Operating Manual

MCON Carbo

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measure – control – automate - measure – control – automate - measure – control – automate –.measure – control

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Your Sales Partner

Content

This manual applies to the MCON Carbo controller. It documents the functioning and operation of the device and the diagnosis of faults. The guide is intended for all users (operators) and operator of the MCON Carbo. It must be accessible to this group of people and be carefully reviewed before using the device.

Table of Contents:

1. User information

Please read carefully this instruction before operating the device. Here you can find important information for adequate using regarding operators safety and correct device working.

1.1 General information

For correct and safe operate device should be used according to the instructions given by the producer. Correct operating also depends on proper handling, storage, transport and maintenance.

Knowing of warning symbols is needed for proper handling of the device. Among the other, these instructions are defining the area of device usage and needed operator qualification.

Because of the limited size of the manual, there still are some details concerning installation and usage of the device, which are not covered. Thus, for additional explanation, customer should contact producer's technical support.

1.2 Important safety notes and symbol description

It is extremely important to know the meaning of symbols which are appearing in the manual. Safety notes and warnings are intended to prevent operator hazard situations and damage of the device or working environment.

Symbol explanations are given as follow:

DANGER!
Means directly life danger, seriously body injuries and equipment damage.

WARNING!
Means possible death danger, danger of serious body injuries and equipment damage.

CAUTION!
Means possible danger of slight body Injuries and danger of serious device or equipment damage.

CAUTION!
Means danger of serious device or equipment damage.

NOTE
Refer to the important information on which should pay attention.

Proper usage

Device should be used only in purposes which are described in this manual. Information about the field and way of usage can be found in chapters 2. Introduction, 3. Technical description and 4. Operating principle.

Qualified operators

Only qualified personal should operate this device. Qualified personal are persons which are familiar with installation, mounting and handling this device. Also they should be trained for work with the devices and systems concerning safety standards for electronic equipment, gases at high pressures, aggressive and dangerous environment.

Installation, connection to electrical power supply, connection to gas installation, commissioning and maintenance must be done by qualified operators.

1.3 Warranty conditions

Content of this manual is not a part of any agreement, commitment or statutory right. All commitment on the producer's part is contained in the respective sales contract which also contains completely warranty conditions. The warranty conditions are not changed with the content of this manual.

1.4 Packing and delivery

Content of the shipment is listed in the documents associated to the shipment, according to the terms of contract. Please, after receiving, check if the shipment is complete and undamaged.

1.5 Standards and regulations

Specification and production of this device are done according to the harmonized European standards. Where European standards could not be applied, the standards of Federal Republic of Germany were applied.
When using this device outside the area where these standards are applied, the appropriate standards of the country of use should be observed.

1.6 Software release versions

Actual software version can be seen from menu, see Chapter 12.5.1 *System Informations*. This user manual describes software version 1.006k.

2. Introduction

MCON Carbo is device for maintaining and controlling metal carburization processes in heat treatment plants. It controls both temperature and C level and it is capable to work with various types of thermocouples and with both lambda and oxygen probes. It can also control oil bath temperature depending of furnace type. For better stability and accuracy MCON Carbo uses 2 sensors for measuring C level. It also includes maintenance features for probes (flushing, rin test, failure detection) and C level correction method (foil test function).

Carburizing process can be guided through programs with segments which defines C level and temperature setpoints in time domain. Segments tracking function allows user to activate digital outputs when program enters certain segment. All measured data can be logged and transferred to USB stick for further analyzing in dedicated PC software.

Device has alarms feature which controls value limits, any errors and activates dedicated digital outputs.

MCON Carbo offers improved connectivity functions via 2 RS485 MODBUS lines (master and slave) and one TCP/IP Modbus slave communication.

User accounts with password protection improve security in multiuser environment by locking access level to parameters and features depending on user level privileges.

3. Technical description

3.1 Hardware Description

MCON Carbo device is packed in standard DIN ¼ package. Dimensions are 118mm x 96mm x 96mm.

figure 3.1 MCON Carbo controller

Front panel of the device contains TFT touch screen, USB port, status LED's and keys. On the rear side there are connections for analog inputs and outputs, digital inputs and outputs, communications and power supply.

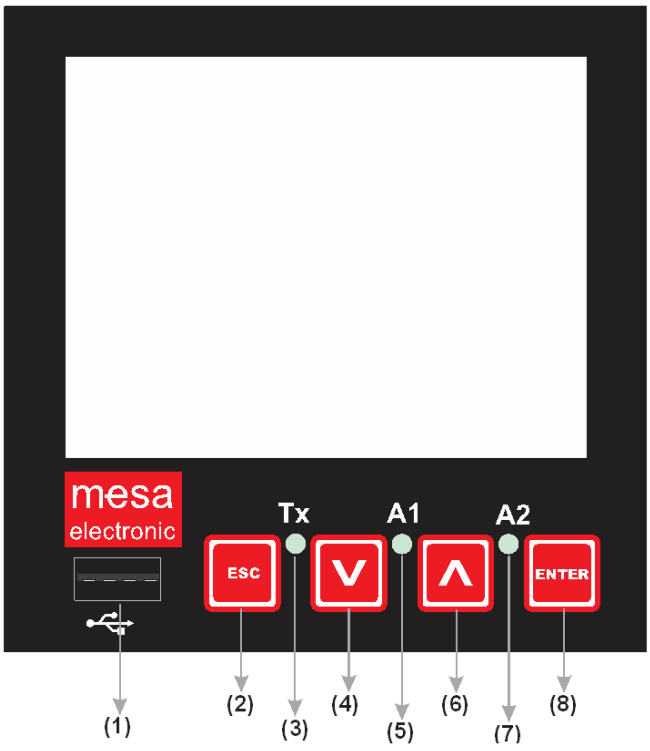


figure 3.2 MCON Carbo front panel

1 – USB port

2 – Escape key

3 – Communication activity LED

4 – Key Down

5 – Alarm1 (dout1) status

6 – Key Up

7 – Alarm2 (dout2) status

8 – Enter Key

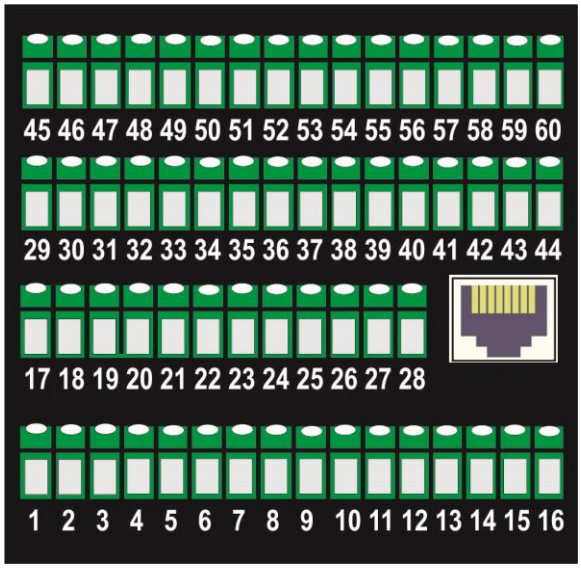


figure 3.3 MCON Carbo back side

On the next table are listed all terminal outputs signals:

TERNINAL #	Signal	Description
1	L	Power Supply L 220V
2	N	Power Supply N 220V
3	Depending of hardware version can be PE or REL2 NO	
4	REL2 (depending of hardware can be REL2 NO or REL 2 NC	REL 2, 5A – DIGOUT2
5	REL2 COM	
6	REL1 NO	REL 1, 5A – DIGOUT1
7	REL1_COM	
8	REL1 NC	

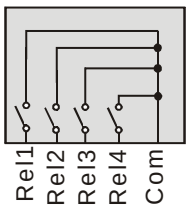
<table>
<tr><td>9</td><td>RXA</td><td colspan="3" rowspan="5">RS 485/422 isolated</td></tr>
<tr><td>10</td><td>RXB</td></tr>
<tr><td>11</td><td>TXB / RS485 B</td></tr>
<tr><td>12</td><td>TXA / RS485 A</td></tr>
<tr><td>13</td><td>GND_ISOLATED</td></tr>
<tr><td>14</td><td>A</td><td colspan="3" rowspan="3">RS485 uninsulated</td></tr>
<tr><td>15</td><td>B</td></tr>
<tr><td>16</td><td>GND</td></tr>
<tr><td>17</td><td>IN1+</td><td colspan="3" rowspan="2">AIN 1
(milivolts or miliamps)</td></tr>
<tr><td>18</td><td>IN1-</td></tr>
<tr><td>19</td><td>IN2+</td><td colspan="3" rowspan="2">AIN 2
(milivolts or miliamps)</td></tr>
<tr><td>20</td><td>IN2-</td></tr>
<tr><td>21</td><td>IN3+</td><td colspan="3" rowspan="2">AIN 3
(milivolts or miliamps)</td></tr>
<tr><td>22</td><td>IN3-</td></tr>
<tr><td>23</td><td>IN4V</td><td colspan="3">AIN 4</td></tr>
<tr><td>24</td><td>IN4A</td><td>Voltage input</td><td>IN4V - IN4N</td></tr>
<tr><td>25</td><td>IN4N</td><td>Current input</td><td>IN4A - IN4N</td></tr>
<tr><td>26</td><td>IN5V</td><td colspan="3">AIN 5</td></tr>
<tr><td>27</td><td>IN5A</td><td>Voltage input</td><td>IN5V – IN5N</td></tr>
<tr><td>28</td><td>IN5N</td><td>Current input</td><td>IN5A – IN5N</td></tr>
<tr><td>29</td><td>M1_1</td><td colspan="2" rowspan="5">MODULE 1
(AOM,REL1,REL2,DIGITAL INPUT)</td><td rowspan="10">MODULE 1,2 and 3

OC12</td></tr>
<tr><td>30</td><td>M1_2</td></tr>
<tr><td>31</td><td>M1_3</td></tr>
<tr><td>32</td><td>M1_4</td></tr>
<tr><td>33</td><td>M1_5</td></tr>
<tr><td>34</td><td>M2_1</td><td colspan="2" rowspan="5">MODULE 2
(AOM,REL1,REL2, DIGITAL INPUT)</td></tr>
<tr><td>35</td><td>M2_2</td></tr>
<tr><td>36</td><td>M2_3</td></tr>
<tr><td>37</td><td>M2_4</td></tr>
<tr><td>38</td><td>M2_5</td></tr>
<tr><td>39</td><td>M3_1</td><td colspan="2" rowspan="2">MODULE 3
(REL1,REL2,REL3, DIGITAL INPUT)</td></tr>
<tr><td>40</td><td>M3_2</td></tr>
</table>

41	M3_3		
42	M3_4		
43	M3_5		
44	M3_6		
45	M4_1	**MODULE 4** (REL1,REL2, DIGITAL INPUT)	**MODULE 4,5 and 6** **OC12**
46	M4_2		
47	M4_3		
48	M4_4		
49	M4_5		
50	M5_1	**MODULE 5** (REL1,REL2, DIGITAL INPUT)	
51	M5_2		
52	M5_3		
53	M5_4		
54	M5_5		
55	M6_1	**MODULE 6** (REL1,REL2,REL3, DIGITAL INPUT)	
56	M6_2		
57	M6_3		
58	M6_4		
59	M6_5		
60	M6_6		

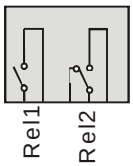
MCON Carbo is highly flexible with inputs and outputs and their number depends on built in modules. There are several module types which can be ordered and installed on certain positions so user can customize I/O peripherals according to custom requirements. On further explanations, Mn is module number. For ex. if module is installed on position 3, Mn_1 is connection M3_1 from therminals table.

