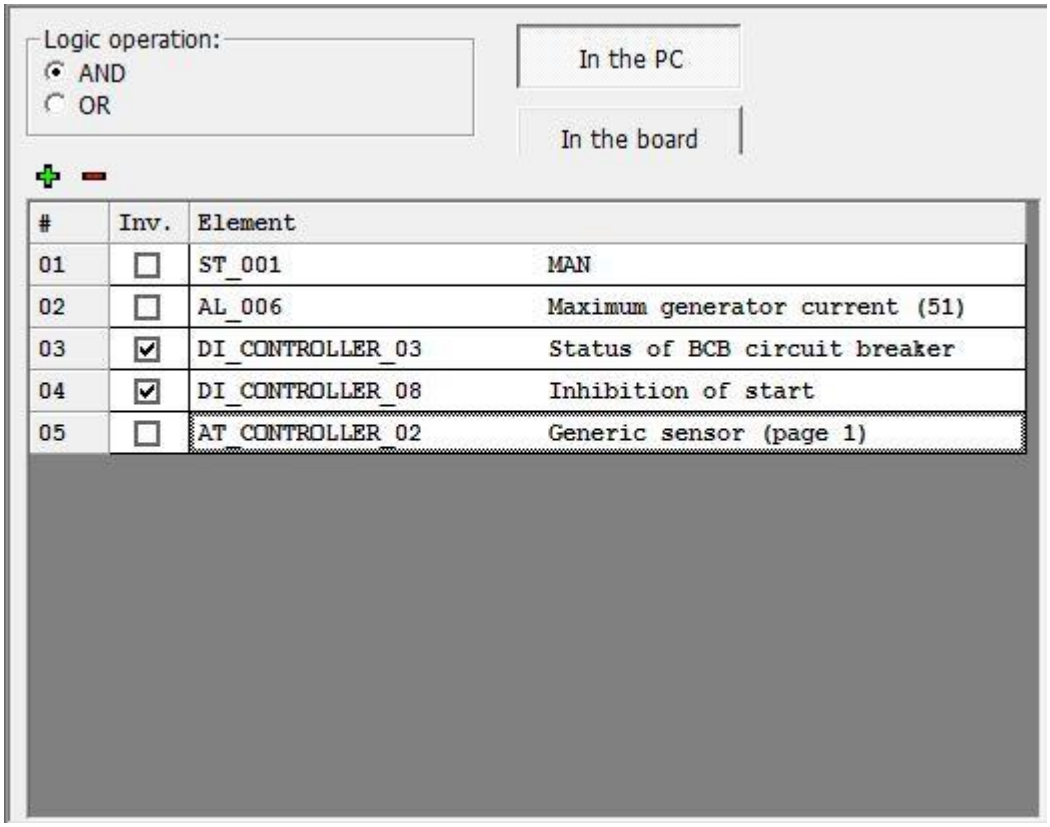
Terminal	**Function**
JE-1	DOF.1006 – Stop solenoid.
JE-2	DOF.3152 – External horn.
JE-3	DOF.2052 – Coil for opening of LCB
JE-4	DOF.0000 – Not used.
JL-1	DOF.1005 – Command to start the engine.
JL-3	DOF.1003 – Fuel solenoid.
JI-4	DOF.2042 – Coil for opening of BCB.
JI-1	DOF.2032 – Coil for opening of GCB.
JT-1	DOF.0000 – Not used.
JT-2	DOF.0000 – Not used.
JT-3	DOF.0000 – Not used.
JT-4	DOF.0000 – Not used.

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

- DOF.0101 - “Used by PLC”. This function matches the digital output to the PLC program inside the device; in this way, it is the PLC logic which commands the output, and not the normal operation logics of the controller. Note: if the PLC program uses some outputs, but those are not configured with function DOF.0101, the outputs will not be commanded (but the controller signals this situation with a warning).
- DOF.0102 - “Controlled by the serial ports”. The board does not control the output with its own internal logics, but with the controls it receives through the serial ports.
- DOF.0103 - “Logics AND/OR”. See next chapter.

5.5.6 AND/OR logics.

The AND/OR logics are, basically, a list of boolean conditions (true/false, on/off, 1/0), which can be configured by the operator (programming), which the controller evaluates and the result of which can be assigned to a digital output or to a virtual digital input (see par. 5.5.3 and par. 5.4.2). For using the AND/OR logics with a digital output, use the DOF.0103 function. **NB: the AND/OR logics cannot be configured directly from the panel of the controller, but through a PC equipped with the BoardPrg4 software.**



The operator must first decide if the list of conditions must be evaluated as AND (all must be checked) or as OR (it is enough that one condition is met). **You cannot have mixed AND/OR logics (this can be done using digital virtual inputs; see below).**

You can add up to 30 conditions. Each condition can be reversed individually: in the previous figure, for instance, the controller will check that the digital input 3 and the digital output 8 are both **inactive**. The following conditions can be added:

- DI_XXX: logic states of all the digital inputs (physical or virtual).
- DO_XXX: logic states of all the digital outputs.
- AL_XXX: warnings/locks present.
- ST_XXX: internal states of the controller.
- AT_XXX: states concerning the thresholds on analogue measures (see par. 5.6.2).

The following table shows the list of the internal states available for the AND/OR logics.

Status	Description
ST_000	OFF_RESET
ST_001	MAN
ST_002	AUTO
ST_003	TEST
ST_004	AVVIAMENTO REMOTO
ST_006	Acknowledgment of anomalies in progress
ST_007	Reset of anomalies in progress
ST_008	Warnings
ST_009	Latched warnings
ST_010	Deactivations
ST_011	Alarms
ST_012	Not recognized warnings

Status	Description
ST_013	Not recognized latched warnings
ST_014	Not recognized deactivations
ST_015	Not recognized alarms
ST_016	Auxiliary source present (voltages/frequency)
ST_017	Auxiliary source absent or out of thresholds
ST_018	Delay for auxiliary source in thresholds
ST_019	Auxiliary source in thresholds
ST_020	Delay for Auxiliary source absent or out of thresholds
ST_024	Generator present (voltages/frequency)
ST_025	Generator absent or out of thresholds
ST_026	Delay for generator in thresholds
ST_027	Generator in thresholds
ST_028	Delay for generator absent or out of thresholds
ST_032	Engine running
ST_033	Lube oil protections enabled
ST_035	Engine management: stopped
ST_036	Engine management: starting
ST_037	Engine management: idle speed
ST_038	Engine management: delay before supply
ST_039	Engine management: ready to supply
ST_040	Engine management: cooling down
ST_041	Engine management: stopping
ST_060	GCB status
ST_061	BCB status
ST_062	LCB status
ST_063	ACB status
ST_064	GCB minimum voltage coil
ST_065	GCB opening pulse
ST_066	GCB closure pulse
ST_067	GCB closure command (stable)
ST_068	BCB minimum voltage coil
ST_069	BCB opening pulse
ST_070	BCB closure pulse
ST_071	BCB closure command (stable)
ST_072	LCB minimum voltage coil
ST_073	LCB opening pulse
ST_074	LCB closure pulse
ST_075	LCB closure command (stable)
ST_076	ACB minimum voltage coil
ST_077	ACB opening pulse
ST_078	ACB closure pulse
ST_079	ACB closure command (stable)
ST_080	Start inhibited by contact
ST_081	Start inhibited by clock/calendar
ST_082	Start inhibited by BMS
ST_088	GCB closure inhibited by contact
ST_090	GCB closure inhibited by serial port
ST_091	GCB closure inhibited by the protection of the circuit breaker
ST_093	GCB closure inhibited for battery disconnected
ST_094	GCB closure inhibited for voltage out of thresholds
ST_095	GCB closure inhibited for bus voltage out of thresholds
ST_096	Ready to supply
ST_104	Supplying
ST_112	Sync per second
ST_113	Sync per minute
ST_114	Sync per hour
ST_127	Daylight Save Time
ST_128	Glow-plugs preheat command
ST_129	ECU enable command
ST_130	Fuel solenoid
ST_131	Gas valve
ST_132	Crank motor
ST_133	Stop solenoid
ST_134	Idle speed command
ST_135	Coolant pre-heat command

Status	Description
ST_136	Pre-lubrication command
ST_137	Inhibit DPF regeneration
ST_138	Force DPF regeneration
ST_139	AdBlue pump command
ST_140	AdBlue solenoid command
ST_144	Plant battery charge: not in progress
ST_145	Plant battery charge: alignment of voltages
ST_146	Plant battery charge: BULK
ST_147	Plant battery charge: ABSORPTION
ST_148	Plant battery charge: FLOAT
ST_149	Plant battery charge: FLOAT terminated
ST_156	Forced regulation of generator voltage
ST_157	Forced regulation of generator current
ST_158	Limitation of the discharge current of the storage battery
ST_159	Limitation of the current of the generator
ST_224	Calendar 1
ST_225	Calendar 2
ST_226	Calendar 3
ST_227	Calendar 4
ST_228	Calendar 5
ST_229	Calendar 6
ST_230	Calendar 7
ST_231	Calendar 8
ST_232	Calendar 9
ST_233	Calendar 10
ST_234	Calendar 11
ST_235	Calendar 12
ST_236	Calendar 13
ST_237	Calendar 14
ST_238	Calendar 15
ST_239	Calendar 16
ST_240	Timer 1
ST_241	Timer 2
ST_242	Timer 3
ST_243	Timer 4
ST_256	CAN 0 BUS-OFF
ST_257	CAN 0 ERR-PASSIVE
ST_258	CAN 0 ERR-ACTIVE
ST_259	No communication on CAN 0
ST_304	START button
ST_305	STOP button
ST_306	GCB button
ST_308	MODE UP button
ST_309	MODE DOWN button
ST_310	UP button
ST_311	DOWN button
ST_312	LEFT button
ST_313	RIGHT button
ST_314	ENTER button
ST_315	EXIT button
ST_316	SHIFT button
ST_317	ACK button
ST_320	Status #01 from engine management by file
ST_321	Status #02 from engine management by file
ST_322	Status #03 from engine management by file
ST_323	Status #04 from engine management by file
ST_324	Status #05 from engine management by file
ST_325	Status #06 from engine management by file
ST_326	Status #07 from engine management by file
ST_327	Status #08 from engine management by file
ST_328	Status #09 from engine management by file
ST_329	Status #10 from engine management by file
ST_330	Status #11 from engine management by file
ST_331	Status #12 from engine management by file
ST_332	Status #13 from engine management by file

Status	Description
ST_333	Status #14 from engine management by file
ST_334	Status #15 from engine management by file
ST_335	Status #16 from engine management by file
ST_336	Status #01 from AVR management by file
ST_337	Status #02 from AVR management by file
ST_338	Status #03 from AVR management by file
ST_339	Status #04 from AVR management by file
ST_340	Status #05 from AVR management by file
ST_341	Status #06 from AVR management by file
ST_342	Status #07 from AVR management by file
ST_343	Status #08 from AVR management by file
ST_344	Status #09 from AVR management by file
ST_345	Status #10 from AVR management by file
ST_346	Status #11 from AVR management by file
ST_347	Status #12 from AVR management by file
ST_348	Status #13 from AVR management by file
ST_349	Status #14 from AVR management by file
ST_350	Status #15 from AVR management by file
ST_351	Status #16 from AVR management by file
ST_352	Status #01 from BMS management by file
ST_353	Status #02 from BMS management by file
ST_354	Status #03 from BMS management by file
ST_355	Status #04 from BMS management by file
ST_356	Status #05 from BMS management by file
ST_357	Status #06 from BMS management by file
ST_358	Status #07 from BMS management by file
ST_359	Status #08 from BMS management by file
ST_360	Status #09 from BMS management by file
ST_361	Status #10 from BMS management by file
ST_362	Status #11 from BMS management by file
ST_363	Status #12 from BMS management by file
ST_364	Status #13 from BMS management by file
ST_365	Status #14 from BMS management by file
ST_366	Status #15 from BMS management by file
ST_367	Status #16 from BMS management by file
ST_368	Active regeneration status: not active (spn3700=0)
ST_369	Active regeneration status: active (spn3700=1)
ST_370	Active regeneration status: will start soon (spn3700=2)
ST_371	DPF status: regeneration not required (spn3701=0)
ST_372	DPF status: regeneration needed - lowest level (spn3701=1)
ST_373	DPF status: regeneration needed - moderate level (spn3701=2)
ST_374	DPF status: regeneration needed - highest level (spn3701=3)
ST_480	Electronic battery #01: warnings
ST_496	Electronic battery #01: alarms
ST_512	Electronic battery #02: warnings
ST_528	Electronic battery #02: alarms
ST_544	Electronic battery #03: warnings
ST_560	Electronic battery #03: alarms
ST_576	Electronic battery #04: warnings
ST_592	Electronic battery #04: alarms
ST_608	Electronic battery #05: warnings
ST_624	Electronic battery #05: alarms
ST_640	Electronic battery #06: warnings
ST_656	Electronic battery #06: alarms
ST_672	Electronic battery #07: warnings
ST_688	Electronic battery #07: alarms
ST_704	Electronic battery #08: warnings
ST_720	Electronic battery #08: alarms
ST_736	Electronic battery #09: warnings
ST_752	Electronic battery #09: alarms
ST_768	Electronic battery #10: warnings
ST_784	Electronic battery #10: alarms
ST_800	Electronic battery #11: warnings
ST_816	Electronic battery #11: alarms
ST_832	Electronic battery #12: warnings

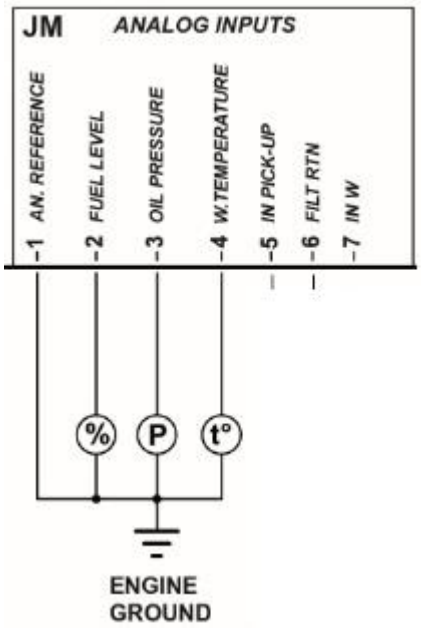
Status	Description
ST_848	Electronic battery #12: alarms
ST_864	Electronic battery #13: warnings
ST_880	Electronic battery #13: alarms
ST_896	Electronic battery #14: warnings
ST_912	Electronic battery #14: alarms
ST_928	Electronic battery #15: warnings
ST_944	Electronic battery #15: alarms
ST_960	Electronic battery #16: warnings
ST_976	Electronic battery #16: alarms
ST_997	PLC first scan
ST_998	Always ON
ST_999	Always OFF

Using the virtual digital inputs, you can create mixed AND/OR logics (consisting of both AND and OR). Suppose you want to activate the digital output #1 when the digital inputs #1 and #2 are both active, or when digital input #3 is active.

First, we must associate to the virtual digital input #1 (for instance) and AND/OR logic configured as AND, which checks that the first two inputs are both active. Then we must associate to the digital output #1 an AND/OR logic configured as OR, which checks that the virtual digital input #1 or the digital input #3 are active. In practice, the virtual digital input #1 is used as “support” for the AND condition. In this case you need not associate a function to the virtual digital input.

5.6 Analogue inputs

5.6.1 Inputs for resistive-type sensors



The device is provided with three inputs designed for the connection to the resistive-type sensors (JM-2, JM-3, JM-4). There is also an input used for measuring their common earth potential JM-1.

The three values of voltage to the terminals and their corresponding resistance value of the sensors and the JM-1 voltage value measured are displayed on page S.15; if an input is not configured, dashes appear.

You can also individually configure the three inputs JM-2, JM-3 and JM-4 as additional digital inputs that become active when connected to ground. So, these will be displayed in the configuration menu of the digital inputs and will be manageable exactly as the other inputs.

If one or more inputs are configured as digital inputs, their state is displayed on page S.11 (0 = input not active, 1 = input active). The inputs not configured as digital are displayed with a dash.

5.6.1.1 Input JM-1 Analogue reference

It is not a real measure input: it is used together with the three inputs for resistive sensors and has no effect on JL-4. Its purpose is to compensate for the lack of equipotentiality between electric earthing of the device (GND terminal) and of the electric panel and electric earthing of the gen-set, usually generated by the voltage drop on the connection cables; particularly, this happens when the connections between electric panel and engine are long and when there is a power flow in the battery minus and earthing connections, for example due to the presence of the battery recharge device inside the electric panel.

The system can efficiently compensate for both positive and negative potentials, ranging between -2.7VDC and +4VDC, with sensors resistance values of 100 ohms. The range of compensation increases for lower resistance values and decreases for higher values of resistance, being optimized for the resistance values of the sensors in normal operating conditions of the system.

The measure of the voltage with respect to the GND terminal is displayed on page S.15, under item JM1; the measuring range of the system, and therefore the value indicated, can be higher than the one useful for compensation, mentioned above.

The input measures the potential of the common ground point (negative) of the resistive sensors, which for the sensors mounted on the engine is represented directly by the engine itself or the chassis of the gen-set; JM-1 can therefore be connected to a grounding system or to a bolt on the engine.

If the minus of one or several sensors is isolated from the engine or the gen-set chassis, for example in the case of floats for fuel level measurement mounted on the plastic tanks or electrically separated from the gen-set, you need to connect the JM-1 to the return of the sensor and also to the negative electric mass of the engine or to the negative limit of the starting battery.

Note: this connection should be made using a dedicated wire having the shortest possible length. Avoid making the wire lies near high power and high voltage cable.

5.6.1.2 Input JM-2

The input has a useful resistance measurement range between 0 and 1500 ohm; within this range the measurement error guaranteed is less than 1%, with a voltage to the JM-1 terminal with respect to the GND=0. Higher resistance values can be measured, although with gradually decreasing precision.

5.6.1.3 Input JM-3

The input has a useful resistance measurement range between 0 and 2000 ohm; within this range the measurement error guaranteed is less than 1%, with a voltage to the JM-1 terminal with respect to the GND=0. Higher resistance values can be measured, although with gradually decreasing precision.

5.6.1.4 Input JM-4

The input has a useful resistance measurement range between 0 and 1700 ohm; within this range the measurement error guaranteed is less than 1%, with a voltage to the JM-1 terminal with respect to the GND=0. Higher resistance values can be measured, although with gradually decreasing precision.

5.6.1.5 Using resistive-type analogue inputs as digital

To use the previously described analogue input as digital ones, simply configure the input with the function AIF.0100. To activate the input, connect the its terminal to GND. To deactivate the input, leave its input unconnected.

5.6.1.6 Usable VDO sensors

To use the previous input to acquire measures of pressure, temperature or level, normally the operator must manually configure the relations between the ohms measured from the sensors and the related °C, bar or %. For some commonly used VDO sensors, the conversions points are still stored into the controller. The characteristics of these sensors are:

VDO TEMPERATURE SENSORS	
0°C	1800 ohms
50°C	195 ohms
100°C	38 ohms
150 °C	10 ohms

VDO PRESSURE SENSORS	
0 bar	10 ohms
10 bar	180 ohms

VDO LEVEL SENSORS	
0%	180 ohms
100%	0 ohms

5.6.2 Input JL-4

The function of this terminal depends on parameter P.4041:

- AIF.0100. In this case the terminal is used as digital input (input 17). To activate the input, connect its terminal to +BATT. To deactivate the input, leave the terminal unconnected or connect it to GND.
- AIF.1300. In this case, the terminal is used to provide the energizing current to the battery charger of the engine. It is also used to measure the voltage provided by this battery charger.
- All other values: in this case the terminal is used as analogue input, with measuring range 0-32VDC with respect to the power minus of the controller (GND).

5.6.3 Input Q

The function of this terminal depends on parameter P.4009:

- AIF.0100. In this case the input is used as digital input (input 13). Connect the terminal JQ-2 to GND. To activate the input, connect the terminal JQ-1 to +BATT. To deactivate the input, connect it to GND.
- All other values: in this case the terminal is used as analogue input, with measuring range +/-85VDC (differential mode between the two terminals).

5.6.4 Analogue inputs on expansion modules

You can also increase the number of analogue inputs by adding two optional DITHERM/DIGRIN modules (three temperature input each) and one DIVIT module (four Vdc/mA inputs), up to a total number of 10 additional analogue inputs. The expansion modules must be connected to HS315 via CAN-BUS

5.6.5 Virtual analogue inputs

In addition to the physical analogue inputs, the controller also operates 8 virtual analogue inputs. The same are operated by the controller just as if they were physical inputs (with no limitation), but the status of the virtual inputs is not acquired from the hardware, but it is determined through the software. In fact, by means of the “function” parameter of each virtual analogue input, you can “copy” in the analogue input one of the internal measures made available by the controller. See table in 5.6.6

The purpose of the virtual analogue inputs is double:

- Allowing the issuing of warnings/locks related to the internal measures available.
- Activating digital outputs based on the value of the internal measures available.

See example in par.5.6.6.

5.6.6 Configuration of analogue inputs

The following table shows all the functions related to analogue inputs:

Function	JM_2 JM-3 JM-4	JL_4	JQ	Virtual	DIGRIM DITHERM	DIVIT	Curve	Description
AIF.0000	X	X	X	X	X	X		Not used
AIF.0100	X	X	X					Used as digital input
AIF.1000	X							Oil pressure (VDO)
AIF.1001	X	X	X		X	X	X	Oil pressure (generic)
AIF.1100	X							Oil temperature (VDO)
AIF.1101	X	X	X			X	X	Oil temperature (generic)
AIF.1110	X							Coolant temperature (VDO)
AIF.1111	X	X	X		X	X	X	Coolant temperature (generic)
AIF.1200	X							Oil level (VDO)
AIF.1201	X	X	X			X	X	Oil level (generic)
AIF.1210	X							Coolant level (VDO)
AIF.1211	X	X	X			X	X	Coolant level (generic)
AIF.1220	X							Fuel level (VDO)
AIF.1221	X	X	X			X	X	Fuel level (generic)
AIF.1231	X	X	X			X	X	Fuel level (I) (generic)
AIF.1300		X						D+ signal
AIF.1601	X	X	X		X	X	X	Intake manifold temperature
AIF.1603	X	X	X		X	X	X	Exhaust gas temperature - left
AIF.1605	X	X	X		X	X	X	Exhaust gas temperature - right
AIF.1641	X	X	X			X	X	Boost pressure
AIF.1901			X	X	X	X		Storage battery temperature
AIF.1903			X	X		X		Storage battery voltage
AIF.1905			X	X		X		Storage battery current
AIF.1907			X	X		X		Storage battery rated current
AIF.1909			X	X		X		Charge current during bulk phase
AIF.1911			X	X		X		Setpoint for generator current regulation
AIF.1913			X	X		X		Storage battery charge level
AIF.1915			X	X		X		Storage battery charge limit
AIF.1917			X	X		X		Storage battery discharge limit
AIF.1919			X	X		X		Generator voltage
AIF.1921			X	X		X		Generator current
AIF.1923			X	X		X		Loads voltage
AIF.1925			X	X		X		Loads current
AIF.1926			X	X		X		Auxiliary source voltage
AIF.1927			X	X		X		Auxiliary source current
AIF.2001	X	X	X	X	X	X	X	Generic sensor (page 1)
AIF.2003	X	X	X	X	X	X	X	Generic sensor (page 2)
AIF.2005	X	X	X	X	X	X	X	Generic sensor (page 3)
AIF.2051	X	X	X	X	X	X	X	Generic sensor
AIF.2113				X				Speed/power setpoint
AIF.4001				X				Generator frequency
AIF.4006				X				Generator voltage L1-L2
AIF.4007				X				Generator voltage L2-L3
AIF.4008				X				Generator voltage L3-L1
AIF.4009				X				Generator average voltage L-L
AIF.4012				X				Auxiliary source frequency
AIF.4017				X				Auxiliary source voltage L1-L2
AIF.4018				X				Auxiliary source voltage L2-L3
AIF.4019				X				Auxiliary source voltage L3-L1
AIF.4020				X				Auxiliary source voltage L-L media

Function	JM_2 JM-3 JM-4	JL_4	JQ	Virtual	DIGRIM DITHERM	DIVIT	Curve	Description
AIF.4023				X				Current (DC) of the generator
AIF.4024				X				Current (DC) of the battery
AIF.4025				X				Current (DC) of the loads
AIF.4026				X				Current (DC) of the auxiliary source
AIF.4031				X				Power of the generator
AIF.4032				X				Power of the battery
AIF.4033				X				Power of the loads
AIF.4034				X				Power of the auxiliary source
AIF.4044				X				Voltage (DC) of the generator
AIF.4045				X				Voltage (DC) of the battery
AIF.4046				X				Voltage (DC) of the loads
AIF.4047				X				Voltage (DC) of the auxiliary source
AIF.4088				X				Engine speed
AIF.4091				X				Engine oil level
AIF.4092				X				Engine coolant level
AIF.4093				X				Engine fuel level
AIF.4094				X				Engine fuel level (l)
AIF.4096				X				Engine fuel rate (actual)
AIF.4097				X				Engine fuel rate (average)
AIF.4105				X				Battery voltage
AIF.4108				X				Engine number of starts
AIF.4111				X				Engine total hours of operation
AIF.4112				X				Engine hours of operation
AIF.4114				X				Engine hours of operation with GCB closed (partial)
AIF.4116				X				Engine hours to maintenance 1 (partial)
AIF.4118				X				Engine hours to maintenance 2 (partial)
AIF.4119				X				Days to maintenance (partial)
AIF.4121				X				Engine oil pressure
AIF.4122				X				Engine coolant pressure
AIF.4123				X				Engine fuel delivery pressure
AIF.4126				X				Engine intake manifold pressure
AIF.4134				X				Ambient air temperature
AIF.4136				X				Engine oil temperature
AIF.4137				X				Engine coolant temperature
AIF.4138				X				Engine fuel temperature
AIF.4139				X				Engine intake manifold temperature
AIF.4140				X				Engine turbocharger compressor outlet temperature
AIF.4141				X				Engine exhaust gas temperature - Left manifold
AIF.4142				X				Engine exhaust gas temperature - Right manifold
AIF.4143				X				Engine intercooler temperature
AIF.4153				X				Soot level
AIF.4154				X				Ash level
AIF.4156				X				DEF level (AdBlue)

The configurations AIF.2001, AIF.2003 and AIF.2005 “Generic sensor (page x)” allow you to select the display page in the **E** menu in which the measure acquired will be displayed (page 1= first page available, page 2, the second, etc.).

The column “Curve” shows the functions that allow the definition of generic conversion curves, with at least two couples of points of the measurement (for example resistance/temperature). See the description of the conversion curves in the next chapters.

Each analogue input, both the five inputs on the controller and the optional ones on the expansion module, be they physical or virtual, have eight parameters associated; see below for example the ones related to input JM-3; for the parameters of the other inputs, physical, of the expansions or for the virtual ones see document [1] or the I/O configuration page of the BoardPrg4.

NOTE: On the BoardPrg4 the parameters are all displayed only when the input is configured as analogue input and not, for example as digital. The analogue inputs of the expansion modules are displayed only if the module is configured.

We have:

- One parameter which configures its function (P.4017 for input JM-3).
- One parameter which configures any message to be shown on the display (P.4018 for input JM-3).
- Two thresholds consisting of three parameters each:
  - One parameter which configures the threshold value (P.4019 and P.4022 for input JM-3).
  - One parameter which configures the delay for managing the “out of threshold” (P.4020 and P.4023 for input JM-3).
  - One parameter which configures the checking options and the actions in case of “out of threshold” (P.4021 and P.4024 for input JM-3).

NOTE: the thresholds defined here do not depend on any threshold set within the menus Protections; for example, for the coolant temperature sensor you can set a high temperature threshold through the parameter P.0337 to stop the engine and a pair of independent temperature thresholds through the parameters described above, used to create other alarms, different signals or logics.

The parameter containing the message for a certain analogue input (in the example above, what is written in the P.4018 parameter) is displayed and used by the controller every time the thresholds are used to activate warnings and/or alarms (see below); it is also used for the following functions of the analogue inputs: AIF.2001, AIF.2003 and AIF.2005 of the type “Generic sensor (page X)”, available **only on certain inputs.** In this case the measure acquired will be displayed according to the X value (1, 2 or 3) on pages E.08, E.09 and E.10, preceded by the message configured. **NOTE: You can also use the AIF.2051 function instead of the previous three. in this case, the measure acquired will not be displayed on pages E.08, E.09 and E.10; however, you can still use it with the thresholds to manage digital outputs and activate warnings/locks.**

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

- Bit 0. If this bit is “OFF”, the controller checks if the measure is higher than the threshold. If this bit is “ON”, the controller checks if the measure is lower than the threshold.
- Bit 1. If this bit is “OFF”, the controller sets to OFF the internal status related to this analogue measure if the measure is “out of threshold”. If this bit is “ON”, the controller sets to ON the internal status related to this analogue measure if the measure is “out of threshold”.
- Bit 4. If this bit is “ON”, the controller issues a warning if the measure is “out of threshold”.
- Bit 5. If this bit is “ON”, the controller issues a latched warning if the measure is “out of threshold”.
- Bit 6. If this bit is “ON”, the controller issues a deactivation if the measure is “out of threshold”.
- Bit 7. If this bit is “ON”, the controller issues an alarm (block) if the measure is “out of threshold”.
- Bit 08. If this bit is “ON”, the controller checks that the engine is running to activate possible warnings/alarms configured with the preceding bits.
- Bit 09. If this bit is “ON”, the controller checks that the mask time for the lube oil protection has elapsed to activate possible warnings/alarms configured with the preceding bits.
- Bit 10. If this bit is “ON”, the controller checks that the GCB is closed, to activate possible warnings/alarms configured with the preceding bits.
- Bit 11. If this bit is “ON”, the controller activates a warning/alarm only if the fuel valve is activated.
- Bit 12. If this bit is “ON”, the controller activates a warning/alarm only if the gas valve is activated.

- Bit 13. If this bit is “ON”, to activate any warning/alarm configured with the preceding bits, the controller checks the status of any digital input configured with the function “DIF.2705 - Disable the protections on the analogue measures”. The warnings/alarms will be activated if no digital input is configured as such, or if they are all OFF.
- Bit 14. If this bit is “ON”, the warning/alarm entails the arrest of the fuel pump
- Bit 16. If this bit is “ON”, the warning/alarm is subject to engine protections override.

You can set any combination of these bit.

Using the two thresholds and the AND/OR logics together, you can activate a digital output regarding the value of an analogue measure, with hysteresis. Suppose you want to activate a digital output if plant battery voltage exceeds 30.0 Vdc. First, you must maintain a minimum hysteresis on the threshold, otherwise, when the plant battery voltage is close to the threshold, the output will continue to switch on and off, due to minimum variations of the voltage itself. So, suppose you want to activate the output if the voltage exceeds 30.0 Vdc and deactivate the output if the voltage is lower than 29.8 Vdc. To do that, we can use, for example, the virtual analogue input #1 which has been configured to contain the plant battery voltage.

Let us set the parameters as follows:

- P.4051 (function #1): 4045 (AIF.4045).
- P.4052 (message #1): “”.
- P.4053 (threshold #1): 30.0 Vdc
- P.4054 (delay #1): 0.5 sec
- P.4055 (configuration #1): 0002 (bit 0 OFF, bit 1 ON)
- P.4056 (threshold #2): 29.8 Vdc
- P.4057 (delay #2): 0.5 sec
- P.4058 (configuration #2): 0001 (bit 0 ON, bit 1 OFF)

The first threshold is used to activate the internal status related to the analogue input. Looking at the configuration parameter you can see that:

- Bit 0 OFF (checks that the measure is higher than the threshold).
- Bit 1 ON (activates the internal status in “out of threshold” condition).

The second threshold is used to deactivate the internal status related to the analogue input. Looking at the configuration parameter you can see that:

- Bit 0 ON (check that the measure is lower than the threshold).
- Bit 1 OFF (deactivates the internal status in “out of threshold” condition).

So, with the previous programming, the controller activates the internal status related to the analogue input when the measure is greater than 30.0 Vdc for 0,5 seconds; it deactivates the internal status when the measure is less than 29.8 Vdc for 0,5 seconds.

Using the AND/OR logics, you can “copy” the internal status on a physical output.

5.7 Analogue outputs

5.7.1 Analogue output JR

HS315 provides one DC voltage analogue output. The maximum range of the output is +/-10Vdc; it can be reduced to +/- 1VDC using the TR1 trimmer (near the JR terminals). This output is normally used for the connection to the voltage regulator for traditional alternators, or for the connection to the speed regulator for permanent magnets alternators. If a positive only voltage range is required, you can use parameters P.0856 and P.0857 to limit the hardware range.

5.7.2 Analogue outputs on expansion modules

It is possible to add one DANOUT module (through Can Bus link), that provides 4 additional analogue outputs. These outputs can be configured as 0-20 mA, 4-20 mA, +/- 10Vdc or 0-20 Vdc.

5.7.3 Configuration of analogue outputs

All outputs are completely configurable.

The values of the outputs (percentage) is shown on page S.19.

HS315 provides one parameter for each analogue output, that allows the configuration of the function of the output. See document [1] for the parameters list.

Analogue outputs can be used directly for sending commands to external devices, or to signal working conditions.

The following table lists all the functions available:

Code	Description.	Curve	Note
AOF.0000	Not used		
AOF.0101	Used by PLC		Output used by the internal PLC logic
AOF.0102	Managed by serial ports		The controller does not control the output with its own internal logics, but with the controls it receives through the serial ports.
AOF.1000	Storage battery charger regulator		Used for the connection to the voltage/speed regulator of the genset.
AOF.1001	Storage battery charger regulator (generic)	X	Used for the connection to the voltage/speed regulator of the genset.
AOF.1002	Speed regulator		Used to select the engine speed more efficient at the current power.
AOF.1003	Speed regulator (generic)	X	Used to select the engine speed more efficient at the current power.
AOF.3001	Engine speed	X	The value of the output is proportional to the speed of the engine.
AOF.3011	Oil pressure	X	The value of the output is proportional to the pressure of the lube oil of the engine.
AOF.3013	Oil temperature	X	The value of the output is proportional to the temperature of the lube oil of the engine.
AOF.3015	Oil level	X	The value of the output is proportional to the level of the lube oil of the engine.
AOF.3023	Coolant temperature	X	The value of the output is proportional to the temperature of the coolant of the engine.
AOF.3025	Coolant level	X	The value of the output is proportional to the level of the coolant of the engine.
AOF.3035	Fuel level	X	The value of the output is proportional to the level of the fuel of the engine.
AOF.3101	Frequency of the generator	X	The value of the output is proportional to the frequency of the AC voltages of the generator.
AOF.3111	Voltage of the generator (AC)	X	The value of the output is proportional to the average AC voltage of the generator.
AOF.3113	Voltage of the generator (DC)	X	The value of the output is proportional to the DC voltage of the generator.
AOF.3121	Power of the generator	X	The value of the output is proportional to the power supplied by the generator.
AOF.3131	Current of the generator (DC)	X	The value of the output is proportional to the current of the generator.
AOF.3201	Frequency of the auxiliary source	X	The value of the output is proportional to the frequency of the AC voltages of the auxiliary source.
AOF.3211	Voltage of the auxiliary source (AC)	X	The value of the output is proportional to the average AC voltage of the auxiliary source.
AOF.3213	Voltage of the auxiliary source (DC)	X	The value of the output is proportional to the DC voltage of the auxiliary source.
AOF.3221	Power of the auxiliary source	X	The value of the output is proportional to the power supplied by the auxiliary source.
AOF.3231	Current of the auxiliary source (DC)	X	The value of the output is proportional to the current of the auxiliary source.
AOF.3313	Voltage of the battery (DC)	X	The value of the output is proportional to the DC voltage of the plant battery.

AOF.3321	Power of the battery	X	The value of the output is proportional to the power supplied by the plant battery.
AOF.3331	Current of the battery (DC)	X	The value of the output is proportional to the current of the plant battery.
AOF.3413	Voltage of the loads (DC)	X	The value of the output is proportional to the DC voltage of the loads.
AOF.3421	Power of the loads	X	The value of the output is proportional to the power supplied by the loads.
AOF.3431	Current of the loads (DC)	X	The value of the output is proportional to the current of the loads.

The column “Curve” shows the functions that allow the definition of generic conversion curves. Specially for functions AOF.3001 and higher, the curve allows to define the percentages for the output related to the values of the selected measure (for example, the function AOF.3001 selects the engine speed as input measure).

The default function for the analogue outputs of the controller are:

Terminal	**Function**
JR	AOF.1000 – Storage battery charger regulator.

The following functions, not directly linked to the operation sequences of the board, are selectable for any analogue output:

- AOF.0101 - “Used by PLC”. This function matches the digital output to the PLC program inside the device; in this way, it is the PLC logic which commands the output, and not the normal operation logics of the controller. Note: if the PLC program uses some outputs, but those are not configured with function AOF.0101, the outputs will not be commanded (but the controller signals this situation with a warning).
- DOF.0102 - “Controlled by the serial ports”. The board does not control the output with its own internal logics, but with the controls it receives through the serial ports.

5.8 Optional additional modules

Using the CAN-BUS engine connection you can connect to the HS315 the following optional additional modules:

- 1 DITHERM module: 3 galvanically isolated thermocouples for temperature measurement.
- 1 DIGRIN module: 3 Pt100 galvanically isolated sensors for temperature measurement.
- 1 DIVIT module: 4 galvanically isolated analogue inputs 0…5V / 0...10V – 0...10mA / 0...20mA
- 1 DANOUT module: 4 galvanically isolated analogue outputs 0...5V / 0...10V – 0...10mA / 0...20mA
- 2 DITEL 16IN modules: 16 optically isolated digital inputs (for a total number of 32 inputs) to each of which you can connect 2 modules DITEL 8 OUT relay for a total number of 32 digital outputs. You cannot use the output modules without a related input module.

For the configurations to be made on the modules, refer to their user manuals.

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

To configure the modules on the HS315, it is necessary to set the number of modules available with the parameters

- P.0141 The number of DITEL 16 IN modules (with any OUT module).
- P.0142 The number of DITEMP modules (i.e., DITHERM or DIGRIN).
- P.0143 The number of DIVIT modules.
- P.0144 The number of DANOUT modules.

Once the modules presence is configured, they appear as digital or analogue inputs or outputs and are driven the same as the ones present on the controller board.

For their related parameters see [1].

In BoardPrg4, once the presence of a module is configured, it appears in the I/O menu on the left column, with each individual input/output ready to be configured.

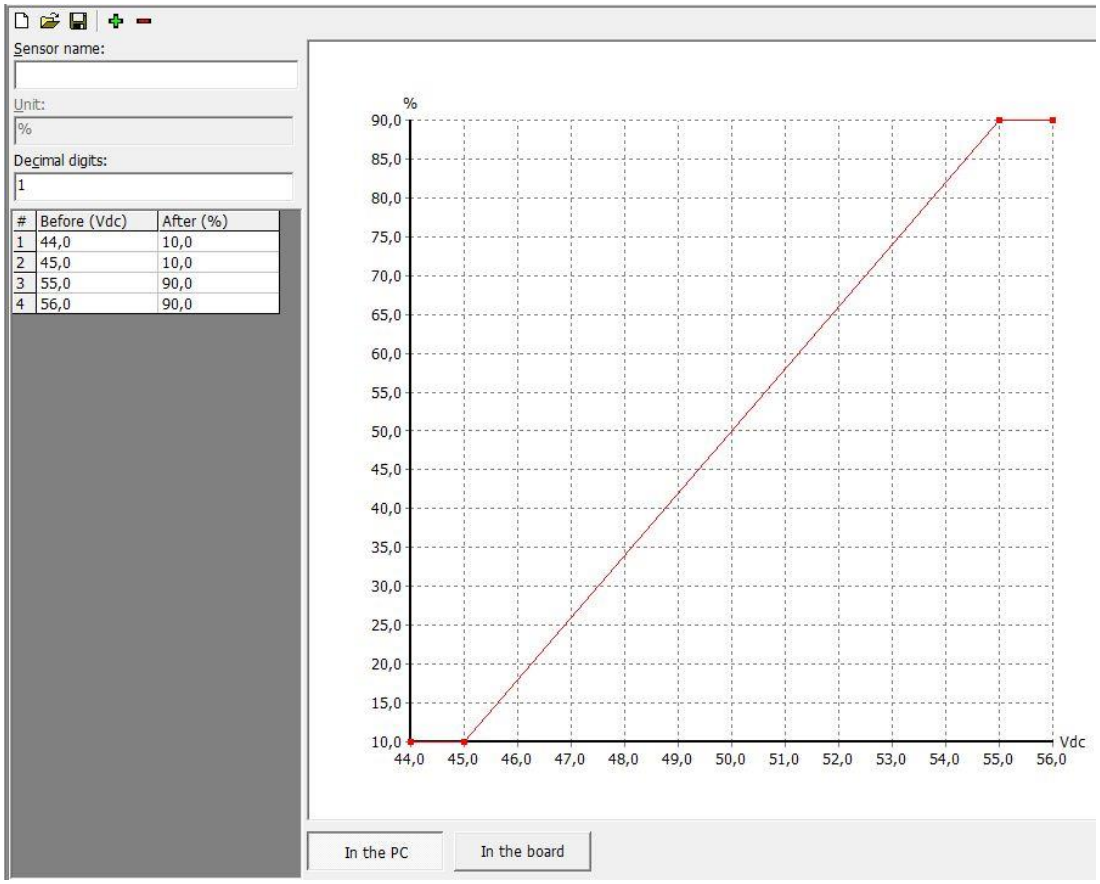
5.9 Conversion curves

The conversion curves are a tool which allow you to convert a numerical value into another numerical value. They can be used for the analogue inputs and for the analogue outputs, for two purposes:

- Convert the value acquired from an analogue input (of voltage, current or resistance (physical) found on the controller board or on the optional expansion modules, from electrical value into the real unit of measurement of the sensor.
- Convert an internal measure of the controller board into a percentage value, prior to "writing" it on an analogue output.

NB: the conversion curves cannot be configured directly from the panel of the controller board, but through a PC equipped with the BoardPrg4 software.

Once created, the curves can be saved on file to be reused, including on other HS315 controllers.



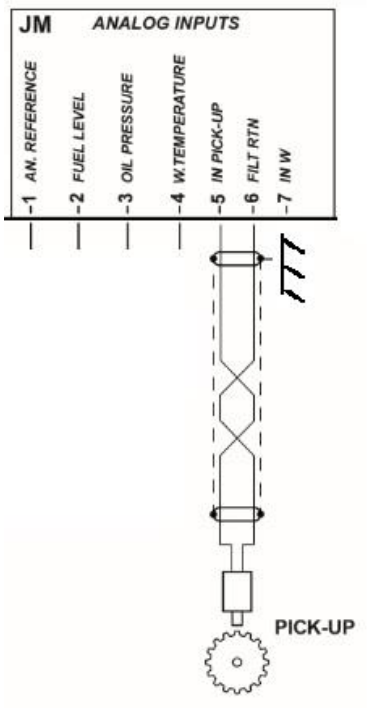
The figure above shows a conversion curve associated to an analogue output. The analogue output has been configured with the function AOF.3113 – "Voltage of the generator (DC)". In this configuration, the output will run at 10% for a voltage of 45 Vdc or lower, and at 90% for a voltage of 55 Vdc or higher; for voltage values ranging between 45 Vdc and 55 Vdc, the output will have a value between 10% and 90%.

You can add up to 32 points in the graph, thus creating also non-linear curves. See in the example that the curve configured has two horizontal segments at the beginning and at the end, obtained by entering two equal values in the "After" column, corresponding to two different values in the "before" column. This is not obligatory, but it allows you to set a saturation limit on one end or on both ends of the curve. In fact, the controller board extends to infinity the first and last segments of the curve. Being horizontal, whatever value the measure "to convert" assumes, you will obtain the same value of the "converted" measure. In the previous example, for any voltage measure lower than 45 Vdc, the analogue output will be set at 10%. If from the example above you removed the first point (44 Vdc 10%), the horizontal segment would not be at the beginning of the curve: in this case, if the voltage should drop below 45 Vdc, the analogue output would drop below the 10%.

The BoardPrg4 software allows you (by means of the first buttons on top left) to save the curve on file to be able to use it again in other applications. So, you can create an archive of the conversions associated to the sensors used.

In case the curve is associated to a physical analogue input configured with the functions AIF.2001, AIF.2003 and AIF.2005 (“Generic sensor”), the measure converted will be displayed on pages E.08, E.09 and E.10: in this case you can also specify (through the conversion curve) how many decimal digits will the value displayed have, as well as its unit of measurement).

5.10 Measurement of the engine rotational speed (PICK-UP or W) JM-5, JM-6 and JM-7



To measure the engine rotational speed, you can use a magnetic pick-up placed on the fly-wheel, or use the W speed signal on the battery recharge alternator. The connection must be made with a shielded cable, with grounded shield.

In the case of engines equipped with digital control unit the rotational speed is measured directly via CAN-BUS.

5.10.1 Magnetic pick-up

You can use either two ground insulated wires pick-up, or a one-wire pick-up with the thread screwed onto the grounded engine (GND), which is the return connection for the signal; the two-wire isolated pick-up is however recommended.

The signal is sinusoidal; the frequency depends on the rotational speed of the engine and on the number of revolutions of the flywheel.

The maximum input voltage with the engine in standard operation is about 3Vac; in case voltage is lower, the signal can be increased by turning the pick-up to bring it closer to the gear wheel, paying the utmost attention not to hit it when turning the flywheel.

Connections:

JM-5 pick-up signal positive input

JM-6 pick-up signal negative input

With the one-wire pick-up, only connect the **JM-5**.

Usually, you can use a single pick-up, connected either to a HS315 or to another device, such as a speed regulator, but paying attention to the polarity of the connections. Check also that the signal amplitude is enough.

The number of teeth of the flywheel must be set in the P.0110 parameters; by entering 0, the pick-up measurement is disabled.

5.10.2 W signal

Some battery charger alternators make available a “W” terminal that has an alternate voltage with a frequency proportional to the rotation speed of the battery charger. The W signal is generated inside the engine start battery recharge alternator. It is a square wave, with an amplitude ranging from 0 to Vbatt and a frequency proportional to the engine speed but depending on how the alternator is built and on the ratio between the diameters of the pulleys onto which the driving belt runs.

To use the W signal, it is required:

- Connect the W signal of the battery charger alternator to the terminal **JM-7**.
- Connect terminal **JM-5** to terminal **JM-6** (short circuit).

As already mentioned, the W signal frequency is proportional to the battery recharge alternator rotational speed, and not to the engine running speed: in fact, between them there is a belt. Therefore, you must set a ratio (parameter P.0111) to allow the controller to convert the frequency of the W signal (battery recharge alternator revolutions per second) in engine revolutions per minute. This ratio depends on many factors and it is not easy to calculate. If a frequency meter is available, simply start the engine (it will run at is rated and known speed, i.e., 1500 rpm) and measure the W signal frequency, and then calculate the ratio. If a frequency meter is not available, the following method can be used:

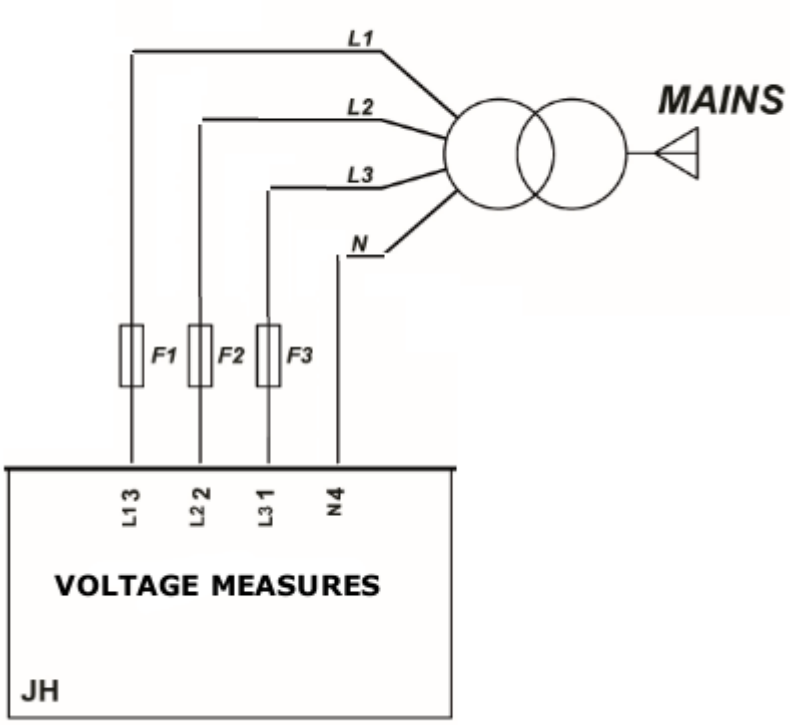
- Set a random value for P.0111 (e.g., 15).
- Start the engine and, when at operating speed, note the rpm value shown by the controller.
- Calculate the ratio between the displayed speed and the actual engine speed (displayed/actual).
- Multiply the value previously set in P.0111 by this ratio and set the new value.

Restarting the engine, the speed measure should be close to the actual speed. Then, manually adjust the value P.0111 until you get the right display, considering that, for the same true speed, the value displayed by the controller decreases when increasing P.0111. To determine the engine speed, the generator frequency can also be used.

Leave P.0111 to 0 if W signal is not used.

Notice: if W signal is used, set P.0110 to zero.

5.11 Connection of the AC voltages of the auxiliary source



The connection to the AC auxiliary source lines is optional; if required, it is made through the connector JH of the controller.

Tri-phase connection:

Parameter	Value	Description
P.9617	015-AC voltage for the auxiliary source (L1)	Connect phase L1 (or R) to terminal JH-3
P.9616	016-AC voltage for the auxiliary source (L2)	Connect phase L2 (or S) to terminal JH-2
P.9615	017-AC voltage for the auxiliary source (L3)	Connect phase L3 (or T) to terminal JH-1
P.9618	018-AC voltage for the auxiliary source (N)	Connect neutral (N) (if any) to terminal JH-4

If the neutral is not present, the terminal JH-4 cannot be used for other functions.

Single-phase connection:

Parameter	Value	Description
P.9617	015-AC voltage for the auxiliary source (L1)	Connect phase L1 (or R) to terminal JH-3

P.9618	018-AC voltage for the auxiliary source (N)	Connect neutral (N) to terminal JH-4

Terminals JH-1 and JH-2 can be used for other functions.

Single phase / three-phase selection depends on the settings of parameters P.9615 e P.9616.

It is required to configure the nominal AC voltage (P.0116) and frequency (P.0105). It is also required to configure the voltage transformers ratio, using P.0117 and P.0118.

Voltage measurement are performed as True RMS.

Maximum 74.5 Vac can be applied between terminals and GND.

The controller uses phase L1 (terminal JH-3) to measure the frequency of the auxiliary source.

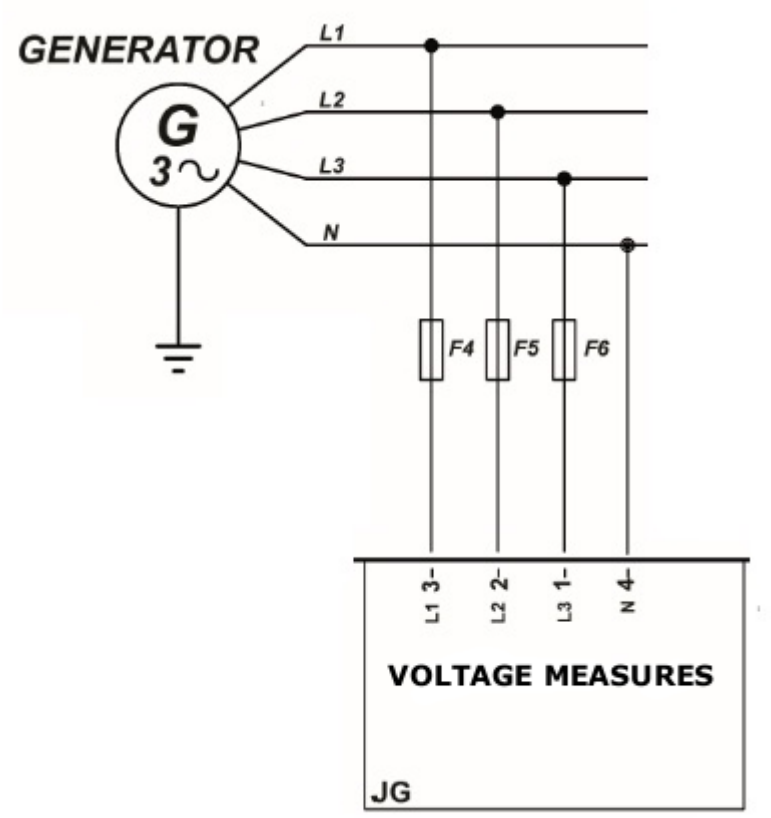
AC voltages and frequency are shown on page M.11. This page is hidden if auxiliary source AC voltages are not connected to the controller.

5.11.1 Measurement of the auxiliary source neutral

The device, in three-phase connection, can function both with the neutral connection and without it; selection is performed through the P.9618 parameter: the value 018 means that the neutral line is connected to JH-4.

If the neutral is connected to the controller, the neutral voltage is measured in relation with GND. The values of the V1-N, V2-N and V3-N phase voltages and the VN voltage of the neutral in relation to GND for the auxiliary source are displayed on page M.12. If the neutral is not connected to the controller, then page M.12 will not be displayed.

5.12 Connection of the AC voltages of the generator



The connection to the AC generator lines is optional; if required, it is made through the connector JG of the controller.

Tri-phase connection:

Parameter	Value	Description
P.9613	025-AC voltage for the generator (L1)	Connect phase L1 (or R) to terminal JG-3
P.9612	026-AC voltage for the generator (L2)	Connect phase L2 (or S) to terminal JG-2
P.9611	027-AC voltage for the generator (L3)	Connect phase L3 (or T) to terminal JG-1
P.9614	028-AC voltage for the generator (N)	Connect neutral (N) (if any) to terminal JG-4

If the neutral is not present, the terminal JG-4 cannot be used for other functions.

Single-phase connection:

Parameter	Value	Description
P.9613	025-AC voltage for the generator (L1)	Connect phase L1 (or R) to terminal JG-3

P.9614	028-AC voltage for the generator (N)	Connect neutral (N) to terminal JG-4

Terminals JG-1 and JG-2 can be used for other functions.

Single phase / three-phase selection depends on the settings of parameters P.9611 e P.9612.

It is required to configure the nominal AC voltage (P.0102) and frequency (P.0105). It is also required to configure the voltage transformers ratio, using P.0103 and P.0104.

Voltage measurement are performed as True RMS.

Maximum 74.5 Vac can be applied between terminals and GND.

The controller uses phase L1 (terminal JG-3) to measure the frequency of the auxiliary source.

AC voltages and frequency are shown on page M.07. This page is hidden if auxiliary source AC voltages are not connected to the controller.

5.12.1 Measurement of the generator neutral

The device, in three-phase connection, can function both with the neutral connection and without it; selection is performed through the P.9614 parameter: the value 028 means that the neutral line is connected to JG-4.

If the neutral is connected to the controller, the neutral voltage is measured in relation with GND. The values of the V1-N, V2-N and V3-N phase voltages and the VN voltage of the neutral in relation to GND for the auxiliary source are displayed on page M.08. If the neutral is not connected to the controller, then page M.08 will not be displayed.

5.13 Connections for DC voltages

HS315 can measure the DC voltages of the generator, of the plant battery, of the loads and of the auxiliary source. The controller performs all the measurement in differential mode between two terminals: the wiring must ensure that the measured voltages are positive (even when the positive of the plant battery is connected to GND).

Voltage measurement are performed as True RMS.

For DC measurement, the terminals of JH, JG and JQ connectors can be used. The terminals of JQ must be used together to acquire a single DC voltage; the terminals of JH and JG, instead, can be freely configured.

From version 1.12, it is also possible to use DIVIT expansion modules to acquire this measurement. Since version 2.05, it is also possible to use commercial sensors connected via CAN, to acquire these measurements (see 11.7.4).

P.9635 allows the configuration of the function of JQ terminals; the following values can be used to configure the measurement of a DC voltage:

Value	Description
012	DC voltage for the auxiliary source
022	DC voltage for the generator
032	DC voltage for the battery
042	DC voltage for the loads

Other values for parameter P.9635 configure the terminals for other purposes. Maximum +/- 87.5 Vdc can be applied to JQ terminals.

For the connections to terminals JH and JG, instead, it is possible to select:

- A “common negative” configuration (one terminal is used to acquire the negative poles of all voltages, and other four terminals acquire the positive poles of the voltages).
- A “common positive” configuration (one terminal is used to acquire the positive poles of all voltages, and other four terminals acquire the negative poles of the voltages).
- A “pure differential” configuration (two terminals are used for each DC voltage).

The first two modes allow to reduce the number of used terminals: they are suggested if part of JH / JG terminals is used for the AC voltages of the auxiliary source / generator.

The configuration of the terminals JH / JG is done through parameters P.9611 (JG-1), P.9612 (JG-2), P.9613 (JG-3), P.9614 (JG-4), P.9615 (JH-1), P.9616 (JH-2), P.9617 (JH-3) e, P.9618 (JH-4); the following values can be used to configure the measurement of DC voltages:

Value	Description
013	DC voltage for the auxiliary source (+)
014	DC voltage for the auxiliary source (-)
023	DC voltage for the generator (+)
024	DC voltage for the generator (-)
033	DC voltage for the battery (+)
034	DC voltage for the battery (-)
043	DC voltage for the loads (+)
044	DC voltage for the loads (-)
051	Common terminal (-) for DC voltages
052	Common terminal (+) for DC voltages

Maximum +/- 105 Vdc can be applied between JH / JG terminals and GND.

If it is necessary to acquire higher DC voltages, external DC/DC voltage converters must be used; use parameters P.9647 and P.9648 to define its transformation ratio.

If no AC measurements are required, we suggest using the eight terminals of JH / JG in “pure differential” mode.

If the AC voltages of the generator are required (three-phases), the terminals JG are used for those measurements: use one terminal of JH as “common negative” of DC voltages, and the other three terminals to acquire three DC voltages. The fourth DC voltage can be acquired using JQ.

If the AC voltages of the auxiliary source are required (three-phases), the terminals JH are used for those measurements: use one terminal of JG as “common negative” of DC voltages, and the other three terminals to acquire three DC voltages. The fourth DC voltage can be acquired using JQ.

If the AC voltages of both generator and auxiliary source are required, we suggest connecting them in single-phase mode: the terminals JH-3, JH-4, JG-3 and JG-4 will be used for AC voltages. Use one of the remaining terminals as “common negative” of DC voltages, and the other three terminals to acquire three DC voltages. The fourth DC voltage can be acquired using JQ.

At least, the DC voltage of the plant battery must be connected to the controller (if not, the controller activates the warning W273). **Note: HS315 may get this value from the messages sent by the BMSs: if the BMSs are not powered (DIF.2763) and the controller is configured to read this value from them (P.9762), HS315 does not activate this warning.**

5.14 Measurement of DC currents.

HS315 can measure up to four DC currents (generator, plant battery, loads and auxiliary source). The measurement of the loads DC current is not mandatory: HS315 can calculate it as the sum of the other currents.

