

USER MANUAL

MSC-D

MULTIFUNCTION SMART CALIBRATOR



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Document revisions

| DATE | REVISION | NOTES | AUTHOR |
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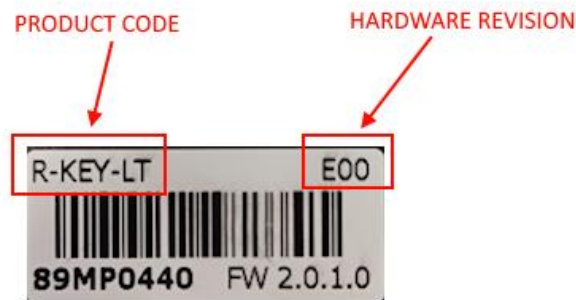
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1. DEVICE HARDWARE REVISION

With a view to continuous improvement, Seneca updates and makes the hardware of its devices increasingly more sophisticated. It is possible to know the hardware revision of a product via the label on the side of the device.

A label example is for instance:



The label also shows the firmware revision present in the device (in this case 2.0.1.0) at the time of sale, the hardware revision (in this case) is E00.

To improve performance or extend functionality, Seneca recommends updating the firmware to the latest available version (see the section dedicated to the product on www.seneca.it).

2. CALIBRATOR ACCURACY AND RESOLUTION

The accuracy and resolution of the signals are represented in the following tables:

SIGNAL GENERATION

| FUNCTIONS | M.U. | RANGE (Generation) | ACCURACY* (Generation) | RESOLUTION (Generation) | Note | STANDARD | CMRR- NMRR |
|--------------------|---------|-----------------------|---------------------------|----------------------------|-------------|-----------------|---------------|
| VOLTAGE [hi range] | [dc V] | 0-26 (minimum) | 0,02% + 3 mV | 1 mV | 1 | - | >100 dB |
| VOLTAGE [lo range] | [dc mV] | -10 +90 | 0.03% + 15 µV | 5 µV | 2 | - | >100 dB |
| ACTIVE CURRENT | [dc mA] | 0.1 ÷ +24 | 0.04% + 3 µA | 1 µA | 3 | - | >60 dB |
| PASSIVE CURRENT | [dc mA] | 0.1 ÷ +24 | 0.04% + 3 µA | 1 µA | 4,21,2 2 | - | >60 dB |
| Pt100 | [°C] | -200 ÷ +859 | 0.03% + 0.2°C | 0,1 °C | 5,19 | IEC 60751 | >140 dB |
| Pt500 | [°C] | -200 ÷ +859 | 0.03% + 0.2°C | 0,1 °C | 5,20 | IEC 60751 | >140 dB |
| Pt1000 | [°C] | -200 ÷ +859 | 0.03% + 0.2°C | 0,1 °C | 5,20 | IEC 60751 | >140 dB |
| CU50, CU100 | [°C] | -180 ÷ +200 | 0.03% + 0.2°C | 0,1 °C | 15,19 | GOST 6651-2009 | >140 dB |
| Ni100, Ni120 | [°C] | -80 ÷ +260 | 0.03% + 0.2°C | 0,1 °C | 16,19 | DIN 43760 | >100 dB |
| TERMOCUPLE J | [°C] | -210 ÷ +1200 | 0.03% + 0.2°C | 0,1 °C | 12,2 | EN 60584-1:1997 | >100 dB |
| TERMOCUPLE K | [°C] | -270 ÷ +1372 | 0.03% + 0.2°C | 0,1 °C | 12,2 | EN 60584-1:1997 | >100 dB |
| TERMOCUPLE T | [°C] | -270 ÷ +400 | 0.03% + 0.1°C | 0,1 °C | 12,2 | EN 60584-1:1997 | >100 dB |
| TERMOCUPLE E | [°C] | -270 ÷ +1000 | 0.03% + 0.2°C | 0,1 °C | 12,2 | EN 60584-1:1997 | >100 dB |
| TERMOCUPLE N | [°C] | -270 ÷ +1300 | 0.03% + 0.2°C | 0,1 °C | 12,2 | EN 60584-1:1997 | >100 dB |
| TERMOCUPLE R | [°C] | -50 ÷ +1768 | 0.03% + 0.3°C | 0,5 °C | 12,2 | EN 60584-1:1997 | >100 dB |
| TERMOCUPLE S | [°C] | -50 ÷ +1768 | 0.03% + 0.3°C | 0,5 °C | 12,2 | EN 60584-1:1997 | >100 dB |
| TERMOCUPLE B | [°C] | 0 ÷ +1820 | 0.03% + 0.3°C | 0,5 °C | 12,2 | EN 60584-1:1997 | >100 dB |
| TERMOCUPLE L | [°C] | -200 ÷ +800 | 0.03% + 0.15°C | 0,1 °C | 12,2 | GOST 8.585-2001 | >140 dB |
| LOAD CELL 350 Ohm | [mV/V] | 0 ÷ +3 | 0.05% | 0,001 | 13,8 | - | >100 dB |
| PULSES/FREQUENCY | [Hz] | 0.1÷1000 | 0.02% | SEE MANUAL | 1 | - | - |

SIGNAL MEASUREMENT

| FUNCTIONS | M.U. | RANGE (Measurement) | ACCURACY (Measurement) | RESOLUTION (Measurement) | STANDARD | Notes (Measurement) | CMRR- NMRR |
|--------------------|---------|------------------------|---------------------------|-----------------------------|-----------------|-------------------------|---------------|
| VOLTAGE [hi range] | [dc V] | 0-26 (minimum) | 0,02% + 3 mV | 1 mV | - | 9 | >100 dB |
| VOLTAGE [lo range] | [dc mV] | -10 +90 | 0.02% + 10 μV | 5 μV | - | 9 | >100 dB |
| ACTIVE CURRENT | [dc mA] | 0 ÷ +24 | 0.04% + 0.01 μA | 1 μA | - | 17 | >60 dB |
| PASSIVE CURRENT | [dc mA] | 0 ÷ +24 | 0.04% + 0.01 μA | 1 μA | - | 18 | >60 dB |
| Pt100 | [°C] | -200 ÷ +850 | 0.03% + 0.2°C | 0.03 °C | IEC 60751 | 6 | >140 dB |
| Pt500 | [°C] | -200 ÷ +850 | 0.03% + 0.2°C | 0.1 °C | IEC 60751 | 6 | >140 dB |
| Pt1000 | [°C] | -200 ÷ +850 | 0.03% + 0.2°C | 0.03 °C | IEC 60751 | 7 | >140 dB |
| CU50, CU100 | [°C] | -180 ÷ +200 | 0.03% + 0.2°C | 0.06 °C , 0.03 °C | GOST 8651-2009 | 6,15 | >140 dB |
| Ni100, Ni120 | [°C] | -60 ÷ +250 | 0.03% + 0.2°C | 0.02 °C | DIN 43760 | 6,16 | >100 dB |
| TERMOCUPLE J | [°C] | -210 ÷ +1200 | 0.03% + 0.2°C | 0.01 °C | EN 60584-1:1997 | 9,12 | >100 dB |
| TERMOCUPLE K | [°C] | -200 ÷ +1372 | 0.03% + 0.2°C | 0.05 °C | EN 60584-1:1997 | 9,12 | >100 dB |
| TERMOCUPLE T | [°C] | -200 ÷ +400 | 0.03% + 0.1°C | 0.05 °C | EN 60584-1:1997 | 9,12 | >100 dB |
| TERMOCUPLE E | [°C] | -200 ÷ +1000 | 0.03% + 0.2°C | 0.05 °C | EN 60584-1:1997 | 9,12 | >100 dB |
| TERMOCUPLE N | [°C] | -200 ÷ +1300 | 0.03% + 0.2°C | 0.05 °C | EN 60584-1:1997 | 9,12 | >100 dB |
| TERMOCUPLE R | [°C] | -50 ÷ +1768 | 0.03% + 0.3°C | 0.05 °C | EN 60584-1:1997 | 9,12 | >100 dB |
| TERMOCUPLE S | [°C] | -50 ÷ +1768 | 0.03% + 0.3°C | 0.05 °C | EN 60584-1:1997 | 9,12 | >100 dB |
| TERMOCUPLE B | [°C] | 250 ÷ +1820 | 0.03% + 0.3°C | 0.05 °C | EN 60584-1:1997 | 9,12 | >100 dB |
| TERMOCUPLE L | [°C] | -200 ÷ +800 | 0.03% + 0.15°C | 0.05 °C | Gost 8.585-2001 | 9,12 | >140 dB |
| LOAD CELL 350 Ohm | [mV/V] | 0 ÷ +2.4 | 0.05% | 0.001 | - | 9,14 | >100 dB |
| PULSES/FREQ UECY | [Hz] | 0.1÷10000 | 0.03% + 3 LSD | 10e-6 Hz | - | 10,11 | - |

NOTE

| |
|---|
| 1 - I _{outMAX} = 20mA per V < 20; I _{outMAX} = 10mA per 20 < V < 25; I _{outMAX} = 5mA per V > 25; output impedance < 50 mΩ |
| 2 - I _{outMAX} = 10mA; output impedance < 100 mΩ |
| 3 - R _{Load} < 1KΩ |
| 4 - 3V minimum loop voltage, 28V maximum |
| 5 - α = 0.00385 |
| 6 - Measurement current: 1 mA |
| 7 - Measurement current: 250 uA |
| 8 - Excitation voltage: from 5 to 10 V |
| 9 - Input impedance: ~ 10 MΩ |
| 10 - Input impedance: 1 MΩ; Voltage from 1 to 24 V |
| 11 - Max frequency measurement 1 kHz |
| 12 - Cold junction error: 1°C between 10 and 35°C ambient, 2°C between -20 and 10°C and between 35 and 50°C ambient |
| 13 - Output impedance: 300 Ω |
| 14 - Excitation voltage < 8V |
| 15 - α = 0.00428 |
| 16 - α = 0.006178 |
| 17 - Voltage drop < 3.5 V |
| 18 - Minimum voltage supplied: 24 V |
| 19 - Accuracy defined with 1 mA measurement current and respected polarity |
| 20 - Accuracy defined with 250 uA measurement current and respected polarity |
| 21 - Output impedance: 3.75 MΩ |
| 22 - Accuracy defined with 26 V loop supply voltage |

3. SAFETY INFORMATION

This manual contains safety rules that must be complied with to safeguard personal safety and to prevent damage to property. The indications to be followed to guarantee personal safety are highlighted by a triangle with the following meanings:

WARNING

The symbol associated with the word 'warning' indicates conditions or actions that put the user's safety at risk.