REL1 module – 4 relays, 3A, 24V, 4NO (normally open) contacts and one common (COM) contact.



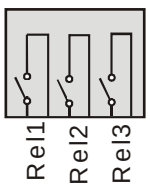
MODULE connection	Terminal connection
Rel1 NO	Mn_1
Rel2 NO	Mn_2
Rel3 NO	Mn_3
Rel4 NO	Mn_4
COM	Mn_5

REL2 module – 2 relays, 3A, 24V, 2NO and 1NC (normally closed) contacts and 2 COM contacts.



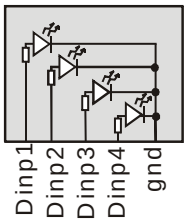
MODULE connection	Terminal connection
Rel1 NO	Mn_1
Rel1 COM	Mn_2
Rel2 NC	Mn_3
Rel2 COM	Mn_4
Rel2 NO	Mn_5

REL3 module – 3 relays, 3A, 24V, 3 NO and 3 COM contacts.



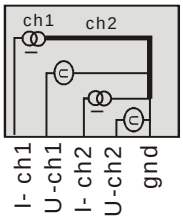
MODULE connection	Terminal connection
Rel1 NO	Mn_1
Rel1 COM	Mn_2
Rel2 NO	Mn_3
Rel2 COM	Mn_4
Rel3 NO	Mn_5
Rel3 COM	Mn_6

DIGIN module – 4 isolated digital inputs with common ground



MODULE connection	Terminal connection
Dinp1	Mn_1
Dinp2	Mn_2
Dinp3	Mn_3
Dinp4	Mn_4
gnd	Mn_5

AOM module - Two independent isolated analog outputs with 10V voltage and 20mA current output in parallel.



MODULE connection	Terminal connection
I-ch1	Mn_1
U-ch1	Mn_2
I-ch2	Mn_3
U-ch2	Mn_4
gnd	Mn_5

OC12 module – 12 open collector outputs for connecting with relay box RL45 or external relays.

MODULE connection	Terminal connection
OUT1	29/45
OUT2	30/46
OUT3	31/47
OUT4	32/48
OUT5	33/49
OUT6	34/50
OUT7	35/51
OUT8	36/52
OUT9	37/53
OUT10	38/54
OUT11	39/55
OUT12	40/56
not connected	41/57
not connected	42/58
+24V	43/59
GND	44/60

MCON Carbo is a plug&play device which means that it scans all module positions during starting and discover which modules are installed. Depending on installed modules, all I/O ‘s are automatically numbered. Details can be viewed in the **Main Menu → Maintenance → I/O Overview → Terminals.**

Analog inputs AIN1 to AIN5 are fixed and always present.

Digital outputs 1 and 2 (DOUT1 and DOUT2) are fixed on the ROW1. Their status is shown on the front panel, red color LED’s A1 and A2. Additional digital outputs are provided by installed modules and are automatically numbered from DOUT3 up to DOUT26.

Analog outputs are optional and there are maximum 4 analog outputs on the MODULE 1 or MODULE 2. They are automatically numbered from AOUT1 to AOUT4.

3.2. Installation

Before use the device it must be installed in dry environment with ambient temperature up to 60 ºC.
Put out the terminals from the back panel and connect the wires.

On ROW1 connect wires for the power supply, DOUT1 (A1), DOUT2 (A2) and communication.

On ROW2 terminal connect sensors for measurement according to the next rules:

- on the AIN1 position , connect Thermocouple (B,C,E,J,K,L,M,N,R, S or T type)
- on the AIN2 position, connect Lambda or O2 probe
- on the AIN3 position connect additional Lambda or O2 probe or thermocouple for oil temperature measurement (B,C,E,J,K,L,M,N,R, S or T type)
- On the AIN4 and AIN5 positions connect sensor for CO or CO2 level measurement or external setpoint source for temperature or C level.

NOTE
AIN4 and AIN5 analog inputs are preconfigured in factory to measure voltage/milliamps or millivolts for thermocouples depending of order code.

NOTE
ROW3 and ROW4 terminals connections depend on installed/ordered module configurations.

Minimum required connection is:

- one thermocouple at the AIN1 for the furnace temperature measurement
- one Lambda/O2 Probe for C level measurement at the AIN2 position
- Heating actuator at the Digital output 1 position
- Gas actuator at the Digital output 2 position

Additional digital outputs can be used for 3 state output for either temperature or C level control (heating/cooling, gas/air and motorized valve for C level control), for quenching control, probe flushing, alarms or program tracks.

Digital inputs connections have next functionalities:

- DIGIN 1 is for Program start
- DIGIN 2 is for Control off/Program pause
- DIGIN 3 is for Program next segment/Program reset

4. Operating principle

MCON Carbo measures furnace temperature and oxygen level with the predefined or measured CO concentration in the furnace atmosphere which allows indirectly measuring C level. For security purposes it is recommend using 2 probes or sensors for C level measurements. If 2 probes are installed, one is always the leading probe and all C level measurements are taken from that probe. In the case of probe malfunctioning, measurement is automatically switched to the second probe and vice versa. Probe is not correct if internal resistance is fall during the exploitation or the probe voltage is not under normal value ranges. Values obtained from both probes are compared during the measurement and if there is notable difference a warning is showed.

Process control can be guided with programs, fixed setpoints, remote setpoints and external setpoints. Program contains furnace temperature and C level setpoints which are changed in time domain. Every program also contains a quench temperature setpoint which is constant during the whole program executions where the furnace temperature and C level setpoints are organized in segments.

Fixed, remote and external setpoints are obtained from user, communication or analog input respectively.

MCON Carbo has up to 3 control loops used to control furnace temperature, C level and quenching. For all loops there are separate control parameters which are organized in presets. Every loop has 3 presets which hold PID parameters and user can chose which one is active.

Main function principle of the device is measuring furnace temperature and the C level (quench temperature optionally) and checking if the measured values are valid. Measured values are process variables (PV) for the control and depending on the difference between setpoint (SP) and process value (PV) and PID settings an output is generated and actuators are activated or deactivated.

During the measurement/control, device also checks all alarms and activates associated digital outputs if the alarm is activated.

Also user can start logging of the measured data and stop the logging automatically or manually and transfer file with logged data to USB stick.

Depending of the communication configurations MCON Carbo can send the measured data and statuses via MODBUS and also can obtain parameters and commands.

4.1 C level calculation

MCON Carbo can calculate value of C level in furnace atmosphere using 2 sensors. Sensor 1 which is either Lambda or O2 probe must be presented on the analog input 2 (AIN2) in order to measure C level in furnace. Optionally, a second sensor (Sensor 2) can be connected to any of analog inputs (AIN3, AIN4 or AIN5). Sensor 2 can be O2/Lambda probe or CO2 transmitter. If O2/Lambda probe is used as a second sensor, it must be connected on analog input 3 (AIN3) only. For the CO2 transmitter can be used AIN3, AIN4 or AIN5 depending on transmitter type (current or voltage output). For details about configuring analog inputs view the chapter "*Analog inputs settings".*

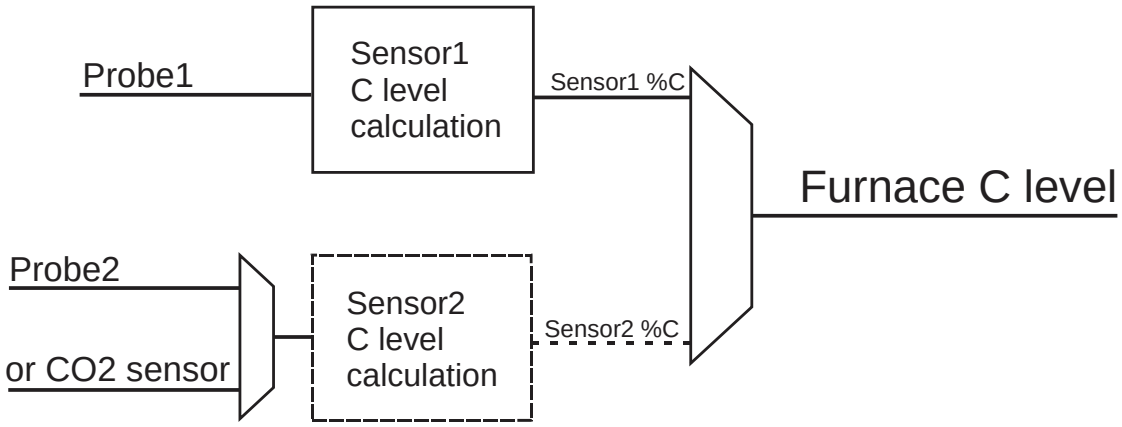


figure 4.1 Sensors combinations for C level calculation

When only one sensor is presented, furnace C level is measured and calculated directly from that sensor (Probe1).

In the case when both sensors are used, device determines which C level will be used as primary (as the process value for control). By default this is Probe 1 but if the Probe 1 breaks or has invalid measurement, C level is automatically switched to a sensor 2 and vice versa.

5. Configuration procedure

Before use the device it must be configured according to your specific needs. Follow the next diagram in order to set up the controller:

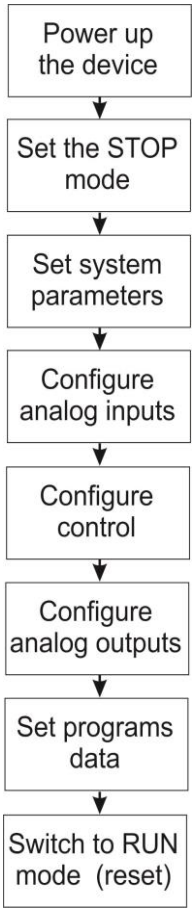


figure 5.1 MCON Carbo workflow diagram

5.1 Device powering up

To start up the device, plug the power supply connector (ROW1, terminals 1 and 2). After power is plugged, device starts initialization routine and the initial screen is displayed. Initialization routine loads parameters, check installed I/O modules and installs file system for logging and USB file transfer.