As a rule, the current is positive when:

- Supplied by the generator.
- Supplied by the plant battery.
- Supplied by the auxiliary source.
- **Absorbed by the loads.**

Please connect the transducer in a way that satisfies that rule.

The current measurements are performed as True RMS.

At least, the DC current of the plant battery must be connected to the controller (if not, the controller activates the warning W273). **Note: HS315 may get this value from the messages sent by the BMSs: if the BMSs are not powered (DIF.2763) and the controller is configured to read this value from them (P.9762), HS315 does not activate this warning.**

The HS315 is provided as standard for use with the SHUNT sensors. If it is required to use it with HALL effect sensors, it must be indicated before the order. The controller must then be suitably configured using parameter P.9600:

- 0: SHUNT sensors.
- 1: HALL effect sensors.

From version 1.12, it is also possible to use DIVIT expansion modules to acquire this measurement. Since version 2.05, it is also possible to use commercial sensors connected via CAN, to acquire these measurements (see 11.7.4).

5.14.1 HALL effect sensors.

HS315 uses Hall effect sensors to perform the DC current measurements; the sensors must be connected to connectors JU1, JU2, JU3 e JU4 of the controller. The connecting cables are provided by Mecc Alte.

HS315 can measure voltages up to +/- 1.053 Vdc on JUx connectors: ensure to use relevant sensors

5.14.2 Shunt resistive sensors.

DC currents are measured via external shunt resistors, which can be connected to the JU connector on the controller. The controller's inputs are galvanically isolated from its power supply.

Shunt up to 200mVdc of signal can be used.

Ensure that appropriate shunts are selected: since the HS315 device can carry overcurrent protection, the value of the shunt must be mediated between the ability to measure the overload current value you need and the required accuracy of measurement.

The use of shunts larger than the rated current of the system will allow you to measure higher over currents but reducing the measuring resolution.

The HS315 shunt inputs have a measurement accuracy <0.1% compared to the 200mV Measuring Scale Fund: this results in a maximum error of 0.2mV.

The accuracy of the DC current measurement, however, also depends on the shunt precision class used.

For example, considering a 250A / 100mV shunt with a precision class of 0.5, the measurement error introduced by the HS315 controller will be up to 0.5A while the measurement error introduced by the shunt will be a maximum of 1.25A.

It is therefore advisable to use shunt with a precision class of at least 0.5 or better (cl.0.2 or 0.1) if you want to take advantage of the excellent measurement accuracy that the HS315 can guarantee.

Pay attention to the cable polarity to avoid reading the current value with polarity opposite to the actual one. To check the orientation, you can start the generator, power up the load and the system battery, ensuring that all readings have the correct polarity.

Use of a shielded cable is recommended for connecting the measurement from the shunt.

Terminal	Shunt input	
JU-1	Shunt IDC1	Positive input
JU-2		Negative input
JU-3	Shunt IDC2	Positive input
JU-4		Negative input
JU-5	Shunt IDC3	Positive input
JU-6		Negative input
JU-7	Shunt IDC4	Positive input
JU-8		Negative input

5.14.3 Measurement inputs configuration

The four inputs configuration can be done by means parameters P.9619, P.9623, P.9627 and P.9631. Those are the possible values for the parameters:

Value	Description
011	DC current for the auxiliary source
021	DC current for the generator
031	DC current for the battery
041	DC current for the loads

The current/voltage ratio (A/V) of the sensors can be adjusted by means parameters P.9601, P.9602, P.9603 and P.9604. Therefore, it is possible to use different size sensors in the same plant.

The measurement input JU of the controller are factory calibrated by Mecc Alte. However, it is possible to calibrate also the external sensors. Use the following parameters:

Input	Gain	Offset + (mV)	Offset - (mV)
1	P.9622	P.9620	P.9621
2	P.9626	P.9624	P.9625
3	P.9630	P.9628	P.9629
4	P.9634	P.9632	P.9633

The parameters of the “gain” column allow the real calibration of the inputs: if the measurement shown by the controller is lower than the real current, increase the “gain” parameter and vice-versa.

The parameters of the “offsets” columns, instead, allow the compensation of the residual voltage on the sensors when no current flows through them. The residual voltage on a Hall sensor is different if the last flowing current was positive or negative: this is the meaning of the two “offset” parameters.

5.15 Measurement of the plant battery temperature.

HS315 can acquire a PT100 sensor to measure the temperature of the plant battery. This temperature is used for diagnostic purposes, but also to compensate the charging voltage/current during the charge process (see the description of the charge process).

The measured temperature is shown on page M.02.

Terminal	Input type	Connect to
JP-1	Reference GND for the measure.	Thermo-resistance input
JP-2	Voltage input for the measurement of the compensation resistance.	Input for compensation resistance
JP-3	Current injection point – voltage input for the measurement of the PT100 resistance.	Thermo-resistance input

The HS315 accepts a PT100 temperature sensor with 2 or 3 wire connection. For the connections, it is recommended to use shielded cables. The measurement input is of the non-isolated type.

2-wire connection: for short-distance connection (<10m) between HS315 and the sensor. It should be noted that this connection introduces an error equal to the resistance of the connecting cables. Connect the PT100 between pins 1 and 3 of JP; it is necessary to bridge the pins 1 and 2 of the JP connector to avoid using the resistance compensation of the connecting cable.

3-wire connection: connection to be used for medium to long distances (> 10 m) between the HS315 and the sensor. Connect the PT100 between JP pins 1 and 3 and connect the third compensation wire to JP pin 2.

The controller automatically compensates the resistance of the connecting cables. For this compensation to be correct, the resistance of each wire must be the same, because the controller measures the resistance of a wire and assumes that the resistance of the other wire s is the same.

From version 1.12, it is also possible to use DIVIT/DIGRIN/DITHERM expansion modules to acquire this measurement.

6 Communication

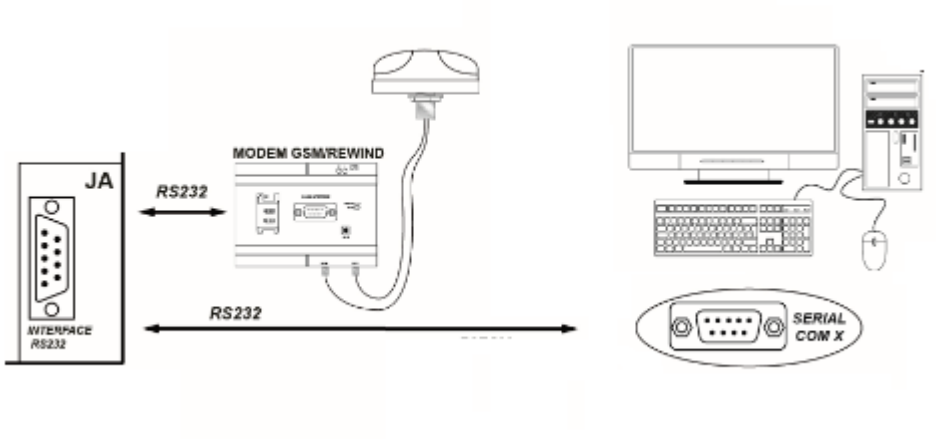
The device is supplied with many communication ports for connecting to a PC, modem, networks etc.

In standard construction, the device is supplied with:

- (JB) USB connection type B, for FW updating and parameter programming
- (JA) RS232 Serial connection: maximum connection length 12m.
- (JO) RS485 Serial connection with galvanic isolation; maximum connection length under optimal conditions, 1200m. The 120ohm termination resistor is built-in; to enable it, all you must do is connect pins 1 and 2 of the JO to each other. Shielded cable with 120ohm impedance should be used (such as BELDEN 3105A Multi-conductor-EIA Industrial RS-485PLT/CM).
- (JS) RJ45 connector for connection to Ethernet networks 10/100.
- CAN-BUS connection to the engine ECU and the additional optional modules (DITEL, DITHERM, DIGRIN and DIVIT), with galvanic isolation. The 120ohm termination resistor is built-in; to enable it, all you must do is connect pins 4 and 5 of the JO to each other. It requires the use of a specific shielded cable (such as HELUKABEL 800571).

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

6.1 Serial port 1 RS232 (JA)



The RS232 JA connector (serial port 1) can be used for interfacing with an external device provided with RS232 interface, such as, for example, a modem or a PC. The maximum length of the connection should be no more than 12m.

The connection can be used for programming the parameters of the device through the BoardPrg4 program, or for connecting to a supervising program such as Mecc Alte SS3.

For the functions and protocols implemented, refer to document [3]. See below the diagram of the connector:

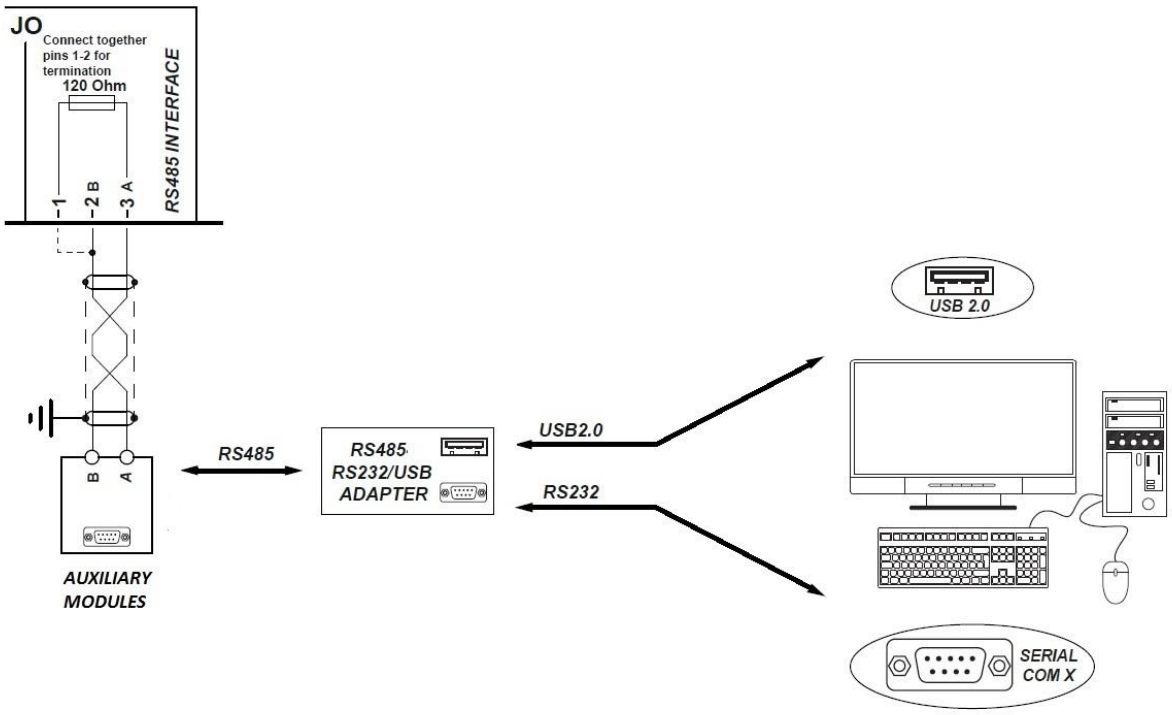
- JA_01: not connected
- JA_02: RXD
- JA_03: TXD
- JA_04: DTR
- JA_05: GND
- JA_06: DSR
- JA_07: RTS
- JA_08: not connected
- JA_09: not connected

To configure the use of the serial port 1 you need to configure the parameters

Parameter	Description
P.0451	Use of serial port
P.0452	Modbus address
P.0453	Baud rate
P.0454	Settings
P.0470	Modbus registers order

The description of these parameters is found in document [3].

6.2 Serial port 2 RS485 (JO-1, JO-2, JO-3)



The device can be equipped with a serial portRS485 (serial port 2), which is galvanically isolated and separated from serial port 1 (RS232), and which can be used to connect via Modbus to a PC or other devices.

For details concerning the RS485 connection, its use and the programming of the parameters, refer to document [3].

Connections:

- JO-3 Connection RS485 A
- JO-2 Connection RS485 B

The RS485 connection needs a 120-ohm termination resistor on both ends of the cable. The device has the resistor built-in; to enable it, all you need to do is jumper connect JO-1 and JO-2 to each other

You cannot connect a modem on serial port 2; as for the rest, you can use it for the same connections as serial port RS232, using RS485/RS232 or RS485/USB adaptors where necessary.

The galvanic isolation ensures the safe operation of the connection, including between remote devices and devices with earth potentials different from that of the HS315.

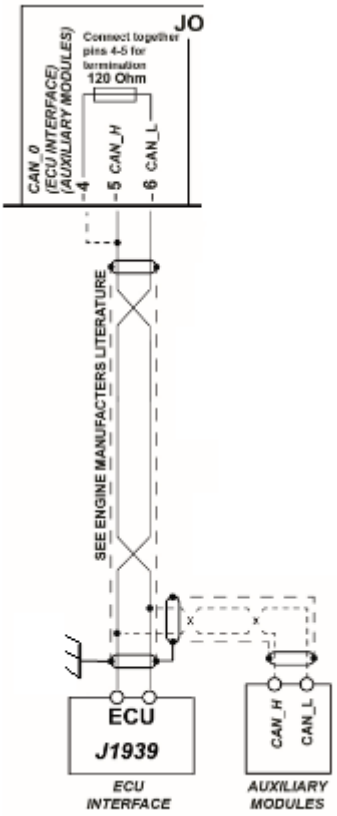
The length of the connection should be no more than 1200m; however, it depends on the transmission baud rate set. A specific shielded cable should be used with grounded shielding mesh.

To configure the use of the serial port 2 you need to configure the parameters

Parameter	Description
P.0471	Use of serial port
P.0472	Modbus address
P.0473	Baud rate
P.0474	Settings
P.0475	Modbus registers order

The description of these parameters is found in document [3].

6.3 CAN-BUS connection (JO-4, JO-5, JO-6).



Using engine equipped with ECU (Electronic Control Unit) and CAN-BUS interface, most of the previous detailed connections are no more required. With only one connection (CAN-BUS to be more precise) the controller can start or stop the engine, as well as to control its speed, to make several measurements (such as running speed, coolant temperature and oil pressure) and to display the diagnose codes activated by the engine itself.

Similarly, with the same CANBUS connection the controller is also able to connect to the automatic voltage regulator (AVR), to control the voltage and acquire diagnostic trouble codes and measurements.

The CANBUS connection can also be used to communicate with one or more electronic BMS that manage the batteries.

The same bus is also used for connecting to the optional modules DITHERM, DIGRIN, DIVIT, DITEL and DANOUT, as well as to some commercial DC voltage/current sensors (Bourns SSD).

CAN-BUS connection is carried out by means connector JO.

The CAN-BUS interface of the HS315 is galvanically isolated.

For the connections described below, use a type of cable suitable for the CAN-BUS.

- Connect terminal JO-5 to terminal CAN_H of the engine's control unit and/or to the automatic voltage regulator.
- Connect terminal JO-6 to terminal CAN_L of the engine's control unit and/or to the automatic voltage regulator.

Connect the shielding mesh of the shielded cable to the protective earth or to signal on both sides make sure that interior, panel and the engine frame are kept at the same potential).

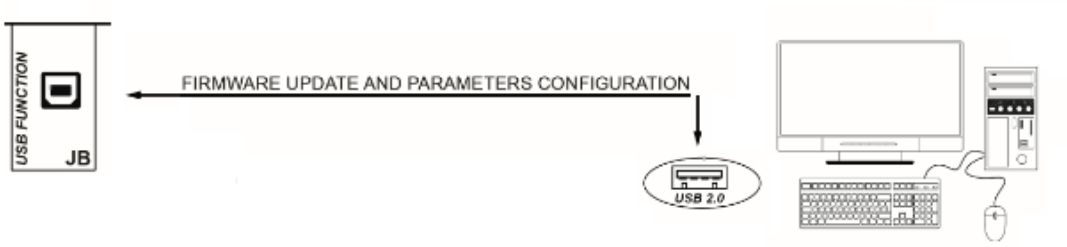
The CAN-BUS connection needs a 120-ohm termination resistor on both ends of the cable. Normally, the control unit of the engine has the termination resistor built-in (if not, connect the resistor directly on the CAN_H and CAN_L terminals of the control unit).

The termination resistor in the case of the HS315 is built-in; to enable it, all you need to do is jumper connect JO-4 and JO-5 to each other.

NOTE: the termination must be always enabled, unless the connection proceeds to other devices and the HS315 is not one of the two ends.

Use the parameters from menu 7 to indicate to the controller which external devices are connected and the functions that must be managed. For configuring the additional expansion modules, see par. 5.8. For external DC sensor management, see parameter P.9640.

6.4 USB (JB)



The USB protocol specifications do not allow it to be used permanently in the industrial sector due to limited length of the cable and to the relatively elevated sensitivity to electrical disturbances including on the PC side. **For this reason, the USB connection cable must only be inserted when it is necessary to operate on the device and it must be removed from the JB connector when the operation is finished.**

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

- Enabling the device firmware
- Parameter's programming

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

The USB port can be used for programming the parameters with the BoardPrg4 program, as an alternative to the serial connection RS232/RS485 or to Ethernet.

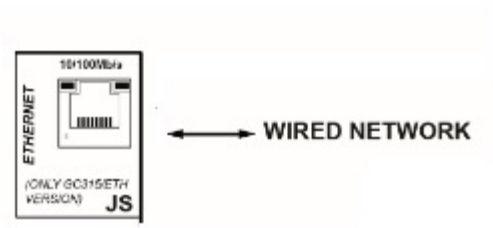
The PC to be connected must have the **CDC_MeccAlte_Win.inf** driver installed, which is supplied by Mecc Alte; for driver installation refer to document [5].

After installing the driver, the PC will acknowledge the HS315 as a new serial port, to be used just as if it were an RS232 serial.

The configuration parameters are:

Parameter	Description
P.0478	Modbus address
P.0479	Modbus registers order

6.5 ETHERNET (JS) – Not available on HS315^{Link}



HS315 is equipped with a RJ45 serial port for data exchange connection via Ethernet network. For details regarding the network connection and the protocol, refer to document [3].

You can connect the device to a LAN network, or directly to a PC (point to point connection).

The connection allows for the use of the Mecc Alte SS3 SW, configuration through the BoardPrg4 and of all the available features using the TCP/IP protocol.

The following parameters must be configured:

Parameter	Description	Default value
P.0500	IP Address.	192.168.1.1
P.0501	Subnet mask.	255.255.255.0
P.0502	Network Gateway.	0.0.0.0
P.0503	Modbus/TCP Port (0=Modbus/TCP disabled).	502
P.0505	Order of the Modbus registers (Ethernet).	0
P.0508	NTP server port (0=NTP Server disabled).	123
P.0509	NTP server address (0=NTP Server disabled).	0.0.0.0
P.0510	Primary DNS server.	0.0.0.0
P.0511	Secondary DNS server.	0.0.0.0
P.0513	DHCP server port (0=DHCP server disabled).	67
P.0514	DHCP server address (0=DHCP server disabled).	255.255.255.255
P.0515	Period of inactivity (min)	5

To join the device inside a LAN network is necessary to configure the parameters P.0500, P.0501 and P.0502. It is possible to proceed in two different ways:

- It is possible to configure the three above mentioned parameters manually, with congruent values with the network which we are connecting to (the sub-net mask and the router/gateway are specific of each network, the IP address must be a univocal address in the network). To proceed this way, it is necessary that the parameter P.0514 is set to 0.0.0.0 or that the parameter P.0513 is set to zero.

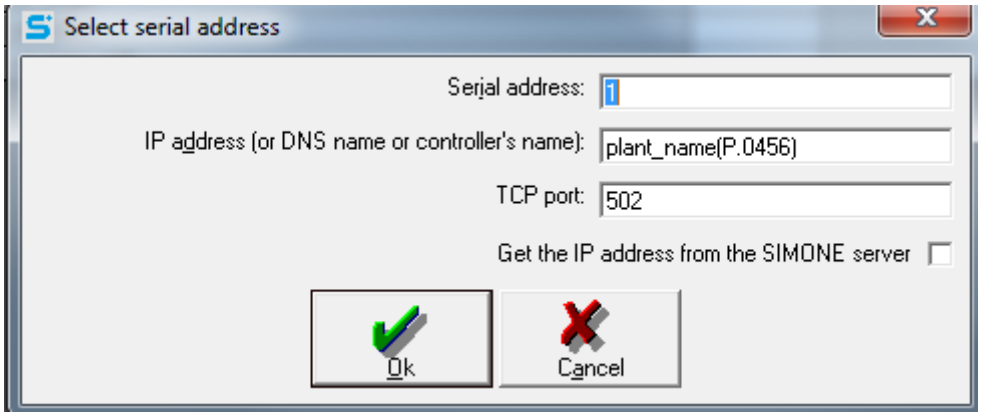
- It is possible to dynamically get from the network the values for the three above mentioned parameters. To do so, it is necessary that the controller can connect to a DHCP server (Dynamic Host Configuration Protocol). To proceed this way, it is necessary that the parameter P.0514 is set to 255.255.255.255 or that the parameter P.0513 is set to 67 (67 is the TCP standard port for the DHCP server; if your server use a different port, set it to P.0513).

  Once the controller has valid values for the parameters P500, P501 and P.502, it can be contacted through TCP-Modbus protocol on the configured IP address and on the configured port with P.053, i.e., with the supervision SW (Mecc Alte SS3) and configuration SW (BoardPrg4).

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

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

  If the DNS server is reachable on the network, the controller provides to register its name (P.0456) on the network, and since that moment it will be reachable through the TCP-Modbus protocol, both on the IP address and on the configured names, on the P.0503 port.



The parameters P.0508 and P.0509 allows to set the IP address and the NTP server port (Network Time Protocol), to be used to connect to a NTP server in such a way to keep the inner time and the given time zone synchronized and updated (that is UTC time “Coordinated Universal Time”). By setting both the parameters to zero, the function will be disabled.

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

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

7 Link LTE controller

Note: refer to paragraph 1.1 - Nomenclature

The **HS315^{Link}** controller is equipped with a **LTE Cat.M1** and **NB-IoT** Multimode module and quad-band **2G** fallback (**GPRS/EDGE)** with multi-regional coverage.
They embed also a Global Navigation Satellite System (**GNSS**) receiver, using **GPS**, **GLONASS, GALILEO** or **BeiDou** system, to provide and reliable positioning information with a high accuracy and performance.
The flexibility extends further with dynamic system selection as **Cat.M1, NB-IoT**, and **GPRS/EDGE** in single mode or as a preferred connection that does not require a module reboot to switch between modes. They provide a solution for applications that require broad geographic coverage, even in areas where **LTE Cat.M1** and **NB-IoT** are not widely available yet.
New **LINK LTE** devices deployed in the field today, can then be activated on existing **2G** networks and still leverage the benefits of **LTE Cat.M1** and **NB-IoT** technology once it becomes available.

The system can be used for different purposes:

- For using the Mecc Alte Smart Cloud system
- To remotely connect to the device via internet, i.e., using the Mecc Alte SS3 program
- To enter the programming of the remote parameter via internet
- To receive **SMS*** messages in case of alarms or information about the plant status.
- To send commands to the plant through **SMS*** messages
- To possibly update the FW by remote by using Mecc Alte program **RemoteWriter**

It 'also present a system for detecting displacements composed of an accelerometer and a gyroscope. If the generator is improperly moved the device will send a series of warning messages and coordinates acquired from the navigation system (**GNSS**) so you can track the route on a map.

The devices can also be equipped, in option, with internal lithium battery, which guarantees several operation hours to the **SMS*** sending system, to the position and status data to the Mecc Alte Smart Cloud system even in case the device main supply is removed.

The battery is automatically recharged and does not need to be periodically replaced.

Note: Module is able to make and receive SMS*, make GPRS/EDGE/LTE traffic but is unable to make and receive voice calls.

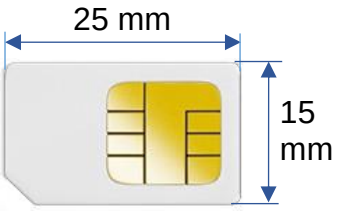
***SMS:** the networks on which cellular Narrowband is deployed, do not always support SMS services over **LTE NB-IoT** or **LTE Cat M1**. Several operators have yet not deployed the SMS functionality for Narrowband. Contact your network provider for details.

7.1 HW Configuration Link LTE

WARNING! Each operation of insertion/extraction of the SIM must be performed when the device is switched off. The access lid must be removed solely in absence of any voltage.

7.1.1 The SIM Card (Only Link LTE)

The device necessarily requires a SIM for its operation.
If you wish to use the packet data functions (communicate with the device through TCP/IP, use of Mecc Alte Smart Cloud system etc.) a SIM with an internet connection active plan is required. The SIM card in the device determines whether the device supports **GSM/GPRS/EDGE**, **LTE Cat M1** and **NB-IoT** or all these connections.



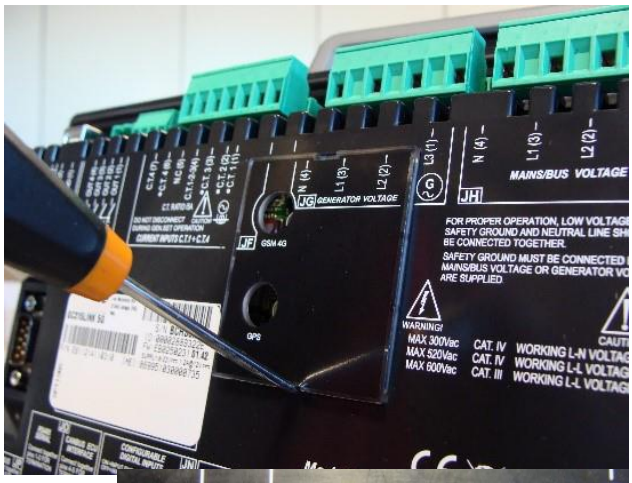
Make sure that your SIM supports the packet data network type you want to use. - i.e., if you want to use the module in **LTE Cat M1** network you have to confirm with the operator that the particular SIM card supports **LTE Cat M1** network.

SIM Type: standard SIM Card type **Mini-SIM** (or **PLUG-IN**).

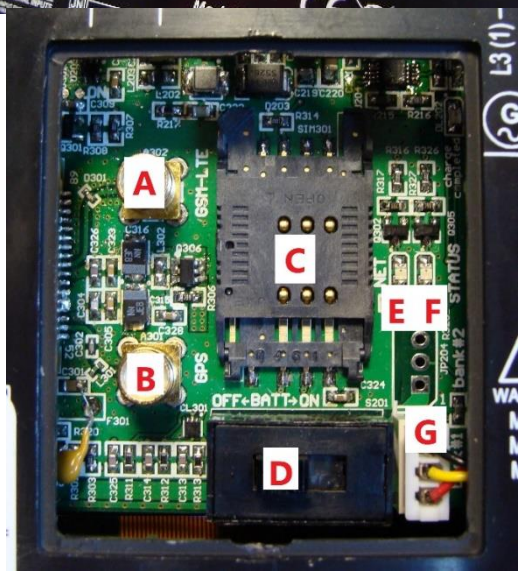
7.1.2 SIM Holder

INFORMATION*: Make sure SIM card does not require PIN code. If it does, it is possible to disable it in any common network unlocked mobile telephone*.

Ensure the device is powered off, then remove the back cover from the device.
Remove the access cover that encloses the SIM holder, the antenna connectors and the battery switch.
Insert a small screwdriver in the little retention hooks and make a slight leverage to remove the panel.



After opening the cover, you will see the following parts:



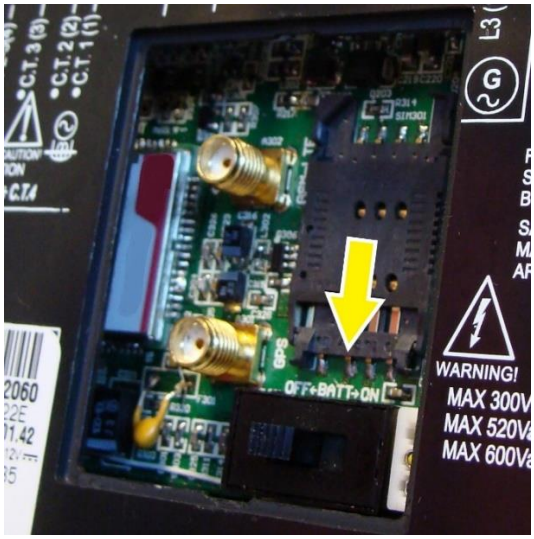
A. SMA FEMALE connector for GSM - LTE antenna.
B. SMA FEMALE connector for GNSS antenna.
C. SIM card holder slide.
D. Switch for internal optional battery (inserted/not inserted).
E. Yellow LED: indicator for Network Status (NET).
F. Green LED: indicator for Module power on/off status (STATUS).
G. Internal Battery connector

7.1.3 SIM insertion

Pull back the upper cover, it clicks as it unlocks. (fig.1).

Open the SIM card holder, it hinges towards you (fig.2).

Fig.1 **Fig.2**

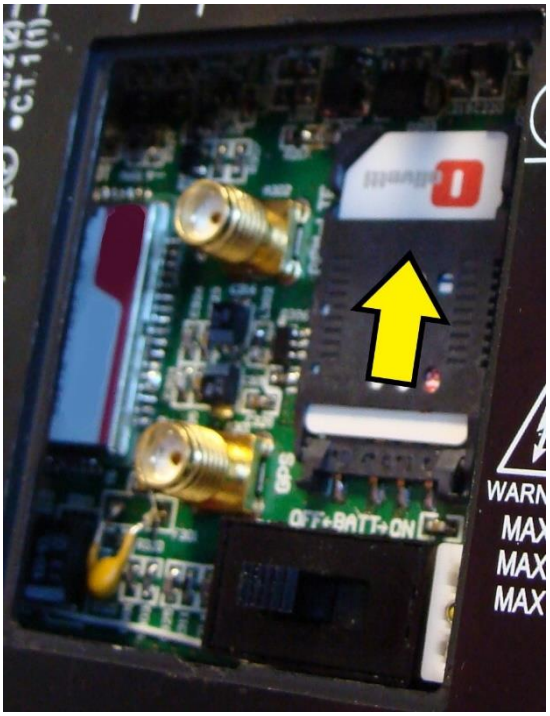


Slide in the SIM card, ensuring the “edge cut out” is as shown (fig.3).

Close the cover, press it down and slide it as shown until it clicks into place (fig.4).

Fig.3

Fig.4



7.1.4 GSM/LTE and GNSS antenna

Connect the antennas when the device is off; let the cable pass through the lid holes paying attention not to invert the two convectors between themselves. **Tighten the connectors by hand without using wrenches or pincers**. (fig.5)

GSM/LTE antenna must be connected to the GSM-LTE SMA plug on the Link device; use only omnidirectional antennas. The maximum gain allowed to antenna and its cable is 3 dB. The impedance of the antenna must be 50 ohm. It is not allowed to connect the antenna directly on the plug but a minimum of 3 m of proper coaxial cable is required.

GPS antenna or GPS+GLONASS antenna must be connected to the GPS SMA plug on the link device.
Use only active antennas with impedance of 50 ohm.

The GPS plug of the Link device provides automatically the power supply required (Max 35mA@3,3Vdc).

Fig.5

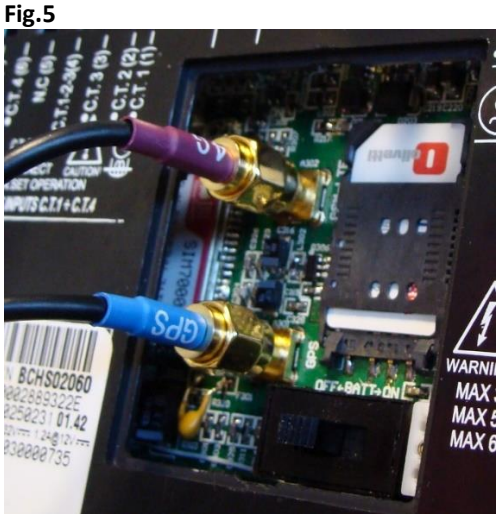


Fig.6

Close the access cover by pressing in the vicinity of the latches (fig.6).

It is possible to use a combined antenna GSM/LTE+GPS/GLONASS or GSM/LTE+GPS antennas.

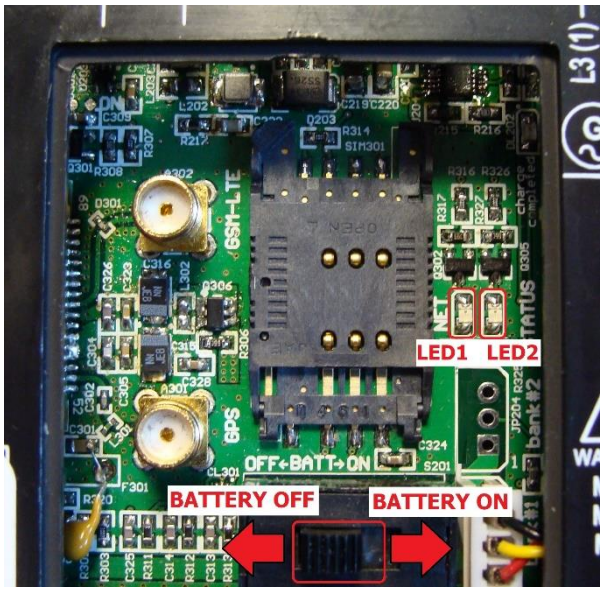
In this case both GPS/GLONASS and GSM/LTE antennas are integrated in just one body; they can be provided on request together with the Link devices.

⚠WARNING*: A separation distance of at least 30 cm (11.81 inches) between the GSM/LTE antenna and the body of the user and other persons must be maintained at all times.*

7.1.5 LED indicator

Controller LINK have two LEDs indicating modem's operating states (Fig.7).

LED light work's behaviour as below:



- **LED1 (Net)**: yellow LED flashes with different modalities according to the connection status with the mobile network.
  64ms ON and 800ms OFF: modem not registered to the mobile network.
  64ms ON and 3000ms OFF: modem registered to the mobile network.
  64ms ON and 300ms OFF: modem is exchanging data on the mobile network.
- **LED2 (Status):** green LED indicates whether the module is on and ready to use.

  Both OFF: the modem is off or in Power Save Mode.

7.2 Parameter's configuration

To activate the function of the **Link LTE** types, it is necessary to set the parameter P.0450 to the "1-Link Module" or "2-Link Module with battery".
Always verify that on the Link or Link LTE controllers the P.0450 parameter is set to "1 Link Module" or "2-Link Module with battery"; in other versions it must be set to "0 - external Modem".

7.2.1 SMS messages

The **Link LTE** controller can send alerts directly to a mobile phone via **SMS*** (mobile originated SMS); to do so, the device can need to be programmed to send **SMS*** to a specific phone.

To this purpose it is necessary to:

1. Set one or more telephone numbers (**P.0457, P.0459, P.0461, P.0463**), indicating for each number that it is to be used as the recipient of an SMS*. This is obtained by setting the parameters for each telephone number entered to "1" (**P.0458, P.0460, P.0462, P.0464**).
2. Using the "Communication events" parameter, configure which system events should cause the **SMS*** to be sent.

In case that the device is configured with at least one phone number dedicated to SMS transmission and it is configured for at least one event inside the “Communication events” parameter, at the selected event occurrence the device performs the following step-by-step sequence:

1. Selects the first phone number configured for **SMS*** transmission.
2. Sends an **SMS*** to that number.
3. Checks if one or more **SMS*** are set for each phone number. If not, or if all the programmed SMS transmissions have been performed, it carries out the following item 4 step. Otherwise, it waits five seconds and carries out item 2 step.
4. Checks if further phone numbers configured for **SMS*** transmission exist. In case that-these exist, the device waits five seconds and carries out item 2 step. Otherwise, it stops the step-by-step sequence, until the next warning event occurrence.

I.e.: at each new anomaly event (set for **SMS*** transmission generation) occurrence, the quantity of programmed **SMS*** is transmitted to each configured phone number, in accordance with “Number of SMS for each event” parameter configuration.

For the **SMS*** you can receive and for the commands you can send see the document [3] **(EAAS0341xx Serial Communication and SMS protocol).**

***SMS:** the networks on which cellular narrowband is deployed, do not always support SMS services over **LTE NB-IoT** or **LTE Cat M1**. Several operators have yet not deployed the SMS functionality for Narrowband. Contact your network provider for details.

INFORMATION: It is important that you deactivate the PIN code check: insert the SIM in a phone and deactivate the PIN code before using it in the Link and Link LTE devices.

7.2.2 Mobile network configuration and data connection

To use the communication on 2G/LTE network it is necessary to configure some parameters that allow the device to connect to the mobile operator appropriately.
For the data exchange through TCP/IP protocol, the IP address is assigned to the controller directly from the mobile network and the controller will then be contactable using this IP address.
Page S.05 shows the IP address given to the controller by the data mobile network. It is also possible to interrogate the controller via **SMS*** to know the current IP address.
It is not possible, instead, to join the controller using the name configured with the parameter P.0456.

If you are using Mecc Alte SS3, it is possible to connect to the plant in any moment by setting the section dedicated to the connection between the Mecc Alte Smart Cloud server.

Below are the minimum configuration parameters to be set to allow the device to connect to the mobile network and communicate with the Mecc Alte Smart Cloud system via TCP/IP protocol**.**

These parameters can be modified on the controller through the relative programming menu, with the BoardPrg4xx and also through the web service in the appropriate configuration page of the device:

Parameter	Name	Default
P.0570	Mobile network mode	1-GSM/GPRS
P.0571	LTE category	2-CAT M and NB-Iot
P.0551	APN primary (access Point Name)	
P.0552	APN primary username (optional)	
P.0553	APN primary password (optional)	
P.0554	APN primary (access Point Name)	
P.0555	APN primary username (optional)	
P.0556	APN primary password (optional)	
P.0557	Connection mode	1-Stay connected
P.0558	Modbus/TCP enable	0-No
P.0559	Modbus/TCP port	502

- **P.0570** parameter configures the preferred Network Mode to:

➢ **0 ("Automatic"):** automatic connection between GSM/GPRS/EDGE or LTE network.
In this mode, the device decides independently, based on the available networks and signal strength, which type of network to connect.
When first power up, it will search with the following priority: CAT-M > NB-IOT > GSM/GPRS/EDGE.
Search time depends on signal strength and active mobile networks detect. It may be necessary to wait several minutes before the first connection to the mobile network is established.

➢ **1 ("GSM/GPRS"):** connection to the GSM/GPRS/EDGE network only

➢ **2 ("LTE")**: connection to the LTE network only

- **P.0571** parameter configures the preferred LTE network mode to:

➢ **0 ("CAT-M"):** connection to the CAT-M1 network only.

➢ **1 ("NB-IoT"):** connection to the NB-IoT network only.

➢ **2 ("CAT-M and NB-IoT"):** automatic connection between CAT-M or NB-IoT network**.**

If you have a **SIM** not enabled for **LTE** connections (**CAT.M1 or NB-IoT**) or if these two new technologies are not available, we recommend setting parameter **P.0570** to **1-GSM/GPRS** to force the connection to the **GSM/GPRS/EDGE** network and make the first connection faster.

- **P.0551** parameter configures the APN (Access Point Name) of the mobile operator used. Some operators require access credentials (username e password) to access the APN: in this case use the parameters **P.0552** and **P.0553** to configure username and password. If access credentials are not required (standard), leave **P.0552** and **P.0553** empty.

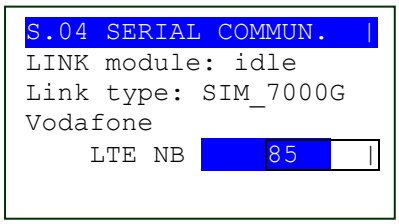
- **P.0557** parameter configures how the controller has to connect to the data mobile network:

➢ **0 ("Disconnect every time**"). In this mode the controller connects to the data mobile network every time it has to send data to the server and disconnects as soon as it has sent the data. If this mode is used, the data exchange with the Modbus/TCP protocol with the controller is not possible.

➢ **1 ("Stay connected**"). This mode is suggested: the controller connects to the data mobile network as soon as possible and remains connected until it is possible. In this mode the data exchange with the Modbus/TCP protocol with the controller is possible (BoardPrg4, Mecc Alte SS3).

- **P.0558** parameter activate/deactivate the data exchange with the protocol Modbus/TCP on the mobile network: when it is enabled, the parameter **P.0559** configures the TCP port on which the controller is able to communicate.

Page S.04 shows:

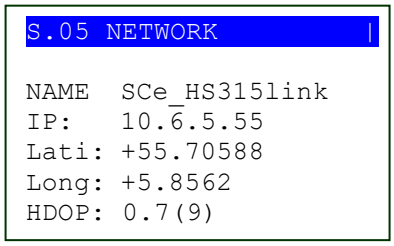


- the active connection type GSM, EDGE, LTE NB-IoT or LTE CAT-M1.
- the Mobile Network Operator (MNO) currently connected (Vodafone, TIM….). If the SIM card does not return the full name the Mobile Country Code (MCC) + Mobile Network Code (MNC) is shown.
- the mobile network signal intensity.

7.2.3 GNSS Receiver

To use the Global Navigation Satellite System (**GNSS**) internal receiver, using **GPS**, **GLONASS, GALILEO** or **BeiDou** system, the internal module must be enabled with the parameter **P.0580** *(*GPS module enable) set to "**1-YES**". Connect also the GNSS antenna.
The purpose of this module is to detect the controller position (latitude/longitude). Once detected, the position coordinates can be asked via **SMS*** and it can be used to pinpoint the genset on a map (many business sites allow this operation).
The position becomes most important in the use with Mecc Alte Smart Cloud system. Directly from the WEB interface it is possible to display the position of a genset on a map, and it is also possible to display the tracking of a rented genset in a period of time: both these functions are useful for rented gensets, but can also be used as antitheft system.

The controller displays the **GNSS** coordinates on page S.05. The coordinates flash if the **GNSS** module is not able in that moment to determine the position (therefore the last position detected is shown). It also shows the **HDOP** (Horizontal Dilution of Precision) value: it is a precision indicator (the lower it is, the sharper the position).



Finally, next to the HDOP value, they are indicated in brackets:

- the number of satellites that are "view" by the **GNSS** module (when searching for coordinates).
- the number of satellites used for the "**FIX**" of the coordinates (once the correct position has been determined).

If the **GNSS** module is not used, it is still possible to manually set the latitude (**P.0581**) and longitude (**P.0582**) of the generator set to display the position on the map or on the Mecc Alte Smart Cloud WEB interface (for example in the versions with Ethernet card that communicate with the Mecc Alte Smart Cloud system).

7.3 Mecc Alte Smart Cloud System

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

The controller uses a proprietary Cloud Link protocol as the preferred connection type that supports any type of network. Thus, it can be connected behind the router on the internal network or on the public internet. The required parameters are Channel ID (P.0563), Cloud Link User (P.0564) and Cloud Link Password (P.0565) are unique for each of them.

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

P.0564	Cloud Link User	
P.0565	Cloud Link Password	

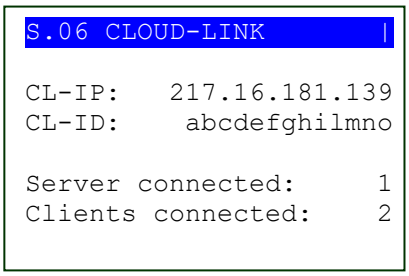
These parameters are configurable on the controller through the relative programming menu, with the BoardPrg4xx in the appropriate configuration page of the device. In details:

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

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

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

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



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

For details about communication with Mecc Alte Smart Cloud server. **See document [7]**.

8 Main functions

8.1 Front panel

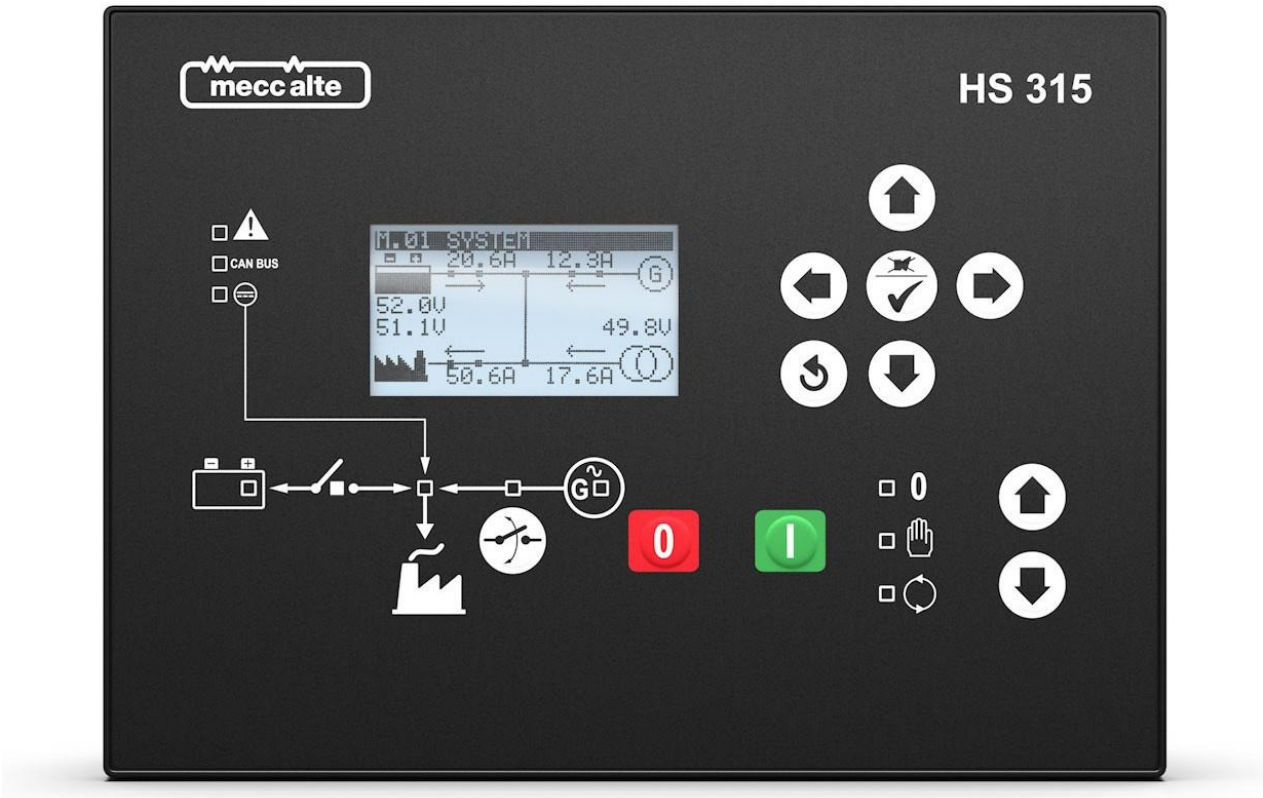
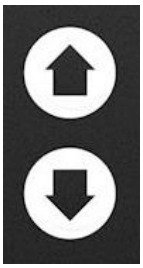


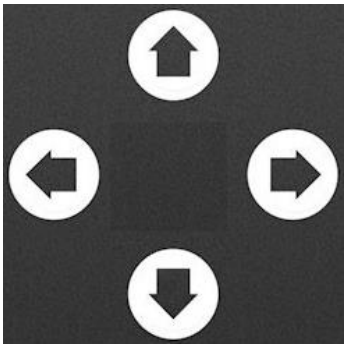
Fig. 1 – Front Panel HS315

The controls consist of 11 buttons.

The front panel also has 11 luminous indicators.

8.2 Pushbuttons (ref. to fig. 1)

Pushbuttons		**Function**
	OFF/RESET ***PROGRAM***	The generator is disabled; warnings and alarms are cancelled. You can program the parameters.
MODE UP  **MODE DOWN**	**MAN (Manual)**	The controller is set for manual gen-set control. Press the **START** button to start the engine. Press the **STOP** button to stop the engine. With the engine running and up to speed, press the **GCB** button for manual opening/closing of the GCB circuit breaker. From display pages M.02…M.04, press **SHIFT+GCB** buttons for manual opening/closing of the BCB circuit breaker From display page M.09, press **SHIFT+GCB** buttons for manual opening/closing of the LCB circuit breaker From display pages M.10…M.12, press **SHIFT+GCB** buttons for manual opening/closing of the ACB circuit breaker
	AUTO (Automatic) ***TEST***	The controller is set for the automatic generator control, which will be started when a charge procedure is needed for the plant battery and, optionally, if the loads are unsupplied. By pressing the **START** button, it is possible to activate/deactivate the TEST mode. This, unless configured differently, does not close the GCB circuit breaker. The **STOP** button, unless configured otherwise, causes the stop of the generator (if running) and the activation of a block.
 **ESC/SHIFT**		In programming mode, it cancels the changes made to a variable value, brings up the previous menu level, or exits programming mode. If it is pressed for at least two seconds in any menu, you exit the programming mode retaining the current menu position for further programming access. When pressed in any menu, it displays on the upper line the engine status. In OFF/RESET mode and depending on the selected page, if pressed together with the **ENTER** button for at least 5 seconds, it can reset counters to zero, reload default values of the programming parameters or cancel the history logs (in the version equipped with CAN-BUS, it allows to force exit from **BUS OFF** mode). When used during the keyboard regulation function, it aborts the function. Used together with **ACK** button, it resets the anomalies. Used together with **GCB** button, depending on the page shown it opens/closes the ACB, BCB or LCB circuit breakers (in MAN mode).

Pushbuttons	**Function**
 **UP / DOWN / LEFT / RIGHT**	Navigation buttons of the multifunction display. These buttons let you select the display page in all modes, except in the PROGRAM and HISTORY LOGS modes. In PROGRAM and HISTORY LOGS mode you can scroll the menus and the variables/settings. You can increase/decrease the value of the variable to change the settings. Used in combination with the **ESC/SHIFT** button you can scroll through the menu ten entries at a time or increase/decrease the variables ten units at a time. In PROGRAM mode, the horizontal buttons are used to position the cursor when entering the strings. The horizontal navigation buttons, used in combination with the **ESC/SHIFT** button, allow to adjust the contrast. To decrease the contrast (lighten), press the combination of buttons **ESC/SHIFT + LEFT**. To increase the contrast (darken), press the combination of buttons **ESC/SHIFT+ RIGHT**.
 **ENTER/ACK**	Upon the occurrence of an alarm or warning, the pressing of the button turns off the siren; a further press recognizes the alarms/warnings. Used together with the **SHIFT** button, it resets all alarms/warnings. In the PROGRAM menu, you can enter the programming mode and open a submenu, change a variable or parameter, and confirm the operation. In the LOG menu, you can activate the HISTORY LOG function and open the selected log.
 **GCB**	The button is enabled only in “MAN” mode. It is used to open and/or close the GCB circuit breaker (with engine running and generator in thresholds). Used together with the **SHIFT** button, depending on the page shown it opens/closes the ACB, BCB or LCB circuit breakers (in MAN mode).
 **START**	In MAN mode it can be used to start the engine. The button can be configured in two ways: P.0252 = 0: fully manual (the starter motor is engaged all the time the button is pressed or until the engine running is detected). P.0252 > 0: fully automatic (simply press and release the “**START**” button to activate an automatic start sequence of maximum P.0252 tries). If the start is not successful, the fail to start anomaly will be activated. The “**START**” button must be pressed and released again to perform a new start attempt. In AUTO mode, it enables/disables the TEST status. At power on, keeping it pressed at the same time as the **STOP** button allows access to the special functions.
 **STOP**	Used to control the stop of the engine in “MAN” mode. In the automatic modes, pressing the button causes the activation of an alarm (block) If bit 0 of parameter P.0495 is set to “0”. If this bit is set to “1”, the button has no effects.

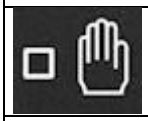
Pushbuttons	**Function**
	Pressed with the controller in OFF/RESET mode, runs the LAMP TEST on all the indicator lights. At power on, keeping it pressed at the same time as the **START** button allows access to the special functions.

To allow maximum customization of the controller, the status of all the buttons can be used in the AND/OR logics or in the PLC, through the following states:

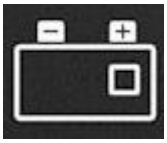
- ST_304: START key pressed.
- ST_305: STOP key pressed.
- ST_306: GCB key pressed.
- ST_308: MODE_UP button pressed.
- ST_309: MODE_DOWN button pressed.
- ST_310: UP key pressed.
- ST_311: DOWN key pressed.
- ST_312: LEFT key pressed.
- ST_313: RIGHT key pressed.
- ST_314: ENTER key pressed.
- ST_315: EXIT key pressed.
- ST_316: SHIFT key pressed.
- ST_317: ACK button pressed.

8.3 Indicators (ref. to fig. 1)

LED OFF	LED steady ON	LED flashing
☐	▣	▣

	Signalling		**Function**
	**PROG. /OFF**	▣	Indicates that the operation mode is OFF/RESET
		▣	Flashing at 50% on: indicates that you are accessing the PROGRAMMING menu
		☐	The controller is in another operating mode.
	**MAN.**	▣	Indicates that the operation mode is MANUAL
		☐	Flashing at 50% on: the controller is in another operating mode.
	**AUTO** **TEST**	▣	Indicates that the operation mode is AUTOMATIC
		▣	Flashing at 50% on: indicates that the operating mode is TEST
			Flashing at 90% on: indicates that the operating mode is REMOTE START.
		☐	The controller is in another operating mode.

	**ALARM**	■	Indicates the presence of at least one alarm (block) or deactivation.
		▣	Flashing at 50% on: indicates the presence of at least one warning or one latched warning.
		□	No anomalies.
	**CAN0**	■	Signals that the CAN-BUS interface is active and in ERROR-ACTIVE mode.
		▣	Flashing at 25% on: signals a communication error. The port is in ERROR-PASSIVE mode.
			Flashing at 75% on: signals a communication error. The port is in BUS-OFF mode.
		□	Indicates that the CAN-BUS has been disabled (no expansion modules, no ECU interface, no AVR, no BMS connected), or that the controller is not receiving any messages from the listed devices.
	**AUC DC SOURCE**	■	The auxiliary source voltage (DC, AC, or from digital input) is present and stable in the tolerance range.
		□	The auxiliary source voltage (DC, AC, or from digital input) is not present.
		▣	Flashes at 50% on: during transition between the previous two states.
			Flashing at 25% on: the auxiliary source voltage (DC, AC, or from digital input) is present but below the tolerance range.
			Flashing at 75% on: the auxiliary source voltage (DC, AC, or from digital input) is present but over the tolerance range.
	**GENERATOR LIVE**	■	The generator voltage (DC or AC) is present and stead within the tolerance range.
		□	The generator voltage (DC or AC) is not present.
		▣	Flashes at 50% on: during transition between the previous two states.
			Flashing at 25% on: the generator voltage (DC or AC) is present but below the tolerance range, or it is absent but the engine is running.
			Flashing at 75% on: the generator voltage (DC or AC) is present but over the tolerance range.
	**GCB**	□	The circuit breaker is opened.
		■	The circuit breaker is closed.
		▣	Flashes at 25% on: the circuit breaker is opened with closure command activated.
			Flashing at 75% on: the circuit breaker is closed with opening command activated.
	**LOAD**	■	DC voltage is present on the LOADS.
		□	DC voltage is not present on the LOADS.

	**BCB**	☐	The circuit breaker is opened.
		▣	The circuit breaker is closed.
		⧈	Flashes at 25% on: the circuit breaker is opened with closure command activated.
			Flashing at 75% on: the circuit breaker is closed with opening command activated.
	**PLANT BATTERY**	▣	The voltage of the plant battery is present and in the tolerance range.
		☐	The voltage of the plant battery is not present.
		⧈	Flashing at 25% on: the voltage of the plant battery is present but below the tolerance range.
			Flashing at 75% on: the voltage of the plant battery is present but over the tolerance range.

By pressing the STOP button when the controller is in OFF/RESET mode, the controller switches on all the indicators ("lamp test") to allow their check by the operator. In this phase the controller activates also the digital outputs configured with the function "DOF.3153 - Lamp test", to switch on external lamps also.

8.4 Multifunctional display

8.4.1 LCD lighting

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

During engine starting phase, the lamp is automatically turned-off to reduce the power consumption of the controller, to ensure greater autonomy for the controller itself in the event of critical conditions of the starter battery. To keep the lamp switched on during cranks, set bit 4 of parameter P.0495. Using the P.0493 parameter, you can force the lamp to stay always on when is engine is started.

8.4.2 Contrast adjustment

Depending on the environmental temperature conditions, the contrast may require adjustment to view the display correctly. Press in sequence the ESC/SHIFT + LEFT buttons to reduce the contrast (lighten), press the ESC/SHIFT + RIGHT buttons to increase it (darken).

8.4.3 Mode navigation (ref. to fig. 2)

The display has different display modes with various pages.

Mode	Description	Page identifier
PROGRAMMING	Programming	P.XX
PLC	PLC	L.XX
STATUS	Status information	S.XX
MEASURES	Electrical measurements	M.XX
ENGINE	Engine measurements	E.XX
HISTORY	History logs	H.XX

Generally, navigation between modes takes place via buttons **UP** and **DOWN**.

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

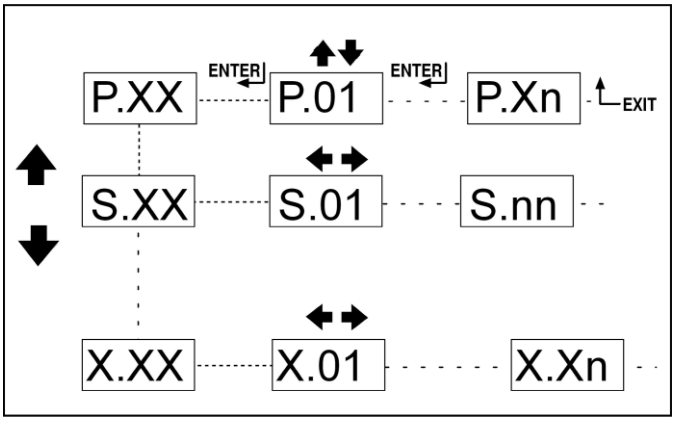


Fig. 2 - Mode navigation

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

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

HS315 can automatically hide some pages according to the configuration parameters of the system.

From version 1.09, it is also possible to use the parameters P.2991, P.2992, P.2993 and P.2994 to hide some pages from the display modes "L", "S", "M" and "E". These are bit-settable parameters, where each bit corresponds to a specific page on the display. For example, setting P.2992 to "000001" (bit 0 active) hides the page M.01.