CAUTION

The symbol associated with the word 'caution' indicates conditions or actions that might damage the calibrator or equipment tested.

QUALIFIED PERSONNEL

The product covered by this documentation may only be used by qualified personnel for the respective assigned task, in compliance with the documentation relating to the task, and especially with the safety warnings and the precautions contained therein. By virtue of their training and experience, qualified personnel can recognize the risks related to the use of this product and avoid possible dangers.

DISCLAIMER

We have checked that the contents of this documentation correspond to the hardware and software described. However, since we cannot rule out any differences, we cannot guarantee a perfect match. However, the content of this documentation is periodically checked and any corrections or changes are inserted in subsequent editions.

WARNING

- *Do not apply different voltages or higher voltages than indicated between terminals, or between any terminal and earth (voltages greater than 50Vdc)*
- *Do not use the calibrator if damaged, or if signs of possible damage are visible on it.*
- *Do not remove the internal battery.*
- *Do not use the calibrator if it runs abnormally.*
- *Use the reset button if there is an anomaly in the operation.*
- *Do not touch the calibrator terminals during use*
- *To carry out the measurements, use the cables supplied or anyway adequate for the measurements to be taken.*
- *Select the appropriate range for the desired measurement or generation.*

 **CAUTION**

- *Make sure the internal battery is charged if you intend to use the calibrator without power from the USB port*
- *Use the calibrator as described in this manual.*
- *Before each measurement or generation, refer to the electrical connections shown in the manual.*
- *Do not use the calibrator in environments containing combustible/explosive dust, gas or vapour.*

The MSC calibrator has been designed according to EN 6101-1 standards

4. DESCRIPTION

The MSC calibrator is a portable multi-function instrument for the generation and measurement of signals commonly found in automation systems.

It was designed to help professionals who have to verify and develop signal processing equipment connected to automatic control devices.

Unlike what the market offers, the MSC calibrator combines simulations and measurements in one instrument through an intuitive and modern interface.

The MSC multifunction process calibrator is a hand-held instrument, powered by rechargeable batteries, used to measure and generate electrical quantities.

Calibrator also has the following characteristics:

- Input/output terminal for thermocouples (TC) and isothermal internal block with automatic temperature compensation of the reference junction.
- 4 standard 4mm diameter bushings for 2-3-4 wire sizes. Protection against overvoltages up to 250 Vac.
- Ethernet and Wi-Fi connection.
- Management of universal signals (analog, digital, pulse, electrical, weight, temperature)
- High accuracy class: 0.05% basic class for each type of input/output.
- Micro USB connector for power supply.
- Ethernet port and Wi-Fi for connection to PCs or mobile devices
- Modbus TCP-IP protocol supported
- Colour touch screen

The analog signals managed both in measurement and generation are:

- mA (dc) current
- V, mV (dc) voltage
- Thermocouples, two/three or four-wire heating elements
- 350 Ω bridge extensometer (LOAD CELL)

The following are also managed:

- Pulse generation with duration, voltage amplitude and variable duty cycle
- Pulse measurement with adjustable threshold
- Frequency measurement and generation

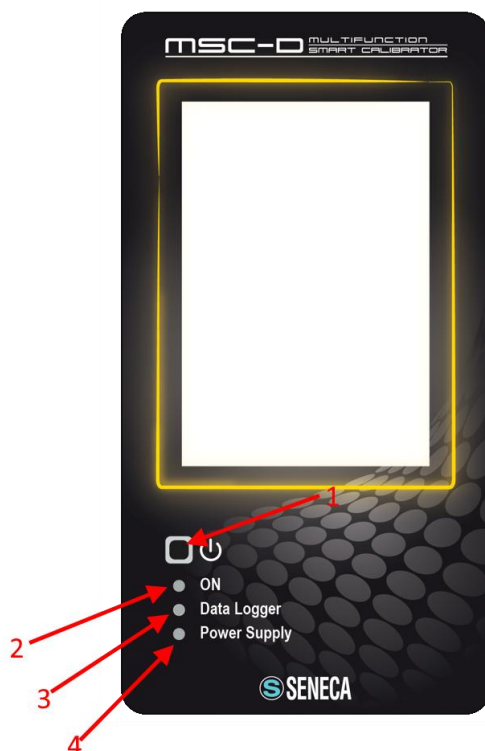
The device is protected against damage due to incorrect connections such as short circuits and overvoltages applied to the inputs (e.g. 230 Vac).

The device supports the industrial Modbus TCP-IP protocol and can therefore be controlled via Ethernet or Wi-Fi from machines external to the device.

Also via the Ethernet or Wi-Fi port it is also possible to connect multiple calibrators to the devices and control them individually.

4.1. LEDS, BUTTONS, PORTS AND BUSHINGS

4.1.1. ON/OFF BUTTON AND LED



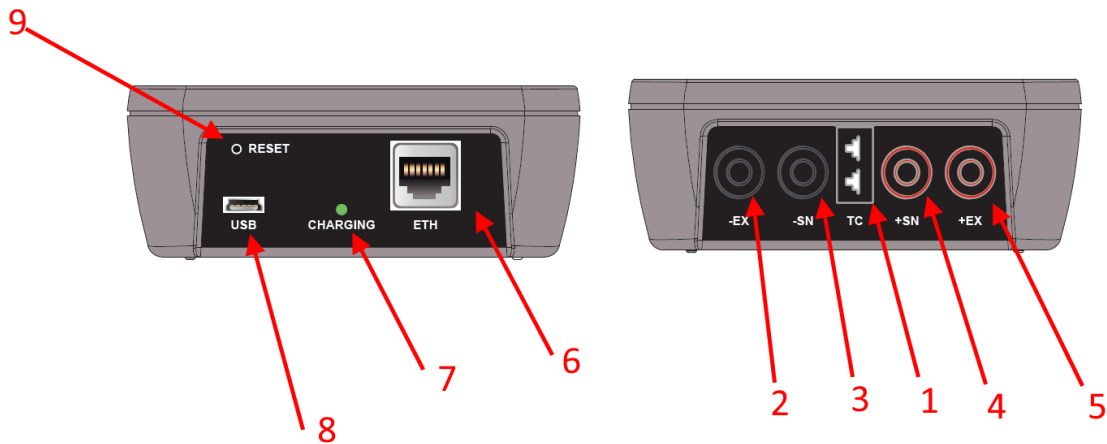
1 Power button, press the button until the screen lights up and then release. Press again for a few seconds to turn off the calibrator.

2 Device Power LED

3 Active datalogger LED

4 External Power Supply LED

4.1.2. PORTS, SOCKETS AND BUSHINGS



- 1 Socket for thermocouple measurement/generation
- 2 Measurement/generation bushing -EX
- 3 Measurement/generation bushing -SN
- 4 Measurement/generation bushing +SN
- 5 Measurement/generation bushing +EX
- 6 10/100Mbit Ethernet port
- 7 LED status of internal battery charging, it lights up if the battery is charging, it turns off if charging is complete
- 8 Micro USB connector for power supply
- 9 Reset button

5. USER GUIDE

The calibrator is a device that can measure or generate electrical quantities to test devices. To proceed with the correct use of the instrument, make sure to follow the following steps:

- Turn on the device.
- Wait at least 5 minutes for the appliance temperature to stabilize.
- Connect the cables correctly, according to the type of measurement or generation to be carried out: refer to the connection diagrams

It is however necessary, before use, to make sure that the battery is fully charged so as to guarantee its life of the generations or measurements that will be carried out. Before each use it is advisable to recharge the instrument using the USB cable supplied, until the LED battery charge indicator on the bottom of the calibrator goes off.

The calibrator can maintain the signals to be generated (set by the user) within a determined error range.

During generation, the calibrator will constantly check the generated signal, warning about any generation error (where provided for).

CAUTION

The calibrator is protected against the risk of applying temporary overvoltages. However, it is good to remember that in this case the device needs 15-20 minutes to restore the normal conditions. If this period of time is not observed, the accuracy of the measurements and/or generations cannot be guaranteed.

CAUTION

Since the negative of the MSC-D device is not at the same potential as the negative of the USB port, it is not advisable to connect it to the USB port of a PC, since this working condition may interfere with the correct operation of the calibrator.