First all parameters are loaded and if there are errors when reading parameter or inappropriate value, “ERROR” mark is displayed.

Second initialization step scans installed I/O modules to configure I/O subsystem of device. If there is errors during this step please contact the service.

After successfully starting process, device enters to the main menu screen.

First time starting may require touch screen calibration. This is a step before initialization where user must calibrate touch screen to make sure that device will operate properly. Calibration is activated immediately after powering the device up and it contains 3 points on the screen which user must press precisely to achieve best accuracy. After last point press, device runs the initialization routine and startup screen is displayed.

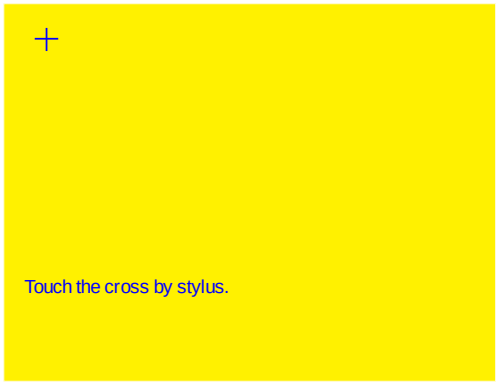


figure 5.2 Calibration screen

NOTE

Touch screen calibration can be done also in the

Main Menu → Settings → System → Calibrate screen

6. Menu and display

6.1 Screens

User has 2 options to interact with the device. One is touch screen where user can directly press desired buttons and second is keypad with 4 keys.

Keyboard keys (DOWN) and (UP) are used to change a focus among the screen buttons. Key (ESC) returns to the previous screen and key (ENTER) press the focused button.

Focused button has green color instead of blue color for unfocused button.

Focused and nonfocused buttons: Button Button

All screens in the MCON Carbo menus consist of several elements:

(1) Exit/return button returning to the previous screen or menu

(2) Button – pressing this button to activate some action or enter to menu/screen

(3) Input button – pressing this button to open keyboard screen for entering parameter value

(4) Checkbox button – check/uncheck an option

(5) Next button – goes to the next page of the screen/menu

(6) Titlebar – shows the name of the current menu/screen

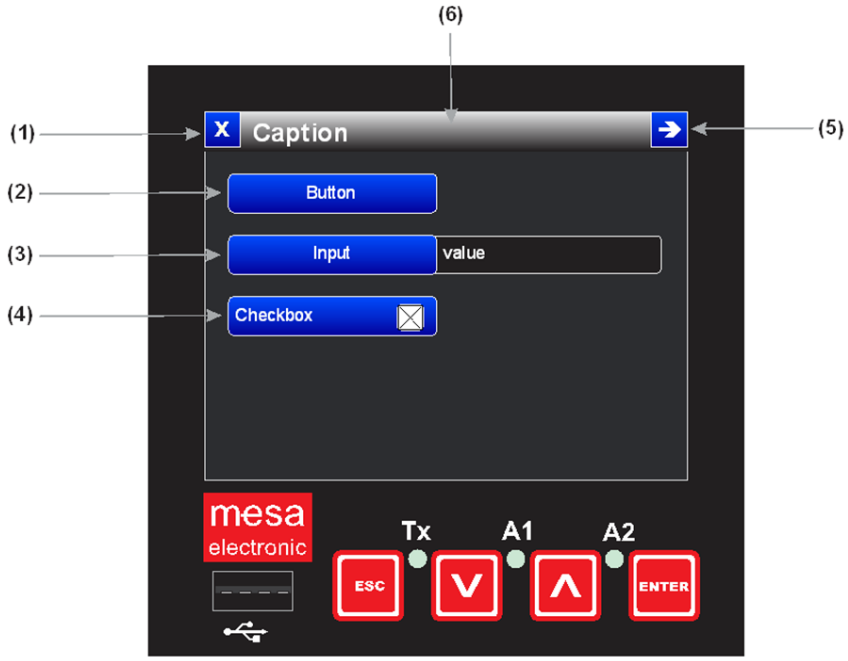


figure 6.1 Basic screen elements

6.2 Inserting values

Parameter values are inserted in the keyboard screen which is displayed after pressing the input button. Parameter can be numeric value, text, selection or date/time values.

For the numeric values on the screen are shown minimum (MIN) and maximum allowed (MAX) value for the parameter, parameter unit and parameter default value.

ESC - escape from keyboard with no changing the value

ENT - confirm entered value and exit

<- - delete letter or number

Default - enter default value for parameter and exit from the keyboard screen

figure 6.2 Keyboard screen

There are parameters with predefined values which are set by choosing one value from a list. After selecting desired parameter value, to confirm press ✓ button, or x button cancel selection.

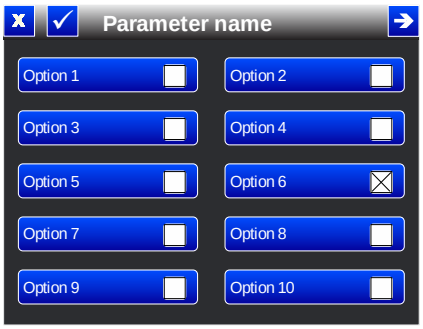


figure 6.3 Options screen

Date and time values are inserted on the separate screen where the + button increase and - button decrease hours, minutes, days months or years.

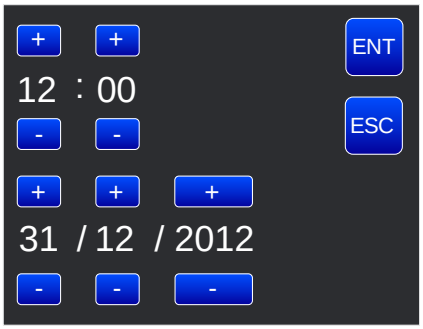
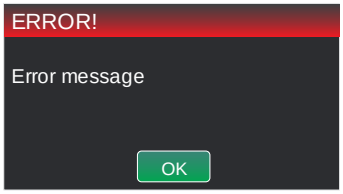


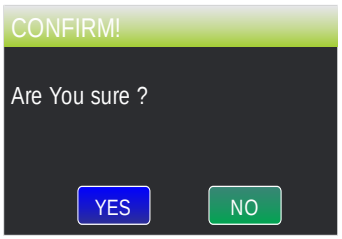
figure 6.4 Date and time inserting screen

6.3 Messages

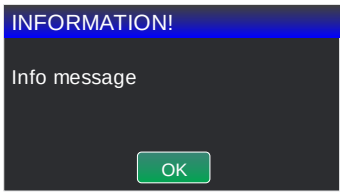
Messages are screens which are shown when some certain events occur. There are several types of messages and their meaning is described below:



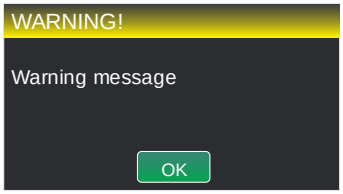
Error message - displays message when error event occurred or inserted value is out of range



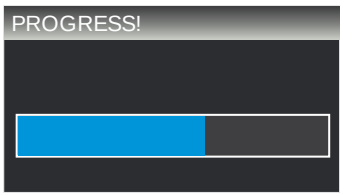
Confirm message - confirms actions such as factory reset, loading or saving parameters or programs etc.
Press *No* to return to the previous screen or *YES* to confirm action



Information message - shows events which are not critical for the system



Warning message - shows warning immediately after warning condition is met. Warnings can be visible in Warnings screen.



Progress message - shows the progress of the actions which requires some finite time to be finished

6.4 System events

System events are errors, warnings and alarms. They occur under certain circumstances and their status is displayed on the separate screen which is accessible from the *Normal View.*
When event occurs in the *Normal View* screen is displayed flashing icon which informs user that there is error, warning or alarm.

On the picture below are shown event icons from alarm, error and warning.

figure 6.5 Event buttons showing

Detailed informations about occurred event are displayed by pressing event icon A E or W.

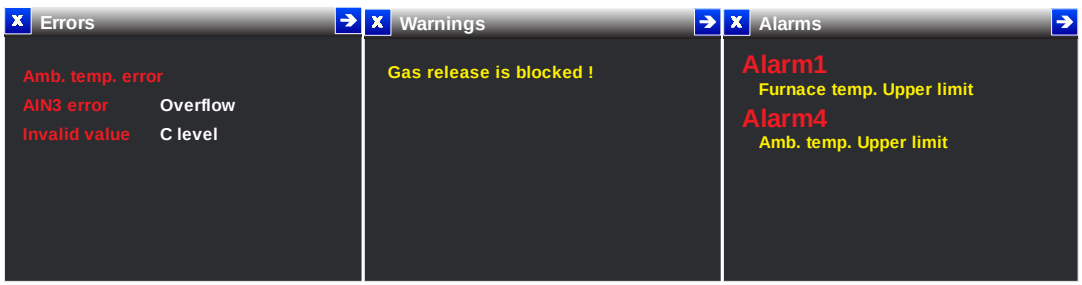


figure 6.6 Errors, Warnigns and Alarms screens

Errors, warnings and alarms are displayed on the same screen. Switching from one to another is performed with button. If there are no any alarms, errors or warnings, on the page for that type of event will be shown information that there are no events occurred.

On the alarm page user can explicitly turn off alarm by pressing button for the certain alarm but only if alarm duration is zero (see Alarms section).

6.4.1 Errors

Errors are critical event which occurs on some system failure invalid measurement values or communication errors. On the errors screen are displayed name of error and detailed description of error (optionally).

ERROR	DESCRIPTION
EEPROM error	Memory for storing parameters or calibration data is corrupted.
Furnace error	Furnace probes voltage is low or probe is malfunctioning.
Amb. temp. error	Device ambient temperature cannot be measured properly. Contact the supplier for details.
AIN error	Analog input overflow or underflow.
Invalid value	Temperature or C level of the furnace cannot be measured and calculated correctly.
Modbus error	Modbus communication has errors.
Ethernet error	Ethernet communication cannot be established.
File system error	USB or internal memory for storing log or graph data cannot be initialized properly.
Time error	Time and date is not set

6.4.2 Warnings

Warnings are less critical than errors and they don't affect the device proper functioning. On the next table are shown all warnings which can be occur in the device.

WARNING	DESCRIPTION
Device is in STOP mode	Informs user that device is in STOP mode
Missing calibration!	Analog input or analog output is not calibrated which can decrease measurement accuracy.
Forgotten foil!	Foiltest is in progress more than 30 minutes. This warning will end foiltest. If foiltest screen is currently displayed, this warning will be shown as a message too.
Soot limit!	C level reach soot limit.
Missing remote value!	Remote setpoint is not received from the MODBUS communication.
Gas release is blocked!	Furnace temperature is below 700 ºC which forbid gas valve opening.
Foil in furnace!	Foiltest is in progress.
High probes %C difference!	Difference in calculated C level values from both probes is high than defined value.
Probe1 high resistance!	Probe 1 internal resistance is too high.
Probe2 high resistance!	Probe 2 internal resistance is too high.
Stop from external!	Program or control is stopped from digital input.