8.4.4 Display area layout (ref. to fig. 3)

LEGEND:
1 - Status bar
2 - Data area

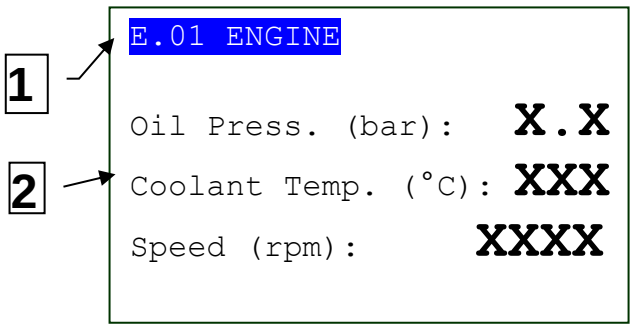


Fig. 3 - Display areas

8.4.5 Top status bar (ref. to fig. 4)

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

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

2 – System status

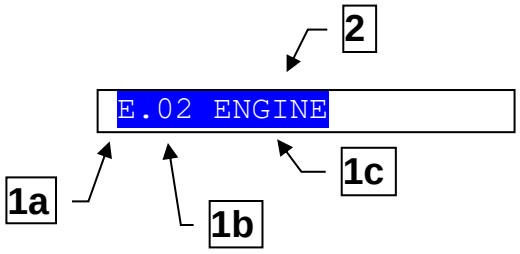


Fig. 4 - Top status bar

The current mode is shown in the relevant field of the top status bar (1a).

The mode identifier (1a), and the page identifier (1b) identify and refer to the page so there is no chance of error.

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

8.5 Display mode

8.5.1 Programming (P.XX)

The controller manages a high number of parameters that allow the manufacturer, the installer or the final user to configure it to adapt it to specific system requirements. This document does not contain the parameters list (even though many of them are quoted in the description of the controller functions); the list is available in the document:[1] where they're described in detail. In this document the general programming structure and the operating procedure to read and/or modify parameters are described.

To access parameters, change mode, scroll with the **UP** and **DOWN** buttons to menu P.03-Programming and press **ACK/ENTER** to start.

To exit programming menu and to return to the main screen press the **ESC/SHIFT** button.

WARNING: assigning an incorrect value to one or more parameters can cause malfunctions, damage to things or injury to people. The parameters must only be changed by qualified personnel. Parameters can be password protected (refer to par. 0).

8.5.1.1 Organization

This mode lets you display and change the programming parameters.

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

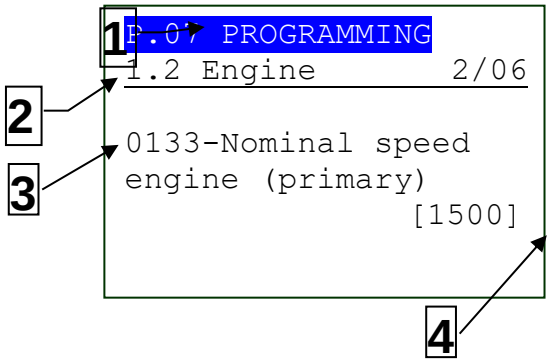


Fig. 3 - Display areas

Each programming parameter 3 has a 4-digit numeric code (e.g., P.0133) to identify the variable regardless of the language used. The current value of the parameter is displayed below the description.

The first line, below the upper status bar, allows to identify the current menu using the ID number of the menu and the associated text. A pair of numbers is displayed on the right of this line (2/06 in the example in fig. 3): the first indicates which entry in the menu is selected, the seconds indicates how many entries can be displayed in the current menu/submenu.

Protection password

If the password is lost, you can reconfigure it using a higher-level password. Contact our service centre if the "MANUFACTURER" password is lost.

The first item (0000-Access Code) of the SYSTEM menu requires setting the access code if one or several passwords have been assigned (available with the path P.03 PROGRAMMING\ 1 SYSTEM\ 1.1 Security\ 1.1.1 Authentication).

Password is not assigned if equal to 0 (only valid for Manufacturer, Installer and User passwords).

The pages corresponding to password setting are displayed only if you are authorized to make changes in the SYSTEM sub-menu (with path P.03 PROGRAMMING\1 SYSTEM\ 1.1 Security\ 1.1.2 Password).

When you enter the programming mode, in case the page for password change is not displayed, press **ESC/SHIFT** to return to the previous menu and try opening the page again. The set access code remains in memory for about 10 minutes after programming has been completed. After this time, it must be entered again to access the programming mode.

Access to programming mode can be controlled through 3 different PASSWORD levels, listed in priority order.

1. At MANUFACTURER level it is possible to display and modify the three passwords (MANUFACTURER, INSTALLER AND END USER) and access all configuration, protection and sequence parameters.
2. At INSTALLER level it is possible to display and modify the User Password and the Installer Password and access all parameters related to configuration, excluding parameters requiring the MANUFACTURER and Mecc Alte passwords.
3. At END USER level it is possible to display and modify only the User Password and access parameters that allow adjusting sequence times and base configurations, but do not allow altering the plant's basic operation.

Each parameter of the controller board is associated to a user type (in the document [1] this association is shown in the "ACC" column with the "C" for Manufacturer, "I" for Installer and "U" for the End User).

A parameter associated to the manufacturer can only be modified by the manufacturer. A parameter associated to the installer can be modified by the manufacturer and the Installer. A parameter associated to the End User can be modified by the Manufacturer, the Installer and the End User.

The general rule provides that parameters can only be modified when the controller board is in "OFF_RESET". Some parameters are an exception and can be modified regardless of the status of the controller board, including with the engine running. Generally, if a parameter cannot be modified, it will be enclosed between < and > while, if it can be modified, it is enclosed between [and] : that is, valid also for the restrictions due to password

If the operator must modify a parameter, he/she must input first the proper password in the parameter P.0000 (1.1.1 Authentication"), so that the controller can recognize it as "Manufacturer", "Installer" or "End User". The parameter is available, with the controller in OFF/RESET-PROGRAM mode, at path: P.03 PROGRAMMING\1.SYSTEM\1.1 Security\1.1.1 Authentication. After completing this operation, it will be possible to modify the required parameters. The access code entered remains saved in P.0000 for about 10 minutes since the end of programming. After this time, the code is automatically reset to zero and must be re-entered to access programming again.

It is possible to customize the passwords for the three types of users, through the parameters P.0001 (manufacturer), P.0002 (installer) and P.0003 (end user), available in the path P.03 PROGRAMMING\1.SYSTEM\1.1 Security\1.1.2 Password configuration. Value "0" for these parameters means no password set. The following examples show all the combinations for passwords assignment.

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

Any operator is seen as a "manufacturer", with no need of setting anything in "P.0000-Access code". 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 modification is allowed. When entering the "uuu" code in "P.0000-Access code", the operator is identified as "End User" but, as no password is associated to "Installer" and "Manufacturer", the controller acknowledges him/her as "Manufacturer". After entering code all parameters are modifiable.

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

No parameter modification is allowed. When entering "uuu" in "P.0000-Access code", the operator is identified as "End User" and can to modify all parameters associated to the end user. By entering "iii", the operator is identified as "installer" but, as no password is associated to the manufacturer, the controller identifies him/her as "manufacturer". After entering code all parameters are modifiable.

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

No parameter modification is allowed. When entering “uuu” in “P.0000-Access code”, the operator is identified as “End User” and can modify all parameters associated to the end user. By entering “iii”, the operator is identified as "installer” and can modify all parameters associated to “installer” and “end user”. When entering “ccc”, the operator is identified as "manufacturer” and is therefore allowed to modify any parameter of the controller board.

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

As no password is associated to End User and Installer, programming the relevant parameters is allowed without entering anything in “P.0000-Access code”. To modify the parameters associated to Manufacturer, simply enter “ccc” in “P.0000-Access code”.

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

As no password is associated to the End User, programming the relevant parameters is allowed without entering anything in “P.0000-Access code”. When entering “iii” in “P.0000-Access code” the operator is identified as “installer” but, as no password is associated to “manufacturer”, the controller identifies him/her as "manufacturer”. After entering code all parameters are modifiable.

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

As no password is associated to End User, programming the relevant parameters is allowed without entering anything in “P.0000”. By entering “iii”, the operator is identified as "installer” and can modify all parameters associated to “installer” and “end user”. When entering “ccc” in P.0000, the operator is identified as “manufacturer” and can modify all parameters.

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

No parameter modification is allowed. When entering the “uuu” code in “P.0000-Access code”, the operator is identified as “End User” but, as no password is associated to “Installer” and “Manufacturer”, the controller acknowledges him/her as "installer”. Therefore, he/she can modify all controller parameters associated to installer and end user. When entering “ccc” in “P.0000 - Access code”, the operator is identified as “manufacturer” and can modify all parameters.

A parameter value can always be read but it can only be modified in case the "P.0000” contains a proper password. Parameters P.0001, P.0002 and P.0003 are excluded: they are not displayed in case "P.0000-Access code” does not contain a proper password.

Parameter P.0469 – “Serial ports password” can only be viewed and/or modified through operator panel and with at least Installer rights.

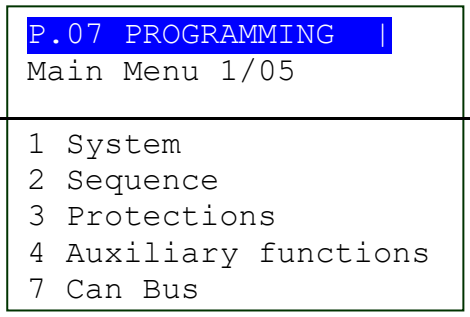
When accessing programming and setting the password ("P.0000”), parameters P.0001, P.0002 and P.0003 might not be immediately displayed. To enable display, return to the previous menu and then re-enter.

In case the code set as password is forgotten, access can only be recovered if you know the higher-level password. Otherwise (or in the event the manufacturer password is lost) you need to send the controller board back to the factory to have its associated programming functions unlocked.

This is the reason why we recommend setting at least the “Manufacturer” password (P.0001): in case someone else sets up this password, or a lower level one (even unwillingly) without providing information, no parameter modification will be possible anymore. On the other hand, knowing the “manufacturer” password will allow to cancel or modify the other passwords.

8.5.1.2 Operating procedure

This procedure will describe the keyboard and display use.



- Menu 1-SYSTEM allows to show how the controller connects to the engine, to the generator and to the plant battery. Correct setting of these parameters is paramount as almost all protection activation thresholds are expressed as a percentage of these parameters.
- Working sequence configuration can be modified through the menu 2-SEQUENCE. In this menu it is possible to set threshold percentages and acquisition times, plus enabling/disabling operation sequences related functions.
- Protections management is accessible through the menu 3-PROTECTION. As to this, it is important to know that, to enable/disable a protection, you may simply modify the associated time, leaving the threshold unchanged: by setting the time to zero, the protection is disabled. However, this general rule provides some exceptions. Refer to the chapter on faults, par. 0, which describes, for each of the faults, the method to disable it.
- All operations not related to system, sequence and protections configuration, can be performed through the menu 4-AUXILIARY FUNCTIONS. This menu contains other menus used for configuring engine's auxiliary functions and history logs.
- The menu 5-COMMUNICATIONS allows the configuration of the serial ports, of the USB port and of the ETHERNET port.
- The menu 7-EXTERNAL DEVICES allows you to configure how the controller must communicate on the bus to acquire measurements (and possibly send commands) from external devices (ECU, AVR, BMS, I/O expansions, DC sensors).

8.5.1.3 Access to programming

The programming is accessible with the controller in any operation state, while parameters can only be modified, in general, with the controller board in **OFF/RESET**. To enter programming mode, use the ▲ and ▼ buttons till the base PROGRAMMING mode (P.03) screen is displayed.

When in a mode that limits the use of vertical scrolling buttons, it could be necessary to press one or several times the **ESC** button (this situation can occur when displaying history logs or during some operations, such as setting the fuel pump control mode).

Then, press **ENTER** to access programming.

The menu or variable selected before the last exit from programming are automatically displayed when starting the procedure (the main menu is displayed the first time you access). This is true if the programming procedure has been previously aborted by changing the operation mode of the controller board in MAN or AUTO or after maximum time with no programming operation has elapsed or keeping the **ESC** button pressed for more than two seconds.

8.5.1.4 Menu selection

Current menu name, selected menu item and number of menu items are always displayed in the second line. Menu items (submenus) are displayed in the following lines. The item selected is displayed in REVERSE. Use the ▲ e ▼ buttons to cyclically scroll through the menu to the lower and upper index items (i.e., pressing the ▲ allows to directly cycle from the first item to the last one).

Press the **ENTER** button to access the selected (highlighted) sub-menu. Press the **ESC** button to leave the menu (back to the previous menu or to the base screen if exiting programming in the main menu).

8.5.1.5 Parameter's selection

The name of the current menu (for example the menu "1-SYSTEM") is always shown in the first line, followed by the numeric ID of the selected item and the number of menu items. The following lines are used to display single parameters. In detail:

- The unambiguous parameter code (four decimal digits), followed by the description in the current language, is shown in the fourth and fifth line.
- The sixth line shows the variable value, aligned to the right side, between brackets or "< >".
- For some parameters, on the eighth line, a value is shown, which is in some way related to the actual parameter value. For example, in the case of the minimum voltage threshold for the generator (%), the rated value in Volt is shown. Sometimes, this additional measure can be displayed for showing its absolute value, when the parameter is a percentage of other values.

Use the ▲ e ▼ buttons to cyclically scroll through the menu to the lower and upper index items (i.e., pressing the ▲ allows to directly cycle from the first item to the last one and vice versa). Press the **ENTER** button to enable the parameter modification procedure (see following paragraph). Press the **ESC** button to leave the menu (back to the previous menu).

8.5.1.6 Modify a parameter

You may only modify parameters displayed between square brackets ([ ]). A parameter between (major/minor) symbols < > cannot be modified. In this case it could be necessary to set an appropriate password or stop the gen-set.

In case modifying the displayed parameter is allowed, press the **ENTER** button; the square brackets ([ ]) enclosing the value will blink to signal that the modification is in progress. To confirm the new value, press again the **ENTER** button; to abort and return to the original value, press the **ESC** button;

Parameter types are the following:

- **Bits**: Some parameters are managed with bits. Each bit set to 1 enables a function and each bit set to 0 disables a function. Each bit is assigned a value. The parameter must be set as the result of the sum of the values associated to the functions you require to enable (in hexadecimal mode). 8 bits can be used. The description of these parameters is shown in a table like the one below:

Bit	Value	Hexadecimal	Description
0	1	0001	Enable function 1
1	2	0002	Enable function 2
2	4	0004	Enable function 3
3	8	0008	Enable function 4
4	16	0010	Enable function 5
5	32	0020	Enable function 6
6	64	0040	Enable function 7
7	128	0080	Enable function 8

In case the operator wants:

  - To disable all functions: he/she must set to 0 the relevant parameter.

- To enable all functions: the value to be set is the sum 1+2+4+8+16+32+64+128 = 255 (0xFF).

- Enable, for example, the functions 3, 4, 6 and 8: the value to be set is the sum 4+8+32+128 = 172 (0xAC) (where 4 is the value associated to the function 3; 8 to the function 4; 32 to the function 6 e 128 to the function 8).

Note: from version 1.09, some of these parameters can be set directly bit by bit, instead of in hexadecimal.

- **Numeric**: the value can be modified by pressing the ▲ and/or ▼ buttons, to increase or decrease one unit from the most rightwards decimal digit (if you press the above buttons plus SHIFT, the figure will be increased or decreased by ten units at a time). The change is cyclical: increasing over the maximum value when will lead to the minimum one and vice versa.
- **Numeric selected in a pre-defined list:** (for example the baud rate for the serial port): same goes for the numeric parameters, considering that the ▲ and/or ▼ buttons allow for passing to the fallowing/previous value in the pre-defined list (pressing the above buttons plus SHIFT, you go to the value ten units after/before the current one).
- **Numeric selected in a number-string couples list** (e.g., the type of pressure sensor): same as the previous point.
- **Time**: same as numerical parameters, with one exception: the controller manages the increment/decrement maintaining valid values (example: increasing from “00.59”, the value goes to “01.00” and not to “00.60”).
- **Strings** (e.g., telephone numbers): in this case the display shows also a cursor indicating the currently selected character in the string. The▲▼ buttons work on the selected character (passing to the one after/before in the ASCII table. If you press the above buttons plus SHIFT, you will move to the one 10 units before/after). The ◄► buttons allow to select the character to be modified. You can only set the ASCII characters from 32 (Space) to 127 (Escape). It is not possible to set extended ASCII characters (over 127) and the control ones (from zero to 31).
- **Hexadecimal strings** (e.g., output bitmaps): same as for the string parameters, but the selectable characters are only ”0-9” and “A-F” (only capitals for the latter).

8.5.1.7 Set up limits

The operator has not to worry about verifying that the set-up value is acceptable for the controller since it is not possible to set up not acceptable values.

This goes for individual parameters; however, it is possible to set two or more parameters in incongruent or incompatible ways. It is up to the operator to prevent this from occurring.

8.5.1.8 Exit from programming

There are three ways to exit programming mode:

- Press the **ESC** button 'n' times to scroll back to the main menu, then press it again to exit programming. The main menu will be displayed on the next access to programming.
- Pressing and holding the **ESC** button for two seconds from any location will cause instantaneous exit from programming and next access will get you to the very same point.
- Turn the operation mode of the controller to **AUTO** or **MAN**: next access will get you to the very same point.

8.5.1.9 Loading default values

WARNING: This procedure permanently reloads all factory parameters according to access rights.

Sometimes, it may be useful to reload parameters factory values. To do so, first access programming, then press and hold the **ACK/ENTER** and **ESC/SHIFT** buttons simultaneously for five seconds. Reload of factory values will be confirmed by a message on the display.

Factory values are reloaded only for parameters for which you are granted access rights.

8.5.2 PLC (L.XX)

Pages from L.01 to L.07 contain the information related to the PLC logic and are only displayed if on the controller is installed a valid PLC program. Refer to [6] for information on PLC.

8.5.2.1 L.01 PLC

This page contains information of identification of the PLC program installed in the device, as:

- The firmware version of the PLC, compilator and editor.
- The date of the last modification.
- The medium/maximum time of execution. These times are reset automatically when the PLC program is sent to the controller, or it is possible to force the reset by pressing **ACK/ENTER** + **ESC/SHIFT** at the same time for five seconds.
- The title of the PLC program.

8.5.2.2 L.02 PLC LOGIC

This page shows information about a single PLC block.

In the second line on the right the selected block is shown, with format “TYPE-NUMBER”. To select the PLC block, press **ACK/ENTER**, then use ▲▼ buttons to search for the PLC block wanted (combined with SHIFT allow moving by 10 blocks at a time); confirm by pressing **ACK/ENTER** again.

All parameters of the PLC block selected are shown in the following lines (one line for each parameter).

- The first column identifies the type of parameter used (input/output).
- The second column identifies the resource associated to the parameter. The resources are normally shown with Mecc Alte codification (e.g., the digital input 1 is identified as DI_CONTROLLER_01). In the PLC program it is possible to associate symbols (“nicknames”) to the resources. It is possible to view the symbols in the second column, in place of Mecc Alte codes: press **ACK/ENTER** (as to select a different PLC block) and press ◄►; confirm with **ACK/ENTER** button. See [6] for Mecc Alte codes description, to identify the PLC resources.
- The third column shows the current value of the resource. For the digital resources, if the viewed value is in REVERSE, it means that the relative parameter is denied.

8.5.2.3 L.03 VIRTUAL INPUTS

This page shows to status of all virtual digital inputs (that is, those inputs the status of which has not been acquired by the hardware but is determined by the PLC program).

8.5.2.4 L.04 DIGITAL SUPPORTS

This page shows the status of all temporary digital variables (DT_XXX) available for the PLC program. Many pages which alternate every 2 seconds are available to view all digital supports. Keeping **ESC/SHIFT** pressed, you can impede the rotation of the pages (keeping on the display the page currently viewed).

8.5.2.5 L.05 DIGITAL STATUSES

This page shows the value of all internal status of the controller (ST_XXX) available for the PLC program). Many pages which alternate every 2 seconds are available to view all digital statuses. Keeping **ESC/SHIFT** pressed, you can impede the rotation of the pages (keeping on the display the page currently viewed).

8.5.2.6 L.06 VIRTUAL ANALOGUEUES

This page shows the status of all virtual analogue inputs (that is, those inputs the heat of which has not been acquired by the hardware but is determined by the PLC program).

8.5.2.7 L.07 NUMERIC SUPPORTS

This page shows the status of all temporary numeric variables (AT_XXX) available for the PLC program. Many pages which alternate every 2 seconds are available to view all numeric supports. Keeping **ESC/SHIFT** pressed, you can impede the rotation of the pages (keeping on the display the page currently viewed).

8.5.3 Status information (S.XX)

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

8.5.3.1 S.01 STATUS

Page S.01 (STATUS) shows system status information. Part of this information is shown on the top status bar. It contains:

- Working status of the generator (stopped, running, supplying, etc.).
- Working mode of the controller (MAN, AUTO, etc.).
- The status of the auxiliary source (absent, low, high etc.)
- Presence of inhibitions for start.
- Presence of inhibitions for GCB closure.
- Presence of the engine protections override.
- Any limitation of the discharge current of the storage battery or of the current supplied by the generator.
- Any forcing of an external setpoint for the generator current.
- Any starting of the engine to power the users at fixed voltage, disconnecting the battery.

Some information is shown alongside an elapsing time; for example, during engine cooling down, the residual time is shown. During the cranking, the controller also shows the number of cranks already performed.

8.5.3.2 S.02 ANOMALIES

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

- A letter that identify the type.
  - “A”: alarm (block)
  - “D”: deactivation.
  - “K”: latched warning.
  - “W”: warning.
- A three-digit numeric code that uniquely identify the anomaly. This code flashes until it is acknowledged pressing the “ACK” pushbutton.
- An alphanumeric description, which depends on the language currently selected and which in some cases can be customized using the controller parameters.

Every fault uses one or two rows of the display. The fault shown in the highest position is the most recent, chronologically. If the space available is not enough to display all the faults, only the most recent will be displayed. To see the other, it is required to:

- Press the ENTER key
- Use the ▲▼ keys to scroll the anomalies
- Press ESC to leave the mode

This page may also contain diagnostic information acquired via CAN-BUS directly from the engine electronic control unit (ECU) or from the voltage regulator (AVR). For each diagnostic code the following is shown:

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

For some external device, the SPN, FMI and OC are not shown, but the DTC code and an alphanumeric description are always displayed.

If one or more of the above-mentioned information is not available, it will be replaced by dashes or it will simply not be displayed. If multiple diagnostic codes are active at the same time, they will be cyclically alternated on the display every 2 seconds. The diagnostic codes are stored (even if the external device deactivates them) until the yellow/red Can-Bus indicator light warning is acknowledged with the “ACK” button.

For some faults W198, A199, W228, W252, W253, W254, W255, W273, W900) additional information are shown on the last two rows. If more than one fault is active, then you must press ENTER and select the required fault to see its additional information. For example, the fault “W252” indicates that an expansion module does not communicate with the controller over the Can Bus: its additional information contains the kind and the address of the missing module).

8.5.3.3 S.03 BOARD

Page S.03 (BOARD) is dedicated to the HS315 and contains:

- The language currently used by the device and allows you to select between the ones installed (see par. 8.6)
- Current date and time in long format (flashing if the clock is not valid)
- The unambiguous serial number of the controller board (called ID CODE).
- The code of the software currently loaded on the controller board (see par. 1.7).

8.5.3.4 S.04 SERIAL COMMUNICATION

Page S.04 (SERIAL COMMUNICATION) is dedicated to the status of the serial communication through the two serial ports, through the USB port and through the internal GSM modem. In case of functional problems, please, verify the content of this page.

The controller shows the status of the communication on of all those resources (on standby, communicating etc.). For the GSM modem connected to the serial port 1 or for the internal GSM modem, information related to the radio signal strength and the provider are shown.

For serial port 1 (or main) the type of connection is also displayed (direct, via modem, via GSM).

For Link controllers or if an external modem is connected to the controller on the RS232 serial port, on the first two lines will be displayed:

- The modem model used.
- In case of a GSM/GPRS external modem and for **Link LTE** controllers:
  - The active connection type: GSM/GPRS/EDGE (EDGE), LTE NB-IoT or LTE CAT-M
  - the Mobile Network Operator (MNO) currently connected (Vodafone, TIM….). If the SIM card does not return the full name the Mobile Country Code (MCC) + Mobile Network Code (MNC) is shown.

- the mobile network signal intensity

8.5.3.5 S.05 NETWORK

Page S.05 (NETWORK) is dedicated to the status of the connection and of the communication via TCP/IP protocol. This protocol can be used with the ETHERNET port.

When using the ETHERNET port, the controller shows:

- The communication status (on standby, idle-linked, communicating etc.).
- The MAC address of the ETHERNET interface.
- The name of the controller (if using DHCP protocol).
- The IP address of the controller (the one configured or the one obtained from the DHCP server).
- The IP address of the network gateway (the one configured or the one obtained from the DHCP server).
- The sub-net mask of the network (the one configured or the one obtained from the DHCP server).
- The IP address of the DNS server (the one configured or the one obtained from the DHCP server).

For HS315^{Link} controllers (equipped with GPRS internal module), the controller shows:

- The IP address assigned to the controller by the GPRS network.
- Some useful information for the connection to Mecc Alte Smart Cloud server.":
  - Controller name
  - Latitude and Longitude acquired by the **GNSS** module or set through the parameters of the controller. This information flashes if the **GNS**S module is not able to set the position.
  - The **HDOP** (Horizontal Dilution of Precision) value: it is a precision indicator (the lower it is, the sharper the position).
  - the number of satellites that are "view" by the **GNSS** module (when searching for coordinates) or the number of satellites used for the "**FIX**" of the coordinates (once the correct position has been determined).

8.5.3.6 S.06 CLOUD LINK (SMART CLOUD)

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

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

8.5.3.7 S.07 CAN-BUS

The page displays the status of the CAN-BUS interface of the controller. The following information is shown:

- Communication status of bus. There are three possible indications:
  - ERROR-ACTIVE: normal operation
  - ERROR-PASSIVE: communication is working despite faults (errors).
  - BUS-OFF: Genset has interrupted the connection to the bus due to too many errors.
- The number of the communication errors. The instantaneous counters of the transmission/reception errors and the maximum values reached by them are displayed. It is possible to reset the maximum values (and in the meanwhile to force the exit from the status of BUS-OFF) by pressing for 5 seconds the digits ENTER e ESC/SHIFT at the same time.

8.5.3.8 S.08-09-10 GENERIC STATUS

Pages S.08, S.09 and S.10 (GENERIC STATUS 1,2,3) are used to show the generic statuses acquired by digital inputs configured with the following functions:

- DIF.3201, DIF.3202: page S.08
- DIF.3203, DIF.3204: page S.09

- DIF.3205, DIF.3205: page S.10

The activation of a digital input configured with the function DIF.3202, DIF.3204 or DIF.3206 forces the display to show the related page (it is an “important status”, the operator must be informed immediately).

The controller uses one row per each status: on the left a description is shown (configured by means the parameters related to the input) and on the right the logical status of the input (“1” or “0”). If the page contains more than seven statuses, the controller shows all them by rotation (every 2 seconds, keep pressed the SHIFT button to stop the rotation).

These pages are hidden if there are no statuses to be shown.

8.5.3.9 S.11-12 DIGITAL INPUTS

Pages S.11, S.12 (DIGITAL INPUTS) display respectively:

- S.11:
  - The status of the digital inputs of the controller (JN, JT).
  - The status of the analogue inputs (JQ, JM and JL) when they are used “as digital” (otherwise dashes are shown)
  - The status of the virtual digital inputs.
- S.12:
  - The status of the digital inputs of the first DITEL module.
  - The status of the digital inputs of the second DITEL module (if present).

Page S.12 is hidden if no DITEL modules is present.

When you press the ACK/ENTER button, the controller changes the visualization through three different modes (LOGICAL STATE, PHYSICAL STATE, BY FUNCTION), showing the statuses of the digital inputs:

- **LOGICAL STATE**: the input's logic state (active or inactive) used by the controller in the management of the operating sequence.
- **PHYSICAL STATE**: electrical level (active or inactive, or high or low) present on the input; this can be the opposite in comparison to the corresponding logic state. Displayed in negative.
- **BY FUNCTION**: it shows a list of the most common functions really configured for the digital inputs, each of them with the logical status of the input that acquires it (it is not possible to understand which input acquires a specific function, but only the fact that this input is active or not). If more than six functions must be shown, the controller shows all them by rotation (every 2 seconds, keep pressed the SHIFT button to stop the rotation)

8.5.3.10 S.13-14 DIGITAL OUTPUTS

Pages S.13, S.14 (DIGITAL OUTPUTS) display respectively:

- S.13:
  - The status of the digital outputs of the terminals JE.
  - The status of the digital outputs of the terminals JL (START, FUEL).
  - The status of the digital outputs of the terminals JI.
  - The status of the digital outputs of the terminals JT.
- S.14:
  - The status of the digital outputs of the first DITEL module.
  - The status of the digital outputs of the second DITEL module (if present).

Page S.14 is hidden if no DITEL modules is present.

When you press the ACK/ENTER button, the controller changes the visualization through three different modes (LOGICAL STATE, PHYSICAL STATE, BY FUNCTION), showing the statuses of the digital outputs:

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

- **BY FUNCTION**: it shows a list of the most common functions really configured for the digital outputs, each of them with the logical command of the output that manages it (it is not possible to understand which output manages a specific function, but only the fact that this output is active or not). If more than six functions must be shown, the controller shows all them by rotation (every 2 seconds, keep pressed the SHIFT button to stop the rotation).

8.5.3.11 S.15 ANALOGUE INPUTS

Page S.15 (ANALOGUE INPUTS) shows the voltages (Vdc) measured on each JM terminals. For terminals 2, 3 and 4, it shows also the ohm measured.

8.5.3.12 S.16 ANALOGUE INPUTS

Page S.16 (ANALOGUE INPUTS) shows the voltages (Vdc) measured on terminals JQ, JL-2 (emergency stop) and JL-4 (+D).

8.5.3.13 S.17 ANALOGUE INPUTS

Page S.17 (ANALOG INPUTS) displays the temperatures measured by DIGRIN and DITHERM expansion modules. The page is hidden if no such module is configured. The temperature can be replaced by the following messages:

- "-----": when the expansion module does not send the measurement or when the controller does not receive it.
- "open": when the expansion module detects a "broken wire" condition on that sensor.
- "+over": when the expansion module measures a too high value (fault).
- "-over": when the expansion module measures a too low value (fault).

S.18 ANALOGUE INPUTS

Page S.18 (ANALOG INPUTS) displays the measures acquired by DIVIT expansion modules (before applying conversion curves). The page is hidden if no such module is configured. The measure can be replaced by the following messages:

- "-----": when the expansion module does not send the measurement or when the controller does not receive it.
- "open": when the expansion module detects a "broken wire" condition on that sensor.
- "+over": when the expansion module measures a too high value (fault).
- "-over": when the expansion module measures a too low value (fault).

8.5.3.14 S.19 ANALOGUE OUTPUTS

The S.19 (ANALOG OUTPUTS) page displays the command (as percentage) for the analogue output of the controller (JR).

Pressing the ENTER button a "display for function" is shown: the controller shows a list of functions really associated to the analogue outputs, showing the analogue value of each function, independently from the output. If more than 6 functions are used for the digital outputs, the controller shows them all turning (6 at a time) every two seconds: keeping SHIFT pressed the turning stops.

8.5.3.15 S.20 ANALOGUE OUTPUTS

The S.19 (ANALOG OUTPUTS) page displays the command (as percentage) for the analogue outputs of the DANOUT expansion module. The page is available only if the DANOUT expansion module is installed in the system.

8.5.4 Electrical measurements (M.XX)

This mode displays all the information on the measurements taken by the Gen-set control module on the electric lines. You can scroll through the various pages using the LEFT and RIGHT buttons.

8.5.4.1 M.01 SYSTEM

Page M.01 (SYSTEM) displays a wiring diagram of the system. The system can be made up by a maximum of four "sources":

- The plant battery.
- The generator.
- The loads.
- The auxiliary source.

Each source is automatically hidden (together with its measurements and its circuit breaker) if not configured (when the controller does not acquire its DC voltage nor its current). However, it is possible to use the parameter P.0494 to force the controller to hide one or more sources.

For each source, the controller shows:

- A symbol for the source:
  - The plant battery symbol shows the charge level of the plant battery. It fills from the bottom to the top (if it is fully black battery charge is 100%, if it has only borders, the battery is fully discharged).
  - The symbol of the generator is in "reverse" if the engine is started and if the generator is powered.
  - The symbol of the load is displayed in "reverse" if the loads are powered.
  - The symbol of the auxiliary source is solid if the auxiliary source is within the tolerance range and flashing if the auxiliary source is missing or if it exceeds the tolerance range.
- A symbol for the circuit breaker. This symbol is hidden if the controller does not acquire the feedback of the circuit breaker and if no outputs have been configured for its commands. However, it is possible to use the parameter P.0494 to force the controller to hide one or more circuit breakers. The symbol changes to show the real status (opened/closed) of the circuit breaker (or its command if the feedback is not acquired). The symbol blinks in case of difference between status and the breaker command.
- The voltage (DC) and current measurements. The current measure is hidden if not acquired or when the circuit breaker is opened. The voltage measure is hidden if not acquired or when the related source is "absent". However, it is possible to use the parameter P.0494 to force the controller to hide the measures of one or more sources.
- The power flow, shown by means an arrow (only if the related circuit breaker is closed). The arrow points in the direction of the power flow.

8.5.4.2 M.02 BATTERY

This page shows a lot of information regarding the plant battery and its charge process:

- Voltage (Vdc).
- Current (Adc, positive during discharge).
- Power (kW, positive during discharge).
- Charge level (Ah).
- Temperature (°C).
- An estimation of the remaining hours to the end of the discharge process (calculated respect to parameter P.9664).

During the charge cycle, it also shows:

- The charge phase in progress (BULK, ABSORBTON, FLOAT, FLOAT END).
- An estimation of the remaining time to the end of the current charge phase ((calculated respect to parameters P.9681 or P.9688).

In the bottom, a graphical representation of the charge level is provided through a progress bar (percentage).

In the bottom-right corner, the symbol of the battery is shown. This allow the operator to immediately understand that he/she is looking at battery measurements (there are very similar pages related to other sources).

8.5.4.3 M.03 BATTERY 2

This page shows a lot of information regarding the charge/discharge process running on the plant battery:

- An indication of the kind of process (charge/discharge).
- Date and time of the start of the process.
- Battery voltage (Vdc) at the beginning of the process.
- Charge level (Ah) at the beginning of the process.
- Actual charge level (Ah).
- Power (Wh) transferred from/to the battery since the beginning of the process.
- Only during charge process: the energy (Ah) transferred to the battery since the beginning of the current charge phase (BULK, ABSORBTON, FLOAT, FLOAT END).

8.5.4.4 M.04 BATTERY TRIP

This page shows the partial (clearable) counters related to charge/discharge cycles. Counters are provided for the number of cycles, for the transferred power (Wh) and for the transferred energy (Ah), for both charge and discharge processes. To clear a counter, please follow these steps:

- Press the ACK/ENTER button: one counter will be highlighted.
- Select the required counter using vertical arrows.
- Keep pressed the buttons ESC/SHIFT + ACK/ENTER until the counter is cleared.
- Press the ESC/SHIFT button.

In the bottom-right corner, the symbol of the battery is shown. This allow the operator to immediately understand that he/she is looking at battery measurements (there are very similar pages related to other sources).

From version 1.08, the counters are protected by the USER level. If a password has been configured by means parameter P.0001, it is first required to type it (login) into parameter P.0000, to be able to reset the counters.

8.5.4.5 M.05 BATTERY TOT.

This page shows the total (not clearable) counters related to charge/discharge cycles. Counters are provided for the number of cycles, for the transferred power (Wh) and for the transferred energy (Ah), for both charge and discharge processes.

In the bottom-right corner, the symbol of the battery is shown. This allow the operator to immediately understand that he/she is looking at battery measurements (there are very similar pages related to other sources).

8.5.4.6 M.06 GENERATOR DC

This page shows some information regarding the generator (DC):

- Voltage (Vdc).
- Current (Adc, positive if supplied by the generator).
- Power (kW, positive if supplied by the generator).

In the bottom-right corner, the symbol of the generator is shown. This allow the operator to immediately understand that he/she is looking at generator measurements (there are very similar pages related to other sources).

8.5.4.7 M.07 GENERATOR AC

This page is shown only if the controller is configured to acquire the AC voltages of the generator. It shows:

- The frequency.
- For three-phases system: the line-to-line voltages.
- For three-phases system: the phases sequence of the voltages (CW / CCW).

- For single-phase system: the line-to-neutral voltage.

In the bottom-right corner, the symbol of the generator is shown. This allow the operator to immediately understand that he/she is looking at generator measurements (there are very similar pages related to other sources).

8.5.4.8 M.08 GENERATOR AC 2

This page is shown only if the controller is configured to acquire the AC voltages of the generator. It is also hidden if the neutral of the generator is not connected to the controller (P.9614 different from “028”). It shows the three line-to-neutral voltages, with their phases sequence (CW / CCW).

In the bottom-right corner, the symbol of the generator is shown. This allow the operator to immediately understand that he/she is looking at generator measurements (there are very similar pages related to other sources).

8.5.4.9 M.09 LOADS

This page shows some information regarding the loads:

- Voltage (Vdc).
- Current (Adc, positive if flowing from outside to the loads).
- Power (kW, positive if flowing from outside to the loads).

In the bottom-right corner, the symbol of the loads is shown. This allow the operator to immediately understand that he/she is looking at loads’ measurements (there are very similar pages related to other sources).

From version 1.09, if the management of the secondary contactors is enabled (for the connection of the loads to the storage battery, see 9.4.3), the opening/closing commands for the contactors are shown in the lower left part: it is possible to open/close the single contactor by pressing ENTER and changing their status with the arrows.

8.5.4.10 M.10 AUXILIARY SOURCE DC

This page shows some information regarding the auxiliary source:

- Voltage (Vdc).
- Current (Adc, positive if supplied by the auxiliary source).
- Power (kW, positive if supplied by the auxiliary source).

In the bottom-right corner, the symbol of the auxiliary source is shown. This allow the operator to immediately understand that he/she is looking at auxiliary source measurements (there are very similar pages related to other sources).

8.5.4.11 M.11 AUXILIARY SOURCE AC

This page is shown only if the controller is configured to acquire the AC voltages of the auxiliary source. It shows:

- The frequency.
- For three-phases system: the line-to-line voltages.
- For three-phases system: the phases sequence of the voltages (CW / CCW).
- For single-phase system: the line-to-neutral voltage.

In the bottom-right corner, the symbol of the auxiliary source is shown. This allow the operator to immediately understand that he/she is looking at auxiliary source measurements (there are very similar pages related to other sources).

8.5.4.12 M.12 AUXILIARY SOURCE AC 2

This page is shown only if the controller is configured to acquire the AC voltages of the auxiliary source. It is also hidden if the neutral of the generator is not connected to the controller (P.9618 different from “018”). It shows the three line-to-neutral voltages, with their phases sequence (CW / CCW).

In the bottom-right corner, the symbol of the auxiliary source is shown. This allow the operator to immediately understand that he/she is looking at auxiliary source measurements (there are very similar pages related to other sources).

8.5.4.13 M.13 V/I REGULATION

This page shows information relating to the regulation of the storage battery charging voltage/current.

It displays the current charging voltage and current, and the relative setpoint (voltage or current, depending on the state of the charging procedure). On the last line, it allows the direct setting of the P.0840 setpoint (without going into programming). It is the "base" value of the analogue output (the control loops move the output around this base value). To change it you need to:

- Press the ACK/ENTER button.
- Modify the value using the vertical arrows.
- Confirm with the ACK/ENTER button.

8.5.4.14 M.14 RPM REGULATION

This page is only visible if an Automatic Voltage Regulator is used to regulate the generator voltage (and consequently the storage battery charging voltage and current).

It shows the data related to the changing of the engine speed depending on the power delivered. It displays the current speed, power (kW) and percentage power of the engine. It also displays the speed setpoint calculated by the controller. On the last line, it allows the direct setting of the P.0867 setpoint (without going into programming). It is the "base" value of the analogue output (the control loop, if used, moves the output around this base value). To change it you need to:

- Press the ACK/ENTER button.
- Modify the value using the vertical arrows.
- Confirm with the ACK/ENTER button.

8.5.4.15 M.15 ELEC. BATTERY

This page is only shown if more than one Battery Management System (BMS) are properly configured It displays the whole battery set values (replaced by dashes if not available):

- Average batteries voltage.
- Total batteries charge/discharge current.
- Total batteries charge level.
- Average batteries temperature.

If there is more than one BMS, then it also shows some statistics related to all BMSs:

- Minimum and maximum voltage.
- Maximum current.
- Minimum and maximum charge level.
- Minimum and maximum temperature.

8.5.4.16 M.16 ELEC. BATTERY 1

This page is only shown if some Battery Management System (BMS) are properly configured.

It shows values related to one of the connected batteries. It is possible to select a different module (only if there are more than one module) by pressing the **ACK/ENTER** button and using vertical arrows (confirm with **ACK/ENTER**). It shows the following values (replaced by dashes if not available):

- Voltage.
- Charge/discharge current.
- Charge level.
- Average temperature.

8.5.4.17 M.17 ELEC. BATTERY 2

This page is only shown if some Battery Management System (BMS) are properly configured.

It shows values related to one of the connected batteries. It is possible to select a different module (only if there are more than one module) by pressing the **ACK/ENTER** button and using vertical arrows (confirm with **ACK/ENTER**). It shows the following values (replaced by dashes if not available):

- Model
- Serial number

8.5.4.18 M.18…M.19 BMS

The controller supports the management of external configuration files which describe the Can bus communication with the electronic battery management systems (BMS). These files may include the definition of one or more display pages, dedicated to displaying the specific measures/states of that BMS.

The controller provides up to two pages. The title of each page is defined in the configuration file for the BMS, as well as the number of measurements shown and their description. Attention: as the descriptions are defined in the external file, they do not adapt to the language selected on the controller (typically they are in English).

8.5.4.19 M.20…M.25 AVR

It contains a series of standard information (J1939-75) acquired via CAN-BUS from the automatic voltage regulator. The amount of information available depends on the type of device to which you are connected. Information not available is not displayed. The number of pages displayed therefore depends on the actual information transmitted by the voltage regulator. The information shown on this page are:

- spn 1122 - Engine Alternator Bearing 1 Temperature.
- spn 1123 - Engine Alternator Bearing 2 Temperature.
- spn 1124 - Engine Alternator Winding 1 Temperature.
- spn 1125 - Engine Alternator Winding 2 Temperature.
- spn 1126 - Engine Alternator Winding 3 Temperature.
- spn 2436 – Average frequency
- spn 2437 - Frequency L1
- spn 2438 - Frequency L2
- spn 2439 - Frequency L3
- spn 2440 - Average L-L voltage
- spn 2441 - Voltage L1-L2
- spn 2442 - Voltage L2-L3
- spn 2443 - Voltage L3-L1
- spn 2444 - Average L-N voltage
- spn 2445 - Voltage L1-N
- spn 2446 - Voltage L2-N
- spn 2447 - Voltage L3-N
- spn 2448 – Average current

- spn 2449 - Current L1
- spn 2450 - Current L2
- spn 2451 - Current L3
- spn 2452 - Total active power
- spn 2453 - Active power L1
- spn 2454 - Active power L2
- spn 2455 - Active power L3
- spn 2456 - Total reactive power
- spn 2457 - Reactive power L1
- spn 2458 - Reactive power L2
- spn 2459 - Reactive power L3
- spn 2460 - Total apparent power
- spn 2461 - Apparent power L1
- spn 2462 - Apparent power L2
- spn 2463 - Apparent power L3
- spn 2464 - Total power factor
- spn 2465 - Power factor L1
- spn 2466 - Power factor L2
- spn 2467 - Power factor L3
- spn 2518 - Load type (total) (0=leading, 1=lagging)
- spn 2519 - Load type L1 (0=leading, 1=lagging)
- spn 2520 - Load type L2 (0=leading, 1=lagging)
- spn 2521 - Load type L3 (0=leading, 1=lagging)
- spn 2468 - Exported active energy
- spn 2469 - Imported active energy
- spn 3380 - Excitation voltage
- spn 3381 - Excitation current

8.5.4.20 M.26…M.31 AVR

From version 1.16, the controller supports the management of external configuration files that describe the Canbus communication with the automatic voltage regulators. These files may include the definition of one or more pages for the display, dedicated to displaying the specific measures / states of that device (usually when they do not follow the J1939-75 standard).

The controller offers up to six pages. The title of each page is defined in the configuration file for the voltage regulator, as well as the number of measurements shown and their description. Attention: since the descriptions are defined in the external file, they do not adapt to the language selected on the controller (typically they are in English).

8.5.5 Engine measurements (E.XX)

The engine related measurements are shown in this mode. The number of pages displayed may depend on the type of engine (J1939, MTU or without communication interface). You can scroll through the various pages using the LEFT and RIGHT buttons.

8.5.5.1 E.01 ENGINE 1

It contains the fundamental measurements for engine management:

- Oil pressure
- Coolant temperature
- Speed

If any of these values is not available, it'll be shown with dashes. If a CAN-BUS connection is active, the type of engine selected is also displayed.

On the first row the name of the engine electronic control unit (ECU, if any) is displayed.

8.5.5.2 E.02 ENGINE 2

It contains other measurements for engine management:

- Engine battery voltage.
- Fuel level (%).
- Fuel level (litres).

If any of these values is not available, it'll be shown with dashes.

8.5.5.3 E.03 ENGINE 3

It contains other quantities for the engine management, **when they are acquired using the analogue inputs of the controller**. If the same measurements are acquired using the CANBUS connection, they are displayed on other pages. This page is automatically hidden if none of the following measures are available:

- coolant level (AIF.1210 or AIF.1211 functions in the configuration of the analogue inputs).
- oil temperature (AIF.1100 or AIF.1101 functions in the configuration of the analogue inputs).
- oil level (AIF.1200 or AIF.1201 functions in the configuration of the analogue inputs).
- air temperature in the intake duct (AIF.1601 function in the configuration of the analogue inputs).
- turbocharger pressure (AIF.1641 function in the configuration of the analogue inputs).
- exhaust gas temperature (left bank) (AIF.1603 function in the configuration of the analogue inputs).
- exhaust gas temperature (right bank) (AIF.1605 function in the configuration of the analogue inputs).

If some of these measures are not available, they are hidden.

8.5.5.4 E.04 COUNTERS

This page contains various counters (managed by the controller board), which concern the engine:

- Crank's counter (resettable to zero).
- Counter of operating hours (resettable to zero).
- Counter of load operating hours with GCB closed (resettable to zero)
- Counter of operating hours in OVERRIDE (resettable).
- Counter of operating hours (total, not resettable to zero).

The first four counters are resettable (individually). To reset a counter, the operator must:

- Press the ACK/ENTER button: one of the counters will be highlighted.
- Use the vertical scrolling buttons UP and DOWN to select the counter you want to reset to zero.
- Press and hold the ACK/ENTER and ESC/SHIFT buttons for five seconds, until the counter is cleared.
- Press the ESC/SHIFT button.

From version 1.08, the counters are protected by the USER level. If a password has been configured by means parameter P.0001, it is first required to type it (login) into parameter P.0000, to be able to reset the counters.

8.5.5.5 E.05 MAINTENANCE

This page is related to the hour / day counters for the genset maintenance. It shows the remaining hours to the next maintenance planned by parameters P.0424 and P.0437, and the remaining days for the maintenance planned by parameter P.0438. If some of these parameters are set to zero (maintenance not planned), the related counters are replaced by dashes.

8.5.5.6 E.06 FUEL PUMP

This page is available only if at least one output is configured for managing the fuel pump. Contains the following information:

- The current managing mode of the fuel pump (MAN-OFF, MAN-ON, AUTO).
- The pump status (on/off).
- An indication of the fuel level referred to the pump management (starting required, arrest required, in hysteresis).

If the pump management is linked to the analogue level sensor, then the controller board displays, by means of a graphic bar, the current fuel level showing also the thresholds for pump start/arrest.

From this page you can change the management mode for the fuel pump without having to go to programming. To do that, you must:

- Press the ENTER button: the square brackets between which the current mode is displayed start flashing.
- Use the vertical scrolling buttons UP and DOWN to select the desired mode.
- Confirm with ENTER or cancel the modification with ESC.

For a detailed description of the features offered by the controller board for the control of the fuel pump, see 9.7.13.

8.5.5.7 E.07 GERAFLEX

This page is shown only if serial communication to the GERAFLEX engine is enabled.

Some engine measures acquired by serial port are shown in this page. Not available measures are shown with dashes. This page shows the following measures

- Signal of the correct oil pressure.
- Battery Potential (Voltage), Switched (SAE J1939: SPN158).
- Engine Intake Manifold #1 Temperature (SAE J1939: SPN105)
- Engine Throttle Position (SAE J1939: SPN51).
- Injection time.
- Total Engine Hours (SAE J1939: SPN247

8.5.5.8 E.08-09-10 EXT MEASURES

These pages are used to show the generic measurements acquired by analogue inputs configured with the following functions:

- AIF.2001: page E.08
- AIF.2003: page E.09
- AIF.2005: page E.10

The controller uses one row per each measure: on the left a description is shown (configured by means the parameters related to the analogue input) and on the right the acquired measure, eventually converted by means a conversion curve. If the page contains more than seven measures, the controller shows all them by rotation (every 2 seconds, keep pressed the SHIFT button to stop the rotation).

These pages are hidden if there are no measures to be shown.

8.5.5.9 E.11 DASHBOARD

This page, as indicated by the title, shows all the standard warning lights (lamps) activated either by the engine control unit or by the automatic voltage regulator. This information are acquired via CANBUS. If none of this information is available, the page is not visible. The lamps displayed are:

-  SPN 1081 (“WAIT TO START LAMP”). It is necessary to wait for the engine control unit to finish the preliminary operations before the engine can be started.
-  SPN 624 (“AMBER WARNING LAMP”). The engine control unit (or the voltage regulator) is signalling on the CANBUS the presence of a diagnostic code (therefore of a problem) which at the moment does not prevent its operation.
- 

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

-  Indicates that the engine emissions system has a malfunction or is working outside the standard operating conditions. It is yellow, it can be fixed or flashing. It is related to SPN 1213 ("MALFUNCTION INDICATOR LAMP") and 3038 ("FLASH MALFUNCTION INDICATOR LAMP")

  This page also shows all the diagnostic codes activated by the engine ECU or by the voltage regulator, **even if the controller is in OFF / RESET**.

  Note: the controller forces this page to be displayed every time a lamp is activated.

8.5.5.10 E.12 Emissions level exceedance

It contains a series of standard information (J1939, DM32) acquired via CAN-BUS from the engine control unit (ECU). It is made up by a maximum of eight diagnostic codes, which indicate why the emissions level allowed by regulation is being exceeded.

If no code is active, HS315 hides this page. If several codes are active at the same time, it alternates them on the display every two seconds. For each code HS315 shows:

- The SPN code (which indicates the engine component responsible for exceeding the emission level).
- The FMI code, which indicates the type of failure on the engine component identified by the SPN.
- A textual description.
- The time since which the code is active (expressed in hours, with a resolution of 12 minutes).
- The time the code has been previously active (expressed in hours, with a resolution of 12 minutes).
- The time remaining before the ECU reduces the delivered power (expressed in hours, with the resolution of 15 minutes).

8.5.5.11 E.13…E.23 CANBUS

It contains a series of standard information (J1939) acquired via CAN-BUS from the engine control unit. The number of information available depends on the type of control unit to which you are connected. Information not available is not displayed. The number of pages displayed therefore depends on the actual information transmitted by the engine control unit. The information shown on this page are:

- spn 22: Engine Extended Crankcase Blow-by Pressure
- spn 51: Engine Throttle Position.
- spn 52: Engine Intercooler Temperature.
- spn 81: Aftertreatment 1 Diesel Particulate Filter Intake Pressure
- spn 91: Accelerator Pedal Position 1.
- spn 92: Engine Percent Load At Current Speed.
- spn 94: Engine Fuel Delivery Pressure.
- spn 96: Fuel Level 1
- spn 98: Engine Oil Level.
- spn 100: Engine Oil Pressure.
- spn 101: Engine Crankcase Pressure.
- spn 102: Engine Intake Manifold #1 Pressure.
- spn 105: Engine Intake Manifold #1 Temperature.
- spn 106: Engine Intake Air Pressure
- spn 106: Engine Intake Air Pressure
- spn 107: Engine Air Filter 1 Differential Pressure
- spn 108: Barometric Pressure.
- spn 109: Engine Coolant Pressure.
- spn 110: Engine Coolant Temperature.
- spn 111: Engine Coolant Level.

- spn 132: Engine Intake Air Mass Flow Rate
- spn 156: Engine Injector Timing Rail 1 Pressure.
- spn 157: Engine Injector Metering Rail 1 Pressure.
- spn 158: Key switch Battery Potential.
- spn 166: Engine Rated Power.
- spn 168: Battery Potential / Power Input 1
- spn 171: Ambient Air Temperature.
- spn 172: Engine Intake 1 Air Temperature
- spn 173: Engine Exhaust Gas Temperature
- spn 174: Engine Fuel Temperature 1.
- spn 175: Engine Oil Temperature 1.
- spn 182: Engine Trip Fuel.
- spn 183: Engine Fuel Rate.
- spn 189: Engine Rated Speed.
- spn 190: Engine Speed.
- spn 247: Engine Total Hours of Operation.
- spn 249: Engine Total Revolutions
- spn 250: Engine Total Fuel Used.
- spn 411: Engine Exhaust Gas Recirculation 1 Differential Pressure
- spn 412: Engine Exhaust Gas Recirculation 1 Temperature
- spn 441: auxiliary temperature 1
- spn 442: auxiliary temperature 2
- spn 512: Driver's Demand Engine - Percent Torque.
- spn 513: Actual Engine - Percent Torque.
- spn 514: Nominal Friction - Percent Torque.
- spn 515: Engine's Desired Operating Speed.
- spn 544: Engine Reference Torque
- spn 977: Fan Drive State
- spn 1108: Engine Protection System Timer Override
- spn 1029: Trip Average Fuel Rate.
- spn 1127: Engine Turbocharger 1 Boost Pressure
- spn 1135: Engine Oil Temperature 2.
- spn 1136: Engine ECU Temperature.
- spn 1172: Engine Turbocharger 1 Compressor Intake Temperature
- spn 1180: Engine Turbocharger 1 Turbine Intake Temperature
- spn 1181: Engine Turbocharger 2 Turbine Intake Temperature
- spn 1182: Engine Turbocharger 3 Turbine Intake Temperature
- spn 1183: Engine Turbocharger 4 Turbine Intake Temperature
- spn 1241: Engine Fuel System 1 Gas Mass Flow Rate
- spn 1636: Engine Intake Manifold 1 Temperature (High Resolution)
- spn 1637: Engine Coolant Temperature (High Resolution)
- spn 1639: Fan Speed
- spn 2432: Engine Demand –

8.5.5.12 E.24 DPF REGENERATION

From version 1.058, the controller fully supports the TIER4 (US) and STAGE V (EU) directives concerning generators emissions. This support consists of two parts:

- Visualization. A minimum of measurements is required:
  - Percent of soot in the Diesel Particulate Filter (DPF).
  - Percentage of ash in the Diesel Particulate Filter (DPF).
  - Diesel Emissions Fluid (DEF) level.

- Icons (shown on page E.11)

- Commands. The specification provides two separate commands, to be sent to the ECU, to influence the regeneration of the DPF:

- Inhibition of regeneration. This command should only be activated when the full power of the generator is required. Regeneration, in fact, involves temperature increases that may require a derating of engine performance. It should be a transient condition: if the level of soot in the filter increases and the ECU cannot regenerate it, at some point the ECU will still apply a derating and eventually it could stop the engine.

- Forcing of regeneration. It is the opposite command: verifying from the previous lamps the request for regeneration from the ECU, the operator can force it in the moments more favourable to him.

The controller implements these commands in two ways:

- Parameter P.0446. This parameter can take three values:

- 0 - Automatic. It does not send any commands to the ECU, which is therefore free to perform the regeneration whenever it wants.

- 1 – Forced. It sends the forcing command to the ECU for a maximum of P.0447 seconds (then the parameter is reset to 0-Automatic). If the ECU can, it carries out a regeneration cycle, which involves overheating the emission treatment system and derating the engine. Following this command, some of the lamps described above can be activated.

- 2 – Inhibited. It activates the ECU inhibition command, which therefore does not regenerate, even if required.

The parameter can be modified directly from page E.24.

- As an alternative to the parameter, it is possible to use two digital inputs configured with the following functions:

- DIF.2071: inhibits regeneration.

- DIF.2072: forces regeneration.

If there is one of the inputs, parameter P.0446 can no longer be changed, because the inputs go to force the value of the parameter.

You can also use virtual digital inputs to build complicated logics to manage the regeneration of the filter.

As a rule, the controller uses the Can bus line to send these commands to the ECU. It is also possible to use digital outputs, configured with the following functions:

- DOF.1035: regeneration inhibited.

- DOF.1036: regeneration forced.

The status of the two commands (forcing and inhibiting) is available for the AND/OR logics through the ST.137 and ST.138 states

Some ECUs, to perform the "active" regeneration of the particulate filter, must necessarily increase the engine speed. For this reason, they require consent from the controller before activating this process. The controller, as a rule, sends the consent to "active" regeneration if the GCB circuit breaker is open: however, if there is a digital input configured with the DIF.2073 function, then regeneration is allowed when this input is active.

Consequently, if the GCB is open and the ECU is performing the "active" regeneration (SPN3700 = 1), the maximum frequency / speed protections are disabled (by contact, by frequency measurement and by rpm measurement).

This page displays the fundamental states in the management of the filter regeneration and allows you to inhibit or force the regeneration of the particulate filter. In fact, it allows you to modify parameter P.0446 directly, without entering the programming menus.

The displayed statuses are:

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

The controller makes available some information concerning the regeneration on the following internal states:

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

8.5.5.13 E.25…E.29 EXHAUST GAS THREATMENT

It contains a series of standard information (J1939) acquired via CAN-BUS from the engine control unit, concerning emissions management (AFTERTREATMENT). The number of information available depends on the type of control unit to which you are connected. Information not available is not displayed. The number of pages displayed therefore depends on the actual information transmitted by the engine control unit. The information shown on this page are:

- SPN 4765 ("AFTERTREATMENT 1 DIESEL OXIDATION CATALYST INTAKE TEMPERATURE")
- SPN 4766 ("AFTERTREATMENT 1 DIESEL OXIDATION CATALYST OUTLET TEMPERATURE")
- SPN 4781 ("AFTERTREATMENT 1 DIESEL PARTICULATE FILTER SOOT MASS")

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

8.5.5.14 E.30 ADBLUE pump

The page is available only if at least one digital output is configured to manage the pump for refilling the AdBlue fluid in the daily tank. It contains the following information:

- The current management mode of the pump (MAN-OFF, MAN-ON, AUTO).
- The status of the pump (on/off).

- An indication of the AdBlue fluid level, referring to the management of the pump (start required, stop required, in hysteresis).

  If the pump management is referred to the analogue measurement of the level in the tank (SPN 1761 SAE J1939), the controller shows the current level with a graphic bar, also indicating the start/stop thresholds of the pump.

  It is possible to change the pump management mode from this page, without having to go to programming. To do this, you must:

- Press the ENTER key: the square brackets that enclose the current pomp operating mode begin to flash.
- Use the UP and DOWN buttons to select the desired mode.
- Confirm with ENTER or cancel the modification with ESC.

  See 9.7.14 for a detailed description of the functions offered by the controller for the management of this pump.