6. USING THE DISPLAY

The display is equipped with capacitive touch and allows access to the device's functions.

6.1. Home screen

The home screen is as follows:



Where:

- 1 Icon of the type of port enabled between Ethernet, Wi-Fi Station or Wi-Fi Access Point
- 2 Icon with the battery charge level
- 3 Button for the signal measurement function menu
- 4 Button for the signal generation function menu
- 5 Scrolling menu

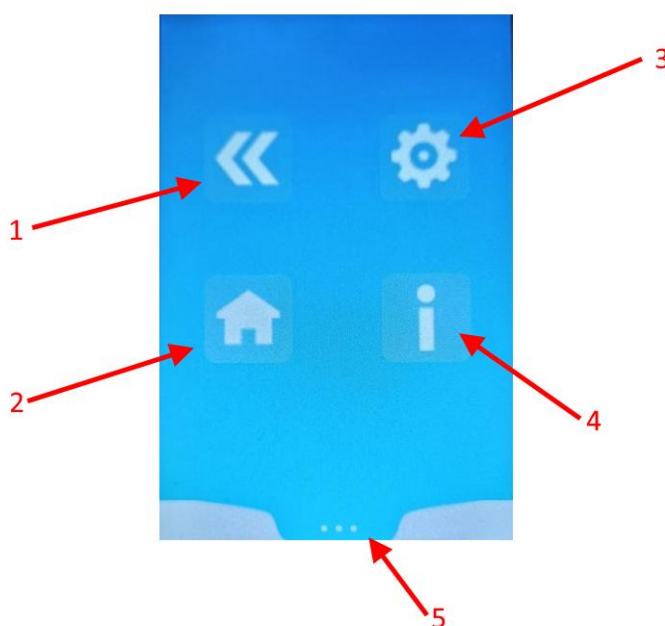
In addition to this, there is some basic information about the device.

6.1.1. THE SCROLLING MENU

The scrolling menu is always present in the device pages:



Once pressed, it allows you to select the following icons:



Where:

- 1 Returns to the previous screen
- 2 Returns to the main screen
- 3 Enters the options (the options change depending on the screen)
- 4 Displays the connection information (depending on the type of generation / measurement being performed)
- 5 Closes the scrolling menu

7. MAIN MENU

The main menu can be accessed from the calibrator's main page by pressing the scrolling menu button:



And then by pressing the  icon

The menu allows you to select 3 different categories of configurations:

7.1. GENERAL SETTINGS

Groups the following general settings:

LANGUAGE

Allows you to choose the interface language

ENABLE ERROR SOUND ALARM

Enables or disables the sound alarm in the event of a measurement/generation error

ENABLE BATTERY SOUND ALARM

Enables or disables the sound alarm in the event of a low battery

ENABLE SOUND DURING SWITCH-ON

Enables or disables the emission of a sound during switch-on

TYPE OF SWITCH-ON

Allows you to select whether the switch-on is Portable or Automatic.

In the case of Portable switch-on, even if external power is supplied, the device will not switch on unless the appropriate button is pressed. To switch off, you must also press the appropriate button.

In the case of Automatic switch-on, the device will switch on automatically once the power cable is inserted and will switch off once the external power is disconnected (to be used on automatic testing machines).

USE ROTARY MEMORY BUFFER

When using the datalogger the device saves the data in an internal memory, once finished the instrument can overwrite (rotary buffer ON) or not (rotary buffer OFF) the data on the recordings already made.

BRIGHTNESS

Sets the screen brightness, the higher the brightness the shorter the battery life.

ENABLE AUTO POWER OFF

This function allows you to set a time after which, if there are no interactions with the screen, the instrument will automatically turn off. In the case of remote connection, disable this function.

DATALOGGER SAMPLING TIME

Sets the datalogger sampling time

TEMPERATURE MEASUREMENT UNIT

Selects the temperature measurement unit

DISPLAY OFF

Selects the time in minutes after which the screen turns off if it has not been touched. Once the screen is off, to turn it back on just touch it. This parameter is important for battery life.

REMOTE CONTROL

Allows you to enable or disable the remote control function from the device's web server.

When the remote control function is active, it is not possible to modify the generation or measurement of signals locally; when the function is deactivated, it is not possible to modify the generation or measurement of signals locally. The basic functions of the web server (firmware update, configuration and download of log files) are, however, always available.

7.2. ETH. SETTINGS

Allows you to set the configuration of the Ethernet port

CAUTION

The Ethernet port and WIFI port cannot be enabled at the same time

Ethernet Enabled

Enables or disables the Ethernet port

DHCP

Enables the DHCP client to retrieve the IP address automatically, if disabled the IP is static and it is possible to set the parameters:

IP

IP static address of the Ethernet port

MASK

Mask of the Ethernet port

GW

Ethernet port Gateway

DNS

Ethernet port Domain Name System

7.3. WIFI. SETTINGS

Allows you to set the configuration of the WI-FI port

CAUTION

The Ethernet port and WIFI port cannot be enabled at the same time

The calibrator's Wi-Fi port can be configured in Wi-Fi "Station" and Wi-Fi "Access Point" modes.

In Station mode, the Wi-Fi port connects to an existing Wi-Fi router (access point).

In Access Point mode, the Wi-Fi port accepts connections from other devices, allowing Wi-Fi connections from devices such as PCs or mobile devices equipped with Wi-Fi.

7.3.1. **WI-FI STATION**

It allows the calibrator to connect to an existing Wi-Fi network through a router set in access point mode. When the mode is activated, it is possible to manually enter the configuration of the router to connect to.

7.3.2. **WI-FI ACCESS POINT**

It allows the creation of a new Wi-Fi network to which Wi-Fi devices such as PCs or tablets, cell phones etc. can be connected.

The calibrator's IP address is:

192.168.4.1

7.3.3. **WI-FI SCAN**

When the Station or Access Point mode is activated, it is possible to scan the network to connect the device to an existing Wi-Fi network.

Press the "SCAN" button and wait for the found networks to be displayed. Then enter the network password (the other parameters are automatically retrieved).

At this point the calibrator will restart in Wi-Fi Station mode and connect to the indicated network.

CAUTION

It is not possible to activate WI-FI SCAN mode without first activating the WI-FI port in Station or Access Point mode

7.4. RTC SETTINGS

Allows you to set the date and time of the device to be used for the datalogger's time tag.

In addition to date insertion, it is possible to enable the connection with an NTP server in order to acquire the date via internet.

NTP ENABLED

If ON, retrieves date/time from NTP servers; if OFF, allows to manually enter date/time.

SRV1

IP address of the primary NTP Server

SRV2

IP address of the secondary NTP server (to be used in case of primary fail)

SYNCHRONISATION

Set date/time synchronisation interval

GMT (min)

Sets the time zone with respect to GMT in minutes (e.g. for Italy GMT= 60 minutes in the case of standard time)

7.5. FACTORY SETTINGS

Resets all configuration parameters to default.

8. CALIBRATOR FUNCTIONS

MEASUREMENT FUNCTIONS:

The MSC calibrator allows measuring the following signals:

- Passive current (with power supplied externally to the calibrator)
- Active current (with power supplied by the calibrator)
- Voltage 0 V/ +27 V
- Voltage -10 mV/ +90 mV
- Thermocouple
- Thermoresistance
- Load cell (strain gauge)
- Frequency/pulses

GENERATION FUNCTIONS

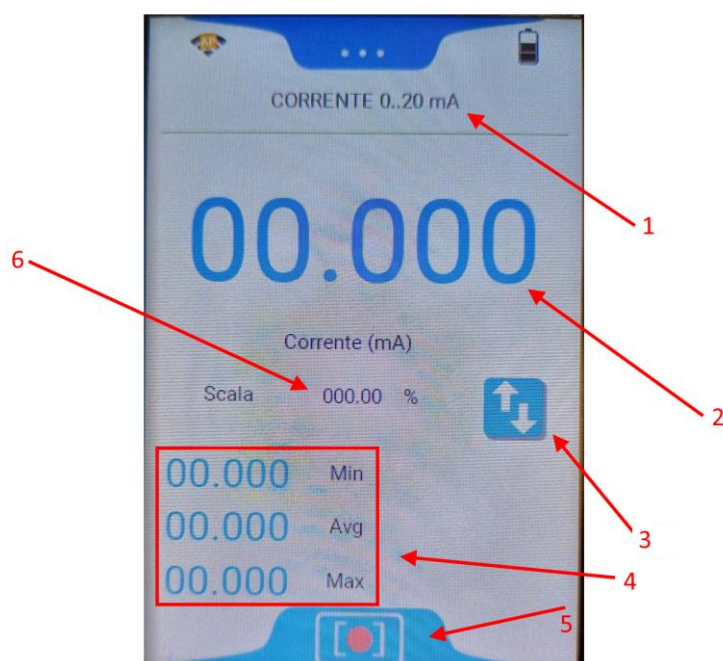
The MSC calibrator allows generating the following signals:

- Passive current (with power supplied externally to the calibrator)
- Active current (with power supplied by the calibrator)
- Voltage 0 V/ +27 V
- Voltage -10 mV/ +90 mV
- Thermocouple
- Thermoresistance
- Load cell
- Frequency/pulses