6.4.3 Alarms

On the alarm page are displayed activated alarms. For every activated alarm is displayed detailed description what caused an alarm to be activated. For details see the "Alarms" sections.

7. Main menu

Main menu is root of the menu structure where user can navigate to all features and parameters. After device powering up, on the screen will be displayed *Normal View* screen. Exit from *Normal View* screen will display *Main menu.*

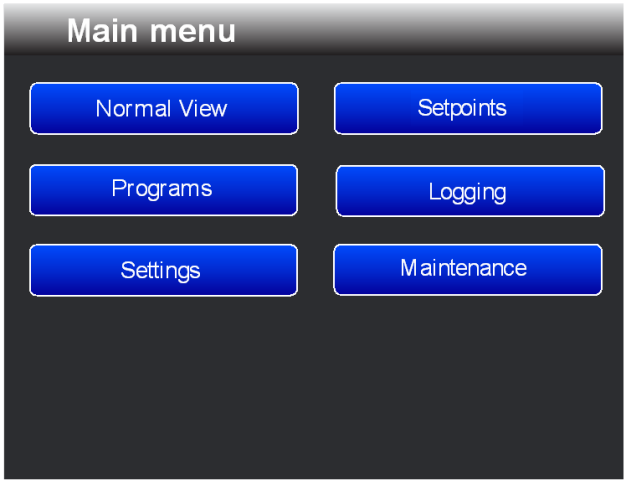


figure 7.1 MCON Carbo Main menu

To choose (enter) the menus from Main menu screen, just press desired button or navigate focus with  and  keys and press  to enter into focused menu.
On the diagram below is shown menu structure of the MCON Carbo. Exit from one menu (or screen) returns the previous menu.

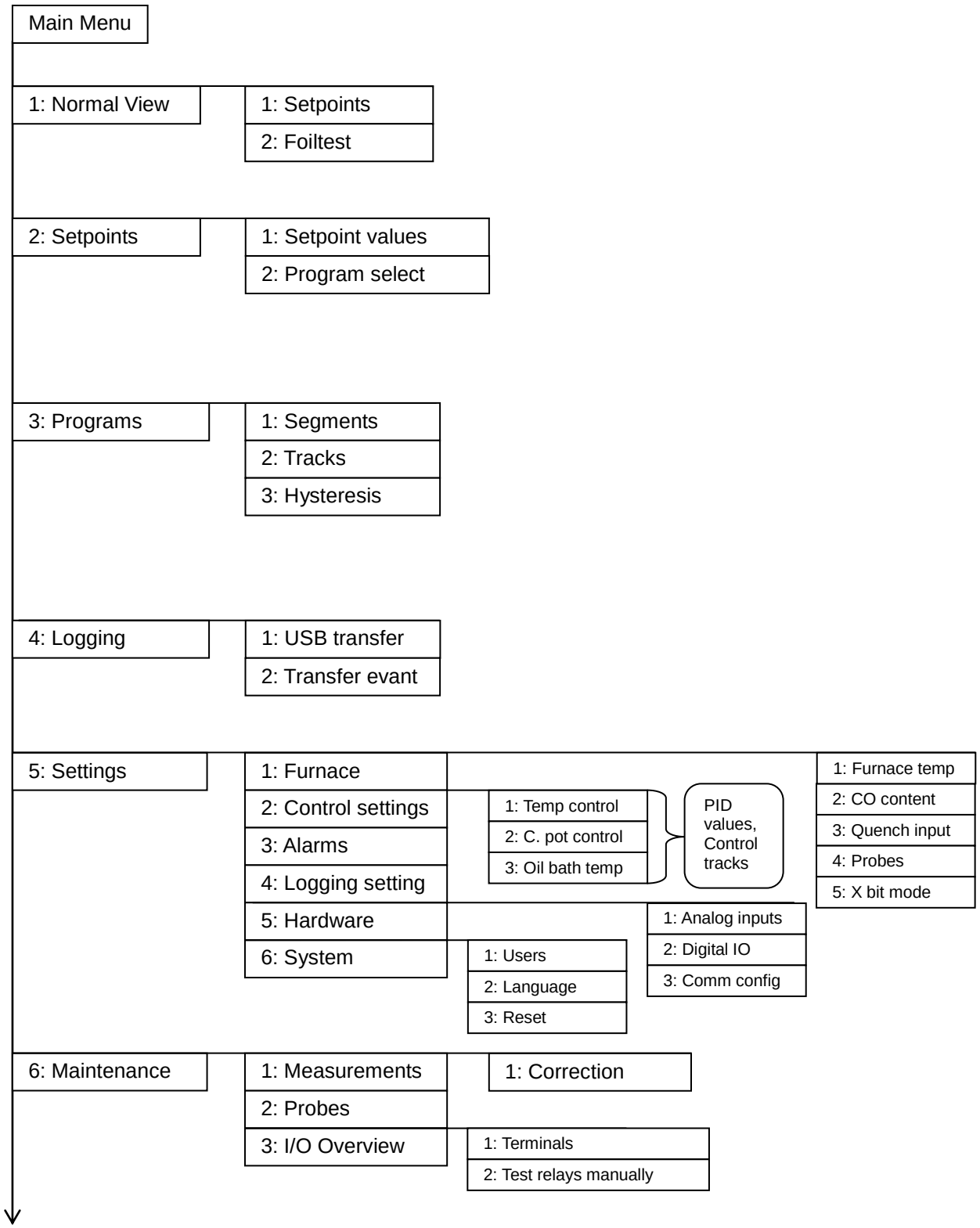


figure 7.2 Menus structure

In the *Normal View* (chapter 8) screen are displayed all measurements and control data. From this screen user can change setpoints and manage C level corrections via *foiltest* function. "*Normal View"*, "*Foiltest"* and "*Setpoints"* sectios describes these screens in details.

In the *Setpoints* (chapter 9) menu customer select process. There are different methods: Fixed setpoints, Program with segments, remote setpoints (via communication) or external setpoints (via AIN's).

Programs (chapter 10) menu allows managing programs. Programs menus and feature are described in the "Programs" section.

Logging (chapter 11) screen shows all information and configurations for the logging feature. Detailed description can be found in the "Logging" section.

Settings (chapter 12) menu contains all configurations and parameters which are divided into several submenus. See the "*Settings"* chapter for detailed description of parameters and settings.

In the *Maintenance* (chapter 13) menu user can view in details informations about measurements, value corrections and probes maintenance. Detailed description about this feature can be found in the *"Maintenance"* section.

8. Normal View

Normal View is accessible from the **Main menu → Normal view**.

Normal view screen shows all important measurement and control data. It contains several pages which are listed by pressing navigation button .

On the first page are displayed temperature (WT) and C level (WC) setpoints and measured (process value) temperature and C level. C level process value on this page is displayed with big white number so value can be viewed from the distance.

- pressing this button returns to the previous screen (Main Menu)

- press this button to go to the next page

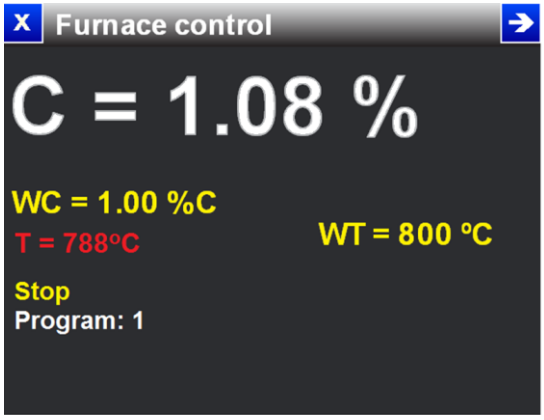


figure 8.1 Normal view - first page

Next page on the Normal view screen (figure 8.2) shows smaller numbers but more details. On the left half of the screen are displayed C level control information (setpoint, process value and output level Y) and on the right half are shown Temperature control data.

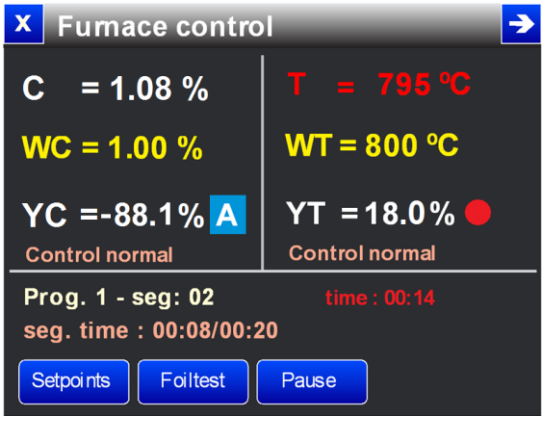


figure 8.2 Normal view- second page

Beside control output value (YT and YC) is shown actual actuator status. For temperature control if heating is turned on, a red circle is displayed. For cooling on this place is displayed blue circle. When no actuators are turned on, nothing is displayed. The same principle is for C level control. When gas or air actuator is switched on, a marked G or A is displayed respectively.

NOTE

Actuator status showing depending of loop output type selected in **Main Menu → Settings → Control Settings → Temperature control (or C.pot control) → PID preset (1 to 3) → Control output** menu. For 2 state output type control, there is no cooling or air actuator showing.

Below the control output values (YT and YC) is displayed “Control Normal” only if the difference between setpoint and process value is in compliance to the setpoint upper and lower tolerances.

If a program control is running, on the bottom of the screen are displayed program number and name, current segment running, segment time and total program running time.

On this page there are 2 buttons: Setpoints, Foiltest.

Setpoints button opens the screen where user can manage setpoints and change their values.

Foiltest buttons opens foiltest screen in which a foiltest correction function is performed.

8.1 Fast SP changing capability

On the *Normal view* screen, page 2, user can insert setpoint values directly by pressing screen on the place where the WT or WC value is displayed. This way user doesn’t need to go to the setpoints menu in order to change setpoint value. This option is only available when no program runs and the current user level on the device privilege is greater or equal the required.

8.2 Foiltest

Foiltest function allows correction of the C level calculation made by the controller. Measured value of C level (calculated by the voltage from probe and temperature of furnace) and real C level (which can measure by foiltester device of MESA Electronic GmbH) are not the same values. Then, user can manually correct C level values. After correction step, device use different algorithm which allows calculation of corrected C level values. This function is available in the *Normal View* screen after pressing *Foiltest* button which shows *Foiltest screen*.