8.5.5.15 E.31…E.36

From version 1.05 the controller supports the management of external configuration files that describe the CanBus communication with the electronic engine control units. Such files may include the definition of one or more pages for the display, dedicated to displaying the measurements / states specific to that control unit (usually when they do not follow the J1939 standard). For example, if you use the files related to MAN DATALOGGER, the controller displays all the measurements acquired by those units in a single page.

The controller provides up to six pages. The title of each page is defined in the configuration file for the engine, as well as the number of measures shown and their description. **Attention:** since the descriptions are defined in the external file, they do not fit the language selected on the controller (typically they are in English).

8.5.6 History logs (H.XX)

When in operation and not in OFF/RESET mode, the controller performs periodical or on-event recordings that can be partially configured with programming parameters. The controller manages six types of archives:

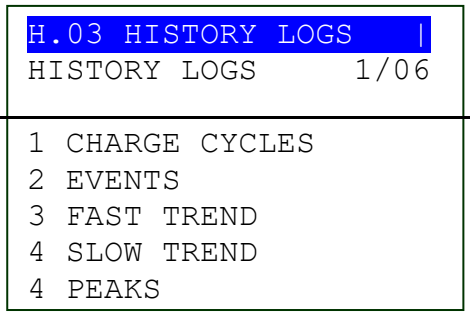
1. Charge cycles.
2. Events.
3. Fast analogues.
4. Slow analogues.
5. Maximum peaks.
6. DTC.

The history logs can be accessed in any controller working status. To access archive visualization, press the ▲ and ▼ buttons till the HISTORY LOGS (H.01) page is displayed.

When in a mode limiting the use of vertical scroll buttons, you may require pressing repeatedly the ESC/SHIFT button.

Then press ACK/ENTER to enable the mode (moving to page “H.03”). At the start of the procedure, the menu of the various archives functions is displayed.

8.5.6.1 Log selection



The second line always shows the numerical indication of the selected function and the number of functions in the menu. The following display lines are used to show the selectable functions. The selected item is highlighted in reverse (REVERSE).

Use the ▲ e ▼ buttons to cyclically scroll through the menu to the lower and upper index items (i.e., pressing the ▲ allows to directly cycle from the first item to the last one).

Press ACK/ENTER button to enable the selected function (the one highlighted in reverse); press the ESC/SHIFT button to return to page “H.01”.

8.5.6.2 Charge/discharge cycles pages

Each time the generator is connected/disconnected to the plant battery, the controller stores a record into this archive, that allows maximum 31 records. If the archive is full and a new recording is required, the less recent is overwritten (so always the last 31 records are stored).

The controller stores the following measurements:

Measure	Page
Type of cycle (charge/discharge).	All
Date/time at the beginning of the cycle.	1
Plant battery voltage (Vdc) at the beginning of the cycle.	1
Plant battery charge level (Ah) at the beginning of the cycle.	1
Date/time at the end of the cycle.	1
Plant battery voltage (Vdc) at the end of the cycle.	1

Plant battery charge level (Ah) at the end of the cycle.	1
Only for charge cycles: energy transferred to the plant battery during BULK phase (Ah).	2
Only for charge cycles: energy transferred to the plant battery during ABSORBTION phase (Ah).	2
Only for charge cycles: energy transferred to the plant battery during FLOAT phase (Ah).	2
Only for charge cycles: total energy transferred to the plant battery during the cycle (Wh).	2

The most recent record is associated to the highest number. Use the ▲ and ▼ buttons to scroll cyclically trough all recordings.

Using the ◄ and ► buttons, you can browse through the pages related to the record.

To display every record, the controller uses one/two pages of the display.

The main page has the following format:

```
H.09 HISTORY LOGS      |
1 CHARGE CYCLES  07/08

Charge cycle
08/03/17 16:27:43
  24.9 Vdc   245 Ah
08/03/17 16:56:57
  27.1 Vdc   330 Ah
```

The second line of each page shows what record is currently displayed (7) and the number of records stored (8). Once the total number of records available is reached, the second value will remain fixed at the limit value (31) up to a possible log resetting. The example in the previous figure shows record 7 of 8 stored (out of 31 available).

The fourth line of each event page displays the kind of cycle.

8.5.6.3 Events pages

When previously configured events occur, the controller adds a record in this archive. Full capacity is 126 records. If the archive is full and a new event occurs, the less recent is overwritten (so always the last 126 events are stored). For each event, the controller stores:

- A numerical code identifying it.
- The date/time of the event.
- The operating mode of the controller.
- The engine status.
- The generator status.
- The status of all circuit breakers.
- The status of the digital inputs (of the controller, of the expansion modules and virtual).
- The first four anomalies (if present).
- The plant battery voltage (Vdc).
- The plant battery current (Adc).
- The plant battery charge level (Ah).

If the event is an anomaly, measures described for the analogue archives are also stored. Configuring the events to be recorded is possible with parameter P.0441 (managed by bits):

Bit	Value	Hexadecimal	Description

0	1	0001	Board operating mode
1	2	0002	Auxiliary source status
2	4	0004	Generator status
3	8	0008	Engine status
4	16	0010	Circuit breakers status
5	32	0020	Circuit breakers commands
6	64	0040	Start/stop requests
7	128	0080	Fuel pump commands
8	256	0100	Charge procedure

Below you will find a table showing the codes of all possible events.

Code	**Ver.**	**Recording cause**
EVT.1001	01.00	Controller in OFF_RESET mode.
EVT.1002	01.00	Controller in MAN mode.
EVT.1003	01.00	Controller in AUTO mode.
EVT.1004	01.00	Controller in TEST mode.
EVT.1005	01.00	Controller in REMOTE START mode.
EVT.1010	01.00	Auxiliary source is missing.
EVT.1011	01.00	Auxiliary source is present (out of thresholds).
EVT.1012	01.00	Auxiliary source is present (in thresholds).
EVT.1013	01.00	Start inhibition activated (from digital input).
EVT.1014	01.00	Start inhibition deactivated (from digital input).
EVT.1020	01.00	Generator voltages are missing.
EVT.1021	01.00	Generator voltages are present (out of thresholds).
EVT.1022	01.00	Generator voltages are present (in thresholds).
EVT.1030	01.00	Closure command for GCB.
EVT.1031	01.00	Opening command for GCB.
EVT.1032	01.00	GCB closed.
EVT.1033	01.00	GCB opened.
EVT.1035	01.00	Closure command for ACB.
EVT.1036	01.00	Opening command for ACB.
EVT.1037	01.00	ACB closed.
EVT.1038	01.00	ACB opened.
EVT.1040	01.00	Engine stopped.
EVT.1041	01.00	Starting the engine.
EVT.1042	01.00	Engine running (rated speed).
EVT.1043	01.00	Cooling down cycle.
EVT.1044	01.00	Stopping the engine.
EVT.1045	01.00	Engine running (idle speed).
EVT.1050	01.00	Manual start command.
EVT.1051	01.00	Manual stop command.
EVT.1052	01.00	Automatic start command.
EVT.1053	01.00	Automatic stop command.
EVT.1054	01.00	Start command from digital input.
EVT.1055	01.00	Stop command from digital input.
EVT.1056	01.00	Start command from serial ports / USB / ETHERNET.

EVT.1057	01.00	Stop command from serial ports / USB / ETHERNET.
EVT.1058	01.00	Start command from real time clock.
EVT.1059	01.00	Stop command from real time clock.
EVT.1060	01.00	Start command from SMS.
EVT.1061	01.00	Stop command from SMS.
EVT.1062	01.00	Start command because loads are unsupplied.
EVT.1065	01.21	Discharge current limit feature started.
EVT.1066	01.21	Discharge current limit feature stopped.
EVT.1067	01.28	Start command from BMS.
EVT.1068	01.33	Enabling generator voltage regulation.
EVT.1069	01.33	Disabling generator voltage regulation.
EVT.1070	01.00	Fuel pump activated.
EVT.1071	01.00	Fuel pump deactivated.
EVT.1072	01.28	AdBlue pump activated.
EVT.1073	01.28	AdBlue pump deactivated.
EVT.1074	01.00	Auto reset of the controller.
EVT.1075	01.00	Real time clock not valid.
EVT.1076	01.00	Real time clock updated.
EVT.1077	01.00	New power on of the controller.
EVT.1078	01.00	Parameters are reloaded with their default values.
EVT.1080	01.00	GCB closure inhibition activated (from digital input).
EVT.1081	01.00	GCB closure inhibition deactivated.
EVT.1082	01.00	Override of the engine protections is activated.
EVT.1083	01.00	Override of the engine protections is deactivated.
EVT.1086	01.00	Daylight Save Time on.
EVT.1087	01.00	Standard time on.
EVT.1202	01.00	GCB closure inhibition activated (from serial ports / USB / ETHERNET).
EVT.1203	01.00	GCB closure inhibition activated (because GCB is tripped).
EVT.1204	01.00	GCB closure inhibition activated (because plant battery is disconnected).
EVT.1205	01.00	GCB closure inhibition activated (because voltage on bus bars is out of tolerance).
EVT.1221	01.00	Start inhibition activated (from clock/calendar).
EVT.1222	01.00	Start inhibition deactivated (from clock/calendar).
EVT.1223	01.28	Start inhibition activated (from BMS).
EVT.1224	01.28	Start inhibition deactivated (from BMS).
EVT.1430	01.00	Closure command for BCB.
EVT.1431	01.00	Opening command for BCB.
EVT.1432	01.00	BCB closed.
EVT.1433	01.00	BCB opened.
EVT.1435	01.00	Closure command for LCB.
EVT.1436	01.00	Opening command for LCB.
EVT.1437	01.00	LCB closed.
EVT.1438	01.00	LCB opened.

EVT.1500	01.00	Charge status: idle.
EVT.1501	01.00	Charge status: voltage matching.
EVT.1502	01.00	Charge status: BULK.
EVT.1503	01.00	Charge status: ABSORBTION.
EVT.1504	01.00	Charge status: FLOAT.
EVT.1505	01.00	Charge status: FLOAT ended.
EVT.1506	01.00	Charge status: cooling down in progress
EVT.1511	01.00	Charge started for minimum voltage.
EVT.1512	01.00	Charge stopped because the final charge voltage has been reached.
EVT.1513	01.00	Charge started for minimum charge level.
EVT.1514	01.00	Charge stopped because the required charge level has been reached.
EVT.1515	01.05	Engine started for discharged cranking battery.
EVT.1516	01.05	Engine stopped for recharged cranking battery.
EVT.1521	01.01	A standard charge cycle has been started.
EVT.1522	01.21	A full charge cycle has been started.
EVT.1523	01.21	The forcing of the external setpoint for the generator current is activated
EVT.1524	01.21	The forcing of the external setpoint for the generator current is deactivated
EVT.1531	01.21	The limitation of the generator current is activated
EVT.1532	01.21	The limitation of the generator current is deactivated

Any anomaly is also stored in this archive. Each anomaly is stored with its own numeric code added to:

- 2000 for the warnings.
- 3000 for the latched warnings.
- 4000 for the deactivations.
- 5000 for the alarms (blocks).

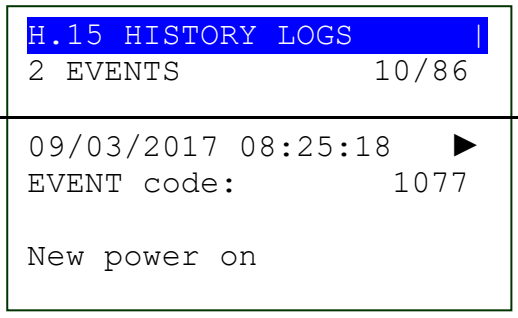
For example, when simulating an emergency stop, the archive window will display: **0048: A048 Emergency stop**. The same event, read by the communication ports, will result as **5048**, where the first digit defines the type (5 = alarm (block)), followed by the anomaly code (048 = Emergency Stop).

The most recent event is associated to the highest number. Use the ▲ and ▼ buttons to scroll cyclically trough all recordings.

Using the ◄ and ► buttons, you can browse through the pages related to the event.

To display every event, the controller uses at least four pages of the display: if the event displayed is one of the 21 most recent anomalies, it uses nine pages.

The main page has the following format:



The second line of each event page shows what event is currently displayed (10) and the number of events stored (86). Once the total number of events available is reached, the second value will remain fixed at the limit value (126) up to a possible log resetting. The example in the previous figure shows event 10 of 86 stored (out of 126 available).

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

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

The first page shows:

- The numerical code of the event (1077 in the given example).
- The clear description of the even (“New power on” in the given example).

The second page shows:

- The operating mode of the controller.
- The status of the engine.
- The status of the generator.

The third page shows the statuses of all available circuit breakers.

The fourth page shows:

- The plant battery voltage (Vdc).
- The plant battery current (Adc).
- The plant battery charge level (Ah).

For the description of pages five to nine, see the description of the analogue history logs.

8.5.6.4 Pages for trends

The controller performs two sets of periodical recordings, configurable with parameters P.0442 (seconds) and P.0443 (minutes). The two sets are described in the following chapters. The recorded measurements, and the way to show them, are common, so they are described in the following.

The controller stores the following measurements:

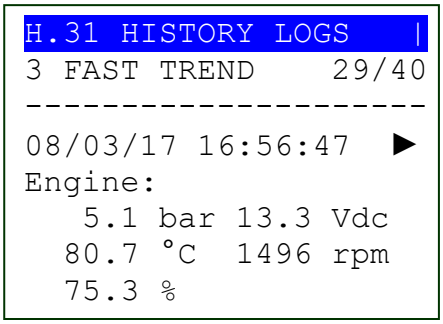
Measure	Page for trend logs	Page for events log
Date/time.	All	All
Engine battery voltage.	1	5
Engine oil pressure.	1	5
Engine coolant temperature.	1	5
Engine fuel level.	1	5
Engine speed.	1	5
Generator voltage (DC).	2	6
Generator current (DC).	2	6
Generator power.	2	6
Plant battery voltage (DC).	3	7
Plant battery current (DC).	3	7
Plant battery power.	3	7
Plant battery temperature.	3	7
Plant battery charge level.	3	7
Loads voltage (DC).	4	8
Loads current (DC).	4	8
Loads power.	4	8

Auxiliary source voltage (DC).	5	9
Auxiliary source current (DC).	5	9
Auxiliary source power.	5	9

Each record is associated with its date/time. The measures not acquired (because the controller was not set to acquire them) are replaced by dashes.

The more recent record is associated to the highest number. Use the ▲ and ▼ buttons to scroll cyclically trough all recordings. Using the ◄ and ► buttons, you can browse through the pages related to the recordings.

To display all records, the controller uses five pages of the display. The main page has the following format:



The second line of each page shows what record is currently displayed (29) and the number of records stored (40). Once the total number of records available is reached, the second value will remain fixed at the limit value (42 for the fast recordings, 64 for the slow recordings) up to a possible log resetting. The example in the previous figure shows record 29 of 40 stored (out of 42 available).

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

8.5.6.5 Fast analogues logs

The fast analogues are recorded at a pace configurable by means of the parameter P.0442 (interval in seconds) and the default interval is 60 seconds. This archive provides a total storage capability of 42 records. Every following record overwrites the older one. The controller records the analogue values described in par. 8.5.6.4.

8.5.6.6 Slow analogues logs

The slow analogues are recorded at a pace configurable by means of the parameter P.0443 (interval in minutes) and the default interval is 30 minutes. This archive provides a total storage capability of 64 records. Every following record overwrites the older one. The controller records the analogue values described in par. 8.5.6.4.

8.5.6.7 Pages for peaks

The controller performs a series of recordings of maximum peaks for some significant measures:

- Total active power: the maximum peak is recorded, having the date/time and the measure of the engine coolant temperature (if available) associated.
- Coolant temperature: the maximum peak is being recorded, with date/time associated.

To display all records, the controller uses one page of the display. Use the ▲ and ▼ buttons to scroll cyclically trough all recordings.

```
H.33 HISTORY LOGS   |
5 PEAKS             1/02
----------------------
Maximum power

17/03/2014 10:35:54
345.4 kW
(   88 °C)
```

The second line shows the record currently displayed, out of the total number of records (the total number of records is 2).

The fourth line shows a description of the peak recording currently displayed:

- Maximum power
- Maximum coolant temperature

The sixth line shows the recording date and time. The seventh line displays the recorded measure (power, temperature etc.) A second measure recorded together with the main measure can be displayed on the eighth line:

- The power is recorded together with the coolant temperature.

If certain data are not available at the time of recording, dashes will be displayed.

8.5.6.8 Diagnostics pages for external devices connected by Canbus (DTC)

The controller records the diagnostic codes that the engine control unit (ECU Interface), the voltage regulator (AVR) and the Battery Management System (BMS) send on the CAN-BUS line.

Basically, depending on the connected external device, the diagnostic message consists of the DTC, SPN and fault description. This archive have can store up to 16 records. Every following record overwrites the older one.

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

```
H.33 HISTORY LOGS   |
5 DTC             16/16
----------------------
17/03/2014 14:27:12
VOLVO EMS 2(0)
DTC:6.6 SPN:100 1 1
Engine oil pressure
Data low (shutdown)
```

The second line shows the record currently displayed, out of the total number of records (the maximum number of records is 16).

The fourth line shows the recording date and time.

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

The sixth line shows the diagnostic code. It contains:

- DTC (Diagnostic Trouble Code): it is a non-standard diagnostic code, specific to the connected external device, which can be found in the technical manual of the external device (in the example, the code "6.6" in the engine technical manual will describe the low oil pressure problem).

- SPN (Suspect Parameter Number): is a numeric code showing the engine part/component that generated the diagnostic code (in the example, “100” identifies oil pressure measure).
- FMI (Fault Mode Identifier): is a numeric code between 0 and 31 that identifies the kind of problem (in the example, “1” indicates an excessively low value of the measure, thus requiring engine stop).
- OC (Occurrence Count): indicates how many times this diagnostic code has already been activated (example “2”).

In addition, if the combination of the SPN and FMI codes (or the DTC code) is known to the controller, a text description of the problem is displayed.

The seventh and eighth line show a text description of the problem, if available.

The more recent record is associated to the highest number. Use the ▲ and ▼ buttons to scroll cyclically trough all recordings.

These diagnostic codes can be reset to zero using a command of the serial port. To send the command you need to write in sequence (within 5 seconds):

- HOLDING REGISTER 101: enter the password configured with the parameter P.0004.
- HOLDING REGISTER 102: enter the value “61”.

8.5.6.9 Reset of the archives

To reset an archive, first you must show it on the display. Then you must keep pressed the buttons ESC/SHIFT + ACK/ENTER for at least 5 seconds, until a message informs you of the successful reset.

8.5.6.10 Locked recordings

Analogue and events recordings are temporarily disabled when the operating mode is “OFF/RESET”.

When the records are locked, a lock appears on the second line, after the text “HISTORY LOGS”, in all the windows of the history log.

In this situation, the controller's internal counters keep decreasing the time left to the expiry of the next recording. When the operation mode shifts from “OFF/RESET” to “MAN” or “AUTO” mode, a check is performed to verify whether some recording counter expired. If so, the recorded date and time of the status change are stored, otherwise the count continues till the next recording is stored.

8.5.6.11 Exit from archives visualization

There are two ways to exit from archive visualization:

- Press the ESC/SHIFT button “n” times to scroll back to page H.01
- Change the operating mode of the controller.

In both cases, page H.01 will display; you may move to other display modes using the ▲ and ▼ buttons.

8.6 Selecting the language

HS315 allows you to select the language to be used for all the text messages shown on the multifunctional display. Currently, two languages are supported: Italian and English (the default one is English).

From page S.03 you can choose the language desired.

9 Working sequence

9.1 Operating modes

Note: the following description assumes that HS315 can open/close the GCB circuit breaker. This is optional: depending on the plants, HS315 can have both opening/closing commands, only the opening command, or none. If HS315 has both commands, then the following description applies. **Instead, if HS315 has the opening command only, it will open GCB only when required by a protection; in normal situations HS315 will not open GCB because it will not be able to close it again.**

HS315 provides for three main working modes:

- **OFF/RESET**: HS315 controls the opening of GCB circuit breaker and stops the engine. Where provided, it also controls the closing of the other circuit breakers. The anomalies are all cancelled, and you can access the programming to modify the parameters.
- **MAN:** the starting and stopping of the generator will be executed by the operator. GCB circuit breaker (and, where applicable, all other circuit breakers) opening/closing as well will be executed by the operator: HS315 always allows the opening of the circuit breakers; it allows closing GCB only if the engine is started and if generator voltages and frequency are within tolerance. Protections are active: HS315 is therefore always able to open the circuit breakers and stop the engine. Accessing programming is allowed, though only some parameters can be modified.
- **AUTO:** the starting and stopping of the generator and the management of the circuit breakers are executed by the controller (the operator cannot intervene). All protections are enabled. Accessing programming is allowed, though only some parameters can be modified.

  Using the parameter P.0498 (menu 4.7.5), it is possible to select the operating mode to be used when switching on the controller. When turned on, the controller remains in OFF/RESET mode for about 1 second, then goes to the mode selected by P.0498: if during this second the "MODE ▲" button is held down, the controller will remain in OFF/RESET mode, regardless of P.0498.

  The operating mode can be selected in three different ways:

- Using the “MODE ▲” and “MODE ▼” buttons of the controller. The buttons must be pressed consecutively and held for at least half a second to force mode change. The buttons are disabled (on the first line of the display a key-shaped icon appears) if at least one of the inputs described below exists and is active.
- Using one or several digital inputs configured with the following functions:
  - DIF.2271 - “Remote OF”.
  - DIF.2272 - “Remote MAN”.
  - DIF.2273 - “Remote AUTO”.

  When one of these inputs is active, the mode of the controller is forced, and the buttons and even the controls from the communication ports cannot be used.

  When none of these inputs is active, it is again possible to use the buttons or the controls from the communication ports to change the operation mode.

  If there are multiple active inputs at the same time, priority is given to the input that forces the OFF / RESET mode, followed by the one that forces MAN mode and finally the one that forces AUTO mode.

  You needn't use all three inputs. For example, it is possible to use only one input to force the status of AUTO: when the input is active, the board is always in AUTO, when the input deactivates, the board returns to the mode selected with the key selector.

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

- Using the commands from the communication ports. To use these controls, no input configured with the functions described in the previous paragraph should be active. These controls can be enabled by a digital input configured with DIF.2706 function - " Enables the commands by the serial ports": if this input exists, it should be active. To change the working mode, it is necessary to write (within 5 seconds) the following Modbus registers in sequence:

  - HOLDING REGISTER 101: enter the password configured with the parameter P.0004.
  - HOLDING REGISTER 102: "1" to force OFF/RESET, "2" to force MAN, "3" to force AUTO.

When the main working mode of HS315 is AUTO, it is possible to activate two additional modes (remember that the board is still in AUTO, then what said above is valid):

- **TEST:** this operation mode differs from AUTO in the fact that the engine is anyway started (automatically), although the conditions of the system require or not the automatic intervention of the generator (the "inhibitions to automatic intervention" are ignored in this mode). With P.0222 parameter ("Enable generator supply on TEST?") it is possible to indicate to the controller if it should automatically close GCB as a result the starting of the engine (if the conditions of the system allow the closure of the circuit breaker): the controller will start the battery charging process. When the TEST mode is disabled, the controller returns to AUTO and, if the automatic intervention of the generator is no longer required, the board opens GCB and stops the engine. Accessing programming is allowed, though only some parameters can be modified.

  To switch to TEST mode, the controller should be in AUTO, there should be no shutdowns and deactivations, there should be no REMOTE START requests (see below) and there should be no requests for automatic intervention (see engine sequence description).

  Note: the request for the switching to TEST is lost if the automatic intervention of the generator is required (for example, if plant battery charge is required): when the automatic intervention is no longer required, the board will not return to TEST. The request of the TEST mode from digital input is an exception: when the automatic intervention is no longer required, if the input is still active, the board will return to TEST.

  You can shift to TEST mode as follows:

  - By simultaneously pressing the START button on the controller panel. The shift to TEST mode is immediate. Press again these same buttons to return to AUTO mode. If the test duration (P.0420) is configured (the value must be different from zero), this stops automatically stops after the indicated time.
  - By using a digital input configured with DIF.2031 function ("Request for TEST mode e"): the controller switches into TEST when this input is activated and returns to AUTO when it is deactivated.
  - By using a digital input configured with the function DIF.2029 (“TEST without load (pulse)”). The controller evaluates the input activation moment (impulse): the controller switches to TEST when it activates this input and goes back to AUTO at the end of the time configured in P.0420 (if P.0420 is set to zero, the test is not carried out). If there is second activation of the input during the test, the test is immediately stopped. During this test, the controller doesn’t close the GCB circuit breaker, independently from the value configured in P.0222.
  - By using a digital input configured with the function DIF.2030 (“TEST with load (pulse)”). The controller evaluates the input activation moment (impulse): the controller switches to TEST when it activates this input and goes back to AUTO at the end of the time configured in P.0420 (if P.0420 is set to zero, the test is not carried out). If there is second activation of the input during the test, the test is immediately stopped. During this test, the controller closes the GCB circuit breaker, independently from the value configured in P.0222.
  - By properly configuring the parameters:

    - P.0418 (“Test enable days”).

- P.0419 (“Test start time”).
- P.0420 (“Test duration”).

They allow selecting the days of the week and a time slot within which the working mode switches from AUTO to TEST. The controller returns to AUTO when the TEST time interval ends.

- By means of a proper command via SMS (refer to document [3]). For this feature to be used, the parameter P.0420 “Test starting duration” shall not be set to zero. In this case, the controller shifts from TEST after receiving the SMS and returns to AUTO after the time P.0420.
- Through a control from the communication ports, using the Modbus registers HOLDING REGISTER 101 and 102. These two registers should be written within 5 seconds one from the other (otherwise the control will not work). These controls can be enabled by a digital input configured with DIF.2706 function - " Enables the commands by the serial ports": if this input exists, it should be active.
- Write the password configured with P.0004 parameter in the register 101.
- Write the following values in the register 102:
- "12" to switch to TEST (without GCB closure).
- "14" to switch to TEST (with GCB closure).
- "21" to return to AUTO.

The TEST control from the communication ports is cancelled if the controller considers the communication interrupted (60 seconds without a message).

- **REMOTE START:** this operation mode differs from AUTO in the fact that the engine is anyway started (automatically), although the conditions of the system require or not the automatic intervention of the generator (the "inhibitions to automatic intervention" are ignored in this mode). If there are no requests for "inhibition to GCB closure", HS315 will automatically close GCB circuit breaker: the controller will start the battery charging process. The operator cannot manually control the circuit breakers. When the REMOTE START mode is disabled, the board returns to AUTO and, if the automatic intervention of the generator is no longer required, the board opens GCB and stops the engine. Accessing programming is allowed, though only some parameters can be modified.

To switch to REMOTE START mode, the board should be in AUTO or TEST and there should be no shutdown and, deactivations. Moreover, it is possible to configure an input with DIF.2701 function ("Enables remote start requests "): if the input exists, it should be active.

You can shift to REMOTE START mode as follows:

- By means of the digital input configured with the feature DIF.2032 (“Request for REMOTE START mode”). In this case, it is necessary pay attention to the delay that is configured for the selected input: the board switches to REMOTE START when the input is active since the configured time, it comes back to MAN as soon as the input is deactivated.
- By properly configuring the parameters:
- P.0426 (“Days for remote start”).
- P.0427 (“Start time for remote start”).
- P.0428 (“Stop time for remote start”).

These parameters allow selecting the days of the week and a time slot within which the working mode switches from AUTO to REMOTE START. The controller returns to AUTO when interval ends.

- By means of a proper command via SMS (refer to document [3]). In this case, the controller shifts to REMOTE START as soon as it receives the SMS and returns to AUTO when it receives the opposite command.

- Through a control from the serial ports, using the Modbus HOLDING REGISTER 101 and 102. These two registers should be written within 5 seconds one from the other (otherwise the control will not work). These controls can be enabled by a digital input configured with DIF.2706 function - " Enables the commands by the serial ports ": if this input exists, it should be active.

- Write the password configured with P.0004 parameter in the register 101.
- Write the value "13" in the register 102 to switch to REMOTE START, the value "21" to return to AUTO.

9.1.1 Events and signalling

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

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

The following functions for the configuration of the digital outputs are related to the operation mode of the board:

- DOF.3001: the output is activated if the board is in OFF/RESET.
- DOF.3002: the output is activated if the board is in MAN.
- DOF.3003: the output is activated if the board is in AUTO.
- DOF.3004: the output is activated if the board is in TEST.
- DOF.3005: the output is activated if the board is in REMOTE START.
- DOF.3011: the output is activated if the board is not in OFF/RESET.
- DOF.3012: the output is activated if the board is in AUTO, TEST or REMOTE START.
- DOF.0103 (Logics AND/OR)

- ST.000: the output is activated if the board is in OFF/RESET.
- ST.001: the output is activated if the board is in MAN.
- ST.002: the output is activated if the board is in AUTO.
- ST.003: the output is activated if the board is in TEST.
- ST.004: the output is activated if the board is in REMOTE START.

9.2 Auxiliary source

The connection of the auxiliary source to the controller is not mandatory. The controller manages the auxiliary source only if at least one DC or AC voltage or its current are acquired.

It is possible to connect AC voltages (single-phase or three-phases) and/or DC voltage. If both DC and AC voltages are connected, DC voltage has higher priority; when it cannot be used (see in the following), the controller will use AC voltages.

The current is always measured as DC.

The connection point of the voltages (both AC and DC) must be “before” the ACB circuit breaker (if present).

The controller acquires the voltages and the current of the auxiliary source for:

- Showing them on the display.
- To protect the plant battery and the loads from high/low voltages on the auxiliary source.
- Eventually to calculate the current on the loads (if not directly measured).
- To detect the condition where the loads are not supplied by the plant battery nor by the auxiliary source. It is possible to configure HS315 to start the genset when the loads are not supplied and LCB is closed (parameter P.9635). This is not the default setting.

9.2.1 AC auxiliary source

The auxiliary source must be connected to the JH connector. On a three-phase system, ensure to connect the three phases (and optionally the neutral); on a single-phase system, ensure to connect the L phase on connector 3 and the neutral on 4.

See paragraph 5.11 for the connections and for the configuration of the JH terminals.

There are various parameters that influence its management:

- P.0105: nominal frequency. It is used for both generator and auxiliary source. All thresholds associated to the frequency are expressed as a percentage of this parameter.
- P.0116: nominal voltage (AC) of the auxiliary source. Phase-to-phase nominal voltage shall be set for three-phases systems; single-phase, for single phase systems. Thresholds are expressed as a percentage of it. If set to zero, auxiliary source voltage is considered still not present, even if physically connected (it is anyway measured and displayed).
- P.0117: primary value (in Volt) of the voltage transformers connected to connector JH.
- P.0118: secondary value (in Volt) of the voltage transformers connected to connector JH.
- P.0201: hysteresis applied to all the thresholds related to auxiliary source voltage and frequency. It is a percentage value related to P.0116 and to P.0105.
- P.0203: auxiliary source low voltage threshold (percentage related to P.0116) (below which the auxiliary source is considered anomalous).
- P.0204: auxiliary source high voltage threshold (percentage related to P.0116) (above which the auxiliary source is considered anomalous).
- P.0236: auxiliary source low frequency threshold (percentage of P.0105); below this value, auxiliary source is considered anomalous and the engine is started.
- P.0237: auxiliary source high frequency threshold (percentage of P.0105); over this value, auxiliary source is considered anomalous and the engine is started.

To assess the auxiliary source status, the controller can perform two different checks that can be individually disabled. These checks are individually described (with examples) below: please, remember that disabling both checks is not possible (in this case, auxiliary source is always considered not present).

9.2.1.1 Frequency check

To disable this check, one of the following conditions shall be true:

- P.0236 = 0 %.
- P.0237 = 200 %.
- P.0236 >= P.0237

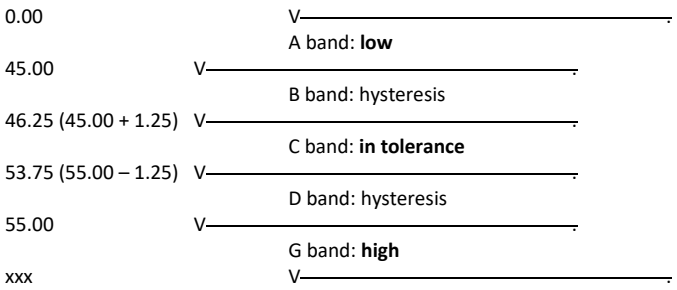
Here follows an example about the various threshold used, including default values for a.m. parameters.

Parameter	Description	Default value	Frequency in Hz
P.0105	Nominal frequency	50 Hz	50.00
P.0236	Auxiliary source low frequency threshold.	90.0 %	45.00
P.0237	Auxiliary source high frequency threshold.	110.0 %	55.00
P.0201	Hysteresis for auxiliary source measures	2.5 %	1.25

The hysteresis on the various thresholds is calculated as half the difference between P.0237 and P.0236. However, it is limited by the maximum value set with parameter P.0201. The hysteresis applies to:

- Upwards, to the minimum frequency threshold (i.e., between 45.00 and 46.25 Hz).
- Downwards to the maximum frequency threshold (i.e., between 53.75 Hz and 55.00 Hz).

These values define the following bands:



If the frequency is within the bands “B” or “D”, previous status is maintained (hysteresis). For example, in case the voltage was within the “C” band and is now within the “D” band, it is anyway considered “In tolerance”. On the other hand, in case the frequency was within the “C” band, and now is within “D” band, it is considered “Low”.

9.2.1.2 Voltage’s check

Note: the controller can acquire max 74.5 Vac between JH terminals and GND. Thus, it is mandatory to use voltage transformers to measure 230/400 Vac standard voltages.

To disable this check, one of the following conditions shall be true:

- P.0203 = 0 %.
- P.0204 = 200 %.
- P.0203 >= P.0204

Here follows an example about the various threshold used, including default values for a.m. parameters.

Parameter	Description	Default value	Voltage in Volts
P.0116	Nominal voltage (AC) of the auxiliary source.	400 V	400
-	Auxiliary source presence threshold	20.0 %	80
P.0203	Auxiliary source low voltage threshold.	80.0 %	320
P.0204	Auxiliary source high voltage threshold.	110.0 %	440
P.0201	Hysteresis for auxiliary source measures.	2.5 %	10

The hysteresis on the various thresholds is calculated as half the difference between P.0204 and P.0203. However, it is limited by the maximum value set with parameter P.0201. The hysteresis applies to:

- Downwards, to auxiliary source availability threshold (i.e., between 70 V and 80 V).
- Upwards, to the minimum voltage threshold (i.e., between 320 V and 330 V).
- Downwards to the maximum voltage threshold (i.e., between 430 V and 440 V).

These values define the following bands:

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

If the voltage is in the “B”, “D” or “F” bands, previous status is maintained (hysteresis). For example, if the voltage was in the “E” band and now it is in “D” band, it is considered however “In tolerance”. On the contrary, if voltage was in the “C” band and now is in “D” band, it is considered “Low”.

In single-phase systems, these tests are executed on phase-to-neutral voltage.

In Three-phases systems, these tests are executed on all phase-to-phase voltages. If the neutral is connected to the terminal JH-4 (P.9618 = “018”), these tests are executed on the three phase-to-neutral voltages too.

9.2.2 DC auxiliary source

The DC voltage of the auxiliary source can be connected to terminals JH, JG or JQ (see 5.13).

To detect the status, normally the controller cannot use the DC voltage of the auxiliary source if it is connected to other active sources, like the generator or the plant battery. In this case, in fact, the measured voltage is an “average” of those connected. It is possible to by-pass the problem in three ways:

- Using an external sensor connected to a digital input of the controller (see the following chapters).

- Connecting also the AC voltages.

If no one of the previous methods can be used, if the controller acquires the DC voltage, it is used (even if it could not be the real voltage of the auxiliary source).

There are various parameters that influence its management:

- P.9641: Nominal voltage (DC). It is used also for the generator, for the plant battery and for the loads.
- P.0201: hysteresis applied to all the thresholds related to auxiliary source voltage. It is a percentage value related to P.9641.
- P.0203: auxiliary source low voltage threshold (percentage related to P.0116) (below which the auxiliary source is considered anomalous).
- P.0204: auxiliary source high voltage threshold (percentage related to P.0116) (above which the auxiliary source is considered anomalous).

To disable this check, one of the following conditions shall be true:

- P.0203 = 0 %.
- P.0204 = 200 %.
- P.0203 >= P.0204

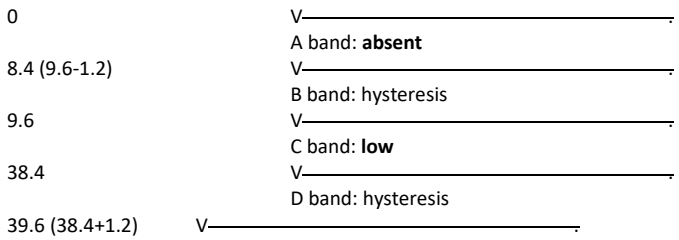
Here follows an example about the various threshold used, including default values for a.m. parameters.

Parameter	Description	Default value	Voltage (Vdc)
P.9641	Nominal voltage (DC).	48 Vdc	48
-	Auxiliary source presence threshold	20.0 %	9.6
P.0203	Auxiliary source low voltage threshold.	80.0 %	38.4
P.0204	Auxiliary source high voltage threshold.	110.0 %	52.8
P.0201	Hysteresis for auxiliary source measures.	2.5 %	1.2

The hysteresis on the various thresholds is calculated as half the difference between P.0204 and P.0203. However, it is limited by the maximum value set with parameter P.0201. The hysteresis applies to:

- Downwards, to auxiliary source availability threshold (i.e., between 8.4 Vdc and 9.6 Vdc).
- Upwards, to the minimum voltage threshold (i.e., between 38.4 Vdc and 39.6 Vdc).
- Downwards to the maximum voltage threshold (i.e., between 51.6 Vdc and 52.8 Vdc).

These values define the following bands:



E band: **in tolerance**

51.6 (52.8-1.2) V

F band: hysteresis

52.8 V

G band: **high**

xxx V

If the voltage is in the “B”, “D” or “F” bands, previous status is maintained (hysteresis). For example, if the voltage was in the “E” band and now it is in “D” band, it is considered however “In tolerance”. On the contrary, if voltage was in the “C” band and now is in “D” band, it is considered “Low”.

9.2.3 Auxiliary source status (from internal sensor)

To diagnose the auxiliary source “global” status, the following algorithms are used, shown in their computing order:

- In case the status of all existing voltages (AC and/or DC) **and** the frequency (if available) are “Absent”, also the global status is “Absent”.
- In case the status of all existing voltages (AC and/or DC) **and** the frequency (if available) is “In tolerance”, also the global status is “In tolerance”.
- In case the status of at least one voltage (AC or DC) **or** the frequency (if available) is “High”, also the global status is “High”.
- In case none of the previous conditions occurs, global status is “Low”.

9.2.4 External contact

The status of the auxiliary source can also be detected by a digital input configured with the function DIF.3101 (“External sensor for auxiliary source”). If the input is logically active, the auxiliary source is “In tolerance”. If the input is logically not active, the status is “Absent”.

If the digital input is active, the auxiliary source is considered “In tolerance”, even if the measure of voltages (AC/DC) is enabled and if said measure indicates that the auxiliary source is out of tolerance.

9.2.5 Auxiliary source global status

For general management purposes, auxiliary source can be described in three steps:

a) Steady out of tolerance: the voltages status (AC/DC) **and/or** the frequency status (if available) must be continuously other than “In tolerance” for P.0206 seconds. The “AUX DC SOURCE” lamp is off if voltages and frequency are in “Absent” status, otherwise it blinks.

b) Steady within tolerance: the voltages status (AC/DC) **and** the frequency status must be “within tolerance” for at least P.0205 seconds (immediately in MAN). The “AUX DC SOURCE” lamp is steady on.

c) Transient: shifting from status “a” to status “b” or vice versa. The “AUX DC SOURCE” lamp blinks.

9.2.6 Events and signalling

The controller records any change of the auxiliary source status in the events log, if it is enabled with bit 1 of the P.0441 parameter:

- EVT.1010: auxiliary source is missing.
- EVT.1011: auxiliary source is present (out of thresholds).
- EVT.1012: auxiliary source is present (in thresholds).

The following feature is also available for the configuration of the digital outputs, related to the auxiliary source status:

- DOF.3033 - “Auxiliary source in tolerance”. The controller activates this output when the voltages (AC/DC) and the frequency (if available) are in tolerance from the time configured.

In addition, the controller makes available the auxiliary source statuses for the AND/OR logics by means of the following internal statuses:

- ST.016 – “Auxiliary source present (voltages/frequency)”.
- ST.017 – “Auxiliary source absent or out of thresholds”.
- ST.018 – “Delay for auxiliary source in thresholds”.
- ST.019 – “Auxiliary source in thresholds”.
- ST.020 – “Delay for Auxiliary source absent or out of thresholds”.

The following functions, for the configuration of analogue outputs, are linked to the auxiliary source management. The outputs are managed based on an auxiliary source analogue value. Use the "conversion curves" to adapt the single value to the output (0-100%):

- AOF.3201 (“Frequency of the auxiliary source”).
- AOF.3211 (“Voltage of the auxiliary source (AC)”).
- AOF.3213 (“Voltage of the auxiliary source (DC)”).
- AOF.3221 (“Power of the auxiliary source”).
- AOF.3231 (“Current of the auxiliary source (DC)”).

9.2.7 Protections

HS315 implements 4 different protections for the auxiliary source current:

- One warning for high current (W232, parameters P.9731, P.9732 and P.9733).
- One latched warning for maximum current (short circuit) (K234, parameters P.9731, P.9734 and P.9735).
- One latched warning for time dependent maximum current (K233, parameters P.9736 and P.9737).
- One latched warning for current reverse (K235, parameters P.9731, P.9738 and P.9739).

The latched warnings (K234, K233 and K235) force the opening of the ACB circuit breaker (if present).

No voltage protections are provided for the auxiliary source. In fact:

- If the controller is able to detect the status of the auxiliary source (it has AC measures, has separation diodes for DC voltage, has an external status contact, or it is not connected to other active sources – generator and plant battery), when the status is not “In tolerance” the controller opens the ACB circuit breaker (**but only if it could be closed again, I mean if the controller has the closure command**).
- Otherwise, the trip of the voltage protections on the loads opens the ACB circuit breaker (the minimum voltage protection only if the controller is not in MAN mode). **Note: the voltage protections on the loads work on the common bus voltage if the LCB circuit breaker is opened**. Once ACB is opened, the controller can detect the status of the auxiliary source:
  - If it is “In tolerance”, the controller can re-close ACB (unless the common bus voltage is still out of thresholds).
  - If it is not “In tolerance”, the controller does not close the ACB.

9.3 Generator

It is possible to connect AC voltages (single-phase or three-phases) and/or DC voltage. If both DC and AC voltages are connected, DC voltage has higher priority; when it cannot be used (see in the following), the controller will use AC voltages.

The current is always measured as DC.

The connection point of the voltages (both AC and DC) must be “before” the GCB circuit breaker (if present).

The controller acquires the voltages and the current of the generator for:

- Showing them on the display.
- To protect the plant battery and the loads from high/low voltages on the generator.
- To protect the generator itself from voltages/current out of thresholds.
- Eventually to calculate the current on the loads (if not directly measured).
- To match the voltage of the generator to the common bar voltage before closing the GCB (voltage matching).
- To regulate the generator current to zero during the cooling down cycle when GCB cannot / must not be opened.

9.3.1 AC generator

The generator must be connected to the JG connector. On a three-phase system, ensure to connect the three phases (and optionally the neutral); on a single-phase system, ensure to connect the L phase on terminal 3 and the neutral on terminal 4.

See paragraph 0 for the connections and for the configuration of the JG terminals.

9.3.1.1 Frequency check

Several parameters are related to frequency measure:

- P.0105: nominal frequency. It is used for both generator and auxiliary source. All frequency measure related thresholds are expressed as percentage of it.
- P.0228: threshold (percentage of P.0105) under which the engine is considered stopped.
- P.0229: threshold (percentage of P.0105) above which the generator is considered started.
- P.0305: low voltage threshold (percentage related to P.0105) below this value the generator cannot be connected to the loads.
- P.0307: high frequency threshold (percentage related to P.0105) above this value the generator cannot be connected to the loads.
- P.0395: low frequency threshold (percentage of P.0105) (under this threshold, the controller activates a warning).
- P.0397: high frequency threshold (percentage of P.0105) (over this threshold, the controller activates a warning).
- P.0331: maximum frequency threshold (percentage of P.0105); over this threshold, the engine must be stopped due to risk of damage to both the engine and the alternator.

Here follows an example about the various threshold used, including default values for a.m. parameters.

Parameter	Description	Default value	Frequency in Hz
P.0105	Nominal frequency.	50 Hz	50

P.0228	Threshold for engine stopped (Hz).	10.0 %	5
P.0229	Threshold for engine started (Hz).	20.0 %	10
P.0305	Minimum frequency threshold.	90.0 %	45
P.0307	Maximum frequency threshold.	110.0 %	55
P.0331	Maximum speed threshold (frequency).	120.0 %	60

0 Hz
A band: **absent**
5 Hz
B band: **hysteresis**
10 Hz
C band: **minimum**
45 Hz
D band: **low**
46 Hz
E band: **in tolerance**
54 Hz
F band: **high**
55 Hz
G band: **Maximum**
60 Hz
Band H: **Over speed**
xxx Hz

The only managed hysteresis band is the one used to diagnose the stopped or running engine status. The generator detects no difference between the “G” and “H” bands; they are separated only to implement an engine over speed protection in case its speed cannot be detected in other ways (pick-up, “W” signal, CAN-BUS, etc.).

Thresholds P.0305, P.0307 and P.0331 are used also to manage the generator protections on frequency. These protections can be individually disabled setting to zero the relevant parameter that specifies the delay (respectively P.0306, P.0308 and P.0332). Even if the protections are disabled, thresholds are however used to define the frequency status: this allows not to close the GCB circuit breaker if the electrical magnitudes are out of the tolerance band.

Thresholds P.0395 and P.0397 are used for protections only; they are not used for detecting the status of the generator.

9.3.1.2 Voltage’s check

Many parameters influence generator voltage measures:

- P.0102: nominal voltage (AC) of the generator. Phase-to-phase rated voltage shall be set for three-phases systems; single-phase, for single phase systems. Thresholds are expressed as a percentage of it.
- P.0103: rated voltage (in Volt) for the primary of the voltage transformers connected to connector JG.
- P.0104: rated voltage (in Volt) for the secondary of the voltage transformers connected to connector JG.
- P.0202: hysteresis applied to all the thresholds related to generator voltage. It is a percentage value of P.0102.
- P.0226: threshold (percentage of P.0102) under which the engine is considered stopped.
- P.0227: threshold (percentage of P.0102) over which the engine is considered started.
- P.0301: low generator voltage threshold (percentage of P.0102); under this value the generator cannot be connected to the loads.
- P.0303: high generator voltage threshold (percentage of P.0102); over this value the generator cannot be connected to the loads.

Here follows an example about the various threshold used, including default values for a.m. parameters.

Parameter	Description	Default value	Voltage in Volts
P.0102	Nominal voltage (AC) of the generator.	400 V	400
P.0226	Threshold for engine stopped (Vac).	17.5 %	70
P.0227	Threshold for engine started (Vac).	20.0 %	80
P.0301	Minimum voltage threshold.	75.0 %	300
P.0303	Maximum voltage threshold.	112.5 %	450
P.0202	Hysteresis for generator's measures.	2.5 %	10

The hysteresis fully configured in the direction for the threshold entry, applies to the two configurable thresholds (P.0301 e P.0303). This means that generator voltage is out of the tolerance if out of the thresholds P.0301 and P.0303; it is in tolerance if between P.0301 + hysteresis and P.0303 – hysteresis; otherwise, the previous status is maintained.

Keeping in account these values, the following bands are defined:

0 V
A band: **Absent**
70 V
B band: Hysteresis
80 V
C band: **Low**
300 V
D band: Hysteresis
310 (300+10) V
E band: **In tolerance**
440 (450-10) V
F band: Hysteresis
450 V
G band: **High**
xxx V

If the voltage is in the “B”, “D” or “F” bands, previous status is maintained (hysteresis). For example, if the voltage was in the “E” band and now it is in “D” band, it is considered however “In tolerance”. On the contrary, if voltage was in the “C” band and now is in “D” band, it is considered “Low”.

In single-phase systems, these tests are executed on phase-to-neutral voltage.

In three-phases systems, these tests are executed on all phase-to-phase voltages. If the neutral is connected to the terminal JG-4 (P.9614 = “028”), these tests are executed on the three phase-to-neutral voltages too.

Thresholds P.0301 and P.0303 are used also to manage the generator protections on voltage. These protections can be individually disabled setting to zero the relevant parameter that specifies the delay (respectively P.0302 and P.0304). Thresholds are however used to define voltage status: this allows not to switch the loads on the generator if the electrical magnitudes are out of the tolerance band, even though protections are disabled.

Thresholds P.0391 and P.0393 are used for protections only; they are not used for detecting the status of the generator.

9.3.2 DC generator

The DC voltage of the generator can be connected to terminals JH, JG or JQ (see 5.13).

To detect the status, normally the controller cannot use the DC voltage of the generator if it is connected to other active sources, like the auxiliary source or the plant battery. In this case, in fact, the measured voltage is an “average” of those connected. It is possible to by-pass the problem in the following ways:

- Connecting also the AC voltages.
- Ensuring that the controller can measure the speed of the engine (pick-up, W, Can Bus). In this way, the controller can check (at least) that the speed is between the provided thresholds (it cannot check the DC voltage).
- Ensuring that the controller can detect the engine running status not using DC voltage (+D, oil pressure). In this way, the controller can check (at least) that the engine is not stopped (it cannot check the DC voltage).

If no one of the previous methods can be used, the controller will activate the W237 warning when it is not able to detect the status of the generator.

9.3.2.1 Frequency check

If the controller acquires the speed of the engine, it checks that it is inside the provided thresholds. Wit is valid what we said about the AC frequency but referred to the engine nominal speed.

Here follows an example about the various threshold used, including default values for a.m. parameters.

Parameter	Description	Default value	Speed (rpm)
P.0133	Engine's nominal speed (primary).	1500 rpm	1500
P.0228	Threshold for engine stopped (Hz).	10.0 %	150
P.0229	Threshold for engine started (Hz).	20.0 %	300
P.0305	Minimum frequency threshold.	90.0 %	1350
P.0307	Maximum frequency threshold.	110.0 %	1650
P.0331	Maximum speed threshold (frequency).	120.0 %	1800

0 Hz
A band: **absent**
150 Hz
B band: **hysteresis**
300 Hz
C band: **minimum**
1350 Hz
D band: **low**
1351 Hz
E band: **in tolerance**
1649 Hz
F band: **high**
1650 Hz
G band: **Maximum**
1800 Hz
Band H: **Over speed**
xxx Hz

The only managed hysteresis band is the one used to diagnose the stopped or running engine status. The generator detects no difference between the “G” and “H” bands.

9.3.2.2 Voltage check

Many parameters influence generator voltage measures:

- P.9641: Nominal voltage (DC). It is used also for the auxiliary source, for the plant battery and for the loads. Thresholds are expressed as a percentage of it.
- P.0202: hysteresis applied to all the thresholds related to generator voltage. It is a percentage value of P.9641.
- P.9651: threshold (percentage of P.9641) under which the engine is considered stopped.
- P.9652: threshold (percentage of P.9641) over which the engine is considered started.
- P.0301: low generator voltage threshold (percentage of P.9641); under this value the generator cannot be connected to the loads.
- P.0303: high generator voltage threshold (percentage of P.9641); over this value the generator cannot be connected to the loads.

Here follows an example about the various threshold used, including default values for a.m. parameters.

Parameter	Description	Default value	Voltage (Vdc)
P.9641	Nominal voltage (DC).	48 Vdc	48
P.9651	Threshold for engine stopped (Vdc).	17.5 %	8.4
P.9652	Threshold for engine started (Vdc).	20.0 %	9.6
P.0301	Minimum voltage threshold.	75.0 %	36
P.0303	Maximum voltage threshold.	135.0 %	64.8
P.0202	Hysteresis for generator's measures.	2.5 %	1.2

The hysteresis fully configured in the direction for the threshold entry, applies to the two configurable thresholds (P.0301 e P.0303). This means that generator voltage is out of the tolerance if out of the thresholds P.0301 and P.0303; it is in tolerance if between P.0301 + hysteresis and P.0303 – hysteresis; otherwise, the previous status is maintained.

Keeping in account these values, the following bands are defined:

0 V
A band: **Absent**
8.4 V
B band: Hysteresis
9.6 V
C band: **Low**
36 V
D band: Hysteresis
37.2 (36+1.2) V
E band: **In tolerance**
63.6 (64.8-1.2) V
F band: Hysteresis
64.8 V
G band: **High**
xxx V

If the voltage is in the “B”, “D” or “F” bands, previous status is maintained (hysteresis). For example, if the voltage was in the “E” band and now it is in “D” band, it is considered however “In tolerance”. On the contrary, if voltage was in the “C” band and now is in “D” band, it is considered “Low”.

9.3.3 Generator status

To diagnose the generator “global” status, the following algorithms are used, shown in their computing order:

- In case the status of all existing voltages (AC and/or DC) **and** the frequency/speed (if available) are “Absent”, also the global status is “Absent”.
- In case the status of all existing voltages (AC and/or DC) **and** the frequency/speed (if available) is “In tolerance”, also the global status is “In tolerance”.
- In case the status of at least one voltage (AC or DC) **or** the frequency/speed (if available) is “High”, also the global status is “High”.
- In case none of the previous conditions occurs, global status is “Low”.

9.3.4 Generator global status

For general management purposes, generator operation can be described in three steps:

a) Steady out of tolerance: the voltages status (AC/DC) **and/or** the frequency/speed status (if available) must be continuously other than “In tolerance” for two seconds. The “GENERATOR LIVE” lamp is off if voltages and frequency are in “Absent” status, otherwise it blinks (it blinks also if the engine is running).

b) Steady within tolerance: the voltages status (AC/DC) **and** the frequency/speed status must be “within tolerance” for at least half a second. The “GENERATOR LIVE” lamp is steady on.

c) Transient: shifting from status “a” to status “b” or vice versa. The “GENERATOR LIVE” lamp blinks.

9.3.5 Events and signalling

The controller records any change of the generator's status in the events log, if it is enabled with bit 2 of the P.0441 parameter:

- EVT.1020: generator voltages are missing.
- EVT.1021: generator voltages are present (out of thresholds).
- EVT.1022: generator voltages are present (in thresholds).

The following feature is also available for the configuration of the digital outputs, related to the generator status:

- DOF.3032 - “Generator in tolerance”. The controller activates this output when the generator voltages (AC/DC) and frequency/speed (if available) are within tolerance from the time configured.
- DOF.4031: the controller activates this output to signal the presence of at least one anomaly related to the generator:
  - 008 - Operating conditions not reached.
  - 003 - Minimum generator's frequency.
  - 058 - Low generator's frequency.
  - 060 - High generator's frequency.
  - 004 - Maximum generator's frequency.
  - 237 - Generator status not available.
  - 001 - Minimum generator's voltage.
  - 056 - Low generator's voltage.
  - 059 - High generator's voltage.
  - 002 - Maximum generator's voltage.
  - 011 - Reverse current on the generator.

- 015 - Trip on GCB circuit breaker.
- 016 - Maximum generator current (50).
- 006 - Maximum generator current (51).
- 225 - High generator current.

In addition, the controller makes available the generator statuses for the AND/OR logics by means of the following internal statuses:

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

The following functions, for the configuration of analogue outputs, are linked to generator management. The outputs are managed based on a generator analogue value. Use the "conversion curves" to adapt the single value to the output (0-100%):

- AOF.3101 (“Frequency of the generator”).
- AOF.3111 (“Voltage of the generator (AC)”).
- AOF.3113 (“Voltage of the generator (DC)”).
- AOF.3121 (“Power of the generator”).
- AOF.3131 (“Current of the generator (DC)”).

9.3.6 Protections

HS315 implements 4 different protections for the generator current:

- One warning for high current (W225, parameters P.9691, P.9692 and P.9693).
- One alarm (block) for maximum current (short circuit) (A016, parameters P.9691, P.0311, P.0312 and P.9694).
- One alarm (block) for time dependent maximum current (A006, parameters P.0309, P.0310 e P.0323).
- One alarm (block) for current reverse (A011, parameters P.9691, P.9695, P.9696 e P.9697).

HS315 implements 4 different protections for the generator frequency. Keep in mind that, when no AC voltages are connected to the controller, the protections can work on the engine speed (if available).

- One deactivation for minimum frequency (D003, parameters P.0202, P.0305, P.0306).
- One warning for low frequency (W058, parameters P.0202, P.0395, P.0396).
- One warning for high frequency (W060, parameters P.0202, P.0397, P.0398).
- One alarm (block) for maximum frequency (A004, parameters P.0202, P.0307, P.0308).

HS315 implements 4 different protections for the generator voltage. They can work with both AC and DC voltages. DC voltage has higher priority, but it cannot be used when another active source (plant battery or auxiliary source) is connected to the generator.

- One deactivation for minimum voltage (D001, parameters P.0202, P.0301, P.0302).
- One warning for low voltage (W056, parameters P.0202, P.0391, P.0392).
- One warning for high voltage (W059, parameters P.0202, P.0393, P.0394).
- One alarm (block) for maximum voltage (A002, parameters P.0202, P.0303, P.0304).

HS315 opens the GCB in case of alarms (blocks) and deactivations (D001, A002, D003, A004, A006, A011, A016) (in MAN the deactivations D001 and D003 are managed only when GCB is closed).

9.3.7 Generator current limitation

If the generator is undersized, it may not be able to fully provide the current required by the loads and that required for charging the storage battery. In these conditions, the reduction of the battery charge current (or even the complete suspension of the charging procedure) is allowed to reduce the current delivered by the generator to avoid the activation of pre-alarms/shutdowns.

HS315, however, must avoid overcharging the battery when it limits the generator current: it activates the limitation only if, as a result of the limitation itself, the battery will not be discharged or will be discharged with a current lower than the threshold P.9791 (“Activation threshold of the discharge current limitation”), or less than the rated battery discharge current (P.9643) if P.9791 were equal to zero.

This function is always enabled. HS315 activates the limitation when, in the previous conditions, the generator current exceeds **the lower** of the following thresholds for two seconds:

- P.9502 (“nominal current of the generator”).
- P.9692 ("generator high current threshold").
- P.0309 ("generator maximum current threshold").

Once the limitation is activated, the generator supplies exactly the current defined by the activation threshold (thus, normally its rated current).

HS315 removes the limitation when the current required to supply the loads and to charge the battery becomes lower (for two seconds) than the previous activation threshold, reduced by the hysteresis defined by P.9691.

HS315 records the events EVT.1531 and EVT.1532 respectively when activating and deactivating the generator current limitation, if enabled with bit eight of P.0441.

Display page S.01 shows a message when the HS315 limits the generator current.

The internal state ST.159 signals the activation of this limitation.

9.4 Loads

It is possible to connect DC voltage only. The current is always measured as DC.

The connection point of the voltage must be “before” the LCB circuit breaker (if present).