8.1. HOW THE CALIBRATOR WORKS AS A SIGNAL METER

8.1.1. CHECKS COMMON TO ALL MEASUREMENTS

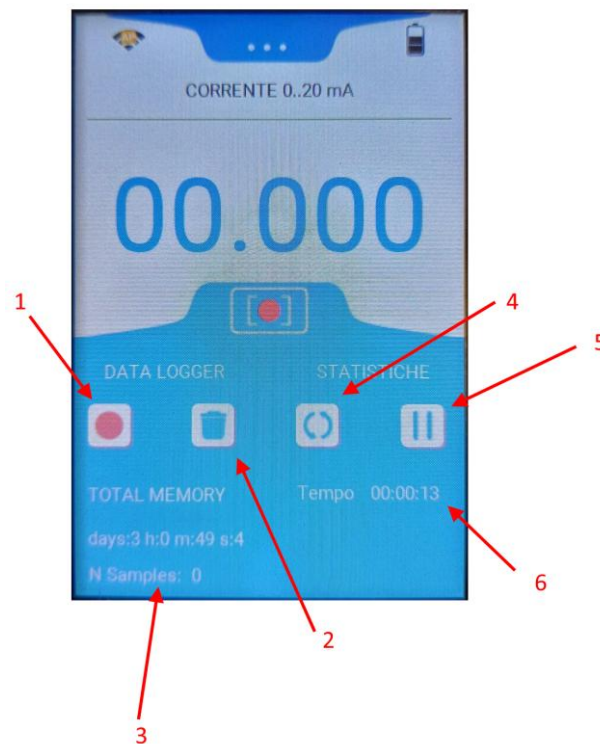
The following are the checks that are common to all measurements:



Where:

- 1 Type of measurement
- 2 Primary measured value
- 3 Button to switch between primary and secondary measurement
- 4 Minimum average maximum statistical values
- 5 Datalogger/Statistics menu button
- 6 Secondary measured value

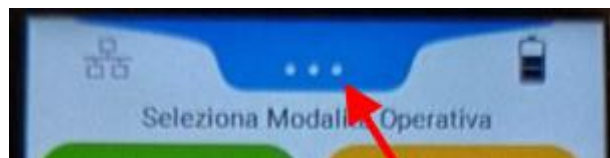
Pressing the Datalogger/Statistics menu button gives:




Where:

- 1 Start/Stop button of the data logger
- 2 Button to delete all logs in the memory
- 3 Display of the statistics of the data logger
- 4 Resets the Minimum Average Maximum values
- 5 Pauses or restarts the calculation of the Minimum Average Maximum values

In all measurements by pressing the button:



It is possible to press the  icon and access a whole series of configuration parameters relating to the measurement in use such as the measurement filtering setting, the type of cold junction etc.

⚠ ATTENTION!

Wait until the device reaches a stable thermal condition before taking measurements with the thermocouples (typically at least 30 minutes).

⚠ ATTENTION!

If the thermocouple does not have its own connector, use the innermost bushings SN+ SN- as an alternative, bearing in mind that the compensation of the cold junction in this case may be less precise.

⚠ ATTENTION!

The 4-wire measurement of the load cell is influenced by the resistance of the conductors supplying it. If it is not possible to shorten the connections between the load cell and the MSC calibrator, by measuring the resistance only of the conductors that supply the load cell (conductors +EX and -EX), the correction coefficient can be calculated:

$$K = \frac{350 + R_{+EX} + R_{-EX}}{350}$$

The obtained coefficient must be multiplied with the value measured by the calibrator to obtain the real value.

8.1.2. DATALOGGER

The calibrator allows you to perform recording sessions using the appropriate button as already described.

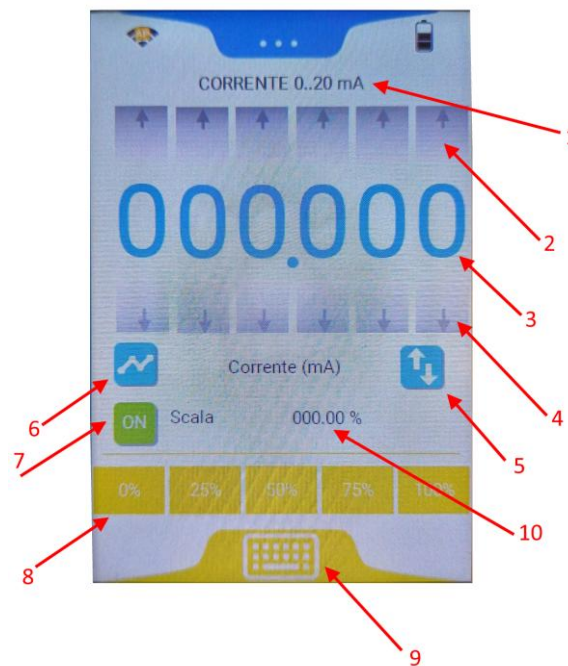
The minimum acquisition time is 1 second.

The download of the datalogger file in csv text format is possible via the appropriate webserver page.

8.2. OPERATION OF THE CALIBRATOR AS A SIGNAL GENERATOR

8.2.1. CHECKS COMMON TO ALL GENERATIONS

The following are the checks that are common to all generations:




Where:

- 1 Generation type
- 2 Buttons to increase the value of the single digit
- 3 Output generated value
- 4 Buttons to decrease the value of the single digit
- 5 Button to switch between primary and secondary generation value
- 6 Ramp menu
- 7 Enables or disables the output
- 8 Quick keys to generate the output in percentage
- 9 Keyboard to enter the value to generate
- 10 Secondary value generated

In all generations by pressing the button:



You can press the  icon and access a whole series of configuration parameters relating to the generation in use.

⚠ ATTENTION!

It is important to note that in frequency generation the time resolution according to which the square wave signal is generated is 50 μs.

This implies an error that is dependent on the numeric value set.

For instance, you want to generate a signal with a frequency of 150 Hz whose corresponding period is 6,666 ms; the number of counts necessary to obtain this frequency is obtained through:

$$6,666 \text{ MHz} / 50 \text{ μs} = 133.33$$

The system then rounds off to the nearest whole number (133) which it will use to generate the output signal.

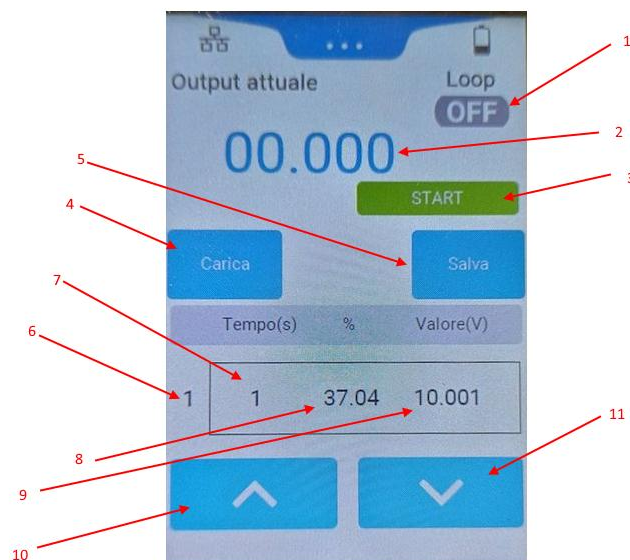
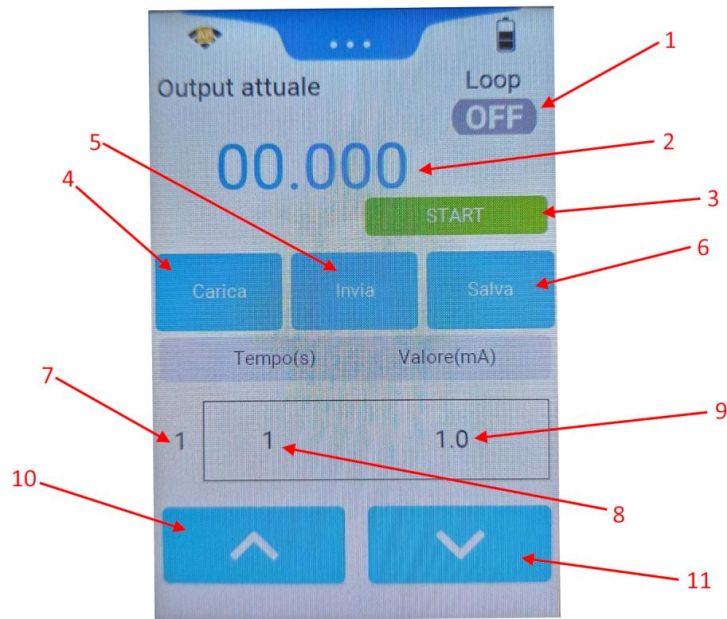
The output frequency will have the value:

$$F_{out} = \frac{1}{133 * 50 \text{ μs}} = 150.37 \text{ Hz}$$

The firmware will automatically show the value actually generated.