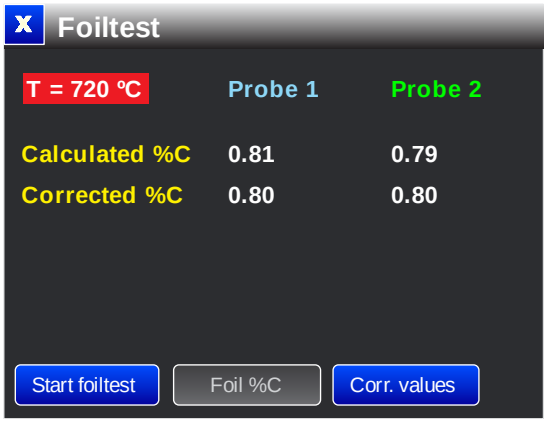


figure 8.3 Foiltest screen

On the foiltest screen user can view measured (uncorrected) and corrected C level value for both probes (if second probe or sensor is installed).

On the bottom of screen there are “Start foiltest”, “Foil %C” and “Corr. values” buttons.

Foiltest calibration is started after pressing *Start foiltest* button. Before that, user must be sure that the foil is inserted properly in the furnace. After minimum one minute, user can stop the foiltest. Next, user must get the inserted foil from the furnace and measure it with some reference method (foiltester device). Measured C level of the treated foil must be inserted by pressing “Foil %C” button and inserting foil C level value. This way, one correction point is saved and further C level calculation is performed using this correction. User can start foiltest again but only if the current temperature in the furnace is at least 15 ºC different from the previous foiltest. If this condition is met, a new foiltest is started and new correction point will be created.

Users can overview foiltest correction points by pressing "*Corr. values"* button.
"Corr. values" button displays the screen with correction points where user can view temperature, measured C level and Foil C level for one or both correction points. Also a date and time of foiltest is displayed. If it is no correction points for C level, "No foiltest corrections !" message will be displayed on the screen.
Foiltest values can be edited in this screen but this screen and for this feature logged user level must be the highest.
During foiltest there are several conditions which can stop foiltest.
If the C level or temperature during foil trial is not stable (C level varying more than 0.1 %C or temperature varying more than 15 ºC) foiltest automatically stops and on the foiltest screen is displayed message "Foiltest failed ! Unstable Value !".
Foiltest cannot be run more than 30 minutes. If user forgot to stop foiltest after 30 minutes from the starting, a warning "*Forgotten foil*" is shown.

Foiltest correction is performed with up to 5 correction points. One correction point is inserted when one foiltest session is performed. Before starting the foiltest, a foil must be inserted into furnace (1). Then user can start the foiltest session (2). During the foiltest are measured average furnace temperature and uncorrected C level (3). If user doesn't stops the foiltest within 30 minutes after starting (4) an FORGOTTEN_FOIL error will be activated (5) and the foiltest will stops so user must start it again. After stopping the foiltest (6), user must remove foil from furnace (7) and measure foil %C level (8) with some referent method or device (for ex. Mesa Electronic Foiltester). Measured foil %C level is then inserted as the correction (9) which ends one foiltest session (10).

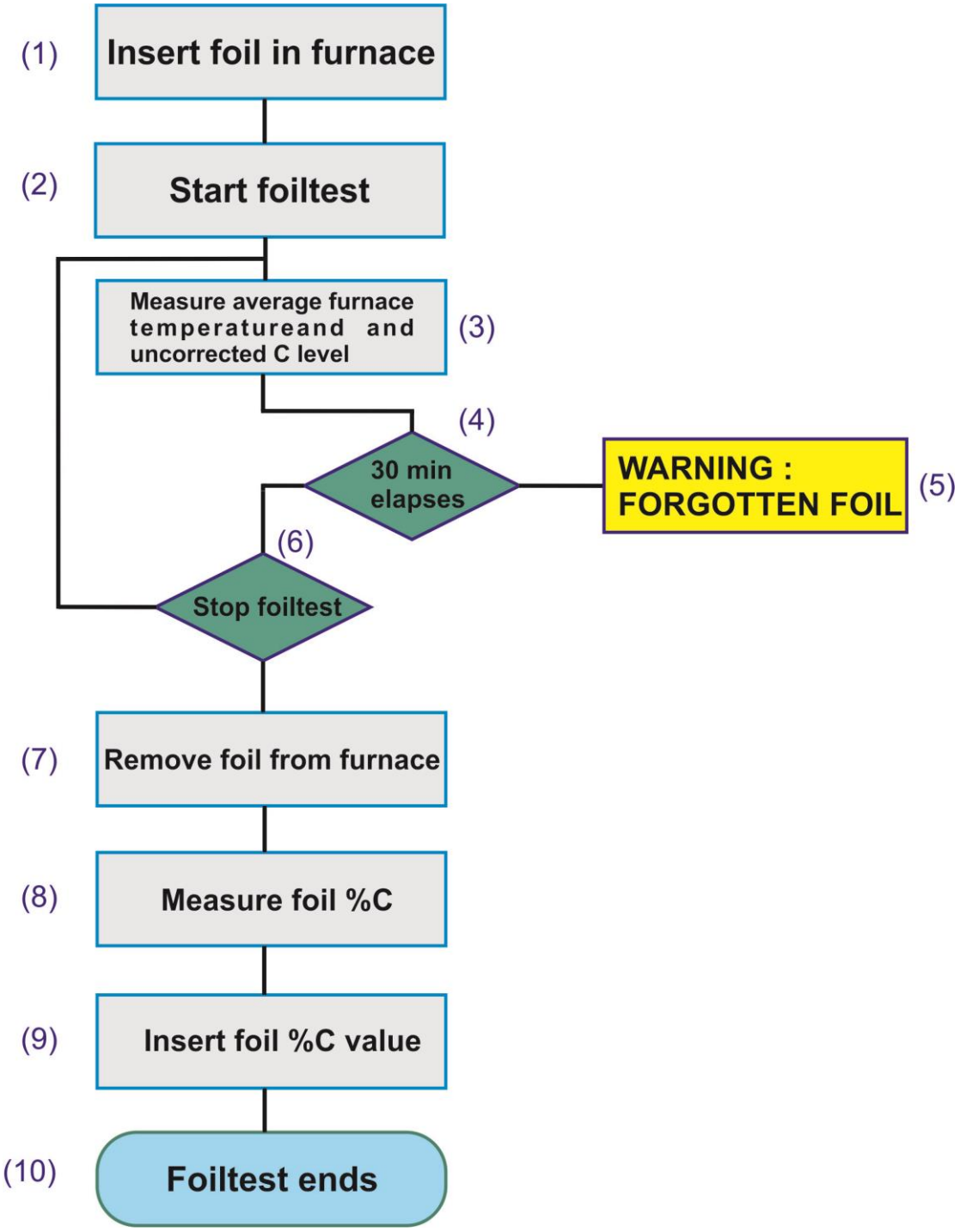


figure 8.4 Foiltest state diagram

8.2.1 Edit correction points

Foiltest forms up to 5 correction points pressing the "*Corr. values*" button.

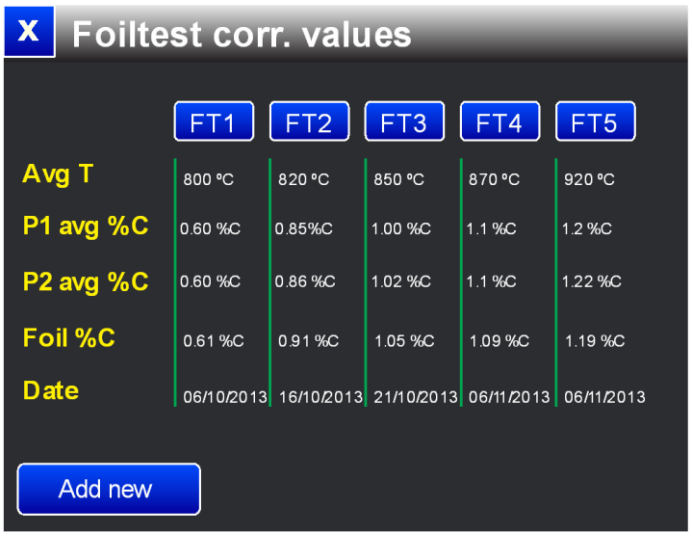


figure 8.5 Up to 5 corrections can be made

On the foiltest correction points screen are displayed all inserted correction points and date and time when they are inserted. These points are formed either by foiltest or manually added.

To add correction point press "*Add new*" button and enter temperature of correction, measured average C level for both probes and correct (foil) %C value. Then press "Submit" button to confirm entering new point but only if inserted temperature is at least 15 ºC different from any correction temperature of previous inserted correction points.

Correction points can be deleted or edited by pressing buttons FT1 to FT5. Then, a correction point menu is shown, in which user can change all correction point values except temperature, or delete correction point by pressing "Delete" button. Changing correction point value automatically updates date of correction point.

8.3 Ideal probe screen (Optionally function)

This page called “Ideal probe screen”. On this screen user can modify probe parameters (K1 and K2) and CO level in the case when CO level is defined, not measured. Calculated ideal probe voltage is presented on screen also.

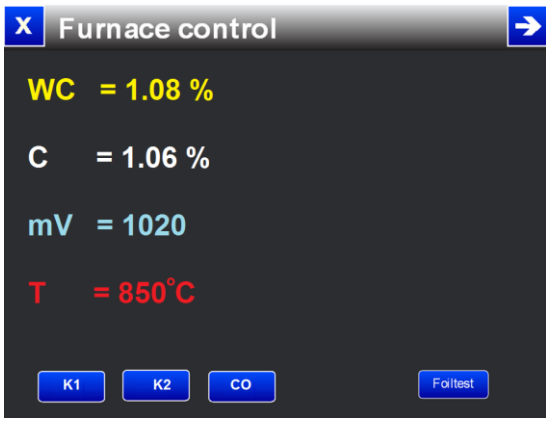


figure 8.6 Ideal probe screen

8.4 Program page

This page is shown only if program is running. On this page in Normal View screen, user can view more details about program that is running. In the upper half of the screen are displayed values for the furnace C level control, temperature control and quenching (oil bath temperature) control. Below is shown program data: program name and number, current production step, program total time, segment elapsed/ duration time, number of program repeats and tracks.

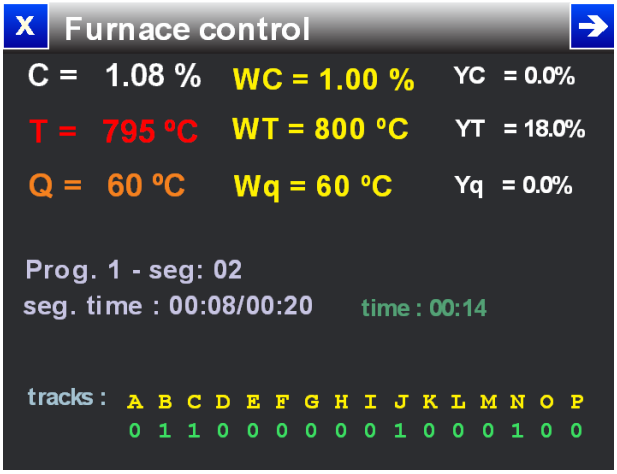


figure 8.7 Normal view- program display

8.5 Horizontal bargraph display

Next page displays C level and temperature control values in horizontal bargraph form. On this page are not shown control output value or actuator data and quenching process control values.