The controller acquires the voltages and the current of the loads for:

- Showing them on the display.
- To protect the loads from high/low voltages on the common bar.
- To protect the loads from high currents.

9.4.1 Protections

HS315 implements 4 different protections for the loads current:

- One warning for high current (W242, parameters P.9751, P.9752, P.9753).
- One latched warning for maximum current (short circuit) (K244, parameters P.9751, P.9756, P.9757).
- One latched warning for time dependent maximum current (K243, parameters P.9754, P.9755).
- One latched warning for current reverse (K245, parameters P.9751, P.9758, P.9759).

The latched warnings (K243, K244 and K245) force the opening of the LCB circuit breaker (if present).

HS315 implements 4 different protections for the loads’ voltages. If the LCB circuit breaker is opened, they would not take sense, but they are used ad protections for the common bar: ACB and GCB circuit breaker, however, must be both closed. In this case, the voltage protections will work on the plant battery voltage (if BCB is closed) or on the generator voltage (if the engine is running) or on the auxiliary source voltage.

- One latched warning for minimum voltage (K261, parameters P.9741, P.9742, P.9743).
- One warning for low voltage (W262, parameters P.9741, P.9744, P.9745).
- One warning for high voltage (W263, parameters P.9741, P.9746, P.9747).
- One latched warning for maximum voltage (K264, parameters P.9741, P.9748, P.9749).

The latched warnings (K261, K264) avoid the closure of the LCB circuit breaker (if opened). Normally, instead, they do not force the opening of LCB. The maximum voltage protection (but also the minimum voltage one if in AUTO) forces the opening of GCB (if the engine is running) and of the ACB (if auxiliary source is present): LCB will be opened only in case of opening failure of ACB/GCB.

9.4.2 Events and signalling

The following functions, for the configuration of analogue outputs, are linked to generator management. The outputs are managed based on a generator analogue value. Use the "conversion curves" to adapt the single value to the output (0-100%):

- AOF.3413 (“Voltage of the loads (DC)”).
- AOF.3421 (“Power of the loads”).
- AOF.3431 (“Current of the loads (DC)”).

9.4.3 Secondary contactors

Starting from version 1.09, HS315 manages up to 8 secondary contactors, which can be used to connect different groups of loads to the storage battery (or to the generator).

Note: if an LCB circuit breaker exists (see 9.8), it must be placed upstream of the secondary contactors: if it opens, the loads connected to any secondary contactor must result unsupplied.

For these contactors, HS315 only manages the stable closing/opening command: the functions from DOF.2261 to DOF.2268 are defined for the configuration of the digital outputs. It is not mandatory to use all the functions: it is possible to manage from a minimum of 2 to a maximum of 8 contactors. If less than 8 contactors are used, it is recommended to use the contiguous functions starting from DOF.2261 (without leaving holes). This allows for optimizations of the display.

There is no management, instead, of any feedback of the contactors (and consequently not even of the failure to open/close alarms).

The management logic is the same in all the operating modes of the controller (MAN and AUTO).

- The contactors are automatically opened (all simultaneously) if the loads are unsupplied (if LCB is open or, in any case, if there is no voltage upstream of LCB).
- When there voltage upstream of LCB and LCB is closed, the controller closes all the configured contactors, one at a time, with a delay between one and the other configurable with parameter P.9772.

Once the closing sequence is finished, the operator can manually control the contactors. Parameter P.9771 allows to indicate which contactors must remain closed and which must be open. This parameter can also be modified directly from page M.09. **Warning**: if you select to open a contactor by this parameter, it will no longer be considered in the automatic closing sequence.

9.5 Plant battery

The plant battery is the main part of a hybrid system. It supplies the loads. Generator and/or auxiliary source are used only to recharge the battery. The whole system must be designed to optimize the use of the generator, to use it as less as possible; when used, it should work in the power range with maximum efficiency (therefore, it should be selected based on the battery charging current). At design time, it must be considered that, during the charge procedure, the generator supplies the loads too.

The controller acquires both voltage and current (DC) of the battery. As a rule, the current must be positive when supplied by the battery (discharge), negative if absorbed by the battery (charge). The connection point of the voltage must be “before” the BCB circuit breaker (if present).

The controller **must** acquire both voltage and current of the battery; if not, it activates the alarm (block) A273 (those two measurements are required for the charge/discharge processes). **Note: HS315 may get these values from the messages sent by the BMSs: if the BMSs are not powered (DIF.2763) and the controller is configured to read these values from them (P.9762), HS315 does not activate this warning.**

9.5.1 Battery capacity

The battery manufacturer specifies its rated capacity (Ah).

The real battery capacity, however, changes based on the discharge current: the rated value, normally, must be considered correct when the battery is discharged in 20 hours (thus with a current equal to 1/20 of the rated capacity). If the discharge current is higher, the battery capacity decreases; if the discharge current is lower, the battery capacity increases.

The relation between the discharge current and the capacity is defined by a constant (Peukert constant). The battery manufacturer should specify this constant, or, alternatively, it can specify two real capacities at two given discharge currents.

Configuration of HS315, when the battery manufacturer states the Peukert constant:

Parameter	Description	Value
P.9642	Capacity (C) at nominal discharge current	Set the rated capacity.

P.9643	Nominal discharge current.	Set the current provided by the manufacturer, if not provided set 1/20 of P.9642
P.9644	Capacity at discharge current #2.	0
P.9645	Discharge current #2.	0,00
P.9646	Constant of Peukert.	Set the value provided by the manufacturer.

Configuration of HS315, when the battery manufacturer states two real capacities at two given discharge currents:

Parameter	**Description**	**Value**
P.9642	Capacity (C) at nominal discharge current	Set the first capacity provided by the manufacturer.
P.9643	Nominal discharge current.	Set the first current provided by the manufacturer.
P.9644	Capacity at discharge current #2.	Set the second capacity provided by the manufacturer
P.9645	Discharge current #2.	Set the second current provided by the manufacturer.
P.9646	Constant of Peukert.	1,00

HS315 allows you to acquire the rated discharge current from an analogue input instead of setting it with P.9643: configure the analogue input with the AIF.1907 function. You can also use this function with virtual inputs.

9.5.2 Format of the voltage thresholds

Parameter P.9641 allows to define the rated voltage (Vdc) of the plant battery.

Common lead-acid batteries are made up by 2 Vdc cells, put in series. The voltages suggested by the battery manufacturer for the charge and the discharge processes are related to a single cell.

Note: HS315 calculates the number of cells by dividing the rated voltage (48/24/12 Vdc) by 2 Vdc.

HS315 can manage many kinds of batteries, so all the voltage setpoints of HS315 related to the plant battery are defined as percentage of the nominal voltage P.9641. For example, the default value for the “End charge (full) voltage for BULK mode” (P.9676) is 115.0%: for a 48 Vdc battery, it corresponds to 55.2 Vdc. In program function, HS315 shows, in addition to the programmed value, the real voltage (Vdc), calculated on the programmed nominal voltage.

This way allows to have similar parameters also among different rated voltage batteries.

9.5.3 Format of the current thresholds

All the current thresholds of HS315 related to the plant battery are defined as percentage of the rated capacity. For example, the default value for the “Charge (full) current in BULK mode” (P.9675) is 0.30 C/h: for a 500 Ah battery, it corresponds to 150 Ah. In program function, HS315 shows, in addition to the programmed value, the real current (Adc) calculated on the rated capacity.

This way allows to have similar parameters also among different capacity batteries.

9.5.4 Temperature compensation of voltage and current

The battery manufacturer normally provides the suggested voltages and currents for the charge process (they will be described in the following chapters). Those values are correct when the battery temperature is 25°C. They should be adjusted to the real battery temperature.

HS315 solves this problem allowing the measurement of the battery temperature using a PT100 device, connected to terminals JP. Temperature measurement via the JP connector must be enabled with parameter P.9636:

- 0: Disabled.

- 1: Enabled.

The controller reports the failure of the temperature sensor ("W213 - broken wire") if parameter P.9636 is different from zero and the resistance measurement exceeds 333 ohms. The same warning is also activated if voltage or current temperature compensation is required, but temperature measurement is not available (for example if P.9636 is set to 0).

Moreover, HS315 provides the following parameters:

- P.9662 ("Voltage compensation due to temperature): it is defined as mV/°C **for a single battery cell**. It applies to the following parameters:
  - P.9676 ("End charge (full) voltage for BULK mode").
  - P.9683 ("End charge (standard) voltage for BULK mode").
  - P.9679 ("Charge (full) voltage in FLOAT mode").
  - P.9686 ("Charge (standard) voltage in FLOAT mode").
  - P.9665 ("Voltage for detecting the end of discharge").

  If set to zero, the controller will not compensate any voltage threshold.

  Note: the controller assumes that the battery's internal cells have a rated voltage of 2 volts (lead-acid batteries). If you want to use temperature compensation for other types of batteries, always set the compensation to apply every 2 Volt DC.

- P.9663 ("Charge current compensation due to temperature"): it is defined as a percentage of the rated capacity (P.9642) per °C. It applies to the following parameters:
  - P.9675 ("Charge (full) current in BULK mode").
  - P.9682 ("Charge (standard) current in BULK mode").
  - P.9677 ("End charge (full) current for ABSORBTION mode").
  - P.9684 ("End charge (standard) current for ABSORBTION mode").

  If set to zero, the controller will not compensate any current threshold.

  For the thresholds involved in temperature compensation, in program function HS315 shows, in addition to the programmed value, the real voltage/current threshold, adjusted by the temperature.

9.5.5 Starting/stopping of the charge process

The charge process can be started for two reasons:

- For low battery voltage. Parameter P.9665 ("Voltage for detecting the end of discharge") allows to select the voltage (% of P.9641, adjusted by temperature) under which the charge process is required. The default value is 87.5% (42 Vdc for a rated 48 Vdc battery).
- For low remaining charge. During the discharge process, HS315 continuously estimates the remaining charge level (Ah). Parameter P.9664 ("Discharge limit") allows to select the remaining charge level (percentage of the rated capacity) under which the charge process is required. The default value is 0.10C (10% of the rated capacity). If an analogue input is configured with the AIF.1917 function ("Storage battery discharge limit"), HS315 uses the value acquired by this input instead of parameter P.9664 (the input must be scaled to provide a value included between 0 and 1).

Parameter P.9661 ("Monitoring mode for charge status") allows to select which method must be used:

1. Voltage only.

2. Energy only (remaining charge level).
3. Both.

Based on charge requests and on parameter P.9661, HS315 starts the generator to recharge the battery. The real start is activated only if the pending requests persist for at least the time configured by P.9666 (“Delay before starting the genset”). When the charge cycle is in progress, its end is determined in the following ways:

- If the charge cycle has been requested for “low remaining charge” and not for minimum voltage, and if P.9681 or P.9688 (see 9.5.7) is different from 1.00, then the cycle will end when the remaining charge level will become greater than the value set by P.9681 (“Charge (full) limit”) or P.9688 (“Charge (standard) limit”) (see 9.5.7), defined as a percentage of the rated capacity. If an analogue input is configured with the AIF.1915 function ("Storage battery charge limit"), HS315 uses the value acquired by this input instead of parameters P.9681 and P.9688 (the input must be scaled to provide a value between 0 and 1). **In this case, the estimation of the remaining charge is not forced to the rated capacity.**
- In all other situations, the cycle will end after the three charge phases (BULK, ABSORBTION and FLOAT). At the end of the cycle, the estimation of the remaining charge is forced to the rated capacity.

The controller records the requests for starting/stopping the charge process in the events log, if it is enabled with bit 8 of the P.0441 parameter:

- EVT.1511: charge started for minimum voltage.
- EVT.1512: charge stopped because the final charge voltage has been reached.
- EVT.1513: charge started for minimum charge level.
- EVT.1514: charge stopped because the required charge level has been reached.

9.5.6 Tuning of the control loops

Parameter P.9659 allows configuring the period with which the HS315 makes corrections on the speed and/or voltage regulators, to adjust the voltage and current supplied by the generator during the storage battery charging process. The default value is 20 ms and you should not modify it if you are using the HS315’s measurement channels for the currents and voltages of the storage battery. If instead you are using the voltage/current measurements received from the external BMS, then you should set P.9659 to a value greater than or equal to the rate at which the BMS sends these measurements. In fact, adjusting faster is not only useless, but even harmful, because the control loops accumulate errors unnecessarily.

The controller internally uses several PI regulators, to determine the voltage and speed references needed in every instant to manage the generator during charge process. All internal PI regulators are configured with two parameters:

- The factor proportional to current error (P), also called "gain".
- The factor related to the integral in error time (I), also called "integrative factor".

In the following chapters the parameters associated with each PI regulator will be indicated.

These two parameters for each PI regulator should be "calibrated" on the field during the commissioning of the generator. In fact, they depend on several factors: type of engine, alternator power, type of alternator; different parameters for similar systems may also be required.

However, setting these parameters is not very critical if carried out following a correct procedure. Unfortunately, the empirical setting-up method (called Ziegler-Nichols) requires measuring the period of oscillation of controlled condition (current, voltage), measurement that is not always possible (or easier) to perform.

For this reason, beside the empirical method, we suggest a simplified one that should allow to properly select the relevant parameters.

PI controllers' parameters can also be modified while the system is running, even from the operator panel. It is advisable to make changes using the BoardPrg4 program, available free of charge on Mecc Alte website.

9.5.6.1 Full method

1) Set "P" at an initial value (0.100) and "I" at 0000.
2) Increase "P" until the controlled condition starts to oscillate (for example, if you are adjusting the IP that manages the battery voltage, increase "P" until the voltage continually increases/decreases). Decrease/increase the value of "P" until the starting point of the oscillation is singled out (a good approximation is enough).
3) Measure the period of oscillation (the time between two consecutive voltage peaks).
4) Set "P" to a slightly lower value than the one obtained by dividing the current value by 2.2.
5) Set the "I" to the calculated value by dividing 1.2 for the oscillation period measured before (in seconds). It can be set a lower value degrading the performance but increasing stability margin.
6) Some other fine tuning might be necessary. Verify how the system work with low, medium and high load. In case there is still an instability of the system, reduce further the value of "P".

9.5.6.2 Simplified method

To overcome the difficulties of measuring the period of oscillation, it is possible to go on, referring to what said in the previous paragraph, from step 6 included, excluding points 3 and 5. Instead of step 5, increase/decrease "I" (after arranging "P" at step 4) to achieve the optimal performance.

9.5.6.3 General remarks

P factor is not able by itself to perform a good regulation. To reduce the error, P should be increased, but after a threshold, the system becomes instable. Usually, the P value set using the explained method is the better compromise between performance and stability.

To get a good adjustment, it is necessary to set "I" factor. Even small values of the parameter "I" increase the performance of the system. Value, obtained used the explained method, usually give the better performance. However, it is not critical and can be set in a wide range of values.

Remember that the factor "I" accumulates adjustment errors: delays in the recovery of the error can cause over-elongations (over-shoots) or under-elongations (under-shoots). Moreover, too high value of "I" lead to system instability.

Once the value that gives a good performance is found, try to decrease it until the performance drops below the expected minimum. Then select the actual value in that range as compromise

In some cases, could be necessary to start the procedure with a minimum "I" value to allow the controller a minimum regulation capability compatible with the system. A very small value of "I" (0.01) can be used with minimal effect on the procedure.

9.5.7 Charge process

To improve the efficiency of the generator, it should be used as little as possible; when used, it should work at a sufficiently high power (the generators have the best efficiency around 80% of rated power).

In practice, therefore, the generator should try to charge the batteries with the maximum possible current, thus reducing the charging time (using only the BULK phase - see below). In this way, however, the batteries do not charge 100% and it is therefore necessary, from time to time, to carry out a complete charge cycle (full or equalization charge).

HS315 can perform both "standard" and "full" charge cycles. To allow the operator to differentiate between the two charge cycles, HS315 provides two sets of parameters:

Cycle	Standard	Full

Menu	2.5.3	2.5.2
Charge current in BULK mode.	P.9682	P.9675
End charge voltage for BULK mode.	P.9683	P.9676
End charge current for ABSORBTION mode.	P.9684	P.9677
Maximum charge duration in ABSORBTION mode.	P.9685	P.9678
Charge voltage in FLOAT mode.	P.9686	P.9679
Charge duration in FLOAT mode.	P.9687	P.9680
Charge limit.	P.9688	P.9681

Normally, HS315 performs the "standard" charge cycle. It executes the "Full" charge cycle in two conditions:

- If a digital input configured with the function DIF.2321 ("Full charge") is active at the start of the charge cycle.
- If the parameter P.9660 ("Number of standard charge cycles to perform one full charge cycle") is set to a value other than zero, HS315 performs a “full” charge cycle for every P.9660 “standard” charge cycle (If P.9660 is set to zero, this function is disabled).

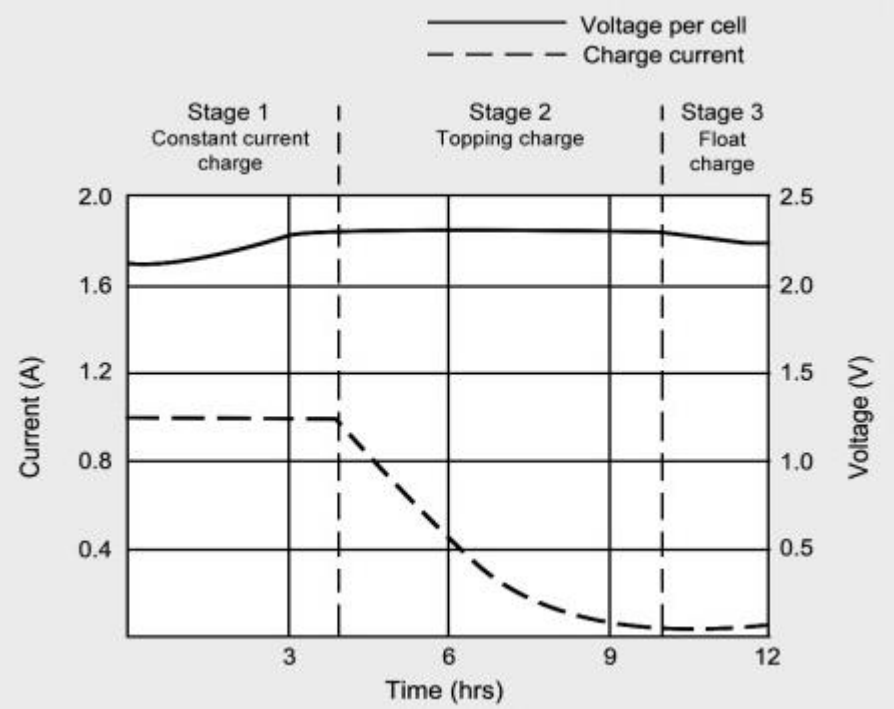
HS315, at the beginning of each charge cycle, records the following events (if enabled with bit 8 of parameter P.0441):

- EVT.1521: Start of the “standard” charge cycle.
- EVT.1522: Start of the “full” charge cycle.

The second line of the page M.02 displays the current cycle type ("standard" or "full") on the second row, in REVERSE (only if the charge is in progress).

HS315 uses a three-stage charge process for the battery, that is the most efficient and most used. The three stages, visible in the following picture, are named:

- Stage 1: BULK.
- Stage 2: ABSORBTION.
- Stage 3: FLOAT.



9.5.7.1 Stage 1: BULK

In this stage, the charge of the battery is made at fixed current.

The current setpoint is provided by P.9675 (“Charge (full) current in BULK mode”) or P.9682 (“Charge (standard) current in BULK mode”) (see 9.5.7). The controller must act on the voltage regulator (or on the speed governor for permanent magnets alternators) to force the battery current to be negative (we are charging the battery) and equal to the setpoint.

Note: during this stage, the generator is supplying the loads also. It is then possible that the sum of the current absorbed by the loads and the current to be supplied to the battery becomes greater than the generator rated current (P.9502): in this case, the current setpoint is limited in order not to exceed the generator rated current. Moreover, if some alarm thresholds are activated on the generator current, the current setpoint is limited in order not to exceed these thresholds. These limitations are signalled by the warning W273. Up to version 1.17, these limitations were signalled with the activation of the warning W273; from version 1.18 this warning is no longer activated, because it is admittable to dimension the generator for the average loads current and not for the maximum.

Once the current setpoint is calculated, the control loop increases/decreases progressively the current supplied to the battery until the required setpoint is reached. Those modifications are applied with the rate defined by P.9669 (“Ramp for current regulation”), defined as %/s.

The control loop used for the current regulation can be configured by:

- P.9670 (“Gain for current regulation loop”).
- P.9671 (“Integrative factor for current regulation loop”).

See paragraph 9.5.6.

This stage ends when the battery voltage becomes higher than the threshold P.9676 (“End charge (full) voltage for BULK mode”) or P.9683 (“End charge (standard) voltage for BULK mode”) (see 9.5.7), or when the charge limit is reached (see 9.5.5).

If you do not want to execute this stage, set parameter P.9675 or P.9682 (see 9.5.7) to 0.

9.5.7.2 Stage 2: ABSORBTION

In this stage, the charge of the battery is made at fixed voltage.

The voltage setpoint is “the voltage at the end of the BULK stage”, that is the parameter P.9676 (“End charge (full) voltage for BULK mode”) or P.9683 (“End charge (standard) voltage for BULK mode”) (see 9.5.7). The controller must act on the voltage regulator (or on the speed governor for permanent magnets alternators) to force the battery voltage to be equal to the setpoint.

Once the voltage setpoint is calculated, the control loop increases/decreases progressively the generator voltage until the battery voltage reaches the setpoint. Those modifications are applied with the rate defined by P.9672 (“Ramp for voltage regulation”), defined as %/s.

The control loop used for the voltage regulation can be configured by:

- P.9673 (“Gain for voltage regulation loop”).
- P.9674 (“Integrative factor for voltage regulation loop”).

See paragraph 9.5.6.

This stage ends when one of the following conditions happens:

- The charge current (battery) becomes lower than the threshold set by P.9677 (“End charge (full) current for ABSORBTION mode”) or P.9684 (“End charge (standard) current for ABSORBTION mode”) (see 9.5.7).
- After the maximum time configured by P.9678 (“Maximum charge (full) duration in ABSORBTION mode”) or P.9685 (“Maximum charge (standard) duration in ABSORBTION mode”) (see 9.5.7).
- When the charge limit is reached (see 9.5.5).

If during this stage the battery current becomes higher than P.9675 (“Charge (full) current in BULK mode”) or P.9682 (“Charge (standard) current in BULK mode”) (see 9.5.7), the procedure goes back to the stage 1 (BULK).

If you do not want to execute this stage, set parameter P.9678 or P.9685 (see 9.5.7) to 0.

9.5.7.3 Stage 3: FLOAT

In this stage, the charge of the battery is made at fixed voltage.

The voltage setpoint is configurable by the parameter P.9679 (“Charge (full) voltage in FLOAT mode”) or P.9686 (“Charge (standard) voltage in FLOAT mode”) (see 9.5.7).

This stage ends after the time configured by P.9680 (“Charge (full) duration in FLOAT mode”) or P.9687 (“Charge (standard) duration in FLOAT mode”) (see 9.5.7).

If during this stage the battery current becomes higher than P.9675 (“Charge (full) current in BULK mode”) or than P.9682 (“Charge (standard) current in BULK mode”) (see 9.5.7), the procedure goes back to the stage 1 (BULK).

If you do not want to execute this stage, set parameter P.9680 or P.9687 (see 9.5.7) to 0.

See the previous chapter for the description of the voltage control loop.

9.5.8 End of the charging process

At the end of the charging process, the HS315 normally leaves the battery’s charge level (Ah) at its current value. There are some exceptions:

- If the charging process was started due to low battery voltage, HS315 forces the rated battery capacity as its charge level.

- If the charging process was started due to low charge **and the current charge limit (P.9681/P.9688) is 1**, HS315 forces the rated battery capacity as its charge level.
- If a digital input configured with the DIF.2768 function (“Force SOC at the end of charging”) is active when the charging process ends, HS315 forces the current charge limit (P.9681/P.9688) as the battery charge level.

9.5.9 Connection to voltage or speed regulator

To correctly manage the storage battery charging process, HS315 must be able to regulate both the charging current (in the BULK phase) and the charging voltage (in the ABSORBTION and FLOAT phases). To do this, HS315 always and only acts on the generator voltage.

Depending on the type of alternator, to control the generator voltage (and consequently the charging voltage/current for the storage battery), HS315 can operate in two ways: it can connect to the speed governor or to the automatic voltage regulator.

9.5.9.1 Traditional alternators equipped with automatic voltage regulator

Starting from version 1.09, parameter P.9656 has been added ("Use the speed governor to control the generator voltage"): for this type of alternators, set it to "0 - No".

To regulate the voltage, HS315 must be connected to the voltage regulator. This connection is possible by an analogue output (JR, or an analogue output on an expansion DANOUT module).

From version 1.16, it is also possible to use the CANBUS connection to connect to voltage regulators that implement the J1939-75 standard, for which the configuration file for HS315 has been implemented. Use P.1700 to select one of the available voltage regulator models (operation that requires the use of BoardPrg4 software). Set P.1701 to “99” to enable voltage regulation via the CAN line. With parameters P.1703 and P.1704 it is possible to establish the maximum voltage regulation range on the CANBUS line.

9.5.9.2 Permanent magnet alternators not equipped with automatic voltage regulator

Starting from version 1.09, parameter P.9656 has been added ("Use the speed governor to control the generator voltage "): for this type of alternators, set it to "1 - Yes".

In generators equipped with this type of alternator, the generated voltage is proportional to the rotation speed of the alternator itself, and thus of the engine. To regulate the voltage, HS315 must therefore be connected to the speed governor. This connection is possible:

- Via an analogue output (JR, or an analogue output on an expansion DANOUT module).
- Via the CANBUS connection.

To regulate the voltage via the speed governor, HS315 uses a PID control loop. It is therefore not important to know how HS315 interfaces in CANBUS with the electronic speed regulator.

Normally, HS315 makes the internal command (0-100%) correspond to a real speed range of +/- 120 rpm, with respect to the rated speed. This is the default condition, configured with P.0713=1380 and with P.0714=1620.

Note: even if the nominal speed of the engine is not 1500, the two previous values force an offset of +/- 120 rpm with respect to the nominal speed: an internal command equal to 0% is translated into a value of -120 rpm, an internal command to 100% is translated into a value of +120 rpm.

The two parameters P.0713 and P.0714 can be modified as required (however, be careful to configure them correctly with respect to the rated speed). For example, if you want a speed range between 1200 and 1600 rpm set P.0713=1200 and P.0714=1600: an internal command equal to 0% will be translated into a speed of 1200 rpm, an internal command equal at 100% it will be translated in a speed of 1600 rpm.

9.5.9.3 Configuration valid for both types of alternator

Parameter P.0840 configures the value for the internal regulation command to be used when the engine is stopped.

To associate the internal regulation command (%, for battery charging) to an analogue output, you can act in three ways (the examples refer to the analogue output 1):

- Configure the analogue output (parameter P.6001 for output 1) with the AOF.1000 function ("Storage battery charge regulator"). The following parameters control the scaling of the output.
  - P.0831: set to 0 if an increase in the output should corresponds to an increase in the voltage. Set to 1 if an increase in the output should corresponds to a decrease in the voltage.
  - P.0856: allows you to set the value for the analogue output corresponding to an internal command of 0% (default 0%). For example, if you only want a positive output, set it to 50%.
  - P.0857: allows you to set the value for the analogue output corresponding to an internal command of 100% (default 100%).
- Configure the analogue output (parameter P.6001 for output 1) with the AOF.1001 function ("Storage battery charge regulator (generic)"). In this case, the output scaling must be done by means of a conversion curve.
- Configure the analogue output (parameter P.6001 for output 1) with the function AOF.0101 ("Used by the PLC"). Using the PLC, the internal command (available through the internal measure AM.086) can be manipulated as required. The converted value can be assigned directly to the analogue output in the PLC.

9.5.10 Voltage matching

Often, the GCB circuit breaker is for protection only, thus it is always closed. In this case, when the engine starts, the generator DC voltage could be higher or lower than the common bus voltage, but the controller cannot do anything to avoid that (it can only quickly regulate the current).

Instead, if HS315 has the opening/closure commands for GCB, it starts the engine with GCB opened and, before closing it, HS315 matches the generator voltage to the common bus voltage. GCB closure is allowed when the voltage difference between generator and common bar is lower than P.9667 (“Voltage match window”) or, in any case, after the maximum time set by P.9668 (“Maximum duration for voltage matching”).

To disable this stage, set P.9668 a 0.

The voltage control loop is the same of the FLOAT and ABSORBTION stages, except it works on the generator voltage instead of on the battery voltage.

9.5.11 Cooling cycle

Often, the GCB circuit breaker is for protection only, thus it is always closed. In this case, the cooling cycle for the engine must performed with GCB closed. During this stage, the controller regulates the generator current to zero.

The current control loop is the same of the BULK stage, except it works on the generator current instead of on the battery current.

9.5.12 Events and signalling

The controller records any change in the charge cycle in the events log, if it is enabled with bit 8 of the P.0441 parameter:

- EVT.1500: charge status: idle.
- EVT.1501: charge status: voltage matching.
- EVT.1502: charge status: BULK.
- EVT.1503: charge status: ABSORBTION.

- EVT.1504: charge status: FLOAT.
- EVT.1505: charge status: FLOAT ended.
- EVT.1506: charge status: cooling down in progress.
- EVT.1521: start of the “standard” charge cycle.
- EVT.1522: start of the “full” charge cycle.

The following functions, for the configuration of analogue outputs, are linked to the plant battery management. The outputs are managed based on a plant battery analogue value. Use the "conversion curves" to adapt the single value to the output (0-100%):

- AOF.3313 (“Voltage of the battery (DC)”).
- AOF.3321 (“Power of the battery”).
- AOF.3331 (“Current of the battery (DC)”).

In addition, the controller makes available the states related to the charging process for the AND / OR logics through the following internal states:

- ST.144: "charging procedure not in progress".
- ST.145: "Voltage alignment before closing GCB".
- ST.146: "charging in progress in BULK mode".
- ST.147: "charging in progress in ABSORPTION mode".
- ST.148: "charging in progress in FLOAT mode".
- ST.149: "charging in progress, FLOAT mode terminated".
- ST.150: "generator current regulation".

9.5.13 Manual sequence

If the operator manually starts the genset (in MAN) and closes the GCB circuit breaker, the controller starts to charge the battery from the ABSORBTION stage. It is possible, however, to force a different stage by keeping pressed the SHIFT button for 2 seconds, when page M.02 is shown:

- FLOAT stage is forced is current stage is ABSORBTION.
- BULK stage is forced is current stage is FLOAT.
- ABSORBTION stage is forced is current stage is BULK.

In manual mode, after the time P.9680 (“Charge (full) duration in FLOAT mode”) or P.9687 (“Charge (standard) duration in FLOAT mode”) (see 9.5.7) is elapsed, the controller continues to be in the FLOAT stage, but it advices the operator about this situation showing “FLOAD END”.

9.5.14 Counters

HAS315 manages the following counter during charge/discharge processes;

Counter	Clearable	Display page
Number of charge cycles	Yes	M.04
Energy transferred to the battery during charge cycles (Ah)	Yes	M.04
Power transferred to the battery during charge cycles (Wh)	Yes	M.04

Number of discharge cycles	Yes	M.04
Energy supplied by the battery during charge cycles (Ah)	Yes	M.04
Power supplied by the battery during charge cycles (Wh)	Yes	M.04
Number of charge cycles	No	M.05
Energy transferred to the battery during charge cycles (Ah)	No	M.05
Power transferred to the battery during charge cycles (Wh)	No	M.05
Number of discharge cycles	No	M.05
Energy supplied by the battery during charge cycles (Ah)	No	M.05
Power supplied by the battery during charge cycles (Wh)	No	M.05
Estimation of the remaining charge level (Ah)	No	M.02
Estimation of the remaining charge level (%)	No	M.02
Energy transferred to the battery during last BULK (Ah)	No	M.03
Energy transferred to the battery during last ABSORBTION (Ah)	No	M.03
Energy transferred to the battery during last FLOAT (Ah)	No	M.03
Potenza transferred to the battery during last charge (Wh)	No	M.03
Potenza supplied by the battery during last discharge (Wh)	No	M.03

HS315 estimates the residual charge level (both in Ah and in %) using its own current measurement. HS315 can also acquire these values from the electronic BMS (if existing and if enabled with bit 0 of P.9762) or from an analogue input (physical or virtual) configured with the AIF.1913 function.

9.5.15 Protections

HS315 implements 3 different protections for the current of the plant battery:

- One warning for high current (W222, parameters P.9721, P.9722, P.9723).
- One latched warning for maximum current (short circuit) (K224, parameters P.9721, P.9726, P.9727).
- One latched warning for time dependent maximum current (K223, parameters P.9724, P.9725).

HS315 implements 4 different protections for the voltage of the plant battery:

- One latched warning for minimum voltage (K218, parameters P.9711, P.9712, P.9713).
- One warning for low voltage (W219, parameters P.9711, P.9714, P.9715).
- One warning for high voltage (W220, parameters P.9711, P.9716, P.9717).
- One latched warning for maximum voltage (K221, parameters P.9711, P.9718, P.9719).

HS315 implements 4 different protections for the temperature of the plant battery:

- One latched warning for minimum temperature (K214, parameters P.9701, P.9702, P.9703).

- One warning for low temperature (W215, parameters P.9701, P.9704, P.9705).
- One warning for high temperature (W216, parameters P.9701, P.9706, P.9707).
- One latched warning for maximum temperature (K217, parameters P.9701, P.9708, P.9709).

The latched warnings (K214, K217, K218, K221, K223, K224) force the opening of the BCB circuit breaker (if present).

9.5.16 Limitation of the discharge current

Normally, the designer sizes the storage battery to ensure that the current absorbed by the loads is always lower than the nominal discharge current of the battery. Sometimes, to reduce the costs, the designer under-sizes the battery, considering that the generator can meet the consumption peaks of the loads itself.

HS315 manages this function with the parameters available in menu 3.3.4:

- P.9791: threshold on the discharge current (% of the rated current of the battery) above which HS315 must limit the discharge current.
- P.9792: delay (s) before applying the limitation if the discharge current is greater than P.9791.
- P.9793: threshold on the discharge current (% of the rated current of the battery) below which HS315 must no longer apply any limitation.
- P.9794: delay (s) before removing the limitation if the discharge current is lower than P.9793.

HS315 continuously monitors the battery discharge current. If it remains greater than the P.9791 threshold for P.9792 seconds:

- It records the EVT.1065 event in the events archive (if enabled with bit six of P.0441).
- If HS315 is in AUTO mode, it starts the engine.
- Once the engine has started, HS315 adjusts the current delivered by the generator to ensure that the current drawn from the battery is equal to its nominal. This, however, only if the battery is not discharged: if it were, HS315 would adjust the generator current to charge the battery and power the loads (limiting the generator current to its nominal current).

After starting the engine, HS315 continuously calculates what the battery discharge current would be if it stopped the engine. If the calculated current remains below the P.9793 threshold for P.9794 seconds:

- It records the EVT.1066 event in the events archive (if enabled with bit six of P.0441).
- If HS315 is in AUTO mode, it removes the start request for the engine. If there are no other start requests, HS315 stops the engine, otherwise it continues with the battery charging operation.

The operator can disable this function by setting the thresholds P.9791 or P.9793 to zero, or by setting P.9793 greater than P.9791.

The internal state ST.158 signals the activation of this limitation.

9.5.17 External setpoint for generator current

HS315 can accept an external setpoint for regulating the generator current (not for the battery charge current). It is therefore possible to use the PLC together with this function to manage a charge profile different from the default one, even with a current that varies over time.

This function is enabled under the following conditions:

- Configure an analogue input with the “AIF.1911” function. For physical inputs, use the conversion curves to convert the electrical measurement (volts, ohms) to DC amps. For virtual inputs, on the other hand, use the PLC to establish the current setpoint.
- Configure a digital input with the “DIF.2761” function. You can also use the virtual inputs, which can be controlled by the PLC.

In the previous conditions, when the digital input configured with the DIF.2761 function is active, HS315 uses the value acquired from the analogue input as a setpoint for regulating the generator current. However, it can limit the setpoint to keep the system in a situation of consistency:

- It limits the setpoint to the rated current of the generator.
- It limits the setpoint to avoid generating more current than the loads and the battery can absorb.
- It limits the setpoint to avoid generating less current than required by the loads, considering the maximum discharge current of the battery.

HS315 records the events EVT.1523 and EVT.1524 respectively when activating and deactivating the regulation of the generator current, if enabled with bit 8 of P.0441.

The internal state ST.157 signals the activation of this function.

Page S.01 of the display shows a message when this function is active.

9.5.18 Regulation of the generator voltage

This function allows to start the generator and keep it running at a constant and configurable voltage, while at the same time disconnecting the utilities from the battery (opening the BCB circuit breaker). It is used to power the utilities in case of problems with the battery itself.

The function is configured with the following parameters (available in menu 2.8):

- P.9766 - “Setpoint for fixed voltage”. Allows to configure the voltage setpoint for the generator (it is a percentage of parameter P.9641 - “Nominal voltage (DC)”.
- P.9767 - “Gain for regulating the generator voltage”.
- P.9768 - “Integrative factor for regulating the generator voltage”.

The function is activated with a digital input (can be virtual) configured with the function DIF.2762 – “Generator voltage regulation forcing”.

The function is available in both MAN and AUTO. When the input is activated:

- If the controller is in AUTO mode, it automatically starts the engine (in MAN the operator must start it manually).
- When the engine is running, the controller opens the BCB circuit breaker (even in MAN, and the operator does not have the possibility to close it).
- After the "delay before supply", if the controller is in AUTO mode, it automatically closes the GCB circuit breaker (in MAN the operator must close it manually).
- If the GCB circuit breaker is closed and the BCB circuit breaker is open, the controller activates the generator voltage regulation loop (also in MAN).

When the input is deactivated:

- The controller stops regulating the generator voltage and removes any inhibition to the closing of the BCB circuit breaker. If the controller is in AUTO mode, it automatically closes the BCB circuit breaker (in MAN the operator must close it manually).

- At this point, if a charging cycle is required (in MAN it is always required) the controller starts regulating the battery current or voltage, depending on the configured charging cycle.
- If the controller is in AUTO mode and a charging cycle is not required, it opens the GCB circuit breaker, carries out the engine cooling cycle and stops the engine. In MAN mode, these operations must be done by the operator.

  The controller records two events (1068 and 1069) to signal the activation and deactivation of this function.

  Page S.01 shows a message to the operator when this function is activated.

  The internal status ST_156 - “Forced regulation of generator voltage” signals the activation of this function.

9.6 Automatic intervention of the generator inhibited.

In AUTO mode, whatever the status of the plant, two causes can anyway inhibit the gen-set automatic start:

- operational time range.
- digital input.

When there is an inhibition active, a flashing lock is displayed in the top right corner of the display.

Note: the inhibition status does not affect TEST and REMOTE START modes.

9.6.1 Inhibition from contact

The controller can use a digital input programmed for inhibiting the gen-set automatic operation (function DIF2501 – “Inhibition of start”). In case of a logically “active” input, the engine is never automatically started, not even if the plants condition requires.

Use parameter P.0207 to set a delay between input's physical activation and this function's logic activation: however, the delay can only be applied to a controller in AUTO mode, otherwise the delay is null.

Use parameter P.0208 to set a delay between input's physical de-activation and this function's logic de-activation: in case the generator is already running, the delay is reduced to two seconds (fixed).

When a function DIF.2501 is coupled with a digital input, acquisition of this input depends on the time set in P.0207 and/or P.0208; the acquisition time related to the digital input is skipped.

The controller also makes available, to the use of AND/OR logics, the internal status ST.080 - "Start inhibited by contact”.

The controller records any change of the inhibition status in the events log, if it is enabled with bit 6 of the P.0441 parameter:

- EVT.1013: start inhibited by contact.
- EVT.1014: start inhibition deactivated (from digital input).

9.6.2 Inhibition from clock

Using parameters P.0421, P.0422 and P.0423, it is possible to define on a weekly basis the hourly operation range. Parameter P.0421 allows to set the generator's weekly operation days. The remaining two allow to set an hour range valid for all selected days. The range start time (P.0422) refers to the days set in P.0421, while the range end time (P.0423) refers to the same day, if its value is higher than P.0422, or to the following day if lower (across midnight). Moreover, setting P.0422 and P.0423 to the same value defines a full day's range.

The controller also makes available, to the use of AND/OR logics, the internal status ST.081 - "Start inhibited by clock/calendar”.

The controller records any change of the inhibition status in the events log, if it is enabled with bit 6 of the P.0441 parameter:

- EVT.1221: start inhibition activated (from clock/calendar).
- EVT.1222: start inhibition deactivated (from clock/calendar).

9.7 Engine

HS315 can start, stop and protect the engine by means of a series of thresholds on the acquired measures (oil pressure, coolant temperature, speed etc.).

9.7.1 Nominal power

HS315 allows specifying the rated power of the engine (P.0125 parameter, in kW). It is important to set this figure, because the thresholds for some protections are expressed as its percentage.

9.7.2 Rated engine speed

The generators are usually designed to work with both the most common frequencies (50Hz and 60Hz). Obviously, at different frequencies, the rated rotation speed of the engine varies. Because some thresholds are expressed as a percentage of rated speed, HS315 should know the present rated speed.

HS315 allows setting two nominal rotation speeds for the engine via P.0133 and P.0134 parameters (both expressed in kW): it uses the one specified in P.0133 ("Primary engine rated speed") if the nominal frequency (P.0105) is lower than 55 Hz, otherwise it uses P.0134 parameter ("Secondary engine rated speed").

9.7.3 Engine speed (RPM)

The board can perform a measurement of the engine rotation speed, to display it, optionally use it to diagnose the statuses of started/stopped engine, and optionally use it to manage a maximum speed protection (A018).

HS315 can acquire this measure in different ways, listed in the order in which they are assessed:

- The measure can be acquired by a pick-up on the engine. See initial chapters for the connection of the signal. To enable this measure, in P.0110 parameter the number of teeth of the rim on which the pick-up works should be set. This is a known value and, anyway, easily computed If P.0110 is set to a nonzero value, the following points are ignored.
- The measure can be acquired by the signal W of the engine battery charging alternator. See initial chapters for the connection of the signal. To enable this measure, it is necessary to set the ratio between the frequency of the signal W and the rotation speed in P.0111 parameter (expressed in revolutions/second) of the engine, and P.0110 parameter should be set to zero. This ratio depends on many factors and it is not easy to calculate. If a frequency meter is available, simply start the engine (it will run at is rated and known speed, i.e., 1,500 rpm) and measure the W signal frequency, and then calculate the ratio. If a frequency meter is not available, the following method can be used:
  - Set a random value for P.0111 (e.g., 15).
  - Start the engine and, when at operating speed, note the rpm value shown by the controller.
  - Calculate the ratio between the displayed speed and the actual engine speed (displayed/actual).
  - Multiply the value previously set in P.0111 by this ratio and set the new value.
  - Restarting the engine, the speed measure should be close to the actual speed. Then, manually adjust the value P.0111 until you get the right display, considering that, for the same true speed, the value displayed by the controller decreases when increasing P.0111. If P.0111 is set to a nonzero value, the following points are ignored.
- The board can also read the engine rotation speed directly from the electronic control unit (ECU) of the engine itself through the CAN0 CAN-BUS or the serial ports. To do this, select the proper ECU using P.0700, and set P.0110 and P.0111 to zero.

9.7.4 Acquiring of analogue measurements

HS315 can acquire a great number of analogue measurements from the engine. For electronic engines, these measures are usually read directly from the ECU of the engine through the CAN-BUS connection.

Anyway, it is possible to configure the analogue inputs from the board and from the expansion modules to acquire these measures. If the same measure is acquired by an analogue input and received by the ECU of the engine via CAN-BUS, the one acquired by the analogue inputs is used.

The following functions are available for the configuration of the analogue inputs:

- AIF.1000 (“oil pressure – VDO”). HS315 automatically uses the characteristic curve of 0-10 bar VDO sensor (10 Ohm 0 bar, 180 Ohm 10 bar).
- AIF.1001 (“oil pressure – generic”). Use a conversion curve to configure the sensor.
- AIF.1100 (“oil temperature – VDO”). HS315 automatically uses the characteristic curve of 0-120 °C VDO sensor (290 Ohm 40 °C, 10 Ohm 150 °C).
- AIF.1101 (“oil temperature – generic”). Use a conversion curve to configure the sensor.
- AIF.1110 (“coolant temperature – VDO”). HS315 automatically uses the characteristic curve of 0-120 °C VDO sensor (290 Ohm 40 °C, 10 Ohm 150 °C).
- AIF.1111 (“coolant temperature – generic”). Use a conversion curve to configure the sensor.
- AIF.1200 (“oil level – VDO”). HS315 automatically uses the characteristic curve of VDO sensor (10 Ohm 100%, 180 Ohm 0%).
- AIF.1201 (“oil level – generic”). Use a conversion curve to configure the sensor.
- AIF.1210 (“coolant level – VDO”). HS315 automatically uses the characteristic curve of VDO sensor (10 Ohm 100%, 180 Ohm 0%).
- AIF.1211 (“coolant level – generic”). Use a conversion curve to configure the sensor.
- AIF.1220 (“fuel level – VDO”). HS315 automatically uses the characteristic curve of VDO sensor (10 Ohm 100%, 180 Ohm 0%).
- AIF.1221 (“fuel level – generic”). Use a conversion curve to configure the sensor.
- AIF.1231 (“fuel level (l)– generic”). Use a conversion curve to configure the sensor.
- AIF.1601 - "air temperature in the intake pipe" Use a conversion curve to configure the sensor.
- AIF.1603 (“exhaust gas temperature – left bank”). Use a conversion curve to configure the sensor.
- AIF.1605 (“exhaust gas temperature – right bank”). Use a conversion curve to configure the sensor.
- AIF.1641 (“pressure of air coming out from the turbocharger”). Use a conversion curve to configure the sensor.

9.7.5 Engine running/stopped status acknowledgement

There are seven possible ways to define whether the engine is running or not:

- Directly from the electronic control unit (ECU) of the engine (P.0700 <> 0).
- Engine speed (RPM) The engine is in motion if the rotation speed is above P.0225 threshold ("Started engine threshold (rpm)"; it is considered stopped if the rotation speed is below P.0224 threshold ("Stopped engine threshold (rpm)"). This control is not used if:
  - The rotation speed is not available (see above).
  - P.0224=0.
  - P.0225=0.

- P.0224 > P.0225.

- From the voltage of the signal D + of the engine battery charger alternator. The engine is in motion if the tension +D is above P.0230 threshold ("Started engine threshold (+D)"; it is considered stopped if the rotation speed is below P.0231 threshold ("Stopped engine threshold (+D)"). This control is not used if:

- The measurement of voltage +D is not available (P.4041 set with a different function from DIF.1300 "Signal +D").

- P.0230=0.

- P.0231=0.

- P.0230 > P.0231.

- From low and/or minimum lubricant pressure contacts or from the thresholds on the oil pressure analogue measure. The engine is in motion if at least one of the contacts is open (if there is pressure) **or** if the oil pressure measurement is higher than the low **or** minimum thresholds consecutively for P.0232 seconds; it is considered stopped if all the contacts are closed (no pressure) **and** the oil pressure measure is not available or if it is lower than the low **and** minimum thresholds consecutively for five seconds. This control is not used if:

- No digital input acquires low and/or minimum lubricant pressure contacts (no input configured with DIF.4221 and DIF.4222 functions) and the oil pressure measure is not available or the low (P.0339) and minimum (P.0341) thresholds are both “0”.

- If P.0232 parameter ("Engine started from oil pressure contacts") is set to zero.

- From generator AC voltage. The engine is in motion if the tension is above P.0227 threshold ("Started engine threshold (Vac)"; it is considered stopped if the tension is below P.0226 threshold ("Stopped engine threshold (Vac)"). This control is not used if:

- P.0226=0.

- P.0227=0.

- P.0226 > P.0227.

- From generator AC frequency. The engine is in motion if the frequency is above P.0229 threshold ("Started engine threshold (Hz)"; it is considered stopped if the frequency is below P.0228 threshold ("Stopped engine threshold (Hz)"). This control is not used if:

- P.0228=0.

- P.0229=0.

- P.0228 > P.0229.

- From generator DC voltage. The engine is in motion if the tension is above P.9652 threshold ("Started engine threshold (Vdc)"; it is considered stopped if the tension is below P.9651 threshold ("Stopped engine threshold (Vdc)"). This control is not used if:

- P.9651=0.

- P.9652 =0.

- P.9651 > P.9652.

To acknowledge engine running status, at least one of the previous conditions must be continuously present for at least **0.2** seconds. The board will immediately disable the starter motor control (and will prevent a new starting) if it detects the running engine.

The engine is considered stopped if all the previous conditions are met (all the enabled ones) continuously for **five** seconds**.**

9.7.6 Engine commands

The board can handle many digital outputs to control the engine. As follows, there is the list of functions for the configuration of digital outputs, with an acronym used below and a description:

Function	Acronym	Description
DOF.1001	**GLOW_PLUGS**	Command for Diesel engines glow-plugs preheating.
DOF.1002	**ECU_ENABLE**	Enabling control for the engine control unit. It is activated along with the FUEL control but may be deactivated after the FUEL control (useful to stop electronic engines, without causing vacuums in the fuel pipes).
DOF.1003	**FUEL**	Fuel solenoid valve control.
DOF.1004	**GAS**	Gas solenoid valve control (gas engines only).
DOF.1005	**START**	Starter motor control.
DOF.1006	**STOP**	Solenoid control for the stopping of the engine.
DOF.1007	**IDLE**	Control to activate engine reduced speed (IDLE).
DOF.1008	**BATT1**	Control used to manage the dual battery.
DOF.1009	**BATT2**	Control used to manage the dual battery.
DOF.1031	**PREHEAT**	Engine preheating control.
DOF.1033	**PRELUBE**	Engine pre-lubrication control.

All digital outputs of the board are configurable, it is therefore possible to associate in all ways the controls of the engine to the outputs of the board (use P.3001 parameters and following ones, with the functions listed in the table). With the factory configuration of parameters, some controls are pre-assigned:

- STOP: output 1 (JE-1).
- START: output 5 (JL-1).
- FUEL: output 6 (JL-3).

The controls are also available as internal statuses for AND/OR logics (DOF.0103):

- ST.128 (GLOW_PLUGS).
- ST.129 (ECU_ENABLE).
- ST.130 (FUEL).
- ST.131 (GAS).
- ST.132 (START).
- ST.133 (STOP).
- ST.134 (IDLE).
- ST.135 (PREHEAT).
- ST.136 (PRELUBE).

As follows, the controls are described individually.

Note: for electronic engines connected via CAN0 CAN-BUS to HS315, many of these controls are managed directly through the CAN-BUS connection, and therefore it is not necessary to configure the outputs. If the outputs are configured, the board controls them, although the engine is connected in CAN-BUS.

9.7.6.1 Engine preheating control (PREHEAT)

The board can control an external heating system, to maintain the temperature of the engine cooling liquid above a specific temperature. This to heat the engine, so that it is ready to deliver at any time.

This function is disabled if the board does not acquire the temperature of the cooling liquid (neither via CAN-BUS from the engine control board nor through the analogue inputs - AIF.1110 or AIF.1111 functions).

The function is configured via P.0355 and P.0356 parameters:

- P.0355: temperature below which the heating system must activate.
- P.0356: temperature above which the one the heating system must deactivate.

The threshold P.0356 must be set to a value higher than P.0355: the two thresholds guarantee a hysteresis to avoid continue turn the heating system on/off due to minimum temperature shifts. The heating activates if the temperature drops below the threshold P.0355 for at least **one** second; it turns off when the temperature rises above the threshold P.0356 for at least **one** second.

This function is always active, even when the engine is running: it is clear however that when the engine is running, the temperature of the coolant will always be higher than P.0356 threshold, therefore the heating system will always be disabled.

9.7.6.2 Engine pre-lubrication control (PRELUBE)

The board can control the engine pre-lubrication pump. In practice, before starting the engine (so when the mechanic pump of the engine is not working yet), the board can control an auxiliary pump to have the lubricating oil already under pressure when the engine starts moving.

To enable this function, it is necessary to set P.0242 parameter ("Maximum duration of pre-lubrication cycle") to a value other than zero.

The board activates the pre-lubrication control at the beginning of the starting cycle, along with the opening of the fuel solenoid valve. The output is active for the entire pre-lubrication cycle: it ends after P.0242 seconds, or if the board realizes that the lubricating oil is under pressure.

The board considers that the lubricating oil is under pressure if at least one of the following conditions is met:

- If the board acquires the measurement of the lubricant pressure (from the engine control unit via CAN0 CAN-BUS, or via the analogue inputs, AIF.1000 or AIF.1001 functions):
  - If the lubricant low-pressure threshold is set (P.0339 <> 0), when the measured pressure is higher than the threshold.
  - If the lubricant low-pressure threshold is not configured, but minimum pressure threshold is configured (P.0341 <> 0), when the measured pressure is higher than the threshold.
- If the board does not acquire the measurement of lubricant pressure, or if both P.0339 and P.0341 thresholds are set to zero:
  - If the digital input is configured to acquire "oil low pressure" (DIF.4222), when this input is not active.
  - If no digital input is configured to acquire "oil low pressure", but the digital input to acquire the "oil low pressure" (DIF.4221) is configured, when this input is not active.

When the pre-lubrication cycle is ended, the starting sequence goes on (with the starter motor): The pre-lubrication controls remains anyway active until the engine starts or until the starting sequence is interrupted. In case of repeated

attempts to start, the pre-lubrication control persists: the time configured with P.0242 is counted, but only during the first attempt.

9.7.6.3 Glow plugs pre-heating control (GLOW_PLUGS)

This control is intended for the old diesel engines, for which it was necessary to heat glow plugs before starting the engine. It can still be used to insert a delay between the opening of the fuel solenoid valve and the starter motor control: sometimes, as a matter of fact, if the two controls are activated together, the vacuum in the fuel ducts caused by the starter motor does not allow the correct opening of the valve (it gets stuck).

To enable this function, it is necessary to set P.0209 parameter ("Pre-heating cycle maximum duration") to a value other than zero.

The controller activates the glow plugs pre-heating command at the beginning of the starting cycle, along with the opening of the fuel solenoid valve. The output remains active throughout the glow plugs pre-heating cycle: it ends after P.0209 seconds.

When the cycle ends, the starting sequence goes on (with the starter motor control): the glow plugs pre-heating control remains active until the engine starts or until the starting sequence is interrupted. In case of repeated attempts to start, the glow plugs pre-heating control goes on: the time configured with P.0209 is counted, but only during the first attempt.

Warning: the glow plugs pre-heating cycle is performed simultaneously with the pre-lubrication cycle. If P.0242 parameter is set to a value higher than P.0209, the glow plugs pre-heating cycle will last P.0242 seconds as well.

9.7.6.4 Using two battery sets (BATT1 e BATT2)

The controller can control engine cranks alternately managing two battery sets to ensure engine start. To use this function requires at least one output configured with function DOF.1008 (BATT1).

If only BATT1 output is configured, then the controller activates this output to select battery #1, it disables this output to select battery #2.

If both BATT1 and BATT2 outputs are configured, then the active board activates BATT1 output to select battery #1 and BATT2 output to select battery #2. It also guarantees a minimum time of **two** seconds with both outputs off during the shift between battery #1 and battery #2.

Finally, HS315 guarantees a minimum delay of **two** seconds between the selection of a battery and the starter motor control.

In automatic, the board performs on battery #1 the number of starting attempts configured with P.0211 parameter. If the engine does not start, it switches on battery # 2 and performs again the same number of starting attempts. If the engine has not been started yet, it activates A022 shutdown ("failure to start").

In manual mode, the board always performs only one starting attempt, and then it always performs it on battery #1.

The automatic starting sequence is:

- BATT1 output **enabled**, BATT2 output **disabled**.
- 2-second wait (note 1).
- First crank attempt.
- Pause
- ……
- Last crank attempt.
- 2-seconds delay

- BATT1 output **disabled**, BATT2 output **disabled**.
- 2-seconds delay
- Only if BATT2 output exists: BATT1 output **disabled**, BATT2 output **enabled**.
- Only if BATT2 output exists: 2-second wait (note 2).
- First crank attempt with the second battery.
- Pause
- ……
- Last crank attempt with the second battery.
- Failed start alarm.
- 2-seconds delay.
- BATT1 output **disabled**, BATT2 output **disabled**.

Note 1: the **two**-second initial delay between the selection of battery #1 and the starter motor control is performed at the same time of the pre-lubrication cycle and the glow plugs pre-heating cycle, and it could be extended to the longer time between those configured in P.0242 and P.0209.

If the engine starts up, the sequence ends. The output BATT1 or BATT2 active in that moment is disabled after a **2** seconds delay after detecting started engine.

9.7.6.5 Control to enable the engine control unit (ECU_ENABLE)

9.7.6.6 Fuel solenoid valve control (FUEL)

These two controls are activated simultaneously at the beginning of the starting sequence. Both remain active even with started engine, until the starting of the shutdown sequence:

The ECU_ENABLE control is removed immediately at the beginning of the shutdown sequence.

The FUEL control is removed after P.0234 seconds ("delay between STOP and FUEL controls") from the starting of the stopping cycle.

The FUEL control should be used to control the solenoid valve placed on the fuel line. At the beginning of the starting sequence, the board opens the valve, thus allowing the fuel to get to the engine. At the beginning of the stopping sequence, the board closes the solenoid valve: the engine receives no more fuel and then it stops.

The ECU_ENABLE control should be used to give a consent to the starting of electronic control units of the engines. Lacking this consent, it is reflected in the shutdown of the fuel injection system: therefore, without this consent then the engine cannot start, but instead it will be stopped if it was running.

If ECU_ENABLE (not present) or STOP (present) controls are used to stop the engine, but a solenoid valve is anyway present on the fuel line, it is possible that the vacuum in the fuel circuit caused by the engine that is stopping may prevent the correct movement of the solenoid valve. In these cases, by using P.0234 parameter, it is possible to delay the closing control of the fuel solenoid valve with reference to the stop control (ECU_ENABLE or STOP) of the engine: the engine is stopped through its own stopping system and, when the engine is stopped, the fuel solenoid valve can be closed.

9.7.6.7 Command for the starter (START)

This control should be used for the direct control of the starter motor. The board enables the START output to start the engine and shall remove it immediately when it detects a "started engine" status (see 9.7.5). In this way, it ensures the

immediate release of the starter motor ring gear, therefore avoiding that the starter motor is dragged by the engine. In case of failure to start, the board deactivates the START output at the end of the starting attempt.

The duration of each starting attempt is automatically determined by the P.0210 parameter ("Duration of the starting control"). This duration may be increased for gas engines (see below).

The cycle duration of the manual start depends on bit 1 of parameter P.0252:

- 0: the duration of the start attempt is established by the operator; the attempt interrupts when the operator releases the START button.
- >0: the duration of the start attempt is selected by parameter P.0210.

For start cycles controlled through the serial port, the instructions for the automatic are valid.