8.2.2. THE RAMP GENERATOR

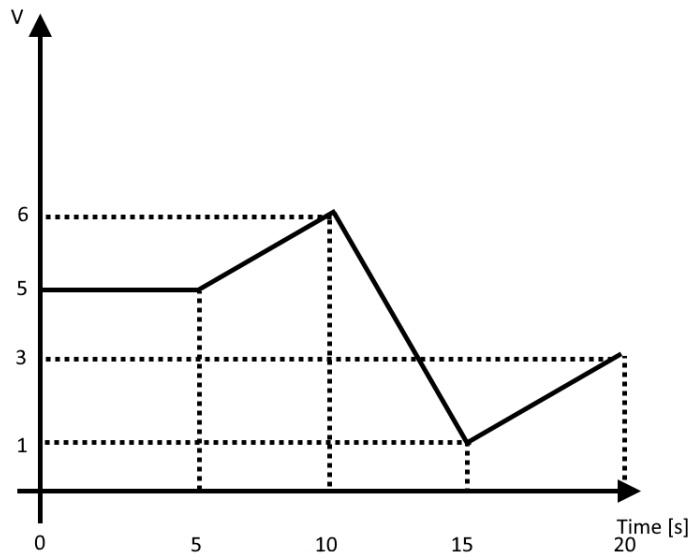
The calibrator allows you to generate ramps through the interface described here



Where:

- 1 Activates or deactivates the ramp loop (if OFF once the ramp is finished it does not restart automatically)
- 2 Currently generated value
- 3 Start/Stop ramp
- 4 Loads a ramp configuration from a previously saved file
- 5 Saves the current ramp configuration to a file
- Sends the current ramp configuration to the motherboard
- 6 N-th ramp point
- 7 Time in seconds
- 8 % value of the generation compared to full scale
- 9 Value that the output value must take on
- 10 Previous ramp point
- 11 Next ramp point

For example, we want to generate a voltage ramp of the type:



We then enter the coordinates of the points, the starting point of the ramp (time = 0) has the value of 5 V, we then enter point 1 with time = 0s, Value = 5V

After 5 seconds the value is stable at 5V so we enter time = 5s, value = 5V

After another 5 seconds the value goes from 6V so we enter time = 5s, value = 6V until we obtain the following table:

| <i>Point Number</i> | <i>Time [s]</i> | <i>Value [V]</i> |
|---------------------|-----------------|------------------|
| 1 | 0 | 5 |
| 2 | 5 | 5 |
| 3 | 5 | 6 |
| 4 | 5 | 1 |
| 5 | 5 | 3 |

Now we can save this ramp in the file from 1 to 5 so that we can load it in the future with the “Save” button.

Now we send the ramp to the motherboard with the “Send” button.

At this point we are ready to generate the ramp with the “Start” button.

To repeat the execution of the same ramp it is not necessary to send the ramp to the motherboard again but it will be enough to press the “Start” button again.

9. THE WEBSERVER

The calibrator has a webserver that allows you to:

- Control and configure the calibrator remotely
- Download the data from the datalogger in CSV text format
- Update firmware

9.1. LOCAL/REMOTE CONTROL OF THE CALIBRATOR

The webserver allows you to remotely control and configure the generator using a web browser. Using Wi-Fi, for example, you can control the calibrator from a mobile phone.

The graphic interface is similar to that of the display and allows the same functions.

To control the calibrator remotely, you need to set the “Remote Control” parameter in the “General Settings” menu to “ON”.

CAUTION

It is not possible to control the calibrator simultaneously from the local display and from the webserver.

If the “Remote Control” parameter is “ON” the message “REMOTE MODE” appears on the initial page of the display. To restore the display operation, it is necessary to return the “Remote Control” parameter to “OFF”.

9.2. ACCESS TO THE WEB SERVER

To access the webserver, you need to know the IP address of the device and have a web browser (for example Chrome).

In the case of connection via ethernet port with the default address, access to the webserver occurs at the address:

<http://192.168.90.101>

In case of connection via Wi-Fi port with the calibrator in Access Point mode, the calibrator web server address is:

<http://192.168.4.1>

In the case of connection via Wi-Fi port with the calibrator in Station mode, the IP address is typically provided by the router's DHCP server. To find out the set IP address, access the WI-FI Station menu of the display's main menu.

Once you have accessed the webserver, when prompted for the user name and password, enter:

User name: admin

Password: admin

10. MEASUREMENT AND GENERATION ERRORS

The calibrator can detect errors both in generation and measurement of a signal. The table shows the types of errors detected:

| TYPE OF ERROR | MEANING |
|----------------------|--|
| Generation error | The set generation is not guaranteed within the declared error |
| Measurement error | The measured signal is out of range |

An error is also detected when the externally generated loop voltage exceeds 29 V.

11. ETHERNET PORT

The factory configuration of the Ethernet port is:

STATIC IP: 192.168.90.101
 SUBNET MASK: 255.255.255.0
 GATEWAY: 192.168.90.1

Multiple devices must not be inserted on the same network with the same static IP.

 **ATTENTION!**
DO NOT CONNECT 2 OR MORE FACTORY-CONFIGURED DEVICES ON THE SAME NETWORK, OR THE DEVICE WILL NOT WORK
(CONFLICT OF IP ADDRESSES 192.168.90.101)

12. FIRMWARE UPDATE

In order to improve, add or optimize the functions of the product, Seneca releases firmware updates on the device section on the www.seneca.it website

The firmware update is performed via the webserver.

 **ATTENTION!**
IN ORDER NOT TO DAMAGE THE DEVICE, THE BATTERIES MUST BE CHARGED AND THE EXTERNAL POWER SUPPLY MUST BE PRESENT.

It is possible to update both the display board firmware and the motherboard firmware.

The display board firmware update can be done directly from the webserver, the motherboard update is done via a command sent from the webserver and then connecting the USB port of the device to a software on the PC.

13. SUPPORTED MODBUS COMMUNICATION PROTOCOLS

The Modbus communication protocols supported are:

- Modbus TCP-IP Server (from Ethernet port or Wi-Fi) with support for up to 8 remote Modbus TCP-IP Clients

For more information on these protocols, see the website:

<http://www.modbus.org/specs.php>.

13.1. SUPPORTED MODBUS FUNCTION CODES

The following Modbus functions are supported:

- Read Holding Registers (function 3)
- Write Single Register (function 6)
- Write Multiple Registers (function 16)

 **ATTENTION!**

All 32-bit variables are contained in 2 consecutive Modbus registers

All 64-bit variables are contained in 4 consecutive Modbus registers

14. INFORMATION ABOUT MODBUS REGISTERS


The following abbreviations are used in the following chapter:

| | |
|-----------------|--|
| MS | Most Significant |
| LS | Least Significant |
| MSBIT | Most Significant Bit |
| LSBIT | Least Significant Bit |
| MMSW | "Most" Most Significant Word (16bit) |
| MSW | Most Significant Word (16bit) |
| LSW | Least Significant Word (16bit) |
| LLSW | "Least" Least Significant Word (16bit) |
| RO | Read Only |
| RW* | Read-Write: REGISTRI CONTENUTI IN MEMORIA FLASH: SCRIVIBILI AL MASSIMO CIRCA 10000 VOLTE |
| RW** | Read-Write: REGISTRI SCRIVIBILI SOLO DOPO LA SCRITTURA DEL COMANDO "ENABLE WRITE CUSTOM ENERGIES=49616" |
| UNSIGNED 16 BIT | Unsigned integer register that can assume values from 0 to 65535 |
| SIGNED 16 BIT | Signed integer register that can take values from -32768 to +32767 |
| UNSIGNED 32 BIT | Unsigned integer register that can assume values from 0 to 4294967296 |
| SIGNED 32 BIT | Signed integer register that can take values from -2147483648 to 2147483647 |
| UNSIGNED 64 BIT | Unsigned integer register that can assume values from 0 to 18446744073709551615 |
| SIGNED 64 BIT | Signed integer register that can assume values from -2^{63} to $2^{63}-1$ |
| FLOAT 32 BIT | 32-bit, single-precision floating-point register (IEEE 754) https://en.wikipedia.org/wiki/IEEE_754 |
| BIT | Boolean register, which can take the values 0 (false) or 1 (true) |

14.1. NUMBERING OF "0-BASED" OR "1-BASED" MODBUS ADDRESSES

According to the Modbus standard the Holding Registers are addressable from 0 to 65535, there are 2 different conventions for numbering the addresses: "0-BASED" and "1-BASED".

For greater clarity, Seneca shows its register tables in both conventions.



ATTENTION!

CAREFULLY READ THE DOCUMENTATION OF THE MODBUS MASTER DEVICE IN ORDER TO UNDERSTAND WHICH OF THE TWO CONVENTIONS THE MANUFACTURER HAS DECIDED TO USE

SENECA USES THE "1 BASED" CONVENTION FOR ITS PRODUCTS

14.2. NUMBERING OF MODBUS ADDRESSES WITH "0-BASED" CONVENTION

The numbering is:

| <i>HOLDING REGISTER MODBUS ADDRESS (OFFSET)</i> | <i>MEANING</i> |
|--|-----------------------|
| 0 | FIRST REGISTER |
| 1 | SECOND REGISTER |
| 2 | THIRD REGISTER |
| 3 | FOURTH REGISTER |
| 4 | FIFTH REGISTER |

Therefore, the first register is at address 0.

In the following tables, this convention is indicated with "***ADDRESS OFFSET***".

14.3. NUMBERING OF MODBUS ADDRESSES WITH "1 BASED" CONVENTION (STANDARD)

The numbering is that established by the Modbus consortium and is of the type:

| HOLDING REGISTER MODBUS ADDRESS 4x | MEANING |
|---|-----------------|
| 40001 | FIRST REGISTER |
| 40002 | SECOND REGISTER |
| 40003 | THIRD REGISTER |
| 40004 | FOURTH REGISTER |
| 40005 | FIFTH REGISTER |

This convention is indicated with "**ADDRESS 4x**" since a 40000 is added to the address so that the first Modbus register is 40001.