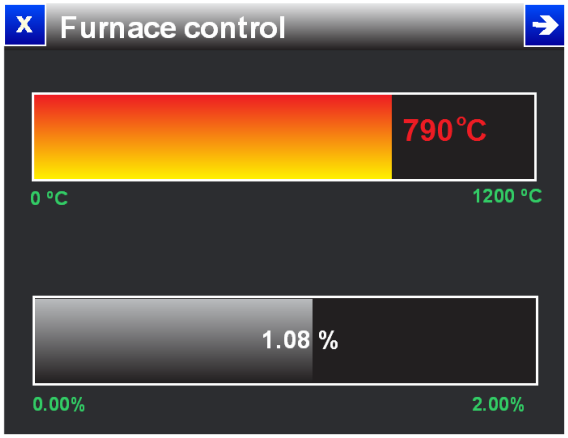


figure 8.8 Normal view- bargraph page

8.6 Graph display

Carburizing process values can be shown in graph which displays a trend of changing temperature and C level in time domain.

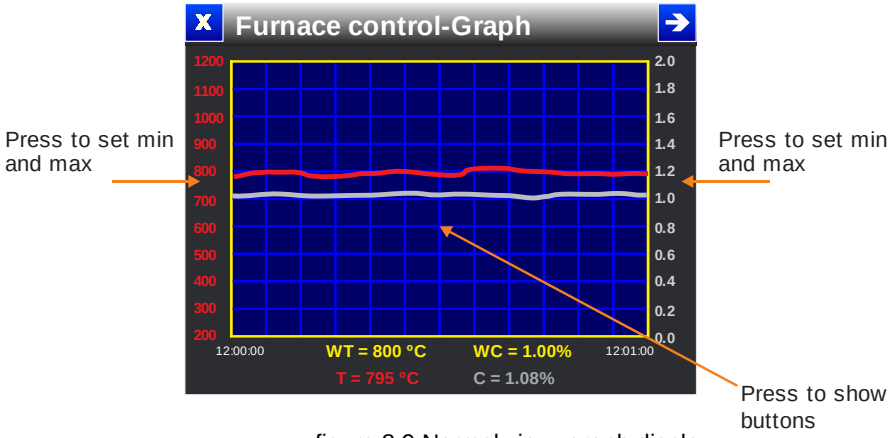


figure 8.9 Normal view- graph display

On the graph screen are plotted trend for C level and furnace temperature. Graph feature has a history capability which allows viewing trend from the starting of the control (transition from STOP to RUN mode).

On the graph screen is displayed trend in real time. Additional trend options and settings are available after pressing graph area when the button bar appears below the graph. Tap on the screen several times to change buttons which will be displayed or to hide button bar. When the button bar is displayed, setpoints and current trend values are not displayed.

Pressing edges of screen, where are displayed temperature and C level labels, opens menu where can be set minimum and maximum value for each trend display.

First group of buttons is for navigation through trend history. Press > or < button to show trend data from one screen time backward or forward respectively.

After pressing again graph area, another buttons appears. Press << button to show trend data from the beginning of process or press >> button to show realtime trend.

Next pressing on the graph area shows buttons for zoom in and zoom out (Zoom+ and Zoom- Pressing these buttons will change *screen time* and redraw trend points with longer or shorted *screen time*.

Every graph sample point is stored to device internal memory. After switching from STOP to RUN mode, device start to storing graph points to the internal memory. Values are sampled on every sample time interval and trend is showed within a selected screen time.

Sample time and screen time are parameters which are available after pressing *Settings* button in the button bar bellow the graph.

Parameter: **Screen time**

Values: *(60sec, 2min, 5min, 10min, 20min, 30min, 60min, 120min, 4hr, 8hr, 16hr, 32hr, 64hr, 128hr)*

Default: *60sec*

Description: Defines the duration of trend showed in one graph window. Pressing Zoom+ / Zoom- buttons decrease/increase screen time respectively.

If screen time is 2h or greater, after pressing Zoom- screen time will be doubled until whole trend can suit in one graph window.

Parameter: **Sample time**

Values: *(2sec, 5sec, 10sec, 20sec)*
Default: *2sec*
Description: Time interval on which one sample value (C level and temperature) is stored to internal memory and plotted on the screen.

9. Setpoints

MCON Carbo device has 3 control loops. First control loop is used to control furnace temperature, second is for C level control and third is optionally used for quenching temperature control. In setpoint menu user can define the fixed setpoint values. Also user can select in setpoint menu *Program* item which starts running the selected program. User can choose which program number to run by pressing the Programs button (second page). Selected program is displayed near on the Setpoints menu. User can start actual program by selecting program item on the Setpoints menu. First, user can define loop setpoints in several ways:

- Fixed setpoints (chapter 9.1) SP1 to SP4 are user explicitly defined setpoints inserted via onscreen keyboard.
- External setpoint (chapter 9.2) – setpoint value is obtained from one of analog inputs. External setpoints can be for temperature and for C level also. External setpoints can be scaling manually by user requirements.
- Remote SP (chapter 9.3) – setpoint value is received from communication.
- Programs (chapter 10) – defines temperature and C level trend in time (segments) and fixed oil temperature.

9.1 Fixed Setpoints

User can insert temperature and C level setpoint and their high and low tolerances. When user select one of 4 fixed setpoints (in the setpoint menu), controller starts the regulation with the setpoint values which are defined by that setpoint.
There are 4 fixed setpoints which user can select. Every fixed setpoint has next parameters:
Parameter: **C pot**

Values: *(0, 2%)*

Default: *0%*

Description: Required value of C level.

Parameter: **Temp**

Values: *(0, 1200^{o}C)*

Default: *0^{o} C*

Description: Required value of Temperature level.

Parameter: **C pot. SP+**

Values: *(0, 0.2%)*

Default: *0.05 %C*

Description: Upper tolerance for C level.

Parameter: **C pot. SP-**

Values: *(-0.2, 0%)*

Default: *-0.05 %C*

Description: Lower tolerance for C level.

Parameter: **Temp. SP+**

Values: *(0, 120^{o}C)*

Default: *5 ^{o}C*

Description: Upper tolerance for temperature.

Parameter: **Temp. SP-**

Values: *(-120, 0^{o}C)*

Default: *-5 ^{o}C*

Description: Lower tolerance for temperature.

Parameter: **Soot limit**

Values: *(-10, 0 %)*

Default: *0 %*

Description: Soot limit parameter shifts the curve (soot limit curve) between maximum C level and temperature percentage down. MCON Carbo calculate the graph of soot limit automatically.

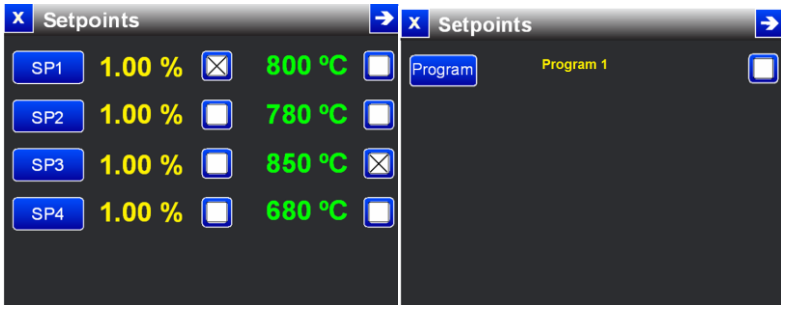


figure 9.1 Setpoints screen first and second page respectively

On the example above, SP1 is selected as C level setpoint and SP3 is selected as Temperature setpoint.

NOTE
When changing from program to some of setpoints, remote or external they both will be selected!

If process value is lower under setpoint tolerances Sp+/SP-, “Control Normal” status is displayed which means that process value is within accepted value boundaries.

9.2 External Setpoints

Setpoints can be defined via analog inputs. That is possible only if there is analog input which is configured as external temperature or external C level setpoint. User can scale voltage or current to represent setpoint value.
Analog inputs can be configured in
Main Menu → Settings → Hardware → Analog inputs. Parameter **Ain Type** must be *0-20mA Rext* or *4-20mA Rext*. Then put the **Ain name** with characters.

Parameter: **Measurement**
Values: *(Custom Scaling, Ext. C level SP, Ext. Temp. SP, Furnace CO, Furn CO2)*
Default: *Custom Scaling*
Description: On this parameter user select the value which will be used from external setpoint. If value is *Custom Scaling* user can manualy define the limits of value and value name.

Scaling parameters

Parameter: **P1.x scalling** and **P2.x scalling**

Values: *(depending of **Ain Type**, can be 0-20mA or 4-20mA)*

Default: *0 or 4 minimum value – 20mA maximum value*

Description: Define the limit of values from external input setpoints.

Parameter: **P1.y scalling** and **P2.y scalling**

Values: *(-9999999, 9999999)*

Default: *0*

Description: Define the limit for measured value (for example min or max temperature, min and max C level).

Parameter: **Unit name**

Values: *characters, maximum 8*

Default: *%*

Description: This parameter is active only for **Custom Scaling** and allow user to define the physical value name.

Parameter: **Decimal points**

Values: *(0, 3)*

Default: *2*

Description: This parameter is active only for **Custom Scaling** and allow user to define the decimal points for observe value.

9.3 Remote Setpoints

Temperature and C level remote setpoints are obtained from some of presented communication interfaces (MODBUS). When one of temperature or C Level remote setpoints option is selected (or both of them), controller use value for those setpoints from the communication. Setting the communication is:

Main Menu → Settings → Hardware → Comm. config → Com 1 (or Com2) → Protocol.

For the remote setpoint is important address of remote device register which holds setpoint value. This register is read as MODBUS input register on the device which is set communication settings.
In order to obtain setpoint from MODBUS, one of com1 or com2 interfaces must be set as MODBUS master and on the Remote SP menu, valid register address must be set. For remote setpoints it is needed to put communication module into device.