9.7.6.8 Gas solenoid valve control (GAS)

This control only makes sense for GAS engines. The aim is to perform the washing cycle of the engine. When a GAS engine is turned off, in the feeding circuit unburned gas is still present. If it is not disposed of before the next starting, it could be dangerous because it could explode unrestrainedly. Therefore, each time the engine is started, the washing cycle to remove this unburned gas is performed. The cycle consists in making the engine run, through the starting motor, without opening the GAS valve: the vacuum caused by the engine is enough to remove the unburned gas.

This function is enabled by setting P.0241 parameter to a value higher than zero. The GAS solenoid valve is opened after P.0241 seconds from the time the starter motor was activated (START): for this reason, if the duration of the starting cycle (P.0210) is lower than P.0241 parameter, it is automatically lengthened to a second more than P.0241.

If the starting attempt ends without that the engine has started, the board closes the GAS valve, and, at the next starting attempt, the washing cycle will be repeated.

9.7.6.9 Engine stop command when energized (STOP)

This control is used in systems where it is preferred to give priority to the supply by the generator. When the FUEL control is used, as a matter of fact, a failure of the solenoid valve control system results in its closure, and the resultant stop of engine consequently.

The STOP control is instead active only during the stopping cycle. Its purpose is to block the flow of fuel to the engine only during the stopping phase: when the engine has been stopped, the output is disabled, so allowing the reopening of the fuel pipeline. In this case, it is always possible to start the engine, even at the presence of a fault on the STOP control: at the limit it will not be possible to stop the engine.

The STOP control is activated at the beginning of the stopping cycle, at the same time when the ECU_ENABLE control is removed. The STOP control will remain active for the time set with P.0213 parameter ("Duration of the stop control").

Note: If the engine stops in a shorter time, and a restarting of the engine is required, the STOP control is disabled before.

9.7.6.10 Idle speed command (IDLE)

This control is used to activate the reduced rotation speed, directly on the rpm regulator of the engine.

The output is active during the entire IDLE cycle. Note: if there is a request for IDLE before starting the engine, the control will be already active from the beginning of the starting sequence. Similarly, if the IDLE request is active during the stopping cycle, the control is active as well.

The IDLE cycle can be requested in two ways:

- By setting a nonzero delay in P.0233 parameter ("Low speed cycle duration"). The board performs an IDLE cycle at each stating of the engine (both manual and automatic). The maximum duration of the IDLE cycle is the one set with P.0233 parameter. It is however possible to link the duration of the cycle to the temperature of the coolant. By setting a nonzero value in P.0223 parameter ("Minimum temperature for the consent to supply"), the board monitors the temperature of the coolant and, as soon as it is above P.0223 threshold, it stops the IDLE cycle.

- With a digital input configured with DIF.2061 function ("Request for reduced speed"). When the input is active, the board runs the IDLE cycle.

  During the IDLE cycle, minimum frequency and minimum voltage protections of the generator are disabled. At the end of the IDLE cycle, before enabling the protections, the board requires that voltages and frequency are within tolerance: if it is not the case, the board activates A008 shutdown ("no steady status").

  During the IDLE cycle the board does not allow the closing of GCB switch. If the IDLE cycle is requested (with the digital input) while GCB is closed, the board opens GCB switch first (in case by discharging power if the generator is parallel to anything), and then activates the IDLE control.

  For some Can Bus engines, the speed during the IDLE phase can be selected by means parameter P.0710.

9.7.7 Consent to starting

HS315 provides for DIF.2709 function ("Consent to starting") for the configuration of the digital inputs.

The board uses this input as consent to start: if the starting of the engine is required and there is an input configured with this function, HS315 waits until the input is active before performing the starting cycle. When the starting is initiated, the input is not more checked (it can also be deactivated). The purpose of this input is to manage external sequences, such as, for example, the pre-ventilation of the room where the generator is installed. Example of use:

- When the board receives a request to start, its internal management mode shifts to "start", but if the digital input is not active, the actual starting procedure will not be performed.
- The internal "start" status can activate a digital output (DOF.0103 function "AND/OR logics" with ST.036 status). This output can activate the external pre-ventilation sequence.
- When the external sequence is finished, it will have to activate the digital input configured as DIF.2709: at this point, **HS315** goes on with the starting of the engine.

  This function is particularly useful when **HS315** should work with a MC100 board. In this case, in fact, it is not possible to use the "inhibition to automatic intervention" function to prevent the starting of the engine during the pre-ventilation phase (or others): MC100, in fact, when it wants to start a generator, switches the related **HS315** to REMOTE START, where the requests for "inhibition to automatic intervention" are ignored.

  It is also useful if the external sequences should be performed also in MAN (because in MAN the requests of "inhibition to automatic intervention" are ignored).

9.7.8 Manual control sequence

9.7.8.1 Manual start

With the board in MAN, it is possible to request the starting of the engine in three ways:

- With the START key of the panel.

  There are two possible sequences of start-up:

  - Sequence totally manual: it is used in MAN if the parameter P.0252 (“Number of manual crank attempts”) is zero. The duration of the start attempt is established by the operator; the attempt interrupts when the operator releases the START button. If the operator releases the START button when the engine has not been started yet, the controller leaves the fuel circuit open for ten seconds (to check if the engine starts): then, in case, it performs an automatic stop cycle. The GAS valve is immediately closed when the START button is released (if the engine is not started).
  - Automatic sequence in manual: it is used in MAN if the parameter P.0252 (“Number of manual crank attempts”) is different from zero. The duration of the start attempt is selected by parameter P.0210. The controller performs P.0252 start attempts, activating the “fail to start anomaly” if the engine does not start.

If the engine starts, the controller automatically removes the command of the starter motor. During the manual start, the controller will automatically perform pre-lubrication, glow plugs pre-heating and cleaning cycles. The starting is always performed with battery #1 (if two batteries are configured).

- With a digital input configured with DIF.2033 function ("Manual starting control"). This input is managed exactly as the START key: same as said above.
- It is possible to control the starting of the engine manually with a control through the serial ports. These controls can be enabled by a digital input configured with DIF.2706 function - "Enable controls from the serial ports": if this input exists, it should be active. To start the engine manually, it is necessary to write (within 5 seconds) the Modbus registers in sequence:
  - HOLDING REGISTER 101: enter the password configured with the parameter P.0004.
  - HOLDING REGISTER 102: enter the value “11”.

  In response to this control, the board performs the starting as if it were in automatic. But it performs only one start attempt, and if it fails, it does not activate A022 "failure to start" shutdown.

  Note: if the starting is requested in MAN when the engine is already running (but it was not started by the board), HS315 acknowledges the situation: it activates all engine controls as if it had started it, except for the starter motor, that is not activated.

9.7.8.2 Manual stop

With the board in MAN, it is possible to request the stopping of the engine in four ways:

- With the STOP key on the board panel of the card.
- With a digital input configured with DIF.2034 function ("Manual stop control"). This input is managed exactly as the STOP key: same as said above.
- It is possible to control the stopping of the engine manually with a control through the serial ports. These controls can be enabled by a digital input configured with DIF.2706 function - "Enable controls from the serial ports": if this input exists, it should be active. To start the engine manually, it is necessary to write (within 5 seconds) the Modbus registers in sequence:
  - HOLDING REGISTER 101: enter the password configured with the parameter P.0004.
  - HOLDING REGISTER 102: enter the value “21” or “22”.

  Note: the stop cycle can also be performed with already stopped engine.

  As a rule, in MAN the controller does not perform any cooling cycle for the engine: the operator is free to keep the engine running (without load) as long as the coolant temperature is sufficiently low. From version 1.09, however, it is possible to enable the cooling cycle also in MAN mode, by setting to "1" the bit 1 of the parameter P.0249. If enabled, the cooling cycle will be performed before each stop cycle, if the GCB circuit breaker has previously been closed. A second stop command during the cooling cycle stops it.

9.7.9 Automatic command sequence

Before describing automatic start/stop procedures, it is necessary to define when the engine should be started and stopped automatically.

The engine is started automatically if there are no shutdowns and deactivations and if at least one of these conditions is present:

- If the TEST is activated.
- If the REMOTE START is activated.

- If there is no active "inhibition to automatic intervention" of the generator and the automatic intervention of the generator is required:

  - A charge cycle is required for the plant battery.
  - The loads are not supplied by the plant battery nor by the auxiliary source. In this condition, the controller starts the engine only if P.9653 is set to 1 (it enables this function).
  - The engine's cranking battery is discharged, and the engine is required to start charging it (P.9655 <> 0).
  - If the controller has both the opening and closing commands for the GCB circuit breaker, it normally opens GCB before stopping the engine. If configured by setting parameter P.0243 to “1”, the controller can keep the engine running if it is not able to open the circuit breaker.

  In automatic mode, the engine can be stopped in two ways:

- With normal procedure. After opening the GCB switch (if possible), the board performs a cooling cycle of the engine (only if previously the load was connected to the generator), by keeping it running without load (or at 0 current if GCB cannot be opened). This procedure applies if:

  - No automatic start request is pending (see above)
  - It triggers an "inhibition to automatic intervention", with the board in AUTO.
  - An anomaly qualified as “deactivation” occurred (it is an anomaly typically dangerous for loads but not for the engine).

- With an emergency procedure. This procedure requires immediate engine stop, without engine cooling cycle. It applies if:

  - The key switch is turned on OFF/RESET
  - Any anomaly described as a "shutdown" is activated. In automatic mode, the stop commands from panel (STOP button, if not disabled by bit 0 of parameter P.0495), from serial port and from SMS are included in this category since they activate the alarm A07 (manual stop in auto mode).

9.7.9.1 Automatic start

The board automatically executes the number of starting attempts configured with P.0211 parameter ("Number of starting attempts") for each battery set. At the end, if the engine is not started, it activates A022 shutdown - "Failure to start".

Each starting attempt has the maximum duration configured with P.0210 parameter ("Duration of the starting control"). It however ends if the condition of started engine is detected. Within the starting procedure, HS315 automatically manages pre-lubrication, glow plugs pre-heating and cleaning cycles.

Between a starting attempt and the next one, the board makes a pause with a duration configured with P.0212 parameter ("Delay between two starts"). This pause may be longer when the selected battery set is changed.

If, during a starting attempt, the board recognizes the started engine condition, it waits for the maximum time configured with P.0217 parameter ("Maximum time for steady statuses") until voltages and frequency of the generator are within tolerance:

- If during the pause the engine stops, the board will go on with the next starting attempts.
- If generator voltages and frequency are "within tolerance", the starting procedure is ended: from this time on, also minimum voltage and minimum frequency protections are active.
- If, at the end of the pause, voltages or frequency are not "within tolerance", the board activates A008 shutdown "no steady status".

If the low-speed cycle is required, the previous pause will be performed after it is finished.

At the end of the automatic starting procedure, the board manages a further delay that allows the generator to stabilize/warm up before being connected to the load. This delay can be configured with P.0218 parameter ("delay before delivery"): it does not work in MAN.

9.7.9.2 Standard automatic stop

This procedure starts after the board has opened GCB switch (or at least after the board has made an attempt to open, if it could be opened).

If during the automatic operations the board closed GCB switch, it considers that the generator was heated by the load, and that it therefore needs to cool down before being stopped. Then a cooling cycle is performed. It simply consists in keeping the engine started without load for the time set with P.0215 parameter ("Duration of the cooling cycle"). The cooling cycle can be aborted before the time set with P.0215 if the coolant temperature becomes lower than the threshold set with P.0271 parameter (if this threshold is different from zero).

9.7.9.3 Automatic emergency stop

The emergency stop procedure consists in stopping the engine without performing the cooling cycle. This procedure is common also in the standard stop, after the cooling cycle.

During the stopping cycle, the board removes ECU_ENABLE and FUEL controls (the second with P.0234 seconds of delay) and activates the STOP control for P.0213 seconds. The board waits until the engine stops. The maximum duration of the shutdown cycle is configurable with P.0214 parameter ("Duration of the stopping cycle"): if at the end of this phase the engine has not stopped, A021 shutdown is activated - "Failure to stop".

Note: normally the stopping cycle lasts P.0214 seconds even if the engine stops in a shorter time. If during the stopping cycle a new automatic intervention of the generator is required, the same stopping cycle will be arrested only when the engine is completely stopped. In this case HS315 ensures that the STOP and FUEL controls do not overlap.

9.7.10 Masking of oil protections

HS315 provides a parameter that allows configuring a delay (from the moment when the "started engine" condition is recognized) within which the oil pressure protections are disabled. This is to allow time for the pump to pressurize oil and prevent false alarms. The delay is configurable with P.0216 parameter ("Engine protection masking time").

9.7.11 Events

The controller records the following events if the status of the engine varies (if enabled by the bit 3 of P.0441 parameter):

- EVT.1040: engine stopped.
- EVT.1041: starting the engine.
- EVT.1042: engine running (rated speed).
- EVT.1043: cooling down cycle.
- EVT.1044: stopping the engine.
- EVT.1045: engine running (idle speed).

Moreover, the controller records the following events at the changing of start/stop requests (if enabled by the bit 6 of P.0441 parameter):

- EVT.1050: Manual start command.
- EVT.1050: Manual stop command.
- EVT.1052: Automatic start command.
- EVT.1053: Automatic stop command.

- EVT.1054: Start command from digital input.
- EVT.1055: Stop command from digital input.
- EVT.1056: Start command from serial ports / USB / ETHERNET.
- EVT.1057: Stop command from serial ports / USB / ETHERNET.
- EVT.1058: Start command from real time clock.
- EVT.1059: Stop command from real time clock.
- EVT.1060: Start command from SMS.
- EVT.1061: Stop command from SMS.
- EVT.1062: Start command because loads are unsupplied.

9.7.12 Signalling

The following functions for the configuration of the digital inputs are linked to engine management (besides those described for engine direct controls):

- DOF.3061: the output will be activated if the engine is in motion.
- DOF.3062 the output will be activated if the engine is in motion and if the “delay before supplying” (P.0218) has been performed.
- DOF.0103 (Logics AND/OR)
  - ST.032: the output will be activated if the engine is in motion.
  - ST.033: the output will be activated if the engine is in motion and if the “oil protection masking” time span has elapsed (P.0216).
  - ST.035: engine stopped.
  - ST.036: starting cycle ongoing.
  - ST.037: low speed cycle ongoing.
  - ST.038: delay before supplying ongoing.
  - ST.039: engine: ready for power delivery.
  - ST.040: cooling cycle ongoing.
  - ST.041: stopping cycle ongoing.
  - ST_256: CAN 0 in BUS-OFF
  - ST_257: CAN 0 in ERROR-PASSIVE
  - ST_258: CAN 0 in ERROR-ACTIVE
  - ST_259: No messages on CAN 0.
- DOF.4032: the controller activates this output to signal the presence of at least one anomaly related to the engine:
  - 005 - Engine's battery charger failure (from D+).
  - 021 – Engine not stopped.

- 022 - Engine not started.
- 031 - High coolant temperature (from contact).
- 032 - High coolant temperature (from measure).
- 033 - Maximum coolant temperature (from contact).
- 034 - Maximum coolant temperature (from measure).
- 035 - Maximum oil temperature (from measure).
- 037 - Low battery voltage (from measure).
- 038 - High battery voltage (from measure).
- 039 - Service required (1st counter).
- 040 - Service required (2nd counter).
- 041 - Minimum oil pressure (from contact).
- 042 - Minimum oil pressure (from measure).
- 043 - Low oil pressure (from contact).
- 044 - Low oil pressure (from measure).
- 049 - Maximum power.
- 050 - Service required (counter of days).
- 054 - High oil temperature (from measure).
- 062 - CANBUS 0 (engine): BUS-OFF.
- 065 - Low coolant temperature (from measure).
- 096 - Magnetic pickup failure
- 098 - CANBUS 0 (engine): timeout without data.
- 105 - Engine's battery charger failure (from CANBUS).
- 132 - High coolant temperature (from CANBUS).
- 134 - Maximum coolant temperature (from CANBUS).
- 135 - Minimum coolant level (from CANBUS).
- 136 - Low coolant level (from CANBUS).
- 137 - Low battery voltage (from CANBUS).
- 142 - Minimum oil pressure (from CANBUS).
- 144 - Low oil pressure (from CANBUS).
- 158 - High oil temperature (from CANBUS).
- 159 - Maximum oil temperature (from CANBUS).
- 198 - Warnings - Yellow lamp (from CANBUS).

- 199 - Alarms - Red lamp (from CANBUS).

- DOF.4033: the controller activates this output to signal the presence of at least one anomaly related to the engine speed.
  - 017 - Maximum speed (from digital input).
  - 018 - Maximum speed (from measure).
  - 019 - Maximum speed (from Hz).
  - 118 - Maximum speed (from CANBUS)
  - 003 - Minimum generator's frequency.
  - 058 - Low generator's frequency.
  - 060 - High generator's frequency.
  - 004 - Maximum generator's frequency.
- DOF.4034: the controller activates this output to signal the presence of at least one anomaly related to the engine fuel.
  - 025 - Minimum fuel level (from contact).
  - 036 - Minimum fuel level (from measure).
  - 027 - Low fuel level (from contact).
  - 028 - Low fuel level (from measure).
  - 029 - High fuel level (from contact).
  - 030 - High fuel level (from measure).
  - 160 - Water in fuel (from CANBUS).

The following functions, for the configuration of analogue outputs, are linked to engine management. The outputs are managed based on an engine analogue value. Use the "conversion curves" to adapt the single value to the output (0-100%):

- AOF.3001 (“engine speed”).
- AOF.3011 (“oil pressure”).
- AOF.3013 (“oil temperature”).
- AOF.3015 (“oil level”).
- AOF.3023 (“coolant temperature”).
- AOF.3025 (“coolant level”).
- AOF.3035 (“fuel level”).

9.7.13 Fuel pump

The genset implements the full management of the fuel pump, to pump the fuel from the storage tank to the tank on the generator. For the management of the pump, HS315 must acquire the fuel tank level on board of the generator: for this purpose, a float with contacts or an analogue level sensor can be used (that can be selected through P.0401 parameter “type of sensor for fuel pump”).

9.7.13.1 Functioning mode

Three functioning modes of the fuel pump are provided:

- **MANUAL-OFF:** the pump is deactivated.
- **MANUAL-ON:** the pump is activated in any case, and it is deactivated only with the maximum level of the tank on board the generator.
- **AUTOMATIC:** the pump is activated and deactivated automatically based on the tank level on board the generator.

The functioning mode can be selected in five different ways:

- Through the digital inputs configured through the functions:
  - DIF.2241: forces the pump in MANUAL-OFF mode.
  - DIF.2242: forces the pump in MANUAL-ON mode.
  - DIF.2243: forces the pump in AUTOMATIC mode.

  If at least one of these inputs is active, the pump functioning mode is forced and cannot be changed with the other methods described below. In case more than one input is active simultaneously, higher priority is assigned to MANUAL-OFF, followed by MANUAL-ON and then AUTOMATIC.
- By changing P.0400 parameter ("fuel pump mode").
- "E.06" page of HS315 display is dedicated to the fuel pump. From this page it is possible to change the pump functioning mode:
  - Use the ENTER button.
  - Use UP and DOWN keys to select the required mode.
  - Press ENTER to confirm or EXIT to abort.

  Note: if no keys are pressed for 60 seconds, the modification procedure is automatically terminated.

9.7.13.2 Use with an analogue level transducer

To use this function:

- The level analogue transducer should be connected to one of the analogue inputs of HS315 or to DIVIT expansion modules. The utilized analogue input should be configured through AIF.1220 functions (dedicated to VDO sensor, 0%-180 Ohm, 100%-0 Ohm) or through AIF.1221 function (configurable).
- Set the thresholds to activate/deactivate the pump (parameters P.0402 and P.0403).
- In case they are configured, also minimum, low and high fuel level are used (P.0347, P.0345, P.0343 parameters): they are used even if the relevant intervention times are set to zero (to disable anomalies).

  Very important is the thresholds setting which should be ranked by level (from down up), as follows: minimum, low, start, stop, high. As already explained, the controller operates even if thresholds are not in this order; all you need is the first three ones lower than the last two ones (within each of the two groups they can be swapped, but it is not recommended).

9.7.13.3 To use this function requires:

To use this function, it is necessary to connect the contacts of the float to the analogue inputs of the board, by using the functions:

- DIF.4211 (“Minimum fuel level”): input activated if the level is under minimum level threshold.
- DIF.4212 (“Low fuel level"): input activated if the level is under low level threshold.
- DIF.3301 (“Level for the fuel pump starting”): input activated if the level is under pump starting threshold.
- DIF.3302 (“Level for the fuel pump stop”): input activated if the level is **under** pump stopping threshold.
- DIF.4213 (“High fuel level”): Input active if the level is **above** high-level threshold.

The inputs configured through DIF.3301 and DIF.3302 functions are mandatory, the other three are optional. If they are present, they will be used even if the delay for the relevant input has been set to “0” to disable the anomaly.

9.7.13.4 Level evaluation

The controller assigns the actual fuel level by calculating in the order all the following evaluations:

- If the level is lower than the pump start threshold, the controller assigns the “start” position.
- If a low-level threshold exists, and the level is lower than threshold, the controller assigns the “low” position.
- If a minimum level threshold exists, and the level is lower than the threshold, the controller assigns the “minimum” position.
- If the level is higher than the stop threshold, the controller assigns the “stop” position.
- If a maximum level threshold exists, and the level is higher than the threshold, the controller assigns the “maximum” position.
- If none of the previous condition is met, the controller assigns the “hysteresis” position.

9.7.13.5 Pump control

HS315 uses two controls to manage the fuel pump, that can be associated to any digital output (P.3001 parameter and subsequent ones) with the functions:

- DOF.1032 (“Fuel pump”).
- DOF.1034 (“Fuel pump solenoid”).

The output for the pump control is mandatory (otherwise this function is disabled).

The output for the electromagnetic valve is optional. When it is used, it is necessary to configure a delay in P.0405 parameter (“delay between solenoid valve and fuel pump”): HS315 guarantees the opening of the solenoid valve P.0405 seconds **before** activating the pump, and the opening of the solenoid valve P.0405 seconds **after** closing the pump. All that to avoid that the vacuum caused by the pump within the fuel circuit could bring about some malfunctioning of the solenoid valve (it could get stuck).

HS315 controls the pump based on the fuel level and based on the working mode:

- AUTOMATIC. Referring to the position evaluated in the previous paragraph, the pump:
  - Activates if the level is “start”, “low” or “minimum”.
  - Deactivates if the level is “stop” or “maximum”.
  - Retains the actual command if in “hysteresis”.
- MANUAL-ON. Pump can be activated and deactivated according to operator needs. However, the controller prevents the start if the level (see previous paragraphs) is “stop” or “maximum”.
- MANUAL-OFF. The pump is deactivated

HS315 can anyway stop the pump (even if the previous logic would require its start) when the following conditions are present:

- In case anomalies activated by the digital inputs configured through the functions are active:
  - DIF.4051 “warning (turns off the fuel pump))”.
  - DIF.4052 “unload (turns off the fuel pump))”.
  - DIF.4053 “Deactivation (turns off the fuel pump))”.
  - DIF.4054 “Lock (turns off the fuel pump))”.

  Warning: it is the anomaly that stops the pump, not the activation of the input.
- In case anomalies activated by thresholds on analogue inputs are active (P.4003...P.4008 parameters for analogue input 1). This happens only if the anomaly has been specifically configured to stop the pump, through the bit 14 of the threshold configuration parameter (P.4005 for the first threshold on the first analogue input). Warning: it is the anomaly that stops the pump, not the activation of the input.
- Moreover, you can set the maximum fuel pump activation time with parameter P.0404. This parameter should be used to set the time needed for the pump to fill the equipment tank, in the worst conditions: empty tank and engine started at maximum power. If the pump stays in motion (both from manual and automatic control) for a longer time span, the board activates W064 early warning: in fact, it is likely the presence of a failure of the pump or, anyway, that the pump is not drawing from the storage tank. The pump is stopped until W064 early warning is activated: when the operator “cancels” it, the pump restarts with another cycle.
- HS315 allows configuring the electric source that must supply the pump, through P.0406 parameter (“Supplying of the fuel pump”):
  - 0: generator voltage.
  - 4: from an always present voltage.

  If HS315 detects that there isn't voltage on the selected source uninterruptedly for five seconds, it will stop the pump (set P.0406 on “4” to disable this control).
- The pump is disabled in OFF/RESET, but only if this mode persists consecutively for five seconds.

9.7.13.6 Events

The board will record the following events, if the fuel pump status changes (if enabled with the bit 7 of P.0441 parameter):

- EVT.1070: the pump is started.
- EVT.1071: the pump is stopped.

9.7.14 AdBlue fluid pump

The controller implements a complete management of the pump for refilling the AdBlue fluid daily tank from the external storage tank. Pump management includes automatic operation and manual controls, accessible from the front panel.

Three pump operating modes are available:

- AUTO: the pump is started/stopped by the controller according to the level of the AdBlue fluid in the daily tank, with a hysteresis band that prevents continuous starts/stops.

- MAN-ON: the pump is stopped only with the daily tank full. No hysteresis band is managed: as soon as the tank is no longer full, the pump starts.
- MAN-OFF: the pump is always off, even when the daily tank is empty.

The operating mode can be selected in two ways:

- By modifying parameter P.1490 (“AdBlue pump mode”).
- From page E.30 (which is only visible if a digital output is configured for the pump control) it is possible to use the normal setting procedure (ENTER to begin, ▲ and ▼ to modify and ENTER to confirm) to select the control mode of the pump.

Using parameter P.1496 it is possible to select which is the power source of the pump between:

0 – Generator.

4 – Always supplied (power supply is always present).

The controller keeps the pump off if the selected power source is not available (while maintaining the selected operating mode). With the controller in OFF_RESET mode, the pump is always stopped.

The controller can work both with a contact level detection system and with an analogue level measurement.

This function is enabled if at least one of the configurable digital outputs of the controller is set with function DOF.1037 - “Pump for AdBlue”.

It is also possible to configure a digital output to control an interception solenoid valve on the pump line (DOF.1038 - “Solenoid valve for the AdBlue pump”).

In BoardPrg4 there is menu 4.2.4 for the configuration of the pump. However, it is possible to set the individual parameters by acting directly on the controller.

Parameter P.1495 configures the delay between the activation of the solenoid valve command and the pump start command.

9.7.14.1 Use with an analogue level measurement

To use this function, it is necessary that:

- The level measurement is acquired via CanBus by the engine control unit (SPN 1761 - SAE J1939). The ECU must therefore provide this measure.
- The contacts for the level must not be configured (see next paragraph), otherwise the controller uses those.
- At least the thresholds for activating and deactivating the pump are configured (parameters P.1492 and P.1493).

Check that the activation threshold (P.1492) is lower than the deactivation threshold (P.1493).

9.7.14.2 Use with a contact level transducer

To use this function, you need to:

- That the contact level transducer exists.
- That the start and stop contacts are connected to two configurable inputs of the controller.

Contacts must respect the following convention:

- Start contact (input with function DIF.3311): closed when the level is below the starting threshold of the pump.
- Stop contact (input with function DIF.3312): closed if the level is below the pump stop threshold.

9.7.14.3 Evaluation of the level

The controller assigns the current position of the AdBlue fluid level by evaluating all of the following conditions in order:

- If the level is below the pump start threshold, it assigns the "start" position.
- If the level is higher than the pump stop threshold, it assigns the "stop" position.
- If none of the above conditions are true, assign the position "Hysteresis".

9.7.14.4 Automatic management of the pump

With reference to the position evaluated in the previous paragraph, the pump is:

- Activated if the level position is “start”.
- Disabled if the position is “stop”.
- Keeps the current command if the position is “hysteresis”.

9.7.14.5 Manual management of the pump

The pump can be activated and deactivated as required by the operator. However, the controller prevents starting if the level position (see previous paragraphs) is "stop".

9.7.14.6 Protections

With parameter P.1494 it is possible to set the maximum activation duration of the pump. The time necessary for the pump to fill the daily tank, in the worst conditions, should be set in this parameter. If the pump remains running (both by manual and automatic control) for longer than this time, the controller stops it (without changing the control mode) and activates the warning W095: probably there is a fault in the pump or however the pump is not drawing from the storage tank. As soon as the alarm is acknowledged by the operator, the pump restarts.

9.7.14.7 Signalling

The controller makes available the internal commands for the pump and the solenoid valve in two internal statuses (usable in AND/OR logics):

- ST.139: pump control.
- ST.140: solenoid valve control.

In addition, the activation and deactivation of the pump are recorded in the event log (if bit 7 of parameter P.0441 is active):

- EVT.1072: pump activation.
- EVT.1073: pump deactivation.

9.7.15 Maintenance

The controller manages three different maintenance counters.

The first and the second are identical:

- The first can be configured by means P.0424 and P.0425, activates the warning W039.
- The second can be configured by means P.0436 and P.0437, activates the warning W040.

The following description is for the first counter, the second is the same. The board can automatically communicate to the operator the request to carry out engine periodic maintenance. This function is configurable with parameters P.0424 and P.0425. With P.0424, it is possible to set extra operation hours for maintenance service. In P.0425, on the contrary, the type of anomaly to be activated at the end of the period is configured:

- 1: warning (W039).
- 2: Latched warning (K039).
- 4: deactivation (D039).
- 8: shutdown (A039).

The function is enabled if the parameter P.0424 contains a value other than zero. The count starts in the moment this parameter is set. When the configured (working) hours have elapsed, the board records, on its non-volatile memory, the maintenance request. In this way, also cutting off the supply to the board, the piece of information doesn't get lost and, above all, the anomaly cannot be cancelled. If an alarm has been selected withy P.0425, then the generator cannot be used again. This function allows to manage rental contracts “by hour number”.

To cancel the maintenance request (and the relevant signal) requires setting again the parameter P.0424: to disable the function, set the parameter to zero; to set the next maintenance after the same period as the previous one, simply confirm the existing parameter; or set a new interval. To modify these parameters requires installer level password.

The third counter can be configured by means parameter P.0438, that allows to select the number of days to the next maintenance request. You can use the previous description for this counter too, except it activates always a warning (W050).

9.7.16 Cranking battery

It often happens that in the control panel of a generator controlled by HS315 there is no standard battery charger to keep the engine cranking battery charged. It is normally charged by the engine’s battery charger, when the engine is running.

Usually, in this type of system, the engine is started several times a day, so the cranking battery should remain charged.

If it is discharged, however, you can configure HS315 to start the engine for the sole purpose of charging the cranking battery; obviously, once the engine is started, the plant battery will also be charged.

To enable this function, it is necessary to set parameter P.9655: it configures how long (in minutes) the engine must be kept running to recharge the cranking battery.

If P.9655 is different from zero, when the warning W037 is activated (low cranking battery voltage, configured with parameters P.0362 and P.0363), HS315 starts the engine and keeps it running for the time P.9655.

The following events are stored in the archives (if bit 8 of P.0441 is set):

- EVT.1515: engine started for discharged cranking battery.
- EVT.1516: engine stopped for recharged cranking battery.

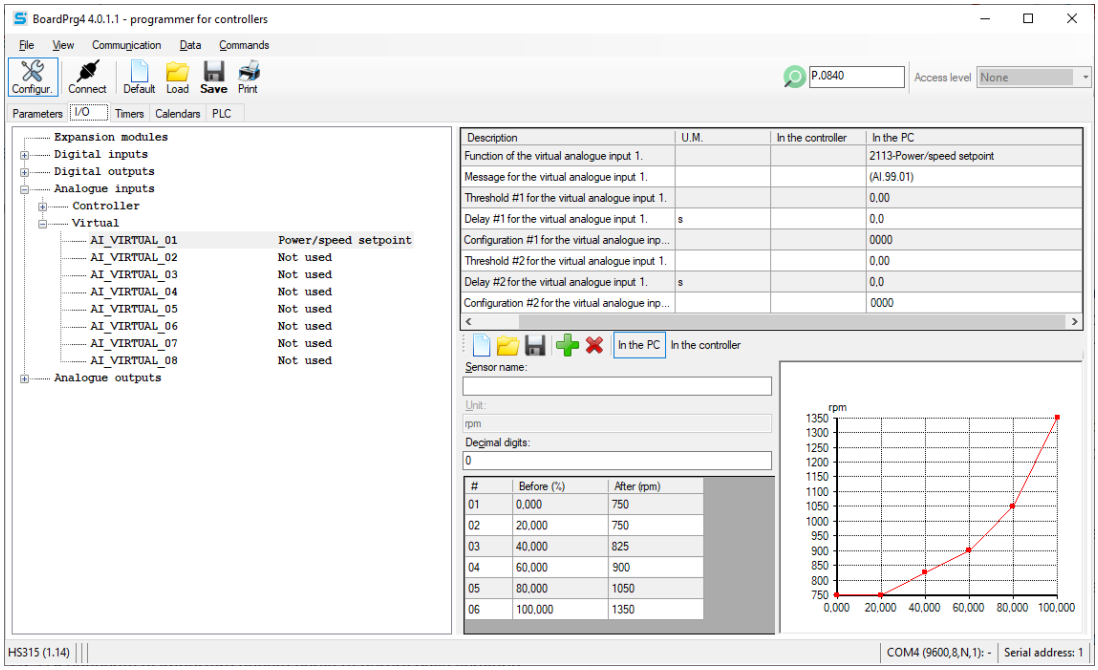
9.7.17 Speed adjustment depending on delivered power

This function is only available for gensets equipped with a traditional alternator with voltage regulator. With these generators, HS315 interfaces with the voltage regulator to manage the charging voltage and current of the storage batteries.

Under these conditions, the engine speed would normally be constant (1500 rpm). However, if the genset is equipped with an ALL-SPEED engine, HS315 can automatically change the engine speed, to make the engine running at the maximum possible efficiency. The engine, in fact, usually has to increase the speed to deliver more power. Making it work at too high speed at low power, however, means consuming fuel unnecessarily.

The engine manufacturer typically provides a curve showing the minimum engine speed required to deliver some powers.

HS315 allows you to import this curve (starting from version 1.09):



By assigning the AIF.2113 function to a virtual analogue input, it is possible to fill in a table as in the previous example, where the engine powers can be indicated in the first column (in % with respect to parameter P.0125). The second column, on the other hand, contains the corresponding minimum speeds (rpm). Up to version 1.13, the engine speeds were also expressed as a percentage in the conversion curve, but this made setting difficult.

Being a virtual analogue input, it is alternatively possible to use the PLC to establish the speed setpoint for the engine (for example taking care of other variables such as the coolant temperature).

To use this function, HS315 must be connected to the speed governor and parameter P.9656 (“Use the speed governor to control the generator voltage”) must be set to “0 - No”. The connection to the speed governor can be made via an analogue output or via CANBUS.

If an analogue output is used, the following parameters allow you to configure it:

- P.0861: configures the direct regulation (the output value increases to increase the engine speed) or inverse (the output value decreases to increase the engine speed).
- P.0862: configure the minimum value for the output (%).
- P.0863: configure the maximum value for the output (%).

The parameters used to configure this function are available in menu 2.7.

The main parameter is P.9781 (“Speed regulation mode”). It accepts three values:

- **0 - Fixed value**.

  This operating mode must be used during commissioning, to check the correspondence between the output command percentage (0-100%) and the real engine speed.

  The analogue output value is determined only by parameter P.0867 ("Offset for speed governor"). By changing P.0867 (0-100%) you can check the real range of the engine speed. If the range is too big, it can be limited using parameters P.0862 and P.0863.

- **1: depending on the power.**

  To work in this mode, you must first:

- From the engine documentation, establish which is the minimum and maximum required speeds (let's assume they are 1300 and 3000 rpm).
- Set P.0713 = 1300 and P.0714 = 3000.
- During commissioning, it is necessary to limit the range of the analogue output, so that an internal command of 0% corresponds to 1300 rpm, and a command of 100% corresponds to 3000 rpm. To make this initial adjustment you need to:
  - Set P.9781 to “0 - Fixed value”.
  - Start the engine.
  - Set P.0867 to 0%. Then, increase P.0862 until the engine runs at 1300 rpm.
  - Set P.0867 to 100%. Then, decrease P.0863 until the engine runs at 1300 rpm.
  - Return P.0867 to 50%.
  - Return P.9781 to “1 - depending on the power”.

  Once this is done:

- The controller measures the power delivered by the generator.
- By interpolating the previous table, it calculates the required speed setpoint.
- By interpolating parameters P.0713 and P.0714, it calculates the 0-100% command percentage for the analogue output.

  The controller does not manage any PID control loop, because the speed regulator is responsible for bringing the speed to the setpoint provided by HS315 through the analogue output.

  In this working mode, the measurement of the engine speed is not required (although it is recommended to have it).

- **2: depending on the power (PID).**

  In this operating mode, the calibration for the analogue output and for parameters P.0713 and P.0714 described in the previous point is not mandatory. However, it is advisable to do it, to avoid requiring a too low or too high engine speed.

  The operations performed in this mode are as follows:

- The controller measures the power delivered by the generator.

- By interpolating the previous table, it calculates the required speed setpoint.
- With a PID control loop, it modifies (every 20 ms) the analogue output to bring the real engine speed to the calculated setpoint.

In this working mode, therefore, the measurement of the engine speed is required. The gains of the PID control loop can be set with parameters P.9785 and P.9786. For this function, the setting of parameter P.0133 (nominal engine speed) is required.

Start-up phase

Parameters P.9782 ("Fixed speed during cranking") and P.9783 ("Fixed speed delay after cranking ") allow you to configure the engine speed during the starting phase.

During this phase (from the start command up to P.9783 seconds after the detection of the engine running), the setpoint P.9782 is used instead of the one calculated depending on the delivered power.

These two parameters were introduced because a 15 kW KUBOTA engine could not start if it was asked to have a too low speed during start-up (but it could then manage such speed once started).

Ramp

Parameter P.9784 (“Speed regulation ramp”) allows you to set a ramp for the speed setpoint. The ramp is not used during start-up and in the initial transient configured with P.9783.

After this transient, the variations of the real speed setpoint (determined by the power supplied by the engine) are followed with this ramp, in order to avoid strong transients (which risk triggering oscillations).

9.8 Breakers management

The controller manages up to 4 circuit breakers:

- BCB (“Battery circuit breaker”).
- GCB (“Generator circuit breaker”).
- LCB (“Loads circuit breaker”).
- ACB (“Auxiliary source circuit breaker”).

The management is identical for all.

Each circuit breaker can be present or not (in this case the controller works as if is present and always closed). The controller can acquire its status or not. The controller can have no command, only the opening command or both opening/closing commands.

The controller manages the stable commands but also the pulse commands (for motorized circuit breakers).

9.8.1 Digital outputs

Four different commands can be used to manage each circuit breakers:

- DOF.2001 - “ACB (NC) Under voltage coil”.

  DOF.2031 - “GCB Under voltage coil”

  DOF.2041 - “BCB (NC) Under voltage coil”

  DOF.2051 - “LCB (NC) Under voltage coil”

  This feature can be used to supply with power the under-voltage coil (if any) of the breaker.

  For the GCB: the controller **disables** this output when it must open the breaker.

  For the other circuit breakers: the controller **enables** this output when it must open the breaker.

  The real closing command will be activated with at least 0.5 seconds after the enabling of this output.

- DOF.2002 - “ACB opening coil”.

  DOF.2032 - “GCB opening coil”.

  DOF.2042 - “BCB opening coil”.

  DOF.2052 - “LCB opening coil”.

  The controller enables this output when it must open the breaker: the output goes back on standby once the breaker feedback shows that it is open (or when the opening time-out expires).

- DOF.2003 - “ACB closing coil”.

  DOF.2033 - “GCB closing coil”.

  DOF.2043 - “BCB closing coil”.

  DOF.2053 - “LCB closing coil”.

  The controller enables this output when it must close the breaker (ensuring that the feature DOF.2001 «if available» has been active for at least 0.5 seconds): the output goes back on standby once the breaker shows that it is closed (or when the closing time-out expires, or if the synchronism condition is no longer met).

- DOF.2004 - “ACB steady opening command”.

  DOF.2034 - “GCB steady closing command”.

  DOF.2044 - “BCB steady opening command”.

  DOF.2054 - “LCB steady opening command”.

  For the GCB: the controller **disables** this output when it must open the breaker.

  For the other circuit breakers: the controller **enables** this output when it must open the breaker.

  HS315 ensures that the DOF.2001 feature «if available» has been active for at least 0.5 seconds.

9.8.2 Digital inputs

The digital inputs of the controller can be used for various purposes, when managing circuit breakers.

9.8.2.1 Acquiring breakers status

The following functions are used by the controller for acquiring the feedbacks of the circuit breakers:

- DIF.3001 - “Status of GCB circuit breaker”.
- DIF.3002 - “Status of ACB circuit breaker”.
- DIF.3006 - “Status of BCB circuit breaker”.
- DIF.3007 - “Status of LCB circuit breaker”.

The controller uses these inputs for:

- Issuing failed opening or failed closing warnings.
- For its own operating sequence.
- It is also used to detect the status of the circuit breaker when it is commanded by external devices.
- To show the status of the circuit breakers on the front panel LEDs.

The delay associated to the input is used as maximum time for opening or closing the breaker.

In theory, the controller could operate even without this feedback. In this case, the controller considers that the breaker is closed once the closing command is issued; it considers that the breaker is open once the opening command is issued. It is always better to connect the feedback.

9.8.2.2 Acquiring the “trip” status of the breakers

The circuit breakers, normally, include an over current protection. The circuit breaker signals the activation of this protection by means a contact: it can be acquired by HS315 by its digital inputs. The following functions are provided:

- DIF.3011 - “Trip of GCB circuit breaker”.
- DIF.3012 - “Trip of ACB circuit breaker”.
- DIF.3016 - “Trip of BCB circuit breaker”.
- DIF.3017 - “Trip of LCB circuit breaker”.

The delay associated to the input is used as filter time for acquiring the contact. If the input is activated for the configured delay, the controller activates an alarm (block, for the GCB circuit breaker) or a latched warning (for the other circuit breakers): these anomalies avoid the closure of the related circuit breakers.

The alarm codes are:

- A015 (for GCB).
- K212 (for ACB).
- K210 (for BCB).
- K211 (for LCB).

9.8.3 Management logic

The general management logic forces the ACB, BCB and LCB circuit breakers always closed. For GCB, instead, it depends on the presence of the closure command (see in the following): if the controller manages the closure command, then the circuit breaker is opened when the engine is stopped and during start/stop/cooling cycles; otherwise, it is always closed.

For each circuit breaker, the controller can manage the following combination of commands:

- No commands. If the controller does not acquire the feedback, then it assumes that the circuit breaker is not present (thus, it is not drawn on page M.01). Instead, if the feedback is acquired, then it assumes that the circuit breaker is “externally managed” (thus it is drawn on page M.01). In both cases, the “not opened” and “not closed” conditions are not signalled.
- Both closure / opening commands. This situation happens with motorized circuit breakers and contactors. The description at the beginning of the paragraph applies. If the controller acquires the feedback of the circuit breaker, a possible inconsistency between command and feedback is signalled by means anomalies.
- Only the closure command. This situation happens in case of “protection only” circuit breakers: the controller can force the opening of the breaker for the trip of its own protections, but a manual operation is required for the re-closure: in this case, the breaker is opened only for the trip of the protections, and never for the management logic. If the controller acquires the feedback of the circuit breaker, a possible inconsistency between command and feedback is signalled by means anomalies.

The following list shows the code for the “not closed” and “not opened” anomalies for the circuit breaker:

- D014: GCB not closed.
- W024: GCB not opened.
- K013: ACB not closed.
- W023: ACB not opened.
- K113: BCB not closed
- W123: BCB not opened.
- K114: LCB not closed
- W124: LCB not opened.

9.8.4 GCB opening requests

The following conditions force the opening of the GCB circuit breaker (and avoid its closure), **but only if one closure command for GCB has been configured**:

- If the controller is in OFF mode.

- If the engine is not running.
- If the engine is running ad idle speed.
- If GCB is opened, when the generator voltage is outside the tolerance thresholds.
- If stop requests are present.
- GCB closure inhibition by a command through the communication ports. The controller does not accept this command if it is in OFF or MAN modes. Such command is temporary (only lasts 30 seconds): so, it must be acknowledged continuously if you want to keep the GCB open. To send the commands you need to write in sequence (within 5 seconds):

  - HOLDING REGISTER 101: enter the password configured with the parameter P.0004.
  - HOLDING REGISTER 102:
    - "31" or "32" to force the GCB opening.
    - "33" to remove the "GCB opening" forcing.
- It is possible to use a digital input configured with the function DIF.2502 – "Inhibition of supply". The controller does not take care of the input when in OFF and MAN modes. When this input is active, the controller commands the opening of the GCB.
- As default, the controller is configured to not supply the loads if they are not connected to the plant battery too (because the battery acts as a filter and stabilizes the voltage produced by the generator). This configuration is achieved by setting the parameter P.9653 to "0". In this condition, if the LCB circuit breaker is closed but the BCB circuit breaker is opened, the controller opens the GCB. This function is not available in OFF and MAN mode.
- If the "voltage matching" is enabled, the controller does not allow the closure of GCB until the generator voltage is aligned with the common bar voltage.

The following conditions always force the opening of the GCB circuit breaker (and avoid its closure):

- Alarms (blocks) and deactivations.
- The trip of the maximum voltage protection for the loads (or the common bar), but only if the engine is running.
- The trip of the minimum voltage protection for the loads (or the common bar). This condition is not checked if the controller is in MAN mode, to allow the charge of a "very discharged" plant battery.

9.8.5 BCB opening requests

The following conditions always force the opening of the BCB circuit breaker (and avoid its closure):

- The trip of the maximum voltage protection for the plant battery.
- The trip of the minimum voltage protection for the plant battery. This condition is not checked if the controller is in MAN mode, to allow the charge of a "very discharged" plant battery.
- The trip of the minimum/maximum temperature protections for the plant battery.
- The trip of the maximum current protections (instantaneous and time dependant) for the plant battery.
- If the BCB is opened, the controller avoids its closure if the plant battery voltage is above the maximum threshold or below the minimum one.

9.8.6 LCB opening requests

The following conditions always force the opening of the LCB circuit breaker (and avoid its closure):

- The trip of the minimum / maximum voltage protections on the loads (or on the common bars), but only after the opening of both GCB and ACB circuit breakers (or in case of opening failure). It acts as backup protection. The minimum voltage protections in not checked if the controller is in MAN mode, to allow the charge of a “very discharged” plant battery.
- If the LCB is opened, the controller avoids its closure if the voltage on the common bar is below the minimum threshold or above the maximum one.
- The trip of the maximum current protections (instantaneous and time dependant) for the loads.
- The trip of the current reverse protection for the loads.

9.8.7 ACB opening requests

The following conditions force the opening of the ACB circuit breaker (and avoid its closure), **but only if one closure command for has been configured**:

- If the auxiliary source voltage is outside the tolerance thresholds.
- As default, the controller is configured to not supply the loads if they are not connected to the plant battery too (because the battery acts as a filter and stabilizes the voltage produced by the auxiliary source). This configuration is achieved by setting the parameter P.9653 to “0”. In this condition, if the LCB circuit breaker is closed but the BCB circuit breaker is opened, the controller opens the ACB. This function is not available in OFF and MAN mode.

The following conditions always force the opening of the ACB circuit breaker (and avoid its closure):

- The trip of the maximum current protections (instantaneous and time dependant) for the auxiliary source.
- The trip of the current reverse protection for the auxiliary source.
- The trip of the maximum voltage protection for the loads (or the common bar), but only if the auxiliary source is present.
- The trip of the minimum voltage protection for the loads (or the common bar). This condition is not checked if the controller is in MAN mode, to allow the charge of a “very discharged” plant battery.
- If ACB is opened, when the auxiliary source voltage is outside the tolerance thresholds.

9.8.8 Management logic in OFF/RESET mode

See 9.8.3.

9.8.9 Management logic in MAN mode

See 9.8.3.

In MAN mode, the operator can decide which breaker must be opened or closed and can interacts with the controller with the manual opening and closing commands.

Manual opening commands are accepted only if at least one digital output of the controller is configured as “opening command”.

Manual closing commands are accepted only if at least one digital output of the controller is configured as “closing command”.

Three types of commands are provided:

- Using the controller buttons.

The keyboard has only one button (GCB) for opening and closing the circuit breakers. If pressed while the circuit breaker is opened, it commands its closure. If pressed while the circuit breaker is closed, it commands its opening. The button can act on all circuit breakers:

- If pressed as a single button, it opens/closes the GCB circuit breaker.
- If pressed together with SHIFT button from the display pages M.02 … M.04, it opens/closes the BCB circuit breaker.
- If pressed together with SHIFT button from the display page M.09, it opens/closes the LCB circuit breaker.
- If pressed together with SHIFT button from the display pages M.10 … M.12, it opens/closes the ACB circuit breaker.

- Using the digital inputs of the controller (to connect external buttons to allow for manual opening/closing of the breakers) The following functions are available:

- Function DIF.1001 – “Request for GCB closure”.
- Function DIF.1002 – “Request for GCB opening”.
- Function DIF.1031 – “Request for ACB closure”.
- Function DIF.1032 – “Request for ACB opening”.
- Function DIF.1061 – “Request for BCB closure”.
- Function DIF.1062 – “Request for BCB opening”.
- Function DIF.1091 – “Request for LCB closure”.
- Function DIF.1092 – “Request for LCB opening”.

  All these commands act on shifting the input from “not active” to “active”, not on the steady “active” state.

  For each breaker you can use both commands or just the closing command. If only the closing command is used, it acts as “toggle”: it commands the breaker opening if it is closed, or its closing if it is open.

- Using the commands received from the communication ports. To send the commands you need to write in sequence (within 5 seconds):

- HOLDING REGISTER 101: enter the password configured with the parameter P.0004.
- HOLDING REGISTER 102:

  - 31 and 32 to open the GCB.
  - 33 to close the GCB.

  - 41 and 42 to open the ACB.
  - 43 to close the ACB.

  - 44 and 45 to open the BCB.
  - 46 to close the BCB.

  - 47 and 48 to open the LCB.
  - 49 to close the LCB.

9.8.10 Management logic in AUTO mode

See 9.8.3.

The GCB circuit breaker is closed, unless the conditions described in 9.8.4.

9.8.11 Management logic in TEST mode

See 9.8.3.

The GCB circuit breaker closure depends whether the TEST is with or without load (see 9.1) and on the conditions described in 9.8.4.

From version 1.09, if the bit 3 of the parameter P.0249 is set to "1", after HS315 has arranged the circuit breakers as described above, the operator has the option of manually open/close them (see 9.8.9).

9.8.12 Management logic in REMOTE START mode

See 9.8.3.

The GCB circuit breaker is closed, unless the conditions described in 9.8.4.

9.8.13 Commands management for the circuit breakers

When using motorized circuit breakers, we suggest using the “pulse” commands for both opening and closing. If the use of the “minimum voltage coil” is required, remember that for ACB, BCB and LCB it works in the opposite way (the controller activates the command to open the circuit breaker): in this way, if HS315 is not supplied, those circuit breakers are not opened.

When using contactors, we suggest the use of the stable commands; remember that for ACB, BCB and LCB they work in the opposite way (the controller activates the command to open the circuit breaker): in this way, if HS315 is not supplied, those circuit breakers are not opened.

The JI connector provides the exchanging contacts free of potential for the digital outputs 07 and 08. Please use these outputs for the stable commands for GCB and BCB (or for the command for the “minimum voltage coils”): the command for GCB must be connected on the NO contact, while the command for BCB must be connected to the NC contact. If the commands for ACB and LCB are also required, you must use the NC contact of external relays commanded by other digital outputs of the controller.

Using parameter P.0220, it is possible to set a minimum time below which it is not possible to invert the command of any circuit breaker. For example, if you set P.0220 to “2.0”, an opening command will be activated at least after two seconds from the previous closing command, and vice versa.

9.8.14 Display lamps

The panel lamps are switched on when the relevant breaker is closed and are switch off when it is open. In details:

- Lamp on: breaker closed.
- Lamp off: breaker open.
- Blinking lamp (during 25% of time): the controller sent the breaker a 'close' command, yet it is open.
- Blinking lamp (during 75% of time): the controller sent the breaker an 'open' command, yet it is closed.

9.8.15 Events and signalling

The following functions for the configuration of the digital inputs are linked to circuit breakers management (besides those described for circuit breakers direct controls):

- DOF.4035: the controller activates this output to signal the presence of at least one anomaly related to the circuit breakers:
  - 013 - ACB not closed.
  - 023 - ACB not opened.

- 014 - GCB not closed.
- 024 - GCB not opened.
- 113 - BCB not closed.
- 123 - BCB not opened.
- 114 - LCB not closed.
- 124 - LCB not opened.

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

- EVT.1030: Closure command for GCB.
- EVT.1031: Opening command for GCB.
- EVT.1032: GCB closed.
- EVT.1033: GCB opened.

- EVT.1035: Closure command for ACB.
- EVT.1036: Opening command for ACB.
- EVT.1037: ACB closed.
- EVT.1038: ACB opened.

- EVT.1430: Closure command for BCB.
- EVT.1431: Opening command for BCB.
- EVT.1432: BCB closed.
- EVT.1433: BCB opened.

- EVT.1435: Closure command for LCB.
- EVT.1436: Opening command for LCB.
- EVT.1437: LCB closed.
- EVT.1438: LCB opened.

The controller records any “GCB open” forcing in the events log, if it is enabled with bit 6 of the P.0441 parameter:

- EVT.1080: GCB closure inhibition activated (from digital input).
- EVT.1081: GCB closure inhibition deactivated.
- EVT.1202: GCB closure inhibition activated (from serial ports / USB / ETHERNET).

- EVT.1203: GCB closure inhibition activated (because GCB is tripped).
- EVT.1204: GCB closure inhibition activated (because plant battery is disconnected).
- EVT.1205: GCB closure inhibition activated (because voltage on bus bars is out of tolerance).
- EVT:1221: start inhibition activated (from clock/calendar).
- EVT:1222: start inhibition deactivated (from clock/calendar).

In addition, the controller makes available the GCB commands and statuses for the AND/OR logics by means of the following internal statuses:

- ST.060 - “GCB status”.
- ST.061 - “BCB status”.
- ST.062 - “LCB status”.
- ST.063 - “ACB status”.
- ST.064 - “GCB minimum voltage coil”.
- ST.065 - "GCB opening pulse".
- ST.066 - "GCB closure pulse”.
- ST.067 - "GCB closure command (stable)”.
- ST.068 - “BCB minimum voltage coil”.
- ST.069 - "BCB opening pulse".
- ST.070 - "BCB closure pulse”.
- ST.071 - "BCB closure command (stable)”.
- ST.072 - “LCB minimum voltage coil”.
- ST.073 - "LCB opening pulse".
- ST.074 - "LCB closure pulse”.
- ST.075 - "LCB closure command (stable)”.
- ST.076 - “ACB minimum voltage coil”.
- ST.077 - "ACB opening pulse".
- ST.078 - "ACB closure pulse”.
- ST.079 - "ACB closure command (stable)”.
- ST.088 - "GCB closure inhibited by contact”.
- ST.090 - "GCB closure inhibited by serial port”.
- ST.091 - "GCB closure inhibited by the protection of the circuit breaker”.
- ST.093 - "GCB closure inhibited for battery disconnected”.

- ST.094 - "GCB closure inhibited for voltage out of thresholds”.
- ST.095 - "GCB closure inhibited for bus voltage out of thresholds”.

10 Anomalies

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

Four types of anomalies are:

- **Warnings**: these anomalies do not require shutting the engine down. They point out to situations that are not dangerous now, but the operator must take some action because, if ignored, they could degenerate in one of the following categories.
- **Latched warning**; these anomalies are very similar to the previous ones. Their activation can result in the opening of one or more circuit breakers. On the contrary of the simple warnings, they require an explicit reset,
- **Deactivations**: these anomalies require shutting the engine down. They are dangerous for the loads but not immediately for the engine. For this reason, the controller opens immediately the GCB breaker, then it stops the engine with standard procedure, i.e., with the cooling cycle. However, it is not possible to restart the engine until the anomaly has not been acknowledged.
- **Alarms**: these anomalies require shutting the engine down. They are dangerous for the loads and/or for the engine and the generator. For this reason, the controller opens immediately the GCB breaker, and stops the engine immediately with standard procedure, i.e., without the cooling cycle. It is not possible to restart the engine until the anomaly is acknowledged.

When an anomaly activates, the controller performs the following:

- It activates the internal horn and, if configured, also the external one. To that purpose, in fact, you can configure an output of the controller with the feature DOF.3152 – “External horn”. The output is controlled together with the inside beeper; the purpose is that of using a more powerful beeper or a lamp.
- Prompts the page S.02 ANOMALIES on the multifunction display. This page shows the numeric code and the current language text related to all active anomalies.
- It activates the flashing of the “ALARM” indicator light, if the anomaly belongs to the warnings or latched warnings categories, or it turns it on if the anomaly belongs to the deactivations or alarms (blocks) categories.
- If the anomaly is an alarm (block) or a deactivation, the controller disconnects the generator and stops the engine (with or without the cooling cycle).
- If the anomaly is a latched warning, it can result in the opening of one or more circuit breakers.

After an anomaly, the operator has three choices:

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

10.1 Silencing the horn

The operator can silence the horn:

- By pressing the ACK/ENTER button.
- By using a command from the communication ports. To send the command you need to write in sequence (within 5 seconds):

- HOLDING REGISTER 101: enter the password configured with the parameter P.0004.
- HOLDING REGISTER 102: enter the value “51”.

Parameter P.0491 (Horn duration) influences the management of the controller's horn.

- 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 presses the ACK button.
- If set to a value between 1 and 998, the horn will be activated when a new anomaly arises and will be deactivated when pressing the ACK button, or after P.0491 seconds from activation.

Silencing the horn is not the same as acknowledging the anomaly: in fact, it continues to flash on page S.02 ANOMALIES.

10.2 Acknowledging the anomaly

The operator can “acknowledge” the anomaly in three ways:

- By pressing the ACK/ENTER button.
- Using a digital input configured with the feature DIF.2002 - “Command for alarm acknowledgment”. When the input becomes active, the controller executes an acknowledge of all anomalies.
- By using a command from the communication ports. To send the command you need to write in sequence (within 5 seconds):
  - HOLDING REGISTER 101: enter the password configured with the parameter P.0004.
  - HOLDING REGISTER 102: enter the value “52”.

When the anomaly has been acknowledged, it stops flashing on page S.02 ANOMALIES. Once acknowledged, if it is only a warning, it is automatically cancelled, if the cause that triggered it is no longer present.

Instead, if the cause disappears before the anomaly is acknowledged, the same will remain on the display.

When the controller performs an anomaly acknowledgement, it also activates for one second the outputs configured with the function DOF.3154 - “Acknowledge of the anomalies”. This helps in using the acknowledge command of the controller for acknowledging alarms on external devices.

10.3 Resetting the anomaly

The operator can “reset” the anomaly in four ways:

- By putting the controller in OFF/RESET mode.
- By pressing the buttons SHIFT + ACK/ENTER.
- By using a command from the communication ports. To send the command you need to write in sequence (within 5 seconds):
  - HOLDING REGISTER 101: enter the password configured with the parameter P.0004.
  - HOLDING REGISTER 102: enter the value “53”.
- Using a digital input configured with the feature DIF.2001 - “Command for resetting alarms”. When the input becomes active, the controller executes a reset of all anomalies.