A further convention is also possible where the number 4 is omitted in front of the register address:

| HOLDING MODBUS ADDRESS WITHOUT 4x | MEANING |
|--|-----------------|
| 1 | FIRST REGISTER |
| 2 | SECOND REGISTER |
| 3 | THIRD REGISTER |
| 4 | FOURTH REGISTER |
| 5 | FIFTH REGISTER |

14.4. BIT CONVENTION WITHIN A MODBUS HOLDING REGISTER

A Modbus Holding Register consists of 16 bits with the following convention:

| | | | | | | | | | | | | | | | |
|--------|--------|--------|--------|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| BIT 15 | BIT 14 | BIT 13 | BIT 12 | BIT 11 | BIT 10 | BIT 9 | BIT 8 | BIT 7 | BIT 6 | BIT 5 | BIT 4 | BIT 3 | BIT 2 | BIT 1 | BIT 0 |
|--------|--------|--------|--------|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|

For instance, if the value of the register in decimal is

12300

the value 12300 in hexadecimal is:

0x300C

the hexadecimal 0x300C in binary value is:

11 0000 0000 1100

So, using the above convention, we get:

| | | | | | | | | | | | | | | | |
|--------|--------|--------|--------|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| BIT 15 | BIT 14 | BIT 13 | BIT 12 | BIT 11 | BIT 10 | BIT 9 | BIT 8 | BIT 7 | BIT 6 | BIT 5 | BIT 4 | BIT 3 | BIT 2 | BIT 1 | BIT 0 |
| 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |

14.5. **MSB and LSB BYTE CONVENTION WITHIN A MODBUS HOLDING REGISTER**

A Modbus Holding Register consists of 16 bits with the following convention:

| | | | | | | | | | | | | | | | |
|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| BIT 15 | BIT 14 | BIT 13 | BIT 12 | BIT 11 | BIT 10 | BIT 9 | BIT 8 | BIT 7 | BIT 6 | BIT 5 | BIT 4 | BIT 3 | BIT 2 | BIT 1 | BIT 0 |
|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|

LSB Byte (Least Significant Byte) defines the 8 bits ranging from Bit 0 to Bit 7 included, we define MSB Byte (Most Significant Byte) the 8 bits ranging from Bit 8 to Bit 15 inclusive:

| | | | | | | | | | | | | | | | |
|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| BIT 15 | BIT 14 | BIT 13 | BIT 12 | BIT 11 | BIT 10 | BIT 9 | BIT 8 | BIT 7 | BIT 6 | BIT 5 | BIT 4 | BIT 3 | BIT 2 | BIT 1 | BIT 0 |
| BYTE MSB | | | | | | | | BYTE LSB | | | | | | | |

14.6. **REPRESENTATION OF A 32-BIT VALUE IN TWO CONSECUTIVE MODBUS HOLDING REGISTERS**

The representation of a 32-bit value in the Modbus Holding Registers is made using 2 consecutive Holding Registers (a Holding Register is a 16-bit register). To obtain the 32-bit value it is therefore necessary to read two consecutive registers:

For example, if register 40064 contains the 16 most significant bits (MSW) while register 40065 contains the least significant 16 bits (LSW), the 32-bit value is obtained by composing the 2 registers:

| | | | | | | | | | | | | | | | |
|-----------------------------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| BIT 15 | BIT 14 | BIT 13 | BIT 12 | BIT 11 | BIT 10 | BIT 9 | BIT 8 | BIT 7 | BIT 6 | BIT 5 | BIT 4 | BIT 3 | BIT 2 | BIT 1 | BIT 0 |
| 40064 MOST SIGNIFICANT WORD | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | |
|------------------------------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| BIT 15 | BIT 14 | BIT 13 | BIT 12 | BIT 11 | BIT 10 | BIT 9 | BIT 8 | BIT 7 | BIT 6 | BIT 5 | BIT 4 | BIT 3 | BIT 2 | BIT 1 | BIT 0 |
| 40065 LEAST SIGNIFICANT WORD | | | | | | | | | | | | | | | |

$$Value_{32bit} = Register_{LSW} + (Register_{MSW} * 65536)$$

In the reading registers it is possible to swap the most significant word with the least significant word, therefore it is possible to obtain 40064 as LSW and 40065 as MSW.

15. MANAGING MSC-D FROM MODBUS REGISTERS

CAUTION

To control the calibrator from Modbus registers, the “Remote Control” parameter must be set to “ON” and the webserver must be disconnected and not interacting with the device.

15.1. DESCRIPTION

The MSC product has Modbus registers that allow you to control the device and read or generate electrical quantities.

The protocol supported by MSC is Modbus TCP-IP server.

The purpose of this chapter is to provide information for the complete control of MSC so that it can be integrated into third-party software.

For .NET developers, various libraries for the Modbus protocol are available.

An example, the Open Source Modbus library is available at this address:

<https://github.com/NModbus/NModbus>

15.2. USE OF MSC TO TAKE MEASUREMENTS

15.2.1. MEASUREMENT MIN/MAX/AVG VALUES

To reset the Min/Max/Avg values, write the value 5 on CMD register

To pause the Min/Max/Avg values write the value 10 in the CMD register

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|-------------------------|--------------------------|----------------------|-----------------------|
| 40108 | 107 | CMD | 16 bit without a sign |

15.2.2. DATALOGGER

It is possible to control the datalogger start/stop in this way:

| COMMAND | AUX1 REGISTER WRITING VALUE | CMD REGISTER WRITING VALUE |
|------------------|------------------------------------|-----------------------------------|
| DATALOGGER START | 1 | 3 |
| DATALOGGER STOP | 0 | 3 |

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|-------------------------|--------------------------|----------------------|-----------------------|
| 40108 | 107 | CMD | 16 bit without a sign |
| 40109 | 108 | AUX1 | 16 bit without a sign |

| REGISTER ADDRESS | REGISTER (OFFSET) | VARIABLE | VARIABLE TYPE | Unit of Measure |
|-------------------------|--------------------------|--|-----------------------|------------------------|
| 40195-196 | 194-195 | Dimensions of the datalogger file in bytes | 32 bit without a sign | Byte |

15.2.3. DIAGNOSTICS REGISTER FOR MEASUREMENTS

The reading diagnostics register is:

| REGISTER ADDRESS | REGISTER (OFFSET) | VARIABLE | VARIABLE TYPE | Unit of Measure |
|-------------------------|--------------------------|-----------------|-----------------------|------------------------|
| 40103 | 102 | Diagnostics | 16 bit without a sign | - |

The bit indicating a measurement error is

| BIT 16 | BIT 15 | BIT 14 | BIT 13 | BIT 12 | BIT 11 | BIT 10 | BIT 9 | BIT 8 | BIT 7 | BIT 6 | BIT 5 | BIT 4 | BIT 3 | BIT 2 | BIT 1 |
|--------|--------|-------------------|--------|--------|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| - | - | MEASUREMENT ERROR | - | - | - | - | - | - | - | - | - | - | - | - | - |

Where if the MEASUREMENT ERROR bit:

is 1 -> Measurement error

is 0 -> Measurement OK

15.2.4. CURRENT/VOLTAGE MEASUREMENTS

The type of measurement is selected by writing the AUX1 register followed by the CMD register

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|-------------------------|--------------------------|----------------------|-----------------------|
| 40108 | 107 | CMD | 16 bit without a sign |
| 40109 | 108 | AUX1 | 16 bit without a sign |

The values to write in the registers for the different types of measurement are:

| TYPE OF MEASUREMENT | AUX1 REGISTER WRITING VALUE | CMD REGISTER WRITING VALUE |
|--------------------------------------|------------------------------------|-----------------------------------|
| CURRENT PASSIVE MEASUREMENT 0..20 mA | 1 | 1 |
| CURRENT ACTIVE MEASUREMENT 0..20 mA | 2 | 1 |
| VOLTAGE 0..27 V | 3 | 1 |
| VOLTAGE -10..90 mV | 4 | 1 |

Reading registers:

| REGISTER ADDRESS | REGISTER (OFFSET) | VARIABLE | VARIABLE TYPE | Unit of Measure |
|-------------------------|--------------------------|-------------------|----------------------|------------------------|
| 40137-40138 | 136-137 | Measurement value | Floating Point | mA / V / mV |
| 40133-40134 | 132-133 | Minimum value | Floating Point | mA / V / mV |
| 40135-40136 | 134-135 | Maximum value | Floating Point | mA / V / mV |
| 40171-40172 | 170-171 | Medium value | Floating Point | mA / V / mV |

15.2.5. THERMOCOUPLE MEASUREMENTS

The type of thermocouple is selected by writing the AUX1 register followed by the CMD register

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|-------------------------|--------------------------|----------------------|-----------------------|
| 40108 | 107 | CMD | 16 bit without a sign |
| 40109 | 108 | AUX1 | 16 bit without a sign |

The values to write in the registers to select the type of thermocouple are:

| THERMOCOUPLE TYPE | AUX1 REGISTER WRITING VALUE | CMD REGISTER WRITING VALUE |
|--------------------------|------------------------------------|-----------------------------------|
| J | 5 | 1 |
| K | 6 | 1 |
| T | 7 | 1 |
| E | 8 | 1 |
| L | 9 | 1 |
| N | 10 | 1 |
| R | 11 | 1 |
| S | 12 | 1 |
| B | 13 | 1 |