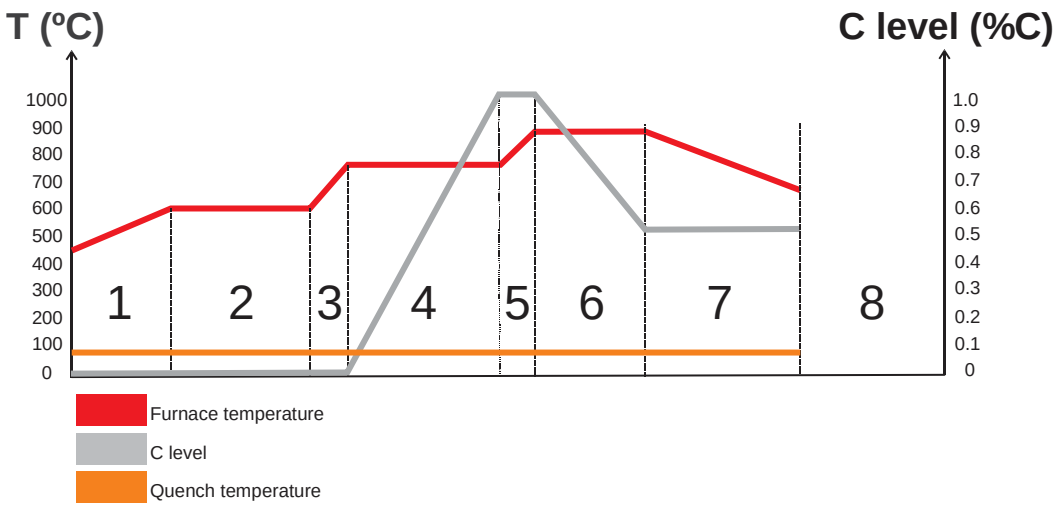
10. Programs

Programs can be configured in **Main menu → Programs→ Program edit** menu.
Also, created program can be listed in **Main menu → Programs→ List program**.

Program is set of segments which are executed sequentially. Every segment defines temperature and C level setpoint and time required for those setpoints to be approached. MCON Carbo can store up to 99 programs. Every program can be custom named and has its own number (from 1 to 99).

Every segment can activate some digital outputs when the segment is about to run. This feature is called “program tracking”. There are 16 tracks, named from A to P.

Every track can be associated with a digital output which it activates. User can define tracks which will be activated or deactivated for every segment.



segment	1	2	3	4	5	6	7	8
Temperature setpoint	600 ºC	600 ºC	780 ºC	780 ºC	850 ºC	850 ºC	650 ºC	x
C level setpoint	0 %C	0 %C	0 %C	1.0 %C	1.0 %C	0.5 %C	0.5 %C	x
segment duration	30 min	45 min	10 min	50 min	8 min	25 min	50 min	0 min

figure 10.1 Example of program segments

Segment setpoint (not process value) is target value which must be achieved on the end of segment. If segment duration is short, then device tries to achieve setpoint as quick as possible. If segment time is too long, device will goes smoothly to the target setpoint. Therefore there is no need to define rising times because it is automatically calculated depending of the previous and current segment setpoint value and the segment time.

For example: segment 3 has temperature setpoint SPT = 780 ºC. Previous segment, segment 2, ends on 600 ºC.

Because segment time is 10 minutes, device will regulate temperature from 600 ºC to 780 ºC with rising value: (780 ºC - 600 ºC)/10min = 18 ºC/min. It is assumed that the 780 ºC temperature will be reached at the end of segment.

When there is no need to have constant process value over the certain time, it is required to define segment which has the same setpoint as previous segment (dwell).

Every segment defines both temperature and C level setpoints. Because oil bath temperature (quenching) is constant during the program running, it is not part of a segment. Quench temperature is associated with the program and it is accessible as a parameter when configuring program.

Program parameters:

Parameter: **Program no**
Values: *(1 - 99)*
Default: *1*
Description: Select number of program which has to be edited or started. User must first choose program number before editing/viewing program parameters or segments.

Parameter: **Program name**
Values: *(text up to 15 characters)*
Default: *not set*
Description: Program name for which describes program purpose.

Parameters: **C pot. SP+, C pot. SP-, Temp. SP+, Temp. SP-, Soot limit** are the same as parameters for the setpoints. Refer to the “Fixed setpoints chapter 9.1”. Setpoints tolerances for the program execution are used only to define when the control is achieved setpoint value in order to go to the next segment (only if the X bit is set). These parameters are parts of a program.

Parameter: **Alloy factor**
Values: *(0.85 – 1.15)*
Default: *1.00*
Description: When alloy factor is < 1.00, C level is increased proportionally. When alloy factor is > 1, C level is decreased proportionally. The value of this parameter depends of material which is carburizing and its capability to absorb carbon from the atmosphere. This parameter is part of a program.

Parameter: **Quench T**

Values: *(0 ºC – 120 ºC)*

Default: *60 ºC*

Description: Quenching temperature (oilbath temperature) setpoint value. MCON Carbo regulates quenching temperature if the quenching control is enabled (3 loops controller). Quenching temperature is parameter of a program.

Parameters: **Quench Temp. SP+, Quench Temp. SP-** define tolerances for oil bath temperature regulation.

Parameter: **Copy program to:**

Values: *(1 – 99)*

Default: *1*

Description: This parameter allows user to copying some program (with setpoints, C level and Temperature limits, alloy factor, quench temperature and soot limit) to another program.

10.1 Program segments

Program segments can be edited under segments screen which is available in: **Main menu → Programs → Program edit → Segments** screen. Before editing or viewing segments, user must choose desired program.

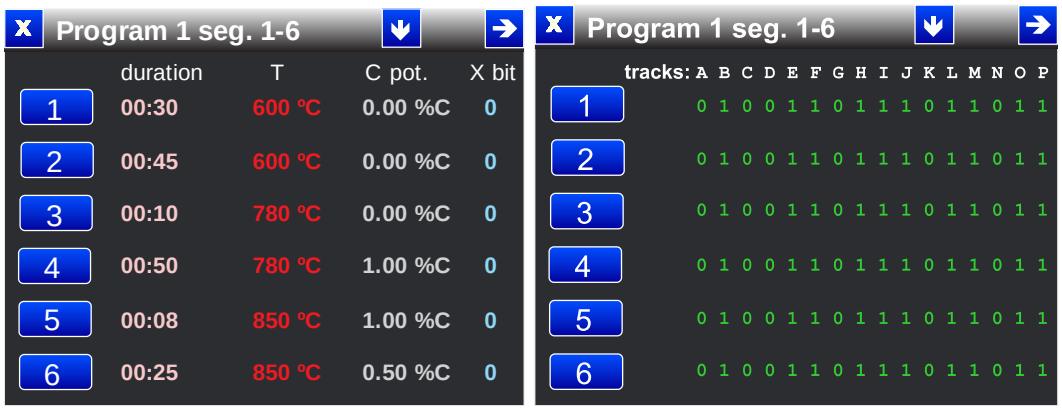


figure 10.2 Program segments and tracks displaying

Segments screen shows 6 segments by one screen. Press button to show next 6 segments or button to show previous 6 segments. Maximum number of

segments per program are 24. On the first page there is basic information of every segment: time of segment (duration), temperature setpoint (T), C level setpoint (C pot.) and X bit. To change segment values, press appropriate segment button which opens segment editing menu.

In the *Edit segment* menu there are temperature and C level setpoint parameters which have the same meaning and values range as fixed setpoints in *Setpoint* menu. Other segment parameters are:

Parameter: **Segment time**
Values: *(0 – 6000 min)*
Default: *30 min*
Description: Segment time in minutes.

Parameters **C pot** and **Temp** are segment setpoints for C level and temperature.

Parameter: **X bit**
Values: *(checked, unchecked)*
Default: *unchecked*
Description: When the X bit is checked (logical value “1”), this segment waits to reach process values according to setpoints and their tolerances before switching to the next step even the segment time elapses.

TIP

When you need to reach setpoint values for temperature and C level as fastest as possible, you need to declare segment to be very short (1 minute) and set X bit to 1. This way, device will not smoothly change setpoint value because time is very short and do not go to the next segment until current segment setpoint regulated.

10.2 Segment tracks and tracks configuration

Program segments can activate program tracks (from track A to track P). This function is available on:

Main menu → Programs → Program edit → Segments → 2 page menu. This function helps user to visiting the process status.

Each track can be assigned with selected digital output for any process operation:

Main menu → Settings → Hardware → Config tracks

Parameter: **Track A, Track B, Track C … Track P**

Values: *(not set, dout 1, dout 2, … dout n)*

Default: *not set*

Description: Digital output which is associated to track. If *not set,* track will not activate any digital output. Tracks configuration is common for all programs.

On the segment tracks screen there are tracks A to P which can be configured. If certain track is set (checked) its digital output will be activated when that segment executes, otherwise if track is unchecked, appropriate digital output will be deactivated on this segment.

TIP

Use tracks to send commands to PLC or some other electronics which can be used for automation control of the furnace. For ex. some tracks can be activated on the end of a program in order to close furnace door or put the charge into oil.

11. Logging

This feature allows measurement data to be logged during the control process. Every log session stores data into one file. Log session can be started manually or at desired time. Also it can be stopped manually or automatically. When log session ends, log file is created and it can be transferred to USB stick.

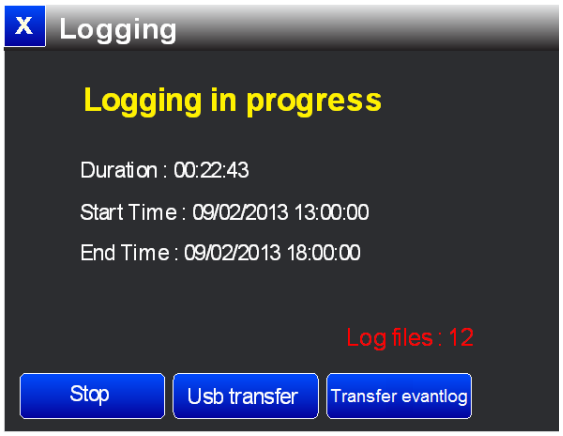


figure 11.1 Logging screen

To start logging go to **Main Menu → Logging** screen and press *Start* button. If there is no enough memory space for new logging file, an error message will be displayed.
Logging session can be ended by pressing *Stop* button or at desired time depending on logging settings.

When the logging is not in progress (logging status label shows yellow colored *Logging Off*), user can transfer all log files onto USB stick by pressing *USB transfer* button. Before this operation you must be sure that the USB stick is properly inserted. Logged files will be transferred to USB stick root directory. Log files can be transferred to the USB stick only in STOP mode.

NOTE
After transferring log files to USB, they will be automatically deleted from the device.

Logging parameters:

To configure logging parameters press
Main Menu → Settings → Logging settings

There are next logging settings which can be configured:

Parameter: **Log info**
Values: *(name up to 15 characters)*
Default: *not set*
Description: Symbolically represents log session. This info will be visible when log file is loaded via dedicated PC software.

Parameter: **Logging mode**
Values: *(Manual, Auto Start, Auto Stop, Auto Start/Stop, By Process)*
Default: *Manual*
Description: *Manual* – user directly starts and stops logging
Auto Start – logging automatically starts at desired time and stops manually
Auto Stop – logging manually started and automatically stopped at desired time
Auto Start/Stop – logging automatically started and automatically stopped at desired time
By Process – logging automatically by some process

Parameter: **Sample time**
Values: *(1 – 1000 S)*
Default: *5 S*
Description: Time interval on which new measurement value will be captured and logged to a file.