When the controller performs an anomaly reset, it also activates for one second the outputs configured with the function DOF.3151 - "Reset of the anomalies". This helps in using the reset command of the controller for resetting alarms on external devices.

10.4 Events and signalling

All anomalies are being recorded (each with its own code) in the events log.

There are some functions available for configuring the digital outputs related to anomalies:

- DOF.4001 - "Warnings". The output is "active" if there is at least one warning or one latched warning active.
- DOF.4003 - "Deactivations". The output is "active" if there is at least one deactivation active.
- DOF.4004 - "Alarms". The output is "active" if there is at least one alarm (block) active.
- DOF.4005 - "Alarms and deactivations". The output is "active" if there is at least one alarm (block) or one deactivation active.

  In addition, the controller makes available the anomalies statuses for the AND/OR logics by means of the following internal statuses:

- ST.006 - "Alarms acknowledgment in progress".
- ST.007 - " Alarms reset in progress".
- ST.008 - "Warnings".
- ST.009 - "Latched warnings".
- ST.010 - "Deactivations".
- ST.011 - "Alarms".
- ST.012 - "Not recognized warnings".
- ST.013 - "Not recognized latched warnings".
- ST.014 - " Not recognized deactivations".
- ST.015 - " Not recognized alarms".

10.5 Anomalies list

NOTE: since we cannot define in advance neither which digital or analogue inputs (those from the controller or from the additional modules) will be used, nor what function will they perform, the list below refers, as an example, to the parameters of the first configurable input. The symbol **(*)** or the indication "or equivalent for the other inputs" next to a parameter show that the same varies according to the input configured.

01 – Minimum generator voltage

Type:	**Deactivation**
Related parameters:	**P.0102** Nominal voltage (AC) of the generator. **P.9641** Nominal voltage (DC). **P.0202** Hysteresis for generator's measures. **P.0301** Minimum voltage threshold. **P.0302** Minimum voltage delay.
To disable:	**P.0302=0**
Enabled in:	***MAN, AUTO, TEST, REMOTE START**

Override: **Generator, Full**.

This protection, when possible, works on the DC voltage of the generator. If not possible (GCB closed), if AC voltages are available it works with them, **otherwise it will never be activated**. It is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and it is disabled during the crank/stop cycles. It is enabled the first time (from engine start) the generator's voltages and frequency/speed enter the tolerance range (see generator sequence description). It is activated if, under the conditions previously mentioned, the DC voltage of the generator or at least one of the AC voltages is continuously below the threshold P.0301 for the time P.0302.

In MAN it is only enabled if the GCB breaker is closed, or if the bit 2 of the parameter P.0249 is set to “1”.

02 – Maximum generator voltage

Type: **Alarm**

Related parameters: **P.0102** Nominal voltage (AC) of the generator.
P.9641 Nominal voltage (DC).
P.0202 Hysteresis for generator's measures.
P.0303 Maximum voltage threshold.
P.0304 Maximum voltage delay.

To disable: **P.0304=0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Generator, Full**.

This protection, when possible, works on the DC voltage of the generator. If not possible (GCB closed), if AC voltages are available it works with them, **otherwise it will never be activated.** The protection is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and it is disabled during the crank/stop cycles. It is activated if, under the conditions previously mentioned, the DC voltage of the generator or at least one of the AC voltages exceeds continuously the threshold P.0303 for the time P.0304.

03 – Minimum generator frequency

Type: **Deactivation**

Related parameters: **P.0105** Nominal frequency.
P.0133 Engine's nominal speed (primary).
P.0134 Engine's nominal speed (secondary).
P.0305 Minimum frequency threshold.
P.0306 Minimum frequency delay.

To disable: **P.0306=0**

Enabled in: * **MAN, AUTO, TEST, REMOTE START**

Override: **Generator, Full**.

This protection works on the generator frequency if the AC voltages have been connected, Otherwise, if possible, it works on the engine speed. It is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and it is disabled during the crank/stop cycles. It is enabled the first time (from engine start) the generator's voltages and frequency/speed enter the tolerance range (see generator sequence description). In MAN it is only enabled if the GCB breaker is closed. It is activated if, under the conditions previously mentioned, the generator frequency (or the engine speed) is continuously below the threshold P.0305 for the time P.0306.

In MAN it is only enabled if the GCB breaker is closed, or if the bit 2 of the parameter P.0249 is set to “1”.

04 – Maximum generator frequency

Type: **Alarm**

Related parameters: **P.0105** Nominal frequency.
P.0133 Engine's nominal speed (primary).
P.0134 Engine's nominal speed (secondary).
P.0307 Maximum frequency threshold.
P.0308 Maximum frequency delay.

To disable: **P.0308=0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Generator, Full**.

This protection works on the generator frequency if the AC voltages have been connected, Otherwise, if possible, it works on the engine speed. The protection is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and it is disabled during the crank/stop cycles. It is activated if, under the conditions previously mentioned, the generator frequency (or the engine speed) exceeds continuously the threshold P.0307 for the time P.0308.

05 – Engine's battery charger failure (from D+)

Type: **Configurable**

Related parameters: **P.4041** Function of the analogue input 6 (JL_4).
P.0230 Threshold for engine stopped (D+).
P.0231 Threshold for engine started (D+).
P.0357 Action on belt break.
P.0349 Belt break delay.

To disable: **P.0349=0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Engine**.

This protection is only enabled if the controller is configured to use the D+ signal (P.4041 = AIF.1300 - “D+ Signal”) and if said signal is physically connected to the JL connector.

The protection is enabled if the engine was started from the controller (if the command for fuel solenoid is activated) and it is disabled during the crank/stop cycles. It is activated if the D+ signal voltage is continuously below threshold P.0230 for time P.0349.

06 – Maximum generator current (51)

Type: **Configurable (Alarm/Deactivation)**

Related parameters: **P.9502** Nominal current of the generator.
P.0309 Generator maximum current threshold.
P.0310 Generator maximum current delay.
P.0323 Generator maximum current action.

To disable: **P.0310=0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Generator, Full**.

HS315 performs a time-dependent current protection (therefore, the higher the current overload, the shorter the reaction time) The curve used is called EXTREMELY INVERSE with function I^2t. It is a generator protection as it limits the thermal accumulation of the generator during the supply phase. As engine protection, the maximum power protection must be used, that is independent from the load type.

A maximum current threshold and the maximum time the generator can work with this current are defined. If the current is lower than the defined threshold, the protection does not activate. If the current rises above the threshold,

the protection activates with a time inversely proportional to the overcurrent. To correctly set the thresholds, perform the following steps:

- Set the maximum current threshold with the parameter P.0309, as a percentage of the rated current (P.9502).
- Set the action time in the parameter P.0310: the protection will be activated exactly after this time if the current is constantly equal to the threshold P.0309 multiplied by $\sqrt{2}$, in a shorter time if the current is higher; in a longer time if the current is lower; and it will never do if the current is lower than P.0309.

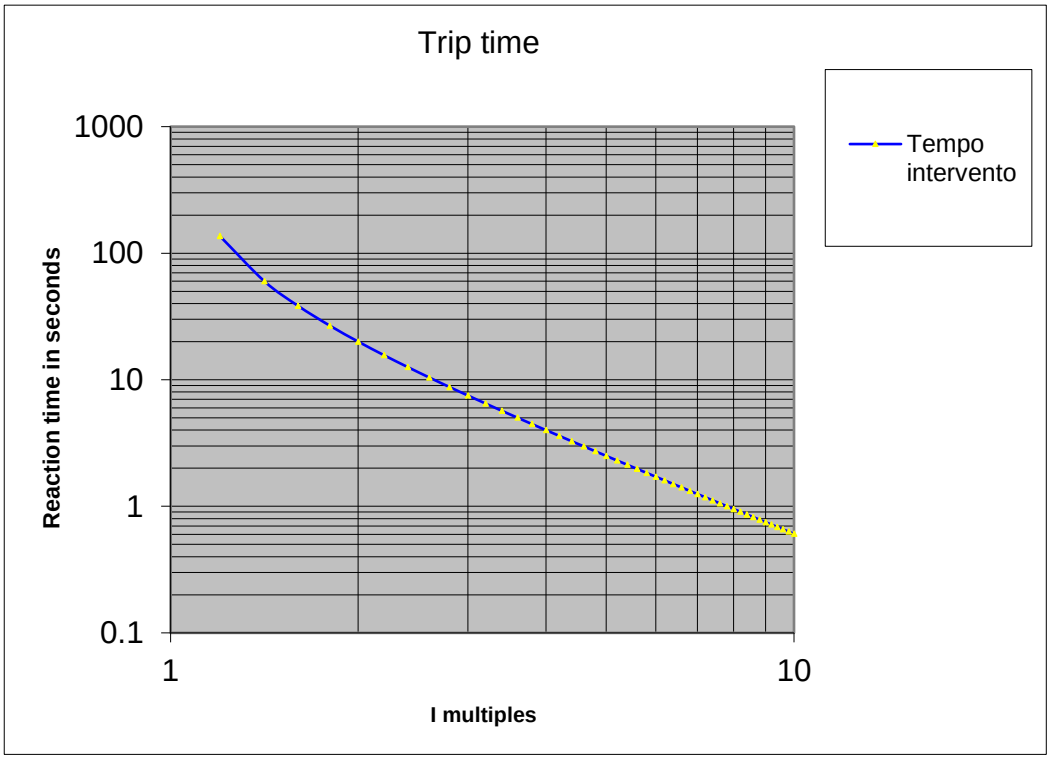
To calculate the intervention time for a set current, please use the following formula:

$$t_I = \frac{P.310}{\left(\frac{I}{P.309}\right)^2 - 1}$$

Where *I* is the current in the circuit.

Please remember that the protection acts by performing the integral of the current value during time; therefore, current values above the rated threshold all concur to define the intervention time, with their instant weight resulting from the above formula. Thus, the only way to experimentally verify this formula is to switch instantaneously from a normal load situation to an overload situation.

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



This protection is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and it is disabled during the crank/stop cycles. Type is configurable with parameter P.0323 (though it cannot be configured as warning).

07 – Manual stop command in automatic mode

Type: **Alarm**

Related parameters: **P.0495** Keyboard options.

To disable: **Bit 0 of P.0495=1**

Enabled in: **AUTO, TEST, REMOTE START**

Override: **-**

This protection is always enabled if the stop command comes through the communication ports or via SMS; it can be disabled for the STOP button by setting the bit 0 of parameter P.0495 to 1.
It is activated when pressing the STOP button on the front panel or sending a stop command through the communication port or via SMS, while in AUTO, TEST or REMOTE START mode.

08 – Operating conditions not reached

Type: **Alarm**

Related parameters: **P.0217** Maximum time for operating conditions.

To disable: **P.0217=0**

Enabled in: **AUTO, TEST, REMOTE START**

Override: **Generator, Full.**

This protection is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and it is disabled during the crank/stop cycles. It is activated when the generator voltages (DC or AC) and the generator frequency (or the engine speed) are not steady within tolerance range within time P.0217 from the engine running acknowledgement (or from the end of the engine's idle cycle, if enabled).

11 – Reverse current on the generator

Type: **Configurable**

Related parameters: **P.9502** Nominal current of the generator.
P.9695 Generator reverse current threshold.
P.9696 Generator reverse current delay.
P.9697 Generator reverse current action.

To disable: **P.9696 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Generator, Full.**

This protection is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and it is disabled during the crank/stop cycles. It is activated if, in the previous conditions, the generator current is negative and has an absolute value continuously above threshold P.9695 (percentage of the nominal current P.9502), for time P.9696. Type is configurable with parameter P.9697 (though it cannot be configured as warning).

13 – ACB not closed

Type: **Warning / latched warning**

Related parameters: **P.2001** Function of the input 01 or equivalent for the other inputs
P.2002 Delay for the input 01 or equivalent for the other inputs.

To disable: **P.2002 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled only when one of the digital inputs of the controller is configured to acquire the ACB status (function DIF.3002 - "Status of ACB circuit breaker") (in parameter P.2001 or equivalent for the other inputs) and if a

time other than zero has been set for said input (parameter P.2002 or equivalent). It activates only when ACB is commanded to close and the status acquired is continuously “open” for the time set. In MAN it is a warning, in the other modes it becomes a latched warning.

14 – GCB not closed

Type: **Warning / deactivation**

Related parameters: **P.2001** Function of the input 01 or equivalent for the other inputs
P.2002 Delay for the input 01 or equivalent for the other inputs.

To disable: **P.2002 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled only when one of the digital inputs of the controller is configured to acquire the GCB status (function DIF.3001 - “Status of GCB circuit breaker”) (in parameter P.2001 or equivalent for the other inputs) and if a time other than zero has been set for said input (parameter P.2002 or equivalent). It activates only when GCB is commanded to close, and the status acquired is continuously “open” for the time set. In MAN it is a warning, in the other modes it becomes a deactivation.

15 – Trip on GCB circuit breaker

Type: **Alarm**

Related parameters: **P.2001** Function of the input 01 or equivalent for the other inputs
P.2002 Delay for the input 01 or equivalent for the other inputs.

To disable: **P.2002 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled only when one of the digital inputs of the controller is configured to acquire the external contact that signals the trip of the over current protection of the circuit breaker (function DIF.3011- “Trip of GCB circuit breaker”) (in parameter P.2001 or equivalent for the other inputs) and if a time other than zero has been set for said input (parameter P.2002 or equivalent). It activates if the configured input remains continuously active for the associated time.

16 – Maximum generator current (50)

Type: **Configurable (Alarm/Deactivation)**

Related parameters: **P.9502** Nominal current of the generator.
P.9691 Generator current hysteresis.
P.0311 Generator short circuit threshold.
P.0312 Generator short circuit delay.
P.9694 Generator short circuit action.

To disable: **P.0312 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Generator, Full.**

In addition to the maximum current protection, the HS315 also provides a short circuit protection for quick intervention independently of timing for the maximum current protection curve. Protection is given by setting a threshold (P.0311) expressed as a percentage of the system rated current (P.9502). It is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and is disabled in the engine start/stop phases. It activates

when the current remains continuously above the P.0311 threshold for time P.0312. Type is configurable with parameter P.9694 (though it cannot be configured as warning).

17 – Maximum speed (from digital input)

Type: **Alarm**

Related parameters: **P.2001** Function of the input 01 or equivalent for the other inputs
P.2002 Delay for the input 01 or equivalent for the other inputs.

To disable: **P.2002 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is enabled only when one of the digital inputs of the controller is configured to acquire the external over speed contact (feature DIF.4251 - “Over speed”) (in parameter P.2001 or equivalent for the other inputs) and if a time other than zero has been set for said input (parameter P.2002 or equivalent). It is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and is disabled in the engine start phase. Active if the configured input remains continuously “active” for the configured time.

18 – Maximum speed (from measure)

Type: **Alarm**

Related parameters: **P.0110** Number of teeth of the pick-up wheel.
P.0111 Rpm/W ratio.
P.0133 Engine's nominal speed (primary).
P.0134 Engine's nominal speed (secondary).
P.0333 Maximum speed threshold (pick-up/w).
P.0334 Maximum speed delay (pick-up/w).
P.0700 Engine type.

To disable: **P.0334 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is enabled only if the controller acquires the measure of the engine speed; it can acquire it through its pick-up input (JM_05, P.0110 other than zero) or through its W input JM_07, P.0111 other than zero) or, finally, from CAN-BUS (P.0700 other than zero). It is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and is disabled in the engine start phase. It is activated if the acquired speed measure exceeds threshold P.0333 (percentage of the rated speed – P.0133 or P.0134) continuously, for time P.0334.

19 – Maximum speed (from Hz)

Type: **Alarm**

Related parameters: **P.0105** Nominal frequency.
P.0331 Maximum speed threshold (frequency).
P.0332 Maximum speed delay (frequency).

To disable: **P.0332 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is only enabled if the AC voltages of the generator have been connected to JG terminals. It is enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and is disabled in the

engine start phases. It is activated if the generator frequency exceeds threshold P.0331 (percentage of the rated frequency P.0105) continuously for time P.0332.

21 – Engine not stopped

Type: **Alarm**

Category: **Generic**

Related parameters: **P.0214 Duration of stopping cycle.**

To disable: **P.0214 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Full**

This protection is activated if the engine does not stop within the time set in P.0214 (since the stop command).

22 – Engine not started

Type: **Alarm**

Related parameters: **P.0211 Number of starts attempts.**

To disable: **-**

Enabled in: **AUTO, TEST, REMOTE START**

Override: **-**

This protection is always enabled. It activates if the controller has performed P.0211 consecutive engine start attempts (auto start) without success.

23 – ACB not opened

Type: **Warning**

Related parameters: **P.2001** Function of the input 01 or equivalent for the other inputs
P.2002 Delay for the input 01 or equivalent for the other inputs.

To disable: **P.2002 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled only when one of the digital inputs of the controller is configured to acquire the ACB status (function DIF.3002 - “Status of ACB circuit breaker”) (in parameter P.2001 or equivalent for the other inputs) and if a time other than zero has been set for said input (parameter P.2002 or equivalent). It activates only when ACB is commanded to open and the status acquired is continuously “closed” for the time set.

24 –GCB not opened

Type: **Warning**

Related parameters: **P.2001** Function of the input 01 or equivalent for the other inputs
P.2002 Delay for the input 01 or equivalent for the other inputs.

To disable: **P.2002 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled only when one of the digital inputs of the controller is configured to acquire the GCB status (function DIF.3001 - “Status of GCB circuit breaker”) (in parameter P.2001 or equivalent for the other inputs) and if a

time other than zero has been set for said input (parameter P.2002 or equivalent). It activates only when GCB is commanded to open, and the status acquired is continuously “closed” for the time set.

25 – Minimum fuel level (from contact)

Type: **Alarm**

Related parameters: **P.2001** Function of the input 01 or equivalent for the other inputs.
P.2002 Delay for the input 01 or equivalent for the other inputs.

To disable: **P.2002 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Engine.**

This protection is enabled only when one of the digital inputs of the controller is configured to acquire the minimum fuel level contact of the float (function DIF.4211 - “Minimum fuel level”) (in parameter P.2001 or equivalent for the other inputs) and if a time other than zero has been set for said input (parameter P.2002 or equivalent). It is activated if the configured input remains continuously active for the associated time.

26 – Minimum fuel level (from measure)

Type: **Alarm**

Related parameters: **P.4009** Function of the analogue input 2 (JQ) or equivalent for the other inputs.
P.0347 Minimum fuel level threshold.
P.0348 Minimum fuel level delay.
P.0700 Engine type.

To disable: **P.0348 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Engine.**

This protection is enabled if the controller acquires the measurement of the fuel level (directly from the ECU of the engine or if one of the analogue inputs of the controller is configured to acquire such measure - function AIF.1220 or AIF.1221 in parameter P.4009 or equivalent for the other inputs) and if a time other than zero has been set for the protection (parameter P.0348). It is activated if the level measure remains continuously below or equal to threshold P.0347 (in percentage) for time P.0348.

27 – Low fuel level (from contact)

Type: **Warning**

Related parameters: **P.2001** Function of the input 01 or equivalent for the other inputs.
P.2002 Delay for the input 01 or equivalent for the other inputs.

To disable: **P.2002 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled only when one of the digital inputs of the controller is configured to acquire the minimum fuel level contact of the float (function DIF.4212 - “Low fuel level”) (in parameter P.2001 or equivalent for the other inputs) and if a time other than zero has been set for said input (parameter P.2002 or equivalent). It is activated if the configured input remains continuously active for the associated time.

28 – Low fuel level (from measure)

Type: **Warning**

Related parameters: **P.4009** Function of the analogue input 2 (JQ) or equivalent for the other inputs.
P.0345 Low fuel level threshold.
P.0346 Low fuel level delay.
P.0700 Engine type.

To disable: **P.0346 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is enabled if the controller acquires the measurement of the fuel level (directly from the ECU of the engine or if one of the analogue inputs of the controller is configured to acquire such measure - function AIF.1220 or AIF.1221 in parameter P.4009 or equivalent for the other inputs) and if a time other than zero has been set for the protection (parameter P.0346). It is activated if the level measure remains continuously below or equal to threshold P.0345 (in percentage) for time P.0346.

29 – High fuel level (from contact)

Type: **Warning**

Related parameters: **P.2001** Function of the input 01 or equivalent for the other inputs.
P.2002 Delay for the input 01 or equivalent for the other inputs.

To disable: **P.2002 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is enabled only when one of the digital inputs of the controller is configured to acquire the minimum fuel level contact of the float (function DIF.4213 - “High fuel level”) (in parameter P.2001 or equivalent for the other inputs) and if a time other than zero has been set for said input (parameter P.2002 or equivalent). It is activated if the configured input remains continuously active for the associated time.

30 – High fuel level (from measure)

Type: **Warning**

Related parameters: **P.4009** Function of the analogue input 2 (JQ) or equivalent for the other inputs.
P.0343 High fuel level threshold.
P.0344 High fuel level delay.
P.0700 Engine type.

To disable: **P.0344 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is enabled if the controller acquires the measurement of the fuel level (directly from the ECU of the engine or if one of the analogue inputs of the controller is configured to acquire such measure - function AIF.1220 or AIF.1221 in parameter P.4009 or equivalent for the other inputs) and if a time other than zero has been set for the protection (parameter P.0344). It is activated if the level measure remains continuously above or equal to threshold P.0343 (in percentage) for time P.0344.

31 – High coolant temperature (from contact)

Type: **Warning**

Related parameters: **P.2001** Function of the input 01 or equivalent for the other inputs.
P.2002 Delay for the input 01 or equivalent for the other inputs.
P.0216 Time mask for engine protections.

To disable: **P.2002 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled only when one of the digital inputs of the controller is configured to acquire the external high coolant temperature contact (function DIF.4231 - “High coolant temperature”) (in parameter P.2001 or equivalent for the other inputs) and if a time other than zero has been set for said input (parameter P.2002 or equivalent). It is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and is disabled in the engine start/stop phases. It activates if the input configured is continuously “active” for the time configured, but only after the time P.0216 (oil mask) from engine start has elapsed (this is to allow you to start the engine idle, to cool it off).

32 – High coolant temperature (from measure)

Type: **Warning**

Related parameters: **P.4009** Function of the analogue input 2 (JQ) or equivalent for the other inputs.
P.0216 Time mask for engine protections.
P.0335 High coolant temperature threshold.
P.0336 High coolant temperature delay.
P.0700 Engine type.

To disable: **P.0336 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled if the controller acquires the measurement of the coolant temperature (directly from the ECU of the engine or if one of the analogue inputs of the controller is configured to acquire such measure - function AIF.1110 or AIF.1111 in parameter P.4009 or equivalent for the other inputs) and if a time other than zero has been set for the protection (parameter P.0336). It is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and is disabled in the engine start/stop phases. It is activated if the temperature remains continuously above or equal to threshold P.0335 for time P.0336, but only after the time P.0216 (oil mask) from engine start has elapsed (this is to allow you to start the engine idle, to cool it off).

33 – Maximum coolant temperature (from contact)

Type: **Alarm**

Related parameters: **P.2001** Function of the input 01 or equivalent for the other inputs.
P.2002 Delay for the input 01 or equivalent for the other inputs.
P.0216 Time mask for engine protections.

To disable: **P.2002 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Engine.**

This protection is enabled only when one of the digital inputs of the controller is configured to acquire the external maximum coolant temperature contact (function DIF.4232 - “Max coolant temperature”) (in parameter P.2001 or equivalent for the other inputs) and if a time other than zero has been set for said input (parameter P.2002 or equivalent). It is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and is disabled in the engine start/stop phases. It activates if the input configured is continuously “active” for the time configured, but only after the time P.0216 (oil mask) from engine start has elapsed (this is to allow you to start the engine idle, to cool it off).

34 – Maximum coolant temperature (from measure)

Type: **Alarm**

Related parameters: **P.4009** Function of the analogue input 2 (JQ) or equivalent for the other inputs.
P.0216 Time mask for engine protections.
P.0337 Maximum coolant temperature threshold.
P.0338 Maximum coolant temperature delay.
P.0700 Engine type.

To disable: **P.0338 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Engine.**

This protection is enabled if the controller acquires the measurement of the coolant temperature (directly from the ECU of the engine or if one of the analogue inputs of the controller is configured to acquire such measure - function AIF.1110 or AIF.1111 in parameter P.4009 or equivalent for the other inputs) and if a time other than zero has been set for the protection (parameter P.0338). It is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and is disabled in the engine start/stop phases. It is activated if the temperature remains continuously above or equal to threshold P.0337 for time P.0338, but only after the time P.0216 (oil mask) from engine start has elapsed (this is to allow you to start the engine idle, to cool it off).

35 – Maximum oil temperature (from measure)

Type: **Alarm**

Related parameters: **P.4009** Function of the analogue input 2 (JQ) or equivalent for the other inputs.
P.0216 Time mask for engine protections.
P.0375 Maximum oil temperature threshold.
P.0376 Maximum oil temperature delay.
P.0700 Engine type.

To disable: **P.0376 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Engine.**

This protection is enabled if the controller acquires the measurement of the oil temperature (directly from the ECU of the engine or if one of the analogue inputs of the controller is configured to acquire such measure - function AIF.1100 or AIF.1101 in parameter P.4009 or equivalent for the other inputs) and if a time other than zero has been set for the protection (parameter P.0376). It is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and is disabled in the engine start/stop phases. It is activated if the oil temperature remains continuously above or equal to threshold P.0375 for time P.0376, but only after the time P.0216 (oil mask) from engine start has elapsed (this is to allow you to start the engine idle, to cool it off).

37 – Low starter battery voltage (from measure)

Type: **Warning**

Related parameters: **P.0362** Low battery voltage threshold.
P.0363 Low battery voltage delay.

To disable: **P.0363 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

It is always enabled except when the cranking motor is activated. It is activated if the engine battery voltage is continuously lower than the threshold P.0362 for time P.0363.

The threshold P.0362 is expressed as a percentage of the rated battery voltage which is not configurable but is automatically selected by the controller between 12 e 24 Vdc. Selection is made when the controller is powered and every time it is forced in OFF/RESET mode. If the controller previously sensed a value lower than, or equal to, 17V, it considers to be powered by a 12V battery, otherwise it will consider a 24 V rated voltage.

38 – High starter battery voltage (from measure)

Type: **Warning**

Related parameters: **P.0364** High battery voltage threshold.
P.0365 High battery voltage delay.

To disable: **P.0365 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

It is always enabled except when the cranking motor is activated. It is activated if the battery voltage is continuously above threshold P.0364 for time P.0365.

The threshold P.0364 is expressed as a percentage of the rated battery voltage which is not configurable but is automatically selected by the controller between 12 e 24 Vdc. Selection is made when the controller is powered and every time it is forced in OFF/RESET mode. If the controller previously sensed a value lower than, or equal to, 17V, it considers to be powered by a 12V battery, otherwise it will consider a 24 V rated voltage.

39 – Service required (1st counter)

Type: **Configurable**

Related parameters: **P.0424** Maintenance interval 1 (running hours).
P.0425 Kind of action for maintenance 1.

To disable: **P.0424 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Engine.**

It is activated after P.0424 engine running hours since parameter P.0424 was last set, by issuing an anomaly whose type is configurable by means parameter P.0425. It cannot be cancelled even disconnecting the controller's power supply. It can be cancelled only by setting P.0424 again, setting it to zero to disable the function or confirming the actual value or setting a new one.

Engine operating hours are counted even when engine is not started by the controller.

To be programmed, parameters P.0424 and P.0425 require “installer” access level: this function can be used for gen-set rental to lock the gen-set when the established hours are elapsed.

40 – Service required (2nd counter)

Type: **Configurable**

Related parameters: **P.0436** Maintenance interval 2 (running hours).
P.0437 Kind of action for maintenance 2.

To disable: **P.0436 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Engine.**

It is activated after P.0436 engine running hours since parameter P.0436 was last set, by issuing an anomaly whose type is configurable by means parameter P.0437. It cannot be cancelled even disconnecting the controller's power supply. It

can be cancelled only by setting P.0436 again, setting it to zero to disable the function or confirming the actual value or setting a new one.

Engine operating hours are counted even when engine is not started by the controller.

To be programmed, parameters P.0436 and P.0437 require “installer” access level: this function can be used for gen-set rental to lock the gen-set when the established hours are elapsed.

41 – Minimum oil pressure (from contact)

Type: **Alarm**

Related parameters: **P.2001** Function of the input 01 or equivalent for the other inputs.
P.2002 Delay for the input 01 or equivalent for the other inputs.
P.0216 Time mask for engine protections.

To disable: **P.2002 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Engine.**

This protection is enabled only when one of the digital inputs of the controller is configured to acquire the external minimum oil pressure contact (function DIF.4221 - “Minimum oil pressure”) (in parameter P.2001 or equivalent for the other inputs) and if a time other than zero has been set for said input (parameter P.2002 or equivalent). It is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and is disabled in the engine start/stop phases. It is activated if the input configured is continuously “active” for the time configured, but only after the time P.0216 (oil mask) from engine start has elapsed (this is to allow you to ignore the normal status of low pressure, which occurs at start up).

42 – Minimum oil pressure (from measure)

Type: **Alarm**

Related parameters: **P.4009** Function of the analogue input 2 (JQ) or equivalent for the other inputs.
P.0216 Time mask for engine protections.
P.0341 Minimum oil pressure threshold.
P.0342 Minimum oil pressure delay.
P.0700 Engine type.

To disable: **P.0342 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Engine.**

This protection is enabled if the controller acquires the measurement of the oil pressure (directly from the ECU of the engine or if one of the analogue inputs of the controller is configured to acquire such measure - function AIF.1000 or AIF.1001 in parameter P.4009 or equivalent for the other inputs) and if a time other than zero has been set for the protection (parameter P.0342). It is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and is disabled in the engine start/stop phases. It is activated if the oil pressure remains continuously below or equal to threshold P.0341 for time P.0342, but only after the time P.0216 (oil mask) from engine start has elapsed (this is to allow you to ignore the normal status of low pressure, which occurs at start up).

43 – Low oil pressure (from contact)

Type: **Warning**

Related parameters: **P.2001** Function of the input 01 or equivalent for the other inputs.
P.2002 Delay for the input 01 or equivalent for the other inputs.
P.0216 Time mask for engine protections.

To disable: **P.2002 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is enabled only when one of the digital inputs of the controller is configured to acquire the external low oil pressure contact (function DIF.4222 - “Low oil pressure”) (in parameter P.2001 or equivalent for the other inputs) and if a time other than zero has been set for said input (parameter P.2002 or equivalent). It is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and is disabled in the engine start/stop phases. It is activated if the input configured is continuously “active” for the time configured, but only after the time P.0216 (oil mask) from engine start has elapsed (this is to allow you to ignore the normal status of low pressure, which occurs at start up).

44 – Low oil pressure (from measure)

Type: **Warning**

Related parameters: **P.4009** Function of the analogue input 2 (JQ) or equivalent for the other inputs.
P.0216 Time mask for engine protections.
P.0339 Low oil pressure threshold.
P.0340 Low oil pressure delay.
P.0700 Engine type.

To disable: **P.0340 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is enabled if the controller acquires the measurement of the oil pressure (directly from the ECU of the engine or if one of the analogue inputs of the controller is configured to acquire such measure - function AIF.1000 or AIF.1001 in parameter P.4009 or equivalent for the other inputs) and if a time other than zero has been set for the protection (parameter P.0340). It is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and is disabled in the engine start/stop phases. It is activated if the oil pressure remains continuously below or equal to threshold P.0339 for time P.0340, but only after the time P.0216 (oil mask) from engine start has elapsed (this is to allow you to ignore the normal status of low pressure, which occurs at start up).

48 – Emergency stop

Type: **Alarm**

Related parameters: **P.0361** Emergency stop delay.

To disable: -

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is always enabled and cannot be disabled. It is activated if the emergency shutdown input remains continuously “not active” for the time set in parameter P.0361 (if the value set is zero, the alarm is triggered as soon as the input becomes inactive).

49 – Maximum power

Type: **Configurable**

Related parameters: **P.0125** Rated engine power.
P.0350 Maximum power threshold.
P.0351 Maximum power delay.
P.0352 Maximum power action.

To disable: **P.0351 =0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Engine.**

This protection is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated), and it is disabled in the engine start/arrest phases. It is activated if the active power of the generator is positive and remains continuously over the threshold P.0350 (percentage of the rated power P.0125) for time P.0351. With parameter P.0352 it is possible to select the protection to be activated.

50 – Service required (counter of days)

Type: **Configurable**

Related parameters: **P.0438** Interval of days for maintenance.

To disable: **P.0438 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

It is activated after P.0438 days since parameter P.0438 was last set (the check is done at each hour change). It cannot be cancelled even disconnecting the controller's power supply. It can be cancelled only by setting P.0438 again, setting it to zero to disable the function or confirming the actual value or setting a new one.

Hours are counted even when engine is stopped

54 – High oil temperature (from measure)

Type: **Warning**

Related parameters: **P.4009** Function of the analogue input 2 (JQ) or equivalent for the other inputs.
P.0216 Time mask for engine protections.
P.0373 High oil temperature threshold.
P.0374 High oil temperature delay.
P.0700 Engine type.

To disable: **P.0374 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled if the controller acquires the measurement of the oil temperature (directly from the ECU of the engine or if one of the analogue inputs of the controller is configured to acquire such measure - function AIF.1100 or AIF.1101 in parameter P.4009 or equivalent for the other inputs) and if a time other than zero has been set for the protection (parameter P.0374). It is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and is disabled in the engine start/stop phases. It is activated if the oil temperature remains continuously above or equal to threshold P.0373 for time P.0374, but only after the time P.0216 (oil mask) from engine start has elapsed (this is to allow you to start the engine idle, to cool it off).

56 – Low generator's voltage

Type: **Warning**

Related parameters: **P.0102** Nominal voltage (AC) of the generator.
P.9641 Nominal voltage (DC).
P.0202 Hysteresis for generator's measures.
P.0391 Low voltage threshold.
P.0392 Low voltage delay.

To disable: **P.0392 = 0**

Enabled in: * **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection, when possible, works on the DC voltage of the generator. If not possible (GCB closed), if AC voltages are available it works with them, **otherwise it will never be activated**. It is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and it is disabled during the crank/stop cycles. It is enabled the first time (from engine start) the generator's voltages and frequency/speed enter the tolerance range (see generator sequence description). In MAN it is only enabled if the GCB breaker is closed. It is activated if, under the conditions previously mentioned, the DC voltage of the generator or at least one of the AC voltages is continuously below the threshold P.0391 for the time P.0392.

In MAN it is only enabled if the GCB breaker is closed, or if the bit 2 of the parameter P.0249 is set to “1”.

57 – Clock not valid

Type: **Warning**

Related parameters: **P.0418** Test enable days.
P.0420 Test duration.
P.0421 Generator enable days.
P.0422 Generator enable start time.
P.0423 Generator enable stop time.
P.0426 Days for remote start.
P.0438 Interval of days for maintenance.

To disable: **Set the clock**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This warning is always enabled. It is activated if the controller detects a not-valid clock status, and functions using the clock are set, such as the weekly test (P.0420), operation enabling time (P.0421, P.0422, P.0423), generator start forced (P.0426) and days to next maintenance (P.0438). To deactivate it, you need to set the clock.

58 – Low generator's frequency

Type: **Warning**

Related parameters: **P.0105** Nominal frequency.
P.0133 Engine's nominal speed (primary).
P.0134 Engine's nominal speed (secondary).
P.0395 Low frequency threshold.
P.0396 Low frequency delay.

To disable: **P.0396 = 0**

Enabled in: * **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection works on the generator frequency if the AC voltages have been connected, Otherwise, if possible, it works on the engine speed. It is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and it is disabled during the crank/stop cycles. It is enabled the first time (from engine start) the generator's voltages and frequency/speed enter the tolerance range (see generator sequence description). In MAN it is only enabled if the GCB breaker is closed. It is activated if, under the conditions previously mentioned, the generator frequency (or the engine speed) is continuously below the threshold P.0395 for the time P.0396.

In MAN it is only enabled if the GCB breaker is closed, or if the bit 2 of the parameter P.0249 is set to “1”.

59 – High generator's voltage

Type: **Warning**

Related parameters: **P.0102** Nominal voltage (AC) of the generator.
P.9641 Nominal voltage (DC).
P.0202 Hysteresis for generator's measures.
P.0393 High voltage threshold.
P.0394 High voltage delay.

To disable: **P.0394 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection, when possible, works on the DC voltage of the generator. If not possible (GCB closed), if AC voltages are available it works with them, **otherwise it will never be activated.** The protection is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and it is disabled during the crank/stop cycles. It is activated if, under the conditions previously mentioned, the DC voltage of the generator or at least one of the AC voltages exceeds continuously the threshold P.0393 for the time P.0394.

60 – High generator's frequency

Type: **Warning**

Related parameters: **P.0105** Nominal frequency.
P.0133 Engine's nominal speed (primary).
P.0134 Engine's nominal speed (secondary).
P.0397 Maximum frequency threshold.
P.0398 Maximum frequency delay.

To disable: **P.0398 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection works on the generator frequency if the AC voltages have been connected, Otherwise, if possible, it works on the engine speed. The protection is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and it is disabled during the crank/stop cycles. It is activated if, under the conditions previously mentioned, the generator frequency (or the engine speed) exceeds continuously the threshold P.0397 for the time P.0398.

62 – CANBUS 0 (engine): BUS-OFF

Type: **Configurable**

Related parameters: **P.0700** Engine type.
P.0703 Can-Bus command level.
P.0709 Action on Can-Bus fault.

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Engine.**

It’s enabled only if CAN-BUS is configured (P.0700 other than zero). It is activated when the internal CAN controller switches to BUS-OFF status because of bus communication errors. Parameter P.0709 is used to select the protection type.

64 – Fuel pump failure

Type: **Warning**

Related parameters: **P.0404** Fuel pump maximum activation time.
P.3001 Function of the output 01 (JE_1) or equivalent for the other outputs

To disable: **P.0404 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is only enabled if there is an output configured to control the fuel pump (feature DOF.1032 – "Fuel pump") (parameter P.3001 or equivalent for the other outputs) and if a time other than zero has been set in parameter P.0404. It activates if the pump operates continuously for the time set; the issuance of a warning turns off the pump, which restarts as soon as the warning is acknowledged.

65 – Low coolant temperature (from measure)

Type: **Warning**

Related parameters: **P.4009** Function of the analogue input 2 (JQ) or equivalent for the other inputs.
P.0216 Time mask for engine protections.
P.0353 Low coolant temperature threshold.
P.0354 Low coolant temperature delay.
P.0700 Engine type.

To disable: **P.0354 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is enabled if the controller acquires the measurement of the coolant temperature (directly from the ECU of the engine or if one of the analogue inputs of the controller is configured to acquire such measure - function AIF.1110 or AIF.1111 in parameter P.4009 or equivalent for the other inputs) and if a time other than zero has been set for the protection (parameter P.0354). It is activated if the temperature remains continuously above or equal to threshold P.0353 for time P.0354.

95 – AdBlue fluid pump failure

Type: **Warning**

Category: **AdBlue fluid pump protection**

Related parameters: **P.1494** Pump maximum activation duration
P.3001 Feature of output 1 or equivalent for the other outputs
P.3201 Equivalent feature for DITEL outputs

To disable: **P.1494 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

This protection is only enabled if there is an output configured to control the AdBlue fluid pump (feature DOF.1037 – "AdBlue pump" in parameter P.3001 or equivalent for the other outputs) and if a time other than zero has been set in parameter P.1494. It activates if the pump operates continuously for the time set. The activation of this warning does not change the pump's operating mode (it turns off the pump, which restarts as soon as the warning is acknowledged).

96 – Magnetic pickup failure

Type: **Configurable**

Category: **Engine protection**

Related parameters: **P.0110** Number of teeth of the pick-up wheel
P.0387 Number of teeth of the pick-up wheel
P.0388 Action for magnetic pickup failure

To disable: **P.0387 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

This protection is enabled only if the controller acquires the engine speed with its input dedicated to the magnetic pick-up (P.0110 different from zero).

It is activated if the controller detects the “engine running “condition, but the measured speed is “0”. This condition must persist for the time configured with P.0387 (the protection is disabled if this time is “0”). With P.0388 the protection is configured as warning, unload, deactivation or alarm.

Remark: if engine’s protections override function is enabled, this anomaly becomes a warning.

97 – Communication failure with the AVR

Type: **Configurable**

Related parameters: **P.1700** Voltage regulator (AVR) type
P.1706 Communication timeout with AVR (s)
P.1707 Action for communication failure with AVR

To disable: **P.1707 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

It’s enabled only if the CAN-BUS connection to the automatic voltage regulator is configured (P.1700). It is activated if the controller does not continuously receive messages from the voltage regulator for time P.1706. With P.1707 the protection is configured as warning, unload, deactivation or alarm (or none).

98 – Communication failure with the ECU

Type: **Configurable**

Related parameters: **P.0700** Engine type.
P.0797 Action for communication failure with the ECU.
P.0711 Maximum time without messages from engine.
P.0795 Maximum number of retransmissions to the ECU.
P.0796 Maximum wait for responses from the ECU.

To disable: **P.0797 = 0 (not for MTU engines)**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Engine.**

It’s enabled only if CAN-BUS is configured (P.0700 other than zero). For MTU MDEC engines (value from 140 to 147 in parameter P.0700), it is enabled as per specification when the controller does not continuously receive the message NMT ALIVE PDU for the set time. For the other types of engines, it is activated if the controller does not continuously receive messages from the engine for the configured delays. P.0709 configures the kind of protection.

105 – Battery-charger failure (from CAN-BUS).

Type: **Warning**

Related parameters: **P.0700** Engine type.
P.0704 Can-Bus alarms disable mask.

To disable: **bit 11 of P.0704 on**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled only if the board is connected to the engine via the CAN BUS (P.0700 different from zero). It is activated when the engine signals the battery-charger alternator failure status over the CAN BUS, but only after the time P.0216 (oil mask) from engine start has elapsed.

118 – Maximum speed (from CANBUS)

Type: **Alarm**

Related parameters: **P.0700** Engine type.
P.0704 Can-Bus alarms disable mask.

To disable: **bit 10 of P.0704 on**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled only if the board is connected to the engine via the CAN BUS (P.0700 different from zero). It is activated when the engine signals the over speed state over the CAN BUS.

123 – BCB not opened

Type: **Warning**

Related parameters: **P.2001** Function of the input 01 or equivalent for the other inputs
P.2002 Delay for the input 01 or equivalent for the other inputs.

To disable: **P.2002 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled only when one of the digital inputs of the controller is configured to acquire the BCB status (function DIF.3006 - “Status of BCB circuit breaker”) (in parameter P.2001 or equivalent for the other inputs) and if a time other than zero has been set for said input (parameter P.2002 or equivalent). It activates only when BCB is commanded to open and the status acquired is continuously “closed” for the time set.

124 –LCB not opened

Type: **Warning**

Related parameters: **P.2001** Function of the input 01 or equivalent for the other inputs
P.2002 Delay for the input 01 or equivalent for the other inputs.

To disable: **P.2002 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled only when one of the digital inputs of the controller is configured to acquire the LCB status (function DIF.3007 - “Status of LCB circuit breaker”) (in parameter P.2001 or equivalent for the other inputs) and if a time other than zero has been set for said input (parameter P.2002 or equivalent). It activates only when LCB is commanded to open and the status acquired is continuously “closed” for the time set.

132 – High coolant temperature (from CANBUS)

Type: **Warning**

Related parameters: **P.0700** Engine type.
P.0704 Can-Bus alarms disable mask.

To disable: **bit 4 of P.0704 on**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled only if the board is connected to the engine via the CAN BUS (P.0700 different from zero). It is activated when the engine signals the coolant high temperature state over the CAN BUS. Only for SCANIA engines, the protection is activated only after the time P.0216 (oil mask) from engine start has elapsed.

134 – Maximum coolant temperature (from CANBUS)

Type: **Alarm**

Related parameters: **P.0700** Engine type.
P.0704 Can-Bus alarms disable mask.

To disable: **bit 5 of P.704 on**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Engine.**

This protection is enabled only if the board is connected to the engine via the CAN BUS (P.0700 different from zero). It is activated when the engine signals the coolant maximum temperature state over the CAN BUS. Only for SCANIA engines, the protection is activated only after the time P.0216 (oil mask) from engine start has elapsed.

135 – Minimum coolant level (from CANBUS)

Type: **Alarm**

Related parameters: **P.0700** Engine type.
P.0704 Can-Bus alarms disable mask.

To disable: **bit 7 of P.0704 on**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Engine.**

This protection is enabled only if the board is connected to the engine via the CAN BUS (P.0700 different from zero). It is activated when the engine signals the minimum coolant level state over the CAN BUS.

136 – Low coolant level (from CANBUS)

Type: **Warning**

Related parameters: **P.0700** Engine type.
P.0704 Can-Bus alarms disable mask.

To disable: **bit 6 of P.0704 on**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is enabled only if the board is connected to the engine via the CAN BUS (P.0700 different from zero). It is activated when the engine signals the low coolant level state over the CAN BUS.

137 – Low battery voltage (from CANBUS)

Type: **Warning**

Related parameters: **P.0700** Engine type.
P.0704 Can-Bus alarms disable mask.

To disable: **bit 9 of P.0704 on**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is enabled only if the board is connected to the engine via the CAN BUS (P.0700 different from zero). It is activated when the engine signals the low battery voltage state over the CAN BUS.

142 – Minimum oil pressure (from CANBUS)

Type: **Alarm**

Related parameters: **P.0700** Engine type.
P.0704 Can-Bus alarms disable mask.

To disable: **bit 1 of P.0704 on**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Engine.**

This protection is enabled only if the board is connected to the engine via the CAN BUS (P.0700 different from zero). It is activated when the engine signals the minimum oil pressure state over the CAN BUS. Only for SCANIA engines, the protection is activated only after the time P.0216 (oil mask) from engine start has elapsed.

144 – Low oil pressure (from CANBUS)

Type: **Warning**

Related parameters: **P.0700** Engine type.
P.0704 Can-Bus alarms disable mask.

To disable: **bit 0 of P.0704 on**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled only if the board is connected to the engine via the CAN BUS (P.0700 different from zero). It is activated when the engine signals the low oil pressure state over the CAN BUS. Only for SCANIA engines, the protection is activated only after the time P.0216 (oil mask) from engine start has elapsed.

158 – High oil temperature (from CANBUS)

Type: **Warning**

Related parameters: **P.0700** Engine type.
P.0704 Can-Bus alarms disable mask.

To disable: **bit 2 of P.0704 on**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled only if the board is connected to the engine via the CAN BUS (P.0700 different from zero). It is activated when the engine signals the high oil temperature state over the CAN BUS.

159 – Maximum oil temperature (from CANBUS)

Type: **Alarm**

Related parameters: **P.0700** Engine type.
P.0704 Can-Bus alarms disable mask.

To disable: **bit 3 of P.0704 on**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Engine.**

This protection is enabled only if the board is connected to the engine via the CAN BUS (P.0700 different from zero). It is activated when the engine signals the maximum oil temperature state over the CAN BUS.

160 – Water in fuel (from CANBUS)

Type: **Warning**

Related parameters: **P.0700** Engine type.
P.0704 Can-Bus alarms disable mask.

To disable: **bit 8 of P.0704 on**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is enabled only if the board is connected to the engine via the CAN BUS (P.0700 different from zero). It is activated when the engine signals the water in fuel state over the CAN BUS.

198 – Warnings - Yellow lamp (from CANBUS)

Type: **Warning**

Related parameters: **P.0700** Engine type.
P.0704 Can-Bus alarms disable mask.

To disable: **bit 14 of P.0704 on**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is enabled only if the board is connected to the engine via the CAN BUS (P.0700 different from zero). It is activated when the engine signals the active state of its yellow lamp over the CAN BUS.

199 – Alarms - Red lamp (from CANBUS)

Type: **Configurable**

Related parameters: **P.0700** Engine type.
P.0704 Can-Bus alarms disable mask.

To disable: **bit 15 of P.0704 on**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Engine.**

This protection is enabled only if the board is connected to the engine via the CAN BUS (P.0700 different from zero). It is activated when the engine signals the active state of its red lamp over the CAN BUS. Using bit 13 of P.0704 it is possible to configure the protection as warning or alarm.

210 – Trip on BCB circuit breaker

Type: **Latched warning**

Related parameters: **P.2001** Function of the input 01 or equivalent for the other inputs
P.2002 Delay for the input 01 or equivalent for the other inputs.

To disable: **P.2002 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is enabled only when one of the digital inputs of the controller is configured to acquire the external contact that signals the trip of the over current protection of the circuit breaker (function DIF.3016 - “Trip of BCB circuit breaker”) (in parameter P.2001 or equivalent for the other inputs) and if a time other than zero has been set for said input (parameter P.2002 or equivalent). It activates if the configured input remains continuously active for the associated time.

211 – Trip on LCB circuit breaker

Type: **Latched warning**

Related parameters: **P.2001** Function of the input 01 or equivalent for the other inputs
P.2002 Delay for the input 01 or equivalent for the other inputs.

To disable: **P.2002 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled only when one of the digital inputs of the controller is configured to acquire the external contact that signals the trip of the over current protection of the circuit breaker (function DIF.3017 - “Trip of LCB circuit breaker”) (in parameter P.2001 or equivalent for the other inputs) and if a time other than zero has been set for said input (parameter P.2002 or equivalent). It activates if the configured input remains continuously active for the associated time.

212 – Trip on ACB circuit breaker

Type: **Latched warning**

Related parameters: **P.2001** Function of the input 01 or equivalent for the other inputs
P.2002 Delay for the input 01 or equivalent for the other inputs.

To disable: **P.2002 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled only when one of the digital inputs of the controller is configured to acquire the external contact that signals the trip of the over current protection of the circuit breaker (function DIF.3012 - “Trip of ACB circuit breaker”) (in parameter P.2001 or equivalent for the other inputs) and if a time other than zero has been set for said input (parameter P.2002 or equivalent). It activates if the configured input remains continuously active for the associated time.

213 – Failure of the battery temperature sensor

Type: **Warning**

Related parameters: **P.9636** Function for terminal JP.
P.9662 Voltage compensation due to temperature.
P.9663 Charge current compensation due to temperature.

To disable: **-**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **-**

This protection is enabled if JP terminals are enabled (P.9636 <> 0). It is activated if the resistance measurement on the JP terminals is greater than 333 Ohm ("broken wire").

Moreover, it is enabled if it is required the compensation of the voltage and current thresholds for the plant battery related to the plant battery temperature. It is activated if the measure of the plant battery temperature is not available because the PT100 sensor is not properly connected to the JP terminals.

214 – Min storage battery temperature

Type: **Latched warning**

Related parameters: **P.9701** Battery temperature hysteresis.
P.9702 Min battery temperature threshold.
P.9703 Min battery temperature delay.

To disable: **P.9702 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is activated if the measure of the plant battery temperature remains continuously below to threshold P.9702 for time P.9703.

215 – Low storage battery temperature

Type: **Warning**

Related parameters: **P.9701** Battery temperature hysteresis.
P.9704 Low battery temperature threshold.
P.9705 Low battery temperature delay.

To disable: **P.9705 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is activated if the measure of the plant battery temperature remains continuously below to threshold P.9704 for time P.9705.

216 – High storage battery temperature

Type: **Warning**

Related parameters: **P.9701** Battery temperature hysteresis.
P.9706 High battery temperature threshold.
P.9707 High battery temperature delay.

To disable: **P.9707 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is activated if the measure of the plant battery temperature remains continuously above the threshold P.9706 for time P.9707.

217 – Max storage battery temperature

Type: **Latched warning**

Related parameters: **P.9701** Battery temperature hysteresis.
P.9708 Max battery temperature threshold.
P.9709 Max battery temperature delay.

To disable: **P.9709 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is activated if the measure of the plant battery temperature remains continuously above the threshold P.9708 for time P.9709.

218 – Min storage battery voltage

Type: **Latched warning**

Related parameters: **P.9641** Nominal voltage (DC).
P.9711 Battery voltage hysteresis.
P.9712 Min battery voltage threshold.
P.9713 Min battery voltage delay.

To disable: **P.9713 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is activated if the measure of the plant battery voltage remains continuously below to threshold P.9712 (percentage of the rated voltage P.9641) for time P.9713.

219 – Low storage battery voltage

Type: **Warning**

Related parameters: **P.9641** Nominal voltage (DC).
P.9711 Battery voltage hysteresis.
P.9714 Low battery voltage threshold.
P.9715 Low battery voltage delay.

To disable: **P.9715 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is activated if the measure of the plant battery voltage remains continuously below to threshold P.9714 (percentage of the rated voltage P.9641) for time P.9715.

220 – High storage battery voltage

Type: **Warning**

Related parameters: **P.9641** Nominal voltage (DC).
P.9711 Battery voltage hysteresis.
P.9716 High battery voltage threshold.
P.9717 High battery voltage delay.

To disable: **P.9717 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is activated if the measure of the plant battery voltage remains continuously above to threshold P.9716 (percentage of the rated voltage P.9641) for time P.9717.

221 – Max storage battery voltage

Type: **Latched warning**

Related parameters: **P.9641** Nominal voltage (DC).
P.9711 Battery voltage hysteresis.

P.9718 Max battery voltage threshold.
P.9719 Max battery voltage delay.

To disable: **P.9719 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is activated if the measure of the plant battery voltage remains continuously above to threshold P.9718 (percentage of the rated voltage P.9641) for time P.9719.

222 – High storage battery current

Type: **Warning**

Related parameters: **P.9721** Battery current hysteresis.
P.9722 High battery current threshold.
P.9723 High battery current delay.

To disable: **P.9723 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is activated if the measure of the plant battery current remains continuously above to threshold P.9722 for time P.9723.

223 – Max storage battery current (50)

Type: **Latched warning**

Related parameters: **P.9724** High battery current threshold.
P.9725 High battery current delay.

To disable: **P.9725 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

HS315 performs a time-dependent current protection (therefore, the higher the current overload, the shorter the reaction time) The curve used is called EXTREMELY INVERSE with function I^2t. See description for anomaly 006.

The protection will be activated exactly after this time (P.9725) if the current is constantly equal to the threshold P.9724 multiplied by $\sqrt{2}$, in a shorter time if the current is higher; in a longer time if the current is lower; and it will never do if the current is lower than P.9724

224 – Max storage battery current (51)

Type: **Latched warning**

Related parameters: **P.9721** Battery current hysteresis.
P.9726 Battery short circuit threshold.
P.9727 Battery short circuit delay.

To disable: **P.9727 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is activated if the measure of the plant battery current remains continuously above to threshold P.9726 for time P.9727.

225 – High generator current

Type: **Warning**

Related parameters: **P.9502** Nominal current of the generator.
P.9691 Generator current hysteresis.
P.9692 Generator high current threshold.
P.9693 Generator high current delay.

To disable: **P.9693 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Generator, Full.**

Protection is given by setting a threshold (P.9692) expressed as a percentage of the system rated current (P.9502). It is only enabled if the engine has been started by the controller (if the command for the fuel solenoid is activated) and is disabled in the engine start/stop phases. It activates when the current remains continuously above the P.9692 threshold for time P.9693.

228 – Electronic battery: timeout without data

Type: **Configurable**

Related parameters: **F.1750** BMS type
P.1756 Communication timeout with BMS (s)
P.1763 Maximum number of retransmissions to BMS
P.1764 Maximum wait for responses from BMS
P.1757 Action for communication failure with BMS

To disable: -

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is only enabled if the controller is connected to an electronic battery (F.1750). It activates if HS315 does not receive battery feedback for the configured delays. Parameter P.1757 defines the type of anomaly.

232 – High auxiliary source current

Type: **Warning**

Related parameters: **P.9731** Auxiliary source current hysteresis.
P.9732 High auxiliary source current threshold.
P.9733 High auxiliary source current delay.

To disable: **P.9733 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is activated if the measure of the auxiliary source current remains continuously above to threshold P.9732 for time P.9733.

233 – Maximum auxiliary source current (50)

Type: **Latched warning**

Related parameters: **P.9734** Maximum auxiliary source current threshold.
P.9735 Maximum auxiliary source current delay.

To disable: **P.9735 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

HS315 performs a time-dependent current protection (therefore, the higher the current overload, the shorter the reaction time) The curve used is called EXTREMELY INVERSE with function I^2t. See description for anomaly 006.

The protection will be activated exactly after this time (P.9735) if the current is constantly equal to the threshold P.9734 multiplied by $\sqrt{2}$, in a shorter time if the current is higher; in a longer time if the current is lower; and it will never do if the current is lower than P.9734

234 – Maximum auxiliary source current (51)

Type: **Latched warning**

Related parameters: **P.9731** Auxiliary source current hysteresis.
P.9736 Auxiliary source short circuit threshold.
P.9737 Auxiliary source short circuit delay.

To disable: **P.9737 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is activated if the measure of the auxiliary source current remains continuously above to threshold P.9736 for time P.9737.

235 – Reverse current on the auxiliary source

Type: **Latched warning**

Related parameters: **P.9731** Auxiliary source current hysteresis.
P.9738 Auxiliary source reverse current threshold.
P.9739 Auxiliary source reverse current delay.

To disable: **P.9739 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is activated if the auxiliary source current is negative and has an absolute value continuously above threshold P.9738 for time P.9739.

237 – Generator status not available

Type: **Warning**

Related parameters: -

To disable: -

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

When GCB is closed, and the generator is connected to the plant battery and/or to the auxiliary source, the DC voltage measured by the controller is not the generator voltage, but the common bar voltage. Thus, the controller is not able to detect faults on the generator and signals this situation through this warning. You can avoid this problem in three ways:

- Connecting also at least one AC voltage (separated from the common bar by the rectifier diodes).

- If the controller acquires the engine speed, it can at least detect if the engine is stopped or if it is running outside the seed limits.

242 – High loads current

Type: **Warning**

Related parameters: **P.9751** Loads current hysteresis.
P.9752 High loads current threshold.
P.9753 High loads current delay.

To disable: **P.9753 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is activated if the measure of the loads current remains continuously above to threshold P.9752 for time P.9753.

243 – Max loads current (50)

Type: **Latched warning**

Related parameters: **P.9754** Max loads current threshold.
P.9755 Max loads current delay.

To disable: **P.9755 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

HS315 performs a time-dependent current protection (therefore, the higher the current overload, the shorter the reaction time) The curve used is called EXTREMELY INVERSE with function I^2t. See description for anomaly 006.

The protection will be activated exactly after this time (P.9755) if the current is constantly equal to the threshold P.9754 multiplied by $\sqrt{2}$, in a shorter time if the current is higher; in a longer time if the current is lower; and it will never do if the current is lower than P.9754

244 – Max loads current (51)

Type: **Latched warning**

Related parameters: **P.9751** Loads current hysteresis.
P.9756 Loads short circuit threshold.
P.9757 Loads short circuit delay.

To disable: **P.9757 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is activated if the measure of the loads current remains continuously above to threshold P.9736 for time P.9737.

245 – Reverse current on the loads

Type: **Latched warning**

Related parameters: **P.9751** Loads current hysteresis.
P.9758 Loads reverse current delay.
P.9759 Loads reverse current action.

To disable: **P.9759 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection is activated if the loads current is negative and has an absolute value continuously above threshold P.9758 for time P.9759.

252 – EXBUS: some modules are missing

Type: **Warning**

Related parameters: **P.0141** Number of DITEL modules.
P.0142 Number of DITEMP modules.
P.0143 Number of DIVIT modules.
P.0144 Number of DANOUT modules.