Reading registers:

| REGISTER ADDRESS | REGISTER (OFFSET) | VARIABLE | VARIABLE TYPE | Unit of Measure |
|-------------------------|--------------------------|---------------------------|----------------------|------------------------|
| 40137-40138 | 136-137 | Temperature | Floating Point | °C |
| 40117-40118 | 116-117 | Cold junction voltage | Floating Point | mV |
| 40127-40128 | 126-127 | Cold junction temperature | Floating Point | °C |
| 40133-40134 | 132-133 | Minimum temperature | Floating Point | °C |
| 40135-40136 | 134-135 | Maximum temperature | Floating Point | °C |
| 40171-40172 | 170-171 | Average temperature | Floating Point | °C |

15.2.6. RESISTOR E TEMPERATURE METER

The type of resistance thermometer is selected by writing the AUX1 register followed by the CMD register

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|-------------------------|--------------------------|----------------------|-----------------------|
| 40108 | 107 | CMD | 16 bit without a sign |
| 40109 | 108 | AUX1 | 16 bit without a sign |

The values to write in the registers to select the type of resistance thermometer are:

| RESISTANCE TEMPERATURE METER | AUX1 REGISTER WRITING VALUE | CMD REGISTER WRITING VALUE |
|-------------------------------------|------------------------------------|-----------------------------------|
| PT100 2 WIRES | 14 | 1 |
| PT100 3 WIRES | 15 | 1 |
| PT100 4 WIRES | 16 | 1 |
| PT500 2 WIRES | 17 | 1 |
| PT500 3 WIRES | 18 | 1 |
| PT500 4 WIRES | 19 | 1 |
| PT1000 2 WIRES | 20 | 1 |
| PT1000 4 WIRES | 22 | 1 |
| PT1000 4 WIRES | 22 | 1 |
| PT1000 4 WIRES | 22 | 1 |
| CU50 2 WIRES | 23 | 1 |
| CU50 3 WIRES | 24 | 1 |
| CU50 4 WIRES | 25 | 1 |
| CU100 2 WIRES | 26 | 1 |
| CU100 3 WIRES | 27 | 1 |
| CU100 4 WIRES | 28 | 1 |
| NI100 2 WIRES | 29 | 1 |
| NI100 3 WIRES | 30 | 1 |
| NI100 4 WIRES | 31 | 1 |
| NI120 2 WIRES | 32 | 1 |
| NI120 3 WIRES | 33 | 1 |
| NI120 4 WIRES | 34 | 1 |

Reading registers:

| REGISTER ADDRESS | REGISTER (OFFSET) | VARIABLE | VARIABLE TYPE | Unit of Measure |
|-------------------------|--------------------------|---------------------|----------------------|------------------------|
| 40137-40138 | 136-137 | Temperature | Floating Point | °C |
| 40131-40132 | 130-131 | Resistance | Floating Point | Ohm |
| 40133-40134 | 132-133 | Minimum temperature | Floating Point | °C |
| 40135-40136 | 134-135 | Maximum temperature | Floating Point | °C |
| 40171-40172 | 170-171 | Average temperature | Floating Point | °C |

15.2.7. **LOAD CELL MEASUREMENT**

The type of load cell measurement is selected by writing the AUX1 register followed by the CMD register

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|-------------------------|--------------------------|----------------------|-----------------------|
| 40108 | 107 | CMD | 16 bit without a sign |
| 40109 | 108 | AUX1 | 16 bit without a sign |

The values to write in the registers to select the type of load cell measurement are:

| TYPE OF MEASUREMENT | AUX1 REGISTER WRITING VALUE | CMD REGISTER WRITING VALUE |
|----------------------------|------------------------------------|-----------------------------------|
| LOAD CELL MEASUREMENT | 35 | 1 |

The measurement is expressed in mV/V and is only gross (tare + net weight):

Reading registers:

| REGISTER ADDRESS | REGISTER (OFFSET) | VARIABLE | VARIABLE TYPE | Unit of Measure |
|-------------------------|--------------------------|----------------------------|----------------------|------------------------|
| 40137-40138 | 136-137 | Cell unbalance measurement | Floating Point | mV/V |

If the cell is completely unbalanced the measurement is 2 mV/V so the gross weight coincides with the full scale of the cell.

The gross weight can then be calculated according to the formula:

$$\text{Gross Weight [Kg]} = (\text{Cell Full Scale [Kg]} * \text{Cell Unbalance Measurement [mV/V]}) / 2$$

For example, if the load cell has a full scale of 100 kg and the unbalance measurement is 1 mV/V you will have:

$$\text{Gross Weight [Kg]} = (100 \text{ Kg} * 1 \text{ mV/V}) / 2 = 50 \text{ Kg}$$

15.2.8. FREQUENCY MEASUREMENT

The type of frequency measurement is selected by writing the AUX1 register followed by the CMD register

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|-------------------------|--------------------------|----------------------|-----------------------|
| 40108 | 107 | CMD | 16 bit without a sign |
| 40109 | 108 | AUX1 | 16 bit without a sign |

The values to write in the registers to select the type of load cell measurement are:

| TYPE OF MEASUREMENT | AUX1 REGISTER WRITING VALUE | CMD REGISTER WRITING VALUE |
|----------------------------|------------------------------------|-----------------------------------|
| LOAD CELL MEASUREMENT | 36 | 1 |

Reading registers:

| REGISTER ADDRESS | REGISTER (OFFSET) | VARIABLE | VARIABLE TYPE | Unit of Measure |
|-------------------------|--------------------------|-----------------|----------------------|------------------------|
| 40165-166 | 164-165 | Frequency | Floating Point | Hz |

15.2.9. PULSE NUMBER MEASUREMENT

The type of pulse measurement is selected by writing the AUX1 register followed by the CMD register

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|-------------------------|--------------------------|----------------------|-----------------------|
| 40108 | 107 | CMD | 16 bit without a sign |
| 40109 | 108 | AUX1 | 16 bit without a sign |

The values to write in the registers to select the type of pulse measurement are:

| TYPE OF MEASUREMENT | AUX1 REGISTER WRITING VALUE | CMD REGISTER WRITING VALUE |
|----------------------------|------------------------------------|-----------------------------------|
| LOAD CELL MEASUREMENT | 37 | 1 |

Reading registers:

| REGISTER ADDRESS | REGISTER (OFFSET) | VARIABLE | VARIABLE TYPE | Unit of Measure |
|-------------------------|--------------------------|-----------------------------------|-----------------------|------------------------|
| 40153-154 | 152-153 | Pulse number with Positive Fronts | 32 bit without a sign | Pulse No. |
| 40151-152 | 150-151 | Pulse number with Negative Fronts | 32 bit without a sign | Pulse No. |

To reset the pulse value counted, write the value 5 in the CMD register

To pause the count of the pulses, write the value 10 in the CMD register

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|-------------------------|--------------------------|----------------------|-----------------------|
| 40108 | 107 | CMD | 16 bit without a sign |

15.3. USE OF MSC TO GENERATE SIGNALS

15.3.1. DIAGNOSTICS REGISTER FOR GENERATIONS

The generation diagnostics register is:

| <i>REGISTER ADDRESS</i> | <i>REGISTER (OFFSET)</i> | <i>VARIABLE</i> | <i>VARIABLE TYPE</i> | <i>Unit of Measure</i> |
|-------------------------|--------------------------|-----------------|-----------------------|------------------------|
| 40103 | 102 | Diagnostics | 16 bit without a sign | - |

The bit indicating a measurement error is

| BIT 16 | BIT 15 | BIT 14 | BIT 13 | BIT 12 | BIT 11 | BIT 10 | BIT 9 | BIT 8 | BIT 7 | BIT 6 | BIT 5 | BIT 4 | BIT 3 | BIT 2 | BIT 1 |
|------------------|--------------------|--------|--------|--------|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| GENERATION ERROR | SELF-READING ERROR | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

Where if:

The SELF-READING ERROR bit:

is 1 -> Self-reading error of the current generation

is 0 -> Generation OK

The GENERATION ERROR bit:

is 1 -> Generation error

is 0 -> Generation OK

15.3.2. CURRENT AND VOLTAGE GENERATION

The type of generation is selected by writing the AUX1 register followed by the CMD register

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|-------------------------|--------------------------|----------------------|-----------------------|
| 40208 | 207 | CMD | 16 bit without a sign |
| 40209 | 208 | AUX1 | 16 bit without a sign |

The values to write in the registers for the different types of measurement are:

| GENERATION TYPE | AUX1 REGISTER WRITING VALUE | CMD REGISTER WRITING VALUE |
|-----------------------------|------------------------------------|-----------------------------------|
| PASSIVE CURRENT 0..20 mA | 101 | 1 |
| ACTIVE CURRENT 0..20 mA | 102 | 1 |
| VOLTAGE 0..27 V | 103 | 1 |
| VOLTAGE -10..90 mV | 104 | 1 |

Writing registers (the written value is generated to the terminals) for the currents:

| REGISTER ADDRESS | REGISTER (OFFSET) | VARIABLE | VARIABLE TYPE | Unit of Measure |
|-------------------------|--------------------------|-------------------------------|----------------------|------------------------|
| 40137-40138 | 136-137 | Current value to be generated | Floating Point | mA |

Writing registers (the written value is generated to the terminals) for the voltages:

| REGISTER ADDRESS | REGISTER (OFFSET) | VARIABLE | VARIABLE TYPE | Unit of Measure |
|-------------------------|--------------------------|-------------------------------|----------------------|------------------------|
| 40213-40214 | 212-2016 | Voltage value to be generated | Floating Point | V / mV |