Parameter: **Start Time**
Values: *(01/01/1970 – 19/01/2038)*
Default: *31/12/2011 12:00*
Description: When the *Auto Start* or *Auto Start/Stop* mode is selected, this time determine when to start new logging session.

Parameter: **Stop Time**

Values: *(01/01/1970 – 19/01/2038)*

Default: *31/12/2011 12:00*

Description: When the *Auto Stop* or *Auto Start/Stop* mode is selected, this time determine when to stop logging session.

Logging channels are measurement values which can be logged. User must select minimum one log channel in order to start logging. In the *Logging Settings* menu there is an item *Logging channels* which opens list with channels:

Furnace temp. – logs furnace temperature

Furn. C level – logs C level value which is used as process value for C level control

External CO2 – logs CO2 value from external sensor (if present)

External CO – logs CO value from external sensor (if present)

Probe 1 mV – logs millivolts measured from probe 1

Probe 1 %C – logs corrected C level measured with probe1

Quench T – logs quenching temperature (if present)

Ain1 to Ain5 (scaled and raw values) - logs analog inputs, scaled or row values

NOTE

Log channels which are selected but not present will be logged as 0 on every sample period.

After transferring log files to USB, logged data can be examined via dedicated PC software tool “C300 view”.

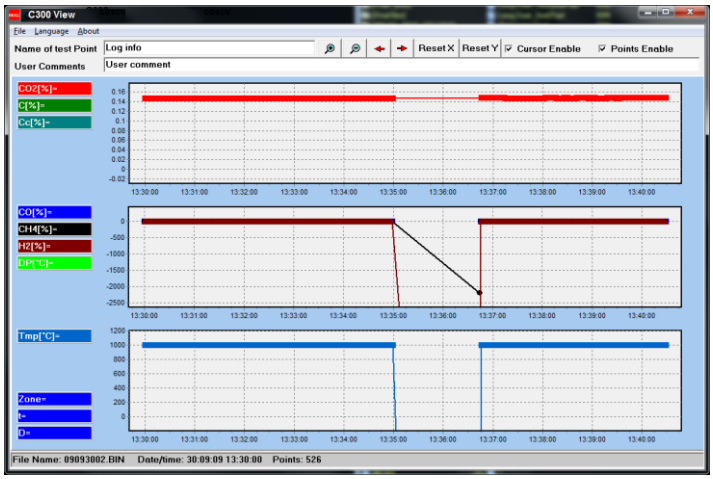


figure 11.2 MCON Carbo log files viewer

12. Settings

12.1 Furnace

This screen presents configuration of the furnace.

Main menu → Settings → Furnace

figure 12.1 Furnace menu, page 1 and page 2

12.1.1 Furnace temperature

Parameter: **Temperature from**

Values: (From input, User defined)

Default: *From input*

Description: Configure how get the furnace temperature. If we used furnace temperature from thermocouple, then this parameter must configure as *From input* and if furnace temperature is constant, then configure as *User defined.* If temperature is *User defined* that means that other device regulate furnace temperature.

Parameter: **Temp. fix value**

Values: (0, 2000 ^{o}C)

Default: *0 ^{o}C*

Description: If parameter **Temperature from** is *User defined*, then in this parameter put the fixed furnace temperature value.

Parameter: **Temp. sensor**

Values: (not set, Ain 1, Ain 2, Ain 3, Ain 4, Ain 5, optinally Ain 6 and Ain 7)

Default: *not set*

Description: If parameter **Temperature from** is *From input*, then put the correspond analog input from which voltage MCON get the furnace temperature. Recommended analog input for furnace temperature is Ain 1. It is needed firsty in *Hardware* menu (see 12.4.1) configure Analog input for adequately temperature measurement.

12.2.2 Probes

MCON Carbo is capable to measure C level with 2 probes. On probe is required while second is optional. 2 probes are used due to safety reasons and measurement accuracy maintenance.

Probe 1 can be connected only on analog input 2 (AIN2). Probe 2 can be connected on AIN3, AIN4, or AIN5 depending of hardware configuration. AIN2 is factory preconfigured for Probe1. If Probe2 is used, appropriate analog input must be set as AIN3 (see the Analog input configurations).

Probe configuration **Main Menu → Settings → Furnace → Probes**

NOTE

If there is no analog inputs (except AIN2) configured to probe input type, Probe2 menu will be disabled.

Probe parameters:

Parameter: **Probe input**

Values: *(not set, Ain 1, Ain 2, Ain 3, Ain 4, Ain 5)* depending of configuration

Default: *not set*

Description: Configure analog input for probe

Parameter: **Probe type**

Values: *(OFF, L Probe, O2 Probe)*

Default: *L Probe*

Description: Type of a probe attached to analog input.

Parameter: **K1**

Values: *(-300, 300mV)*

Default: *0mV*

Description: Correction factor for L probe only. Defines voltage offset of a probe.

Parameter: **K2**

Values: *(-200, 200 ºC)*

Default: *0 ºC*

Description: Correction factor for L probe only. It defines temperature correction.

12.2.2.1 Probes maintenance

Maintenance functions are used to monitor probe (or probes) status and to warn user is there is some errors with probes functioning. It also provides a feature which switch measurement from one to another probe in the case when one of the probes is in error.

Maintenance parameters can be configured into

Main Menu → Settings → Furnace → Probes → Probes maintenance menu.

Parameter: **%C difference**

Values: *(0.0, 0.09 %C)*

Default: *0.0 %C*

Description: When 2 probes used, this parameter defined maximal difference in C level measurement between both probes. Above this value, warning is displayed.

Parameter: **Probe min. voltage**

Values: *(0, 200 mV)*

Default: *10 mV*

Description: When probe voltage drops below this value and temperature is above *Probe min. voltage temp. ,* error will be triggered.

Parameter: **Probe min. voltage temp**

Values: *(0, 1200 ºC)*

Default: *500 ºC*

Description: Temperature above the min voltage constraint is monitored.

12.2.2.2 Probes flushing

Flushing function is used for probes cleaning when they get dirty in the atmosphere with carbon activity. Flushing is activated periodically on defined time intervals. When flushing is activated, appropriate digital output turns on flushing gases for probe cleaning. After the purging, probe is in recovery state in which measurement from this probe is not taken. During the flushing time and recovery time, probe measurement is frozen or taken from another probe (if available). For every probe there are separated digital outputs which are used for flushing. Digital output for probe flushing is activated when the probe is in flushing phase and deactivated when probe working or in recovery phase.

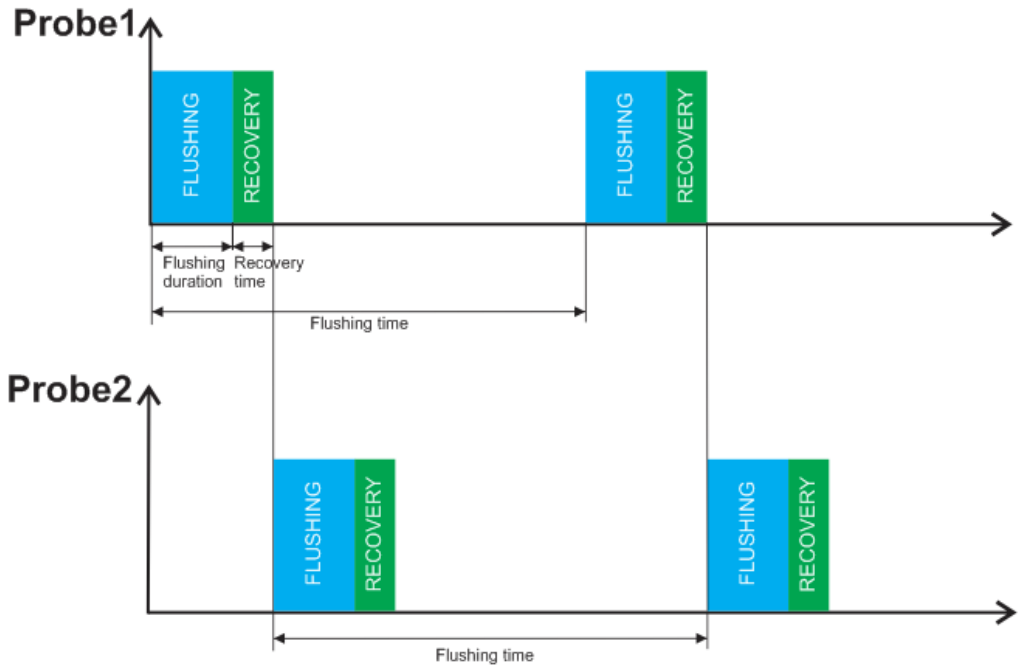


figure 12.2 Probes flushing timings

NOTE

During the probe flushing and recovery period, measurement is not taken from that probe. C level calculation is then performed by measurement of second probe/sensor (if exists) or frozen until probe recovery time expires.

Main Menu → Settings → Furnace → Probes → Probes maintenance→ Flushing config

Flushing parameters:

Parameter: **Flush time**

Values: *(00h:00min, 10h:00min)*

Default: *00h:30min*

Description: Time period in which flushing activates.

Parameter: **Flush duration**

Values: *(0, 300)*

Default: *100*

Description: Duration of active flush output.

Parameter: **Flush recovery**

Values: *(0, 600S)*

Default: *10S*

Description: Time after flushing when probe recovers from flushing and do not measure.

Parameter: **Flush Out1, Flush Out2**

Values: *(not set, dout 1, dout 2, … dout n)*

Default: *not set*

Description: Flush out1 – Probe1 flushing digital output, Flush out2 – Probe2 flushing digital output.

12.2.2.3 Probe Rin test

Rin test is performed in order to measure probe internal resistance which is a very important parameter for the probe endurance and quality. During the time, probe internal resistance increases and within rin test device can determine if the probe has to be replaced.

When the new probe is installed user must activate the function *New probe.* This function is available in

Main Menu → Settings → Furnace → Probe → Probe maintenance → Rin test → New probe1. When user press this button, device measures the internal resistance of new installed probe considering that the probe is new and has minimum internal resistance. On the exploitation, device periodically measures rin of a probe and checks how the internal resistance increases from the initial value (when the new probe installed). If new probe internal resistance is more than 3 times greater than initial value, probe error is triggered. This means that this probe must be replaced with new one. After replacement it is required to activate *New probe* option again.

Probe rin test is performed periodically at the same way as the flushing. For the Rin test there is no duration time because it is not done very fast.

Rin test parameters:

Parameter: **Ri test time**
Values: *(00h:00min, 100h:00min)*
Default: *2h:00min*
Description: Time period in which rin test is performed.

Parameter: **Ri test recovery