To disable: -

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This warning is enabled if a number of modules other than zero has been set (in parameters P.0141, P.0142, P.0143 or P.0144). It is activated if one or more controllers connected to CAN-BUS (EXBUS) are not available. Page S.02 shows the module that does not communicate.

253 – CAN-BUS (EXBUS) missing measure

Type: **Warning**
Related parameters: **P.0142** Number of DITEMP modules.
P.0143 Number of DIVIT modules.

To disable: **P.0142=0** e **P.0143=0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This warning is enabled if a number of analogue modules other than zero has been set (in parameters P.0142 or P.0143). It activates if one or more CAN-BUS (EXBUS) measures are not properly configured or in case of faulty sensor. Page S.02 shows the faulty channel and module.

254 – EXBUS: duplicated address

Type: **Warning**

Related parameters: **P.0141** Number of DITEL modules.
P.0142 Number of DITEMP modules.
P.0143 Number of DIVIT modules.
P.0144 Number of DANOUT modules.

To disable: -

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This warning is enabled if a number of modules other than zero has been set (in parameters P.0141, P.0142, P.0143 or P.0144). It is activated in case of hardware addresses conflict for one or several controllers connected to CAN-BUS (EXBUS). Page S.02 shows the module with conflict.

255 - EXBUS: sensor disconnected.

Type: **Warning**

Related parameters: **P.0142** Number of DITEMP modules.
P.0143 Number of DIVIT modules.

To disable: -

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This warning is enabled if a number of analogue modules other than zero has been set (in parameters P.0142 or P.0143). It activates if an analogue sensor has not been physically connected to an analogue input of the controller on CAN-BUS (EXBUS). Page S.02 shows the faulty channel and module.

261 – Min bus-bars voltage

Type: **Latched warning**

Related parameters: **P.9641** Nominal voltage (DC).
P.9741 Load's voltage hysteresis.
P.9742 Min loads voltage threshold.
P.9743 Min loads voltage delay.

To disable: **P.9743 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection works on the DC voltage of the common bar. Its purpose is to protect the loads from low voltages. Since there isn't a DC measure for the common bar, the protection works with the loads DC voltage if LCB is closed. If LCB is opened, the protection is disabled. It is activated if the measure of the voltage remains continuously below to threshold P.9742 (percentage of the rated voltage P.9641) for time P.9743.

262 – Min bus-bars voltage

Type: **Warning**

Related parameters: **P.9641** Nominal voltage (DC).
P.9741 Load's voltage hysteresis.
P.9744 Low loads voltage threshold.
P.9745 Low loads voltage delay.

To disable: **P.9745 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection works on the DC voltage of the common bar. Its purpose is to protect the loads from low voltages. Since there isn't a DC measure for the common bar, the protection works with the loads DC voltage if LCB is closed. If LCB is opened, the protection is disabled. It is activated if the measure of the voltage remains continuously below to threshold P.9744 (percentage of the rated voltage P.9641) for time P.9745.

263 – High bus-bars voltage

Type: **Warning**

Related parameters: **P.9641** Nominal voltage (DC).
P.9741 Load's voltage hysteresis.
P.9746 High loads voltage threshold.
P.9747 High loads voltage threshold.

To disable: **P.9747 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection works on the DC voltage of the common bar. Since a high voltage can be caused only by the generator or by the auxiliary source, the purpose of this protection is to force the opening of both ACB and BCB in case of high voltage (leaving the loads supplied by the plant battery). Since there isn't a DC measure for the common bar, the protection works with the loads DC voltage if LCB is closed.

If LCB is opened, and both generator and auxiliary source are generating currents, the protection uses another voltage, evaluated in the following order:

- Plant battery DC voltage if BCB is closed.
- Generator DC voltage if GCB is closed and the engine is running.
- Auxiliary source DC voltage.

This protection is activated if the measure of the voltage remains continuously above to threshold P.9746 (percentage of the rated voltage P.9641) for time P.9747.

264 – Max bus-bars voltage

Type: **Latched warning**

Related parameters: **P.9641** Nominal voltage (DC).
P.9741 Load's voltage hysteresis.
P.9748 Max loads voltage threshold.
P.9749 Max loads voltage delay.

To disable: **P.9749 = 0**

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This protection works on the DC voltage of the common bar. Since a high voltage can be caused only by the generator or by the auxiliary source, the purpose of this protection is to force the opening of both ACB and BCB in case of high voltage (leaving the loads supplied by the plant battery). Since there isn't a DC measure for the common bar, the protection works with the loads DC voltage if LCB is closed.

If LCB is opened, and both generator and auxiliary source are generating currents, the protection uses another voltage, evaluated in the following order:

- Plant battery DC voltage if BCB is closed.
- Generator DC voltage if GCB is closed and the engine is running.
- Auxiliary source DC voltage.

This protection is activated if the measure of the voltage remains continuously above to threshold P.9748 (percentage of the rated voltage P.9641) for time P.9749.

273 – Parameters not coherent

Type: **Warning / Alarm**

Related parameters: -

To disable: -

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: -

This anomaly signals a wrong configuration of the parameters of the controller. When it is activated, the page S.02 shows a description that explains the problem:

- **Battery voltage not acquired (alarm).** Check the configuration for terminals JG, JH and JQ:
  - If this voltage is connected to terminals JQ, set P.9635 with the function “032 – DC voltage for the battery”.
  - Otherwise, there should be:
    - One terminal of JG or JH configured with the function “033 – DC voltage for the battery (+)”.
    - One terminal of JG or JH configured with the function “034 – DC voltage for the battery (-)” or with the function “051 – Common terminal (-) for DC voltages”.

  Note: HS315 may get this value from the messages sent by the BMSs: if the BMSs are not powered (DIF.2763) and the controller is configured to read this value from them (P.9762), HS315 does not activate this warning.
- **Battery current not acquired (block).** Check the configuration for terminals JU: one of them must be configured with the function “031 – DC current for the battery”.

  Note: HS315 may get this value from the messages sent by the BMSs: if the BMSs are not powered (DIF.2763) and the controller is configured to read this value from them (P.9762), HS315 does not activate this warning.
- **Negative battery voltage (block).** Swap the two wires that connect this voltage to the controller.
- **Negative generator voltage (DC) (block).** Swap the two wires that connect this voltage to the controller.
- **Negative loads voltage (block).** Swap the two wires that connect this voltage to the controller.
- **Negative auxiliary source voltage (DC) (block).** Swap the two wires that connect this voltage to the controller.
- **Charge current (BULK) limited to nominal (warning).** The generator is not able to charge the battery with the required current (P.9675 or P.9682, see 8.5.7) because the loads are absorbing too much current (the sum of the two is more than the generator nominal current). Since version 1.18 this cause has been eliminated.
- **JG4 can be used for generator neutral only (warning).** The controller is configured to acquire at least one AC voltage of the generator: in this case, the terminal JG-4 can be used only to acquire the neutral (otherwise leave P.9614 = “000 – Not used”).
- **JH4 can be used for auxiliary source neutral only (warning).** The controller is configured to acquire at least one AC voltage of the auxiliary source: in this case, the terminal JH-4 can be used only to acquire the neutral (otherwise leave P.9618 = “000 – Not used”).
- **Capacity of battery not set (block).** The parameter P.9642 is set to zero: set it with the rated battery capacity.

  Note: HS315 may get this value from the messages sent by the BMSs: if the BMSs are not powered (DIF.2763) and the controller is configured to read this value from them (P.9762), HS315 does not activate this warning.
- **Discharge current not set (block).** The parameter P.9643 is set to zero: set it with the rated discharge current.

  Note: HS315 may get this value from the messages sent by the BMSs: if the BMSs are not powered (DIF.2763) and the controller is configured to read this value from them (P.9762), HS315 does not activate this warning.

301...432 – From analogue and virtual input #xxx.

Type: **Configurable**

Related parameters: **P.4009** Function analogue input 2 (JQ) or equivalent for the other inputs
P.4010 Message analogue input 2 (JQ) or equivalent for the other inputs
P.4011 Threshold 1 analogue input 2 (JQ) or equivalent for the other inputs
P.4012 Delay 1 analogue input 2 (JQ) or equivalent for the other inputs

P.4013 Configuration 1 analogue input 2 (JQ) or equivalent
P.4014 Threshold 2 analogue input 2 (JQ) or equivalent for the other inputs
P.4015 Delay 2 analogue input 2 (JQ) or equivalent for the other inputs
P.4016 Configuration 2 analogue input 2 (JQ) or equivalent

To disable: **P.4012** or **P.4015** = 0 (for input 2 (JQ) or equivalent for other inputs.

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Configurable**

These anomalies are triggered by the analogue measure's thresholds. See [1] to check the correspondence between alarm code and analogue input.

See par. 5.6.5 for configuring the activation thresholds for these anomalies.

701...774 – From digital and virtual input #xxx.

Type: **Warning**

Related parameters: **P.2001** Feature of the input 01 or equivalent for the other inputs
P.2002 Delay for the input 01 or equivalent for the other inputs
P.2003 Message for the input 01 or equivalent for the other inputs

To disable: **P.2002** = 0 (for input 01 or equivalent for other inputs).

Enabled in: **MAN, AUTO, TEST, REMOTE START**

Override: **Configurable**

These anomalies are triggered by the digital inputs configured with the following functions:

- DIF.4001 – "Generic warning".
- DIF.4002 – "Generic latched warning".
- DIF.4003 – "Generic deactivation".
- DIF.4004 – "Generic alarm (block)".

  If the input stays continuously "active" for the time configured, an anomaly of the related type is activated: the message shown is the one set by means of the related parameters.
- DIF.4011 – "General warning (after oil delay)".
- DIF.4012 – "General latched warning (after oil delay)".
- DIF.4013 – "General deactivation (after oil delay)".
- DIF.4014 – "General alarm (block) (after oil delay)".

  If the input stays continuously "active" for the time configured, and if the time set by means of the P.0216 parameter (Engine protections mask time) has elapsed, an anomaly of the related type is activated: the message shown is the one set by means of the related parameters. Remark: if engine's protections override function is enabled, this anomaly becomes a warning.
- DIF.4021 – "General warning (if GCB is closed)".
- DIF.4022 – "General latched warning (if GCB is closed)".
- DIF.4023 – "General deactivation (if GCB is closed)".
- DIF.4024 – "General alarm (block) (if GCB is closed)".

If the input stays continuously "active" for the time configured, with GCB closed, an anomaly of the related type is activated: the message shown is the one set by means of the related parameters.

- DIF.4031 – “General warning (if FUEL is activated)”.
- DIF.4032 – “General latched warning (if FUEL is activated)”.
- DIF.4033 – “General deactivation (if FUEL is activated)”.
- DIF.4034 – “General alarm (block) (if FUEL is activated)”.

  If the input stays continuously "active" for the time configured and if the command for the fuel solenoid is active, an anomaly of the related type is activated: the message shown is the one set by means the related parameters.

- DIF.4041 – “General warning (if GAS is activated)”.
- DIF.4042 – “General latched warning (if GAS is activated)”.
- DIF.4043 – “General deactivation (if GAS is activated)”.
- DIF.4044 – “General alarm (block) (if GAS is activated)”.

  If the input stays continuously "active" for the time configured and if the command for the gas valve (for gas driven engines) is active, an anomaly of the related type is activated: the message shown is the one set by means the related parameters.

- DIF.4051 – “General warning (if fuel pump is activated)”.
- DIF.4052 – “General latched warning (if fuel pump is activated)”.
- DIF.4053 – “General deactivation (if fuel pump is activated)”.
- DIF.4054 – “General alarm (block) (if fuel pump is activated)”.

  If the input stays continuously "active" for the time configured, an anomaly of the related type is activated: the message shown is the one set by means of the related parameters. The controller locks the fuel pump if this input is “active” (The pump is stopped and not set to “MAN-OFF”).

- DIF.4062 – “General latched warning (subject to override)”.
- DIF.4063 – “General deactivation (subject to override)”.
- DIF.4064 – “General alarm (block) (subject to override)”.

  If the input stays continuously "active" for the time configured, an anomaly of the related type is activated: the message shown is the one set by means of the related parameters. Remark: if engine’s protections override function is enabled, this anomaly becomes a warning.

  See [1] to check the correspondence between alarm code and analogue input.

900 – Incoherent PLC Parameters

Type:	**Warning**
Related parameters:	-
To disable:	-
Enabled in:	**MAN, AUTO, TEST, REMOTE START**
Override:	-

The protection is enabled only when a valid PLC program has been transferred to the board. It reports possible problems during the running of the PLC:

- The PLC program uses more FLASH memory than available.
- The PLC program uses more RAM memory than available.
- The PLC program has an invalid control check-sum.
- The PLC program is developed with a version not supported by this board.
- A digital or analogue output controlled by the PLC is not configured with DOF.0101 or AOF.0101 function (“used by the PLC”).
- The PLC program uses a resource (of any kind) not available on this board (for example, a digital input of a non-connected expansion module).
- An invalid parameter has been specified for one of PLC blocks.
- An invalid type of block has been specified.
- Calculation error during the running of the program.

On S.02 page, by selecting this early warning, the board shows additional information to help solving the problem.

901...964 - Anomalies connected to the PLC

The PLC program, through one of its blocks, can activate anomalies. 901 through 964 codes are connected to such anomalies. Anomalies triggered by the PLC can be shutdowns, deactivations, warnings or latched warnings.

11 Other functions

11.1 Protections OVERRIDE.

The controller stores the activation/deactivation of the override of the protections (described in the following) in the events log:

- EVT.1082: override of the protections is activated.
- EVT.1083: override of the protections is deactivated.

11.1.1 Engine protections OVERRIDE.

For some plant, loads supply is preferred than the engine protection. HS315 can manage these situations: as the engine can be damaged, this function must be requested by a digital input (cannot be activated by parameters). To activate the engine protection OVERRIDE, an input set by the function “DIF.2062 – Engine protections override” must be active. When this input is active, the controller shows it in the display window “S.01” and all the engine alarms are switched to warnings: In this way the operator receives a signal in case of engine failure, but the generator will keep powering the loads.

At the end of the document [1] there is a table that summarize all the anomalies; if in the “Over” column the character “E” is present, it means that, in presence of the engine protections override, that anomaly becomes a warning.

In the same way, in the description of the anomalies in this document (chapter 10), for each of them it is indicated to which override request it is related: if the text “engine” is specified, it means that, in presence of the engine protections override, that anomaly becomes a warning.

Moreover, also the following generic alarms associated to digital inputs are subject to engine override (and thus switch to warnings when override is active):

- DIF.4012 – Latched warning with oil mask.
- DIF.4013 – Deactivation with oil mask.
- DIF.4014 – Alarm (block) with oil mask.
- DIF.4062 – Latched warning subject to engine override.
- DIF.4063 – Deactivation subject to engine override.
- DIF.4064 – Alarm (block) subject to engine override.

You can configure override for engine protections including on one or both thresholds set on each analogue input. To do that, you must use the thresholds configuration parameters: e.g., for analogue input JM_3 the two parameters for the configuration of the two thresholds are P.4021 and P.4024. These parameters are bit-managed; through them you can define whether any alarm triggered by the set threshold being exceeded is subject to engine override (and therefore shift from alarm to warning). By default, the alarms on the thresholds are not subject to override, which must therefore be specifically configured. For configuring see par. 5.6.2. The BoardPrg4 program makes the management of this configuration much simpler.

The controller manages a separate operating time counter when this engine override mode is active.

WARNING: using this function may seriously damage the engine. Mecc Alte cannot, in any case, be held responsible for damages, resulting from the use of the OVERRIDE function.

11.1.2 Generator protections override.

See previous paragraph. To activate the generator protection override, an input set by the function “DIF.2064 – Override generator protections” must be active.

At the end of the document [1] there is a table that summarize all the anomalies; if in the “Over” column the character “G” is present, it means that, in presence of the generator protections override, that anomaly becomes a warning.

In the same way, in the description of the anomalies in this document (chapter 10), for each of them it is indicated to which override request it is related: if the text “generator” is specified, it means that, in presence of the generator protections override, that anomaly becomes a warning.

11.1.3 Complete protections override.

See previous paragraph. To activate the complete protection override, an input set by the function “DIF.2063 – Full override of protections” must be active.

At the end of the document [1] there is a table that summarize all the anomalies; if in the “Over” column the character “F” is present, it means that, in presence of the complete protections override, that anomaly becomes a warning.

In the same way, in the description of the anomalies in this document (chapter 10), for each of them it is indicated to which override request it is related: if the text “full” is specified, it means that, in presence of the complete protections override, that anomaly becomes a warning.

11.2 Counters

The controller manages internally the following counters:

- Controller total power supply time (hours) counter.
- Counter for engine starts (resettable to zero).
- Counter for engine working hours (resettable to zero).
- Counter for engine working hours with GCB closed (resettable to zero).
- Counter for engine working hours with engine protections override activated (resettable to zero).
- Total counter for engine working hours (resettable to zero).
- Total counter for hours to next service 1.
- Total counter for hours to next service 2.

Moreover:

- Number of charge cycles (resettable to zero).
- Counter for the energy (Ah) transferred to the battery during the charge cycles (resettable to zero).
- Counter for the power (Wh) transferred to the battery during the charge cycles (resettable to zero).
- Number of discharge cycles (resettable to zero).
- Counter for the energy (Ah) absorbed from the battery during the discharge cycles (resettable to zero).
- Counter for the power (Wh) absorbed from the battery during the discharge cycles (resettable to zero).
- Total number of charge cycles.
- Counter for the total energy (Ah) transferred to the battery during the charge cycles.
- Counter for the total power (Wh) transferred to the battery during the charge cycles.
- Total number of discharge cycles.

- Counter for the total energy (Ah) absorbed from the battery during the discharge cycles.
- Counter for the total power (Wh) absorbed from the battery during the discharge cycles.
- Number of “standard” charge cycles from the last “full” charge cycle (resettable to zero).

Almost all these counters and meters are displayed on the controller's front panel (only the total supply time counter is not displayed). However, all can be read via the communication ports (with the Modbus protocol). Some of these counters can be reset by the operator following a proper procedure, or via the communication ports (they are marked in the list with “resettable to zero”). All these counters are saved in a non-volatile memory; therefore, they store their values also when the controller is powered off. Non-volatile memories have limited life cycles, therefore reducing memory writing to minimum is required. Therefore, a counter may not be immediately saved as its value changes; consequently, before powering the controller off, ensure to know when and how the counters were saved.

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

- At the end of each charge/discharge cycle.
- Immediately after each engine start (with engine running, not after each start attempt).
- Immediately after each engine stop (when controller acknowledges the engine stopped status, not when stop is requested).
- After each increase of any counter for the engine running hours (any counter, total or clearable, including the counters for the hours to next maintenance).
- Every time the controller is set to OFF_RESET.
- For each hour the controller is powered.
- When parameters related to maintenance are changed.

Furthermore, counters are saved when they are reset to zero (individually or globally) via front panel or communication ports. Note that some counters have a decimal part (for example the minutes-counters associated to hours-counters), which is also saved in a non-volatile memory. Powering off the controller in an uncontrolled way can cause the loss of the decimal part. It is enough to switch the controller to OFF-RESET to force data saving, before switching off the power.

11.2.1 Counters reset

The resetting procedure is common for all the counters, but it only applies to some of them, based on the page displayed on the multifunctional display. See in paragraph 8.5.5.3 the description of the display page that contains the counter to be reset to zero.

11.3 Clock

The controller is provided with a standard hardware clock. It is shown in detail in the page S.03 of the controller. It can be set through the programming menu “4.7.1 – Date/Time”, using the following parameters:

- P.0411: year.
- P.0412: month.
- P.0413: day of month.
- P.0415: hours.
- P.0416: minutes.
- P.0417: seconds.

You can set the clock manually, but also in the following two ways:

- Using the Modbus protocol through the communication ports. The BoardPrg4 software, for example, allows the synchronization of the controller clock with the clock of the PC (it acts on the previous parameters).
- Using the NTP protocol through the ETHERNET port. It is a standard TCP/IP protocol that allows to keep aligned the clock of the controller with the clock of an external server. The IP address of the NTP server must be set by the parameter P.0509; it is also required to specify the TCP port used by the server using the parameter P.0508 (the default value for this parameter is 123, that is the standard port for all NTP servers – change it only If required).

  The NTP servers provide the date time in the Greenwich meridian format (GMT+0). If the controller is in a different area, the required GMT value must be specified using the parameter P.0410. It allows to select both positive and negative values, with a resolution of 15 minutes. For example, to select GMT+1 (Rome), it must be set to 4 (15 min * 4 = 1 hour).

  The controller can also manage the daylight save time. This configuration can be done by means parameter P.0409 that allows the following values:

- "0 – No": the automatic management of the daylight save time is disabled. If the NTP protocol is used, the controller does not add any value to the date/time received by the server.
- "1 – Yes": the automatic management of the daylight save time is disabled. If the NTP protocol is used, the controller adds the value specified by the parameter P.0408 to the date/time received by the server.
- "2 – Automatic (Europe only)": the automatic management of the daylight save time is enabled. This configuration can be used only in Europe, because the date/time for the activation/deactivation of the daylight save time are fixed:
  - The last Sunday of March, 02:00:00.
  - The last Sunday of October, 03:00:00.

  At the specified date/time, the controller automatically adds/subtracts the value specified by the parameter P.0408 to the current date/time: the following updates from the NTP server will take care of the status (active/inactive) of the daylight save time.
- "3 – Automatic via calendar": the automatic management of the daylight save time is enabled. The date/time for the activation/deactivation of the daylight save time are configurable by means calendars 15 and 16 (see 11.3.4):
  - Use calendar 15 to specify date/time for the activation of the daylight save time.
  - Use calendar 15 to specify date/time for the deactivation of the daylight save time.

  Note: when parameter P.0409 is set to "3", calendars 15 and 16 cannot be used for other purposes.

  At the specified date/time, the controller automatically adds/subtracts the value specified by the parameter P.0408 to the current date/time: the following updates from the NTP server will take care of the status (active/inactive) of the daylight save time.

  The parameter P.0409 allows to select (with a resolution of 15 minutes) which is the time difference when the daylight save time is activated (in Italy we have a difference of 1 hours, so this parameter must be set to 4 (15 min *4 = 1 hour)).

  The clock is used for many functions:

- History logs recordings.
- Weekly planning for engine TEST.
- Weekly planning of time intervals in which the gen-set can start automatically.
- Weekly planning of time intervals in which the gen-set is forced to work.
- Configurable calendars.

The clock is equipped with rechargeable buffer battery and can stay up to date for several months, even if the controller remains unpowered. If the controller is not used (unpowered) for a long time, even if the clock reactivates immediately as soon as it is powered, it needs a few hours to ensure full recharge of the internal battery.

The controller stores the following event into the events log (they are related to the clock):

- EVT.1075: Real time clock not valid.
- EVT.1076: Real time clock updated.
- EVT.1086: Daylight Save Time activated.
- EVT.1087: Standard time activated.

11.3.1 Weekly planning for engine TEST.

The engine TEST is planned on a weekly basis. Thus, it is possible to select in which days the engine must be started for TEST.

WARNING! Periodical test start-up is not linked to manual or auto engine starts.

I.e., the engine may have been used just few minutes before, but test will anyway start at due time. In addition to the dates, it is also possible to select a start time and duration. This time interval is common to all the days selected.

The parameters related to this function are the following:

- P.0418: allows to specify in which days of week the engine TEST will be performed. It is a bit-configurable parameter; each bit of the parameter corresponds to a day of the week. The value for the parameter is the sum of the “value” fields in the following table related to the days you are interested in.

Bit	Value	Hexadecimal	Day
0	1	0001	Sunday
1	2	0002	Monday
2	4	0004	Tuesday
3	8	0008	Wednesday
4	16	0010	Thursday
5	32	0020	Friday
6	64	0040	Saturday

For example, if you want to perform the TEST only on Monday and Thursday, you must set 18 (16+2) (12 in hexadecimal format).

- P.0419: allows to set start time for the TEST (Hours and minutes).
- P.0420: allows to configure the TEST duration (in minutes).

P.0420 sets the duration instead of an end test time. This is due to the same parameter being also used for TEST activated by an SMS command.

11.3.2 Weekly scheduling of engine operating time intervals.

In some applications, it is useful to inhibit the automatic intervention of the engine for auxiliary source failure in hours or days where the auxiliary source is not used. For example, if a factory is closed on Sunday, the engine should never start in this day for auxiliary source fault (because it consumes unnecessary fuel). With this function you can select in which days and in which time intervals the gen-set can start automatically. The planning is made on a weekly basis: therefore, it is possible to plan in which days the generator must operate. Besides days, it is possible to set a single auto operation enable time slot common to all selected days.

The parameters related to this function are the following:

- P.0421: allows to specify in which days of week the engine can start automatically. It is a bit-configurable parameter; each bit of the parameter corresponds to a day of the week. The value to be set for the parameter is the sum of the value fields in the following table related to the days needed.

Bit	Value	Hexadecimal	Day
0	1	0001	Sunday
1	2	0002	Monday
2	4	0004	Tuesday
3	8	0008	Wednesday
4	16	0010	Thursday
5	32	0020	Friday
6	64	0040	Saturday

- P.0422: allows to configure the start of the time interval during which the engine can start automatically (in hours and minutes).
- P.0423: allows to configure the end of the time interval during which the engine can start automatically (in hours and minutes).

Usually, P.0422 will be set to a value lower than P.0423. On the contrary, if it contains a higher value, the controller infers that the time interval is set across midnight: in this case, the time set with P.0422 refers to the days selected with P.0421, while the time set with P.0423 refers to the following days.

For example, in case an automatic gen-set start is required only Monday through Friday, between 08:00 and 18:00, you must set:

P.0421 = 62 (3E in hexadecimal format) (2+4+8+16+32)

P.0422 = 08:00

P.0423 = 18:00

11.3.3 Weekly scheduling for forcing engine operating.

In some applications, it is useful to force the automatic intervention of the engine in hours or days where it is not used. With this function you can select in which days and in which time intervals the gen-set is forced to start. The planning is made on a weekly basis: therefore, it is possible to plan in which days the generator must start. Besides days, it is possible to set a single auto operation forcing time slot common to all selected days.

The parameters related to this function are the following:

- P.0426: allows to specify in which days of week the engine is forced to start automatically. It is a bit-configurable parameter; each bit of the parameter corresponds to a day of the week. The value to be set for the parameter is the sum of the value fields in the following table related to the days needed.

Bit	Value	Hexadecimal	Day
0	1	0001	Sunday
1	2	0002	Monday
2	4	0004	Tuesday
3	8	0008	Wednesday
4	16	0010	Thursday
5	32	0020	Friday
6	64	0040	Saturday

- P.0427: allows to configure the start of the time interval during which the engine is forced to start automatically (in hours and minutes).
- P.0428: allows to configure the end of the time interval during which the engine is forced to start automatically (in hours and minutes).

  Usually, P.0427 will be set to a value lower than P.0428. On the contrary, if it contains a higher value, the controller infers that the time interval is set across midnight: in this case, the time set with P.0427 refers to the days selected with P.0426, while the time set with P.0428 refers to the following days.

  For example, in case an automatic gen-set start must be forced only on Monday through Friday, between 08:00 and 18:00, you must set:

  P.0426 = 62 (3E in hexadecimal format) (2+4+8+16+32)

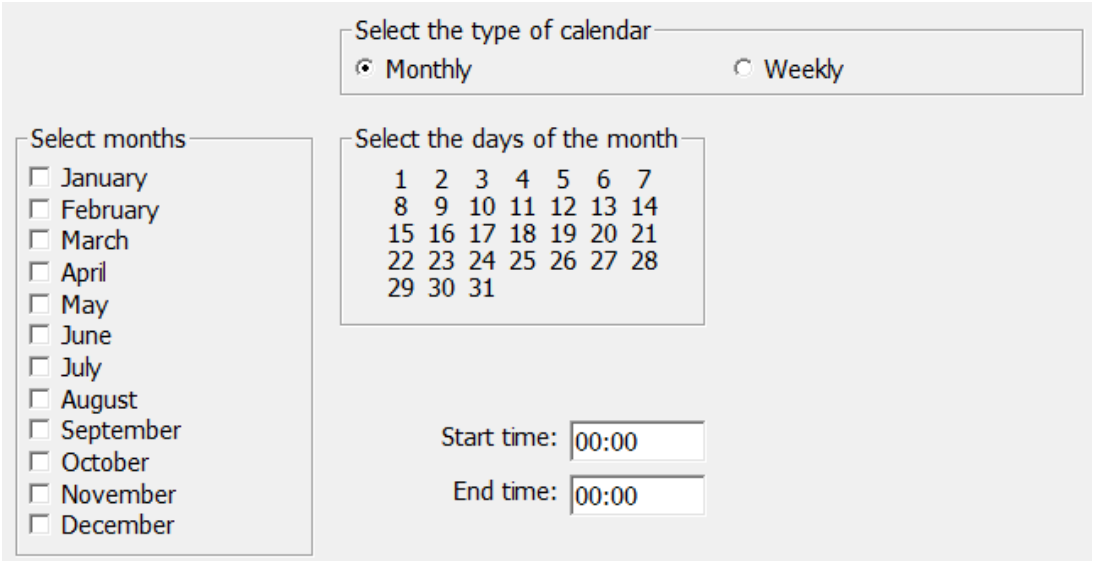
  P.0427 = 08:00

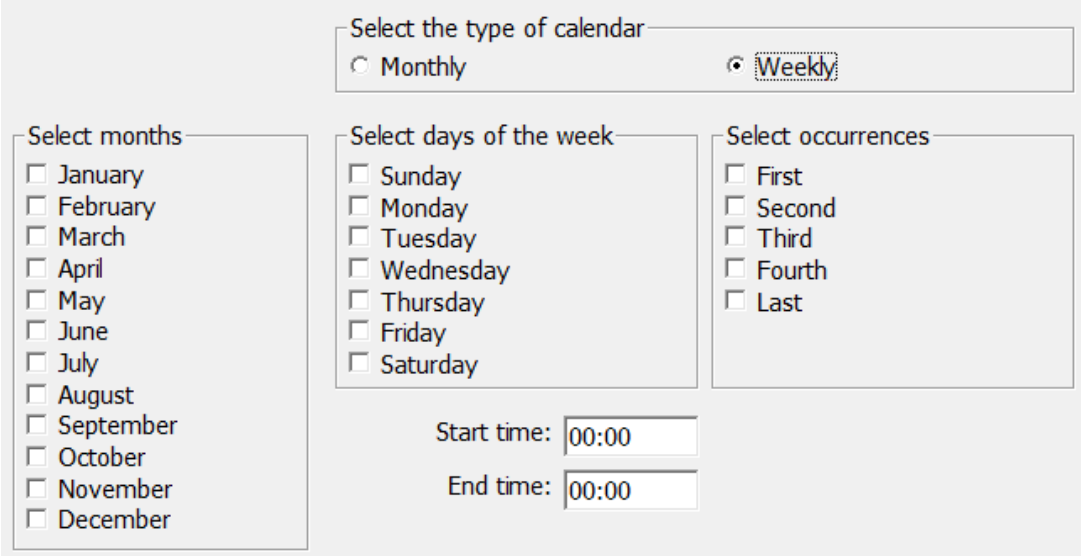
  P.0428 = 18:00

11.3.4 Configurable calendars

The controller provides 16 calendars fully configurable. They allow to select days and time-slots, inside which the controller activates an internal bit. This bit could then be used by AND/OR logics to activate a digital output or to create more complex logics. All calendars are identical: calendars 15 and 16, however, can be used for the activation/deactivation of the daylight save time (if parameter P.0409 is set to “3”).

Each calendar can be individually selected as “monthly” or “weekly”:





Using BoardPrg4 software, it is very easy to select whether a calendar is “weekly” or “monthly”. If you want to use the parameters of the controller, you must act on the parameter P.1900. It is a bit-field parameter; one bit is provided for each calendar:

BIT	Value	Hexadecimal	Calendar
0	1	0001	Calendar 1
1	2	0002	Calendar 2
2	4	0004	Calendar 3
3	8	0008	Calendar 4
4	16	0010	Calendar 5
5	32	0020	Calendar 6
6	64	0040	Calendar 7
7	128	0080	Calendar 8
8	256	0100	Calendar 9
9	512	0200	Calendar 10
10	1024	0400	Calendar 11
11	2048	0800	Calendar 12
12	4096	1000	Calendar 13
13	8192	2000	Calendar 14
14	16384	4000	Calendar 15
15	32768	8000	Calendar 16

The parameter must be set with the sum of the values for all the calendars that have to be selected as “weekly” (in hexadecimal notation). In fact, a bit set to “1” selects the “weekly” mode.

Both calendar types allow to select in which months the controller activates the internal bit (at least one month must be selected, it is even possible to select all months). Using the parameters of the controller, this selection is done by means parameter P.1901 (for the calendar 1 or equivalent for other calendars). This is also a bit-field parameter:

BIT	Value	Hexadecimal	Month
0	1	0001	January
1	2	0002	February
2	4	0004	March
3	8	0008	April
4	16	0010	May

5	32	0020	June
6	64	0040	July
7	128	0080	August
8	256	0100	September
9	512	0200	October
10	1024	0400	November
11	2048	0800	December

The parameter must be set with the sum of the values of the required months (in hexadecimal notation).

For “monthly” calendars, is then possible to select the days of the month for the activation of the internal bit (at least one day must be selected, it is even possible to select all days). Using the parameters of the controller, this selection is done by means parameter P.1902 (for the calendar 1 or equivalent for other calendars). This is also a bit-field parameter:

BIT	Value	Hexadecimal	Day of month
0	1	00000001	1
1	2	00000002	2
2	4	00000004	3
3	8	00000008	4
4	16	00000010	5
5	32	00000020	6
6	64	00000040	7
7	128	00000080	8
8	256	00000100	9
9	512	00000200	10
10	1024	00000400	11
11	2048	00000800	12
12	4096	00001000	13
13	8192	00002000	14
14	16384	00004000	15
15	32768	00008000	16
16	65536	000100000	17
17	131072	00020000	18
18	262144	00040000	19
19	524288	00080000	20
20	1048576	00100000	21
21	2097152	00200000	22
22	4194304	00400000	23
23	8388608	00800000	24
24	16777216	01000000	25
25	33554432	02000000	26
26	67108864	04000000	27
27	134217728	08000000	28
28	268435456	10000000	29
29	536870912	20000000	30
30	1073741824	40000000	31

The parameter must be set with the sum of the values of the required days (in hexadecimal notation).

For “weekly” calendars, is then possible to select the days of the week for the activation of the internal bit (at least one day must be selected, it is even possible to select all days). Using the parameters of the controller, this selection is done by means parameter P.1902 (for the calendar 1 or equivalent for other calendars). This is also a bit-field parameter:

BIT	Value	Hexadecimal	Day of week
16	65536	00010000	Sunday
17	131072	00020000	Monday
18	262144	00040000	Tuesday
19	524288	00080000	Wednesday
20	1048576	00100000	Thursday
21	2097152	00200000	Friday
22	4194304	00400000	Saturday

The parameter must be set with the sum of the values of the required days (in hexadecimal notation).

Selecting a day of the week (Sunday for example), it is then possible to select if all “Sundays” in the month must be used or only some of them. Using the parameters of the controller, this selection is done by means parameter P.1902 (for the calendar 1 or equivalent for other calendars). This is also a bit-field parameter:

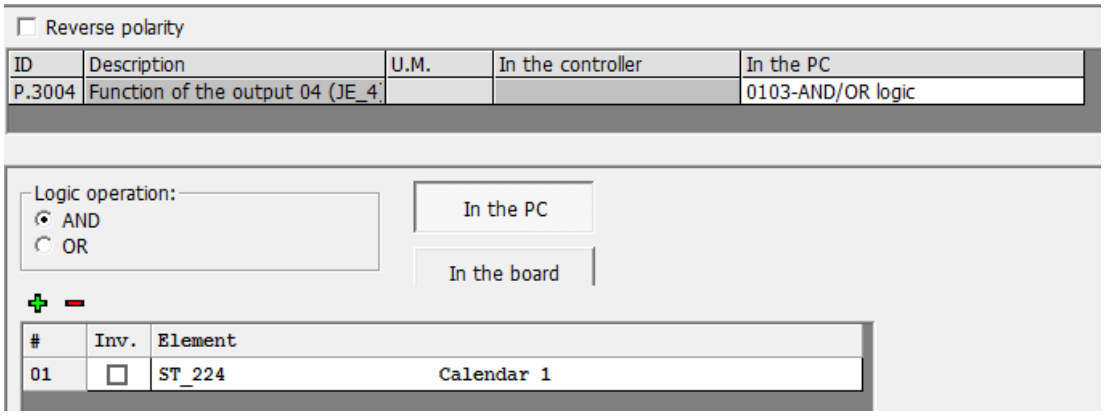
BIT	Value	Hexadecimal	Occurrence
0	1	00000001	First occurrence
1	2	00000002	Second occurrence
2	4	00000004	Third occurrence
3	8	00000008	Forth occurrence
4	16	00000010	Last occurrence

The parameter must be set with the sum of the values of the required occurrences (in hexadecimal notation). **Note: for “weekly” calendars, the days of week and their occurrences in the month are selected by the same parameter, using different bits.**

If the “occurrence” bits are all “0”, then the selected days of week will be managed in any week of the month; otherwise, they will be managed for the selected occurrences only. The “last” option is useful because, depending on the month and on the year, a certain day of the week can be present 4 or 5 times in a month: using the “last” option you can do an action exactly in the last occurrence in the month. A typical example is the management of the daylight save time; in Italy, it is activated on the last Sunday of October, and deactivated on the last Sunday of March. Those Sundays can be the 4° or the 5° occurrence in the month, depending on the first day of the month. Using the “last” option, the problem is solved.

Finally, for both “weekly” and “monthly” calendars, it is possible to select a time-slot (valid for all selected days). The controller will activate the internal bit only inside the selected time-slot. Using the parameters of the controller, the time-slot can be selected by means P.1903 and P.1904 (for the calendar 1 or equivalent for other calendars). If those parameters are set with the same values, the full day is selected. If the start time is lower than the end time, the time-slot is not across midnight; otherwise, the internal bit is activated after the start time of the selected days, and it is deactivated after the end time of the day after the selected one.

Using the AND/OR logics, it is possible to activate a digital output into selected days and time-slot (selected using a calendar):



This is an example for the configuration of the daylight save time for Italy, using calendars 15 and 16:

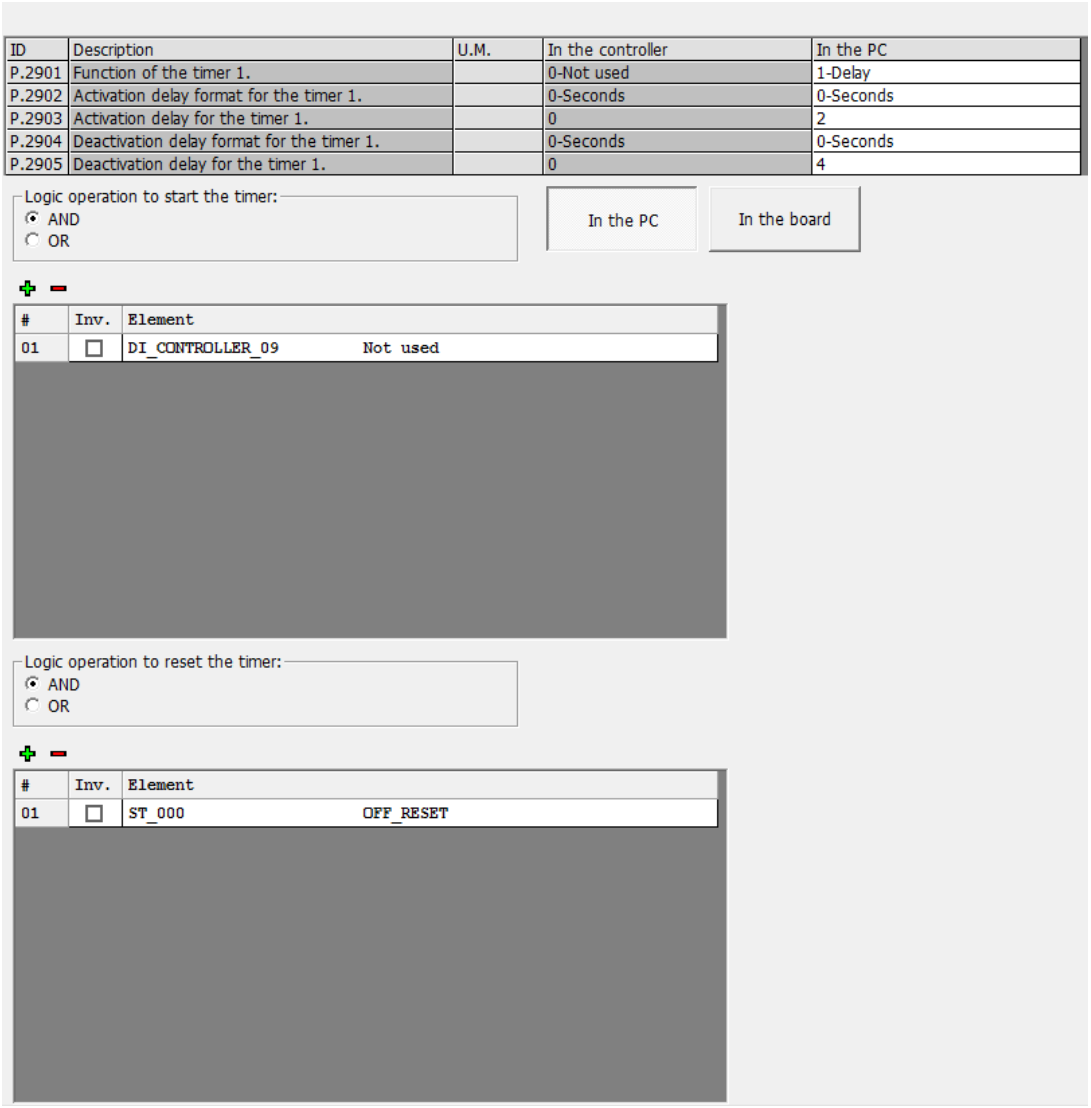
- Calendar 15.
  - Select “weekly” (bit 14 of P.1900 = “1”).
  - Last Sunday of October:
    - Select “October” (P.1957 = “0200”).
    - Select “Sunday”, “Last” (P.1958 = “00010010”).
  - The activation should happen at 02:00:
    - Select “2:00” as start time (P.1959).
    - Select “2:01” as end time (P.1960).
- Calendar 16.
  - Select “weekly” (bit 15 of P.1900 = “1”).
  - Last Sunday of March:
    - Select “March” (P.1961 = “0004”).
    - Select “Sunday”, “Last” (P.1962 = “00010010”).
  - The activation should happen at 03:00:
    - Select “3:00” as start time (P.1963).
    - Select “3:01” as end time (P.1964).

11.4 Configurable timers

The controller provides 4 generic timers fully configurable, that can be used inside the AND/OR logics to create complex sequential logics. Each timer, in fact, activates/deactivates an internal bit that can be used by the AND/OR logics.

The four timers are identical.

For each timer it is possible to select (by means an AND/OR logic) an “activation condition” that starts the timer. In the same way, it is possible (but not mandatory) to select (by means an AND/OR logic) a “reset condition” that resets the timer. When the “reset condition” is true, the internal bit of the timer is forced to “0”.



Moreover, each timer provides the following five parameters (the list refers to the timer 1):

- P.2901: function of the timer 1.
- P.2902: Activation delay format for the timer 1.
- P.2903: Activation delay for the timer 1.
- P.2904: Deactivation delay format for the timer 1.
- P.2905: Deactivation delay for the timer 1.

In addition to the function, two delays are configurable for any timer; for each of them it is possible to select the time base (“0 – Seconds”, “1 – Minutes”, “2 – Hours”) and the delay value.

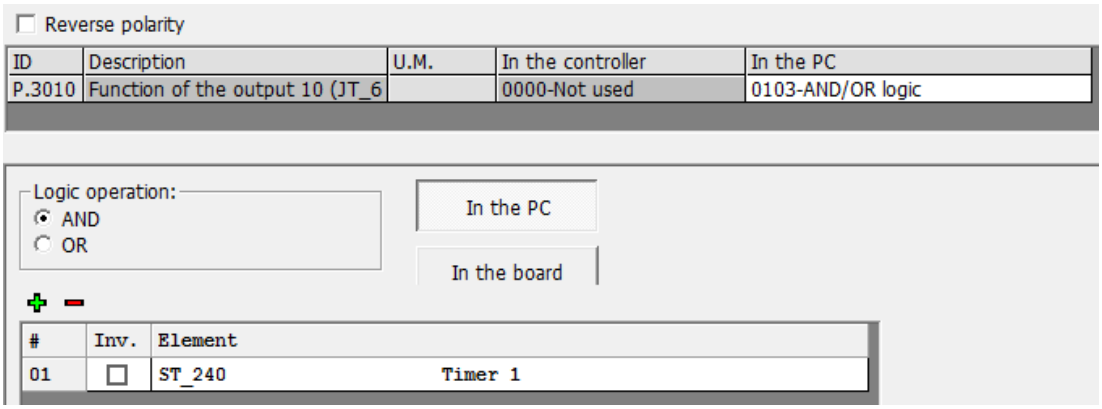
Each timer can work in four different modes, selectable by means parameter P.2901 (for the timer 1 or equivalent for the other timers):

- 0 – Not used. In this case the internal bit related to the timer is always reset.
- 1 – Delay.
  - The internal bit is reset while the “reset condition” is true.

- The internal bit is set with the delay P.2902 – P.2903 from when the “activation condition” becomes true.
- The internal bit is reset with the delay P.2904 – P.2905 from when the “activation condition” becomes false.

- 2 – Pulse.
  - The internal bit is reset while the “reset condition” is true.
  - The internal bit is set for the time configured with P.2902 – P.2903 each time the “activation condition” changes from false to true.
  - The internal bit is set for the time configured with P.2904 – P.2905 each time the “activation condition” changes from true to false.
- 3 – Free run
  - The internal bit is reset while the “reset condition” is true.
  - The internal bit is reset while the “activation condition” is false.
  - While the “activation condition” is true, the internal bit is managed as a square wave: it is set for the time configured with P.2902 – P.2903, then it is reset for the time configured with P.2904 – P.2905, and so on.
- 4 – Set/Reset
  - The internal bit is reset while the “reset condition” is true.
  - The internal bit is set if the “activation condition” is true and the “reset condition” is false.
  - The internal bit keeps its previous status if the “activation condition” is false and the “reset condition” is false.

The following example manages a digital output related to the internal bit of the timer 1:



11.5 Analogue /GSM modem

The controller can manage an analogue or a GSM modem. The modem can be connected to the serial port JA.

The controller can perform/receive data calls (data over voice, not TCP/IP) and to send/receive SMS. For a complete description of this feature see document [3].

The controller is always ready to answer incoming data calls and to receive SMS. On the contrary, it must be configured to make data calls (on the other side a PC with a modem and with Mecc Alte SS3 software is required) or to send SMS. The related parameters are:

- P.0456 – Plant name. You can set here an alphanumeric name for the plant. The controller will include this name in all SMS sent; it must correspond to the name of a plant into the Mecc Alte SS3 software, in case of data calls (it must be unique).

- P.0455 – Events for alerts. This parameter (bit-field) allow to select the conditions that must force the controller to send an SMS or to make a data call.

Bit	Value	Hexadecimal	Event
0	1	0001	For alarms and deactivations.
1	2	0002	Per warnings.
2	4	0004	Per engine started.
3	8	0008	Per engine stopped.
4	16	0010	For auxiliary source failure.
5	32	0020	For auxiliary source presence.

The value to be set for the parameter is the sum of the value fields in the following table related to the events needed.

- It is possible to configure up to four phone numbers (P.0457, P.0459, P.0461, P.0463). Their function can be configured by means parameters P.0458, P.0460, P.0462, P.0464. The available values are:

  - 0 – Not used.
  - 1 – For SMS. The controller will send an SMS to this number each time one of the events selected with P.0455 happens.
  - 2 – For data calls. The controller will perform a data call to this number each time one of the events selected with P.0455 happens.

- For analogue modems, parameter P.0465 allow to configure whether the dialling of the number must be performed with pulses or tones.
- Parameter P.0466 allows to select how many rings the controller must wait before answering an incoming data call.
- Parameter P.0467 allows to select how many SMS the controller must send to each configured number each time one of the events selected with P.0455 happens.
- Parameter P.0468 allows to select how many data call tries the controller must perform each time one of the events selected with P.0455 happens.

11.6 Non-volatile memory

The controller has a non-volatile memory inside (which does not need power), used to store various information such as parameters, counters etc. The memory is subdivided into various areas. When the controller is powered, it performs a check on the data stored in each area: if even just one area is incorrect, it displays an error message. Said message contains a numerical code (in hexadecimal form); each bit to 1 of said code corresponds to an area of the memory that is not valid. Here is a table listing the areas and their bit.

Area	Bit	Value	Hexadecimal	Description
1	0	1	0001	Coefficients for the calibration of the measuring inputs of the controller.
2	1	2	0002	Various information (language selected, display contrast, maintenance request).
3	2	4	0004	Counters
4	3	8	0008	History log for diagnose codes acquired via CAN-BUS from the engine.
5	4	16	0010	History log of the maximum peaks.
6	5	32	0020	Parameter:
7	6	64	0040	Text parameters (e.g., configurable messages related to the inputs)

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

If any of the areas is not valid, the normal operating sequences are not carried out until the operator presses the “ENTER + EXIT” buttons: in fact, the situation must be taken note of, because it may cause malfunctions (for example, imagine what would happen if the invalid area were the one of the parameters) Only when the operator presses “ENTER + EXIT” the controller reloads the default settings for the data stored in the invalid areas: it means that, in the event the controller is shut off without pressing “ENTER + EXIT”, next time you turn it on you will get again the invalid memory report.

11.7 External devices

11.7.1 BMS

HS315 can acquire data from special electronic devices (called BMS), which are responsible for managing the batteries.

The measurements acquired by the BMS are displayed on pages M.15, M.16 and M.17. If additional data (specific to a BMS model) are provided, they are displayed on pages M.18 and M.19 (which are otherwise hidden)

The controller can manage more than one BMS but must interact with them as if they were a single BMS.

In the case of multiple BMS, we define MASTER BMS a particular device that acts as a “concentrator”, i.e. which builds the cumulative data of all of them. It is not mandatory.

The following configurations are therefore possible

- A single BMS:
    - o P.1754: BMS address (CAN or ModBus).
    - o P.9763: 0.
    - o P.1753: **not used**.
    - o P.9764: **not used**.
- Multiple BMSs (SLAVE):
    - o P.1754: address of the first BMS (CAN or ModBus).
    - o P.9763: number of BMSs.
    - o P.1753: set equal to P.1754.
    - o P.9764: it indicates whether the BMS are connected in parallel or in series: HS315 uses this information to calculate the totals.
- Multiple BMSs, one of them having special functions (MASTER) and transmitting the cumulative data of all:
    - o P.1754: address of the MASTER BMS (CAN or ModBus).
    - o P.9763: number of SLAVE BMS.
    - o P.1753: address of the first SLAVE BMS (CAN or ModBus).
    - o P.9764: **not used**.

The logic associated with parameter P.9764 is:

Data	Connected in parallel	Connected in series
Battery voltage	The lowest one.	The sum of all.
Battery current	The sum of all.	The highest one.
Battery temperature	The highest one.	The highest one.
Battery charge level (SOC)	The sum of all.	The lowest one.
Rated capacity	The sum of all.	Equal to the rated value of a single battery (not allowed different values)
Rated voltage	Equal to the rated value of a single battery (not allowed different values)	The sum of all.
Rated discharge current	The sum of all.	Equal to the rated value of a single battery (not allowed different values)
Discharge limit	It's a percentage.	It's a percentage.
Charge limits	They are percentages	They are percentages
Charge current (BULK)	The sum of all.	Equal to the value of a single battery (not allowed different values)
Charge voltage (ABSORBTION)	Equal to the value of a single battery (not allowed different values)	The sum of all.
Charge end-current (ABSORBTION)	The sum of all.	Equal to the value of a single battery (not allowed different values)
Charge voltage (FLOAT)	Equal to the value of a single battery (not allowed different values)	The sum of all.

You can connect HS315 and the BMSs through:

- CANBUS (CAN0)
- RS232 port.
- RS485 port.
- Ethernet.

The parameter F.1750 allows you to select the BMS model from a list. Based on the selected model, the controller knows whether to use the CANBUS interface or a ModBus interface.

If HS315 is unable to communicate with one or more BMS, it activates an anomaly (code 228), the type of which can be configured with P.1757. Sometimes, however, the application may need to turn off the BMS when not required (to reduce consumption from the batteries themselves); it is possible to use a digital input configured as DIF.2763 ("BMS are powered") to indicate the controller that the BMS are powered. When the BMS are not powered, the controller does not activate the anomaly 228.

The alarms/warnings received from the BMS are managed like the diagnostic codes received from the ECUs and AVRs: they therefore contribute to generating the yellow/red lamps and the related faults. They are also recorded in the diagnostic code history together with those of the ECU and AVR.

Whatever the connection selected, parameter P.9762 allows you to indicate which information received from the BMS must be used (those not selected are displayed but not used for the operating logic).

P.1771…P.1778: these parameters are setpoints required by a specific BMS model. They are visible only if provided for by the selected BMS.

CAN interface.

Parameter P.1751 allows you to limit transmissions from HS315 to the BMS (commands). Leave at the value 99 unless expressly prescribed by Mecc Alte.

Parameter P.1752 allows you to configure the address that HS315 must use to send commands via CAN to BMS. It is used only for some specific BMS.

Parameter P.1756 configures the maximum time that HS315 must wait before declaring a BMS “off-line”.

ModBus interface.

Parameter P.1758 allows you to select the communication interface:

• RS232 serial port: in this case, you must also configure this interface as ModBus Master (P.0451 = 2) and correctly set the baud rate and communication characteristics (P.0453 and P.0454).

• RS485 serial port: in this case, you must also configure this interface as ModBus Master (P.0471 = 2) and correctly set the baud rate and communication characteristics (P.0473 and P.0474).

• Ethernet: in this case you need to configure:

o P.1759: the TCP port of the BMSs (the port on which they are listening).

o P.1760: the IP address (or DNS name) of the MASTER BMS.

o P.1761: the IP address (or DNS name) of the first slave BMS.

o P.1762: in case of multiple BMSs, this parameter allows you to establish how to address them:

- Bit 0: if activated, causes the IP address to be increased for each SLAVE BMS after the first.
- Bit 1: if activated, causes the ModBus address to be increased for each SLAVE BMS after the first.

o P.1763: The maximum number of ModBus queries before declaring the BMS “off-line”.

o P.1764: the maximum waiting time for a response to a ModBus query.

11.7.2 ECU

HS315 can acquire data and send commands to the ECU (Engine Control Unit) of the engine.

The measurements acquired by the ECU are displayed on pages E.07 to E.36 (some are hidden if not relevant)

The connection between HS315 and the ECU can be made via:

• CANBUS (CAN0)

• RS232 port.

• RS485 port.

• Ethernet.

The parameters P.0700 and F.0700 allow you to select the ECU model from a list. Based on the selected model, the controller knows whether to use the CANBUS interface or a ModBus interface.

If HS315 is unable to communicate with the ECU, it activates an anomaly (code 98), the type of which can be configured by P.0797.

The alarms/warnings received from the ECU are managed like the diagnostic codes received from the BMSs and AVR: they therefore contribute to generating the yellow/red lamps and the related anomalies. They are also recorded in the diagnostic code history together with those of the BMSs and AVR.

The following parameters are valid regardless of the communication resource:

- P.0708: allows you to activate the DROOP functionality in the ECU (if supported by the ECU itself).
- P.0710: defines the engine rotation speed to be used during the low-speed cycle
- P.0713 and P.0714: allow you to define the engine speed adjustment range (with respect to the HS315 internal percentage command).
- P.0715: defines some options regarding the commands sent to the ECU (if supported by the ECU).
- P.0721…P.0728: these parameters are setpoints required by a specific ECU model. They are visible only if provided by the selected ECU.

CAN Interface.

Parameter P.0703 allows you to limit transmissions from HS315 to the ECU (commands). Leave at 99 unless expressly required by Mecc Alte.

Parameter P.0716 allows you to configure the address that HS315 must use to send commands via CAN to the ECU. It is used only for some specific ECUs

Parameter P.0711 configures the maximum time that HS315 must wait before declaring the ECU “off-line”.

ModBus Interface.

Parameter P.0792 allows you to select the communication interface:

- RS232 serial port: in this case, you must also configure this interface as ModBus Master (P.0451 = 2) and correctly set the baud rate and communication characteristics (P.0453 and P.0454).
- RS485 serial port: in this case, you must also configure this interface as ModBus Master (P.0471 = 2) and correctly set the baud rate and communication characteristics (P.0473 and P.0474).
- Ethernet: in this case you must configure:
  - o P.0793: the ECU's TCP port (the port it is listening on).
  - o P.0794: the ECU's IP address (or DNS name).
  - o P.0795: The maximum number of ModBus queries before declaring the ECU "off-line".
  - o P.0796: the maximum waiting time for a response to a ModBus query.

11.7.3 AVR

HS315 can acquire data and send commands to the AVR (Automatic Voltage Regulator) of the alternator.

The measurements acquired by the AVR are displayed on pages M.20 to M.31 (some are hidden if not relevant)

The connection between HS315 and the AVR can only be made via CANBUS (CAN0).

The parameter F.1700 allows you to select the AVR model from a list.

If HS315 is unable to communicate with the AVR, it activates an anomaly (code 97), the type of which can be configured with P.1707.

The alarms/warnings received by the AVR are managed like the diagnostic codes received from the BMS and the ECU: they therefore contribute to generating the yellow/red lamps and the related anomalies. They are also recorded in the historical archive of diagnostic codes together with those of the BMS and the ECU.

Applicable parameters:

- P.1701: allows you to limit transmissions from HS315 to the AVR (commands). Leave at 99 unless expressly required by Mecc Alte.
- P.1702: allows you to configure the address that HS315 must use to send commands via CAN to the AVR. It is used only for some specific ECUs
- P.1703 and P.1704: allows you to define the alternator voltage regulation range (with respect to the HS315 internal percentage command).
- P.1706: configures the maximum time that HS315 must wait before declaring the AVR “off-line”.
- P.1708: configures the nominal voltage for the AVR.
- • P.1721…P.1728: these parameters are setpoints required by a specific AVR model. They are visible only if provided by the selected AVR.

11.7.4 DC sensors

For applications with DC voltages greater than 100 V, the DC inputs of the controller cannot be used directly. It is possible to use DC/DC converters, or alternatively it is possible to use specific sensors (Bourns SSD) connected to HS315 via CAN.

In the same applications, even the use of the shunt for measuring currents becomes problematic: the same sensors also measure currents.

The parameter P.9640 allows you to indicate which DC measurements HS315 must read from these sensors. If a measurement is selected, but the related sensor does not communicate via CAN, the controller activates the anomaly 252 (missing expansion device).

Before being able to use the sensors, they must be configured by Mecc Alte. This operation requires both specific software and hardware, therefore it cannot be done by the customer.

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