15.3.3. THERMOCOUPLE SIGNAL GENERATION

Configuration of the cold junction:

| COLD JUNCTION | AUX1 REGISTER WRITING VALUE | AUX2 REGISTER WRITING VALUE | CMD REGISTER WRITING VALUE |
|----------------------|------------------------------------|------------------------------------|-----------------------------------|
| INSIDE MSC | 2 | 1 | 2 |
| OUTSIDE MSC | 1 | 1 | 2 |

Where:

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|-------------------------|--------------------------|----------------------|-----------------------|
| 40209 | 208 | AUX1 | 16 bit without a sign |
| 40210 | 209 | AUX2 | 16 bit without a sign |
| 40208 | 207 | CMD | 16 bit without a sign |

In case of manual cold junction compensation, it is possible to enter the compensation value in mV in the register:

| REGISTER ADDRESS | REGISTER (OFFSET) | VARIABLE | VARIABLE TYPE | Unit of Measure |
|-------------------------|--------------------------|----------------------------|----------------------|------------------------|
| 40241-40242 | 240-241 | Manual cold junction value | Floating Point | mV |

The type of thermocouple is selected by writing the AUX1 register followed by the CMD register

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|-------------------------|--------------------------|----------------------|-----------------------|
| 40208 | 207 | CMD | 16 bit without a sign |
| 40209 | 208 | AUX1 | 16 bit without a sign |

The values to write in the registers to select the type of thermocouple are:

| THERMOCOUPLE TYPE | AUX1 REGISTER WRITING VALUE | CMD REGISTER WRITING VALUE |
|------------------------------|--|---------------------------------------|
| J | 105 | 1 |
| K | 106 | 1 |
| T | 107 | 1 |
| E | 108 | 1 |
| L | 109 | 1 |
| N | 110 | 1 |
| R | 111 | 1 |
| S | 112 | 1 |
| B | 113 | 1 |

Writing Registers of the value to be generated:

| REGISTER ADDRESS | REGISTER (OFFSET) | VARIABLE | VARIABLE TYPE | Unit of Measure |
|-----------------------------|------------------------------|-----------------------------|----------------------|------------------------|
| 40221-40222 | 220-221 | Temperature to be generated | Floating Point | °C |

15.3.4. RESISTANCE THERMOMETER SIGNAL GENERATION

The type of resistance thermometer is selected by writing the AUX1 register followed by the CMD register

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|-------------------------|--------------------------|----------------------|-----------------------|
| 40208 | 207 | CMD | 16 bit without a sign |
| 40209 | 208 | AUX1 | 16 bit without a sign |

The values to write in the registers to select the type of resistance thermometer are:

| RESISTANCE TEMPERATURE METER | AUX1 REGISTER WRITING VALUE | CMD REGISTER WRITING VALUE |
|-------------------------------------|------------------------------------|-----------------------------------|
| PT100 2 WIRES | 114 | 1 |
| PT500 2 WIRES | 117 | 1 |
| PT1000 2 WIRES | 120 | 1 |
| CU50 2 WIRES | 123 | 1 |
| CU100 2 WIRES | 126 | 1 |
| NI100 2 WIRES | 129 | 1 |
| NI120 2 WIRES | 132 | 1 |

Writing Registers of the value to be generated:

| REGISTER ADDRESS | REGISTER (OFFSET) | VARIABLE | VARIABLE TYPE | Unit of Measure |
|-------------------------|--------------------------|-----------------|----------------------|------------------------|
| 40229-40230 | 228-229 | Temperature | Floating Point | °C |

15.3.5. LOAD CELL GENERATION

The type of load cell generation is selected by writing the AUX1 register followed by the CMD register

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|------------------|-------------------|---------------|-----------------------|
| 40208 | 207 | CMD | 16 bit without a sign |
| 40209 | 208 | AUX1 | 16 bit without a sign |

| GENERATION TYPE | AUX1 REGISTER WRITING VALUE | CMD REGISTER WRITING VALUE |
|-----------------|-----------------------------|----------------------------|
| CELLA DI CARICO | 135 | 1 |

The unbalance of the cell must be entered in the register:

| REGISTER ADDRESS | REGISTER (OFFSET) | VARIABLE | VARIABLE TYPE | Unit of Measure |
|------------------|-------------------|----------------|----------------|-----------------|
| 40215-40216 | 214-215 | Cell unbalance | Floating Point | mV/V |

To generate a value in Kg (gross), use the following relation:

$$\text{Cell unbalance [mV/V]} = (\text{gross Kg to be generated} * 2) / \text{Cell Full Scale [Kg]}$$

For example, if you want to simulate a load cell with 100 kg full scale and want to generate 25 gross kg, you will have:

$$\text{Cell unbalance [mV/V]} = (25 \text{ Kg} * 2) / 100 \text{ Kg} = 0.5 \text{ mV/V}$$

15.3.6. FREQUENCY GENERATION

The type of frequency generation is selected by writing the AUX1 register followed by the CMD register

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|-------------------------|--------------------------|----------------------|-----------------------|
| 40208 | 207 | CMD | 16 bit without a sign |
| 40209 | 208 | AUX1 | 16 bit without a sign |

| GENERATION TYPE | AUX1 REGISTER WRITING VALUE | CMD REGISTER WRITING VALUE |
|------------------------|------------------------------------|-----------------------------------|
| FREQUENCY | 136 | 1 |

The frequency value to generate is obtained by writing four registers:

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|-------------------------|--------------------------|----------------------|-----------------------|
| 40255-40256 | 254-255 | TICK1 | 32 bit without a sign |
| 40257-40258 | 256-257 | TICK2 | 32 bit without a sign |
| 40263-40264 | 262-263 | % HIGH VOLTAGE | Floating Point 32 bit |
| 40265-40266 | 264-265 | % LOW VOLTAGE | Floating Point 32 bit |

Where:

TEMP = Math.Round((20000/ Frequency to generate [Hz]),0)

TICK1 = Math.Floor(TEMP/2)

TICK2 = TEMP-TICK1

% HIGH VOLTAGE is the voltage percentage value of when the signal must be low (0.0 = 0%, 1.0 = 100%) referred to 27V (100%)

% LOW VOLTAGE is the voltage percentage value of when the signal must be low (0.0 = 0%, 1.0 = 100%) referred to 27V (100%)

| COMMAND | AUX1 REGISTER WRITING VALUE | CMD REGISTER WRITING VALUE |
|------------------|------------------------------------|-----------------------------------|
| GENERATION START | 1 | 9 |

Example:

If you want to generate a 100 Hz frequency with 0-5V band:

TEMP = Math.Round((20000/ 100 [Hz]),0) = 200

TICK1 = Math.Floor(200/2) = 100

TICK2 = 200-100=100

% HIGH VOLTAGE = 0

% LOW VOLTAGE = 0,185

15.3.7. NUMBER OF PULSES GENERATION

The type of pulse generation is selected by writing the AUX1 register followed by the CMD register

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|-------------------------|--------------------------|----------------------|-----------------------|
| 40208 | 207 | CMD | 16 bit without a sign |
| 40209 | 208 | AUX1 | 16 bit without a sign |

| GENERATION TYPE | AUX1 REGISTER WRITING VALUE | CMD REGISTER WRITING VALUE |
|------------------------|------------------------------------|-----------------------------------|
| FREQUENCY | 137 | 1 |

The number of pulses to generate is obtained by writing 5 registers:

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|-------------------------|--------------------------|----------------------|-----------------------|
| 40253-40254 | 252-253 | PULSE No. (x2) | 32 bit without a sign |
| 40255-40256 | 254-255 | TICK1 | 32 bit without a sign |
| 40257-40258 | 256-257 | TICK2 | 32 bit without a sign |
| 40263-40264 | 262-263 | % HIGH VOLTAGE | Floating Point 32 bit |
| 40265-40266 | 264-265 | % LOW VOLTAGE | Floating Point 32 bit |

Where:

No. OF PULSES (x2) = Number of pulses to generate multiplied by 2

TICK1 = Duration of the High pulse in how many 50 ms

TICK2 = Duration of the Low pulse in how many 50 ms

% HIGH VOLTAGE is the voltage percentage value of when the signal must be low (0.0 = 0%, 1.0 = 100%) referred to 27V (100%)

% LOW VOLTAGE is the voltage percentage value of when the signal must be low (0.0 = 0%, 1.0 = 100%) referred to 27V (100%)

| COMMAND | AUX1 REGISTER WRITING VALUE | CMD REGISTER WRITING VALUE |
|----------------------------------|------------------------------------|-----------------------------------|
| GENERATION START WITH LOW START | 2 | 9 |
| GENERATION START WITH HIGH START | 3 | 9 |
| PAUSE / START | 4 | 9 |

The number of pulses still to generate is represented in the reading register:

| REGISTER ADDRESS | REGISTER (OFFSET) | REGISTER NAME | REGISTER TYPE |
|-------------------------|--------------------------|-------------------------|-----------------------|
| 40251-40252 | 250-251 | REMAINING PULSES / 2 | 32 bit without a sign |

This value must be divided by 2 to obtain the number of remaining registers.

Example:

If you want to generate 500 pulses lasting 500ms High and 500ms Low with 0-10V band:

No. OF PULSES (x2) = 1000

TICK1 = 10

TICK2 = 10

% HIGH VOLTAGE = 0.37

% LOW VOLTAGE = 0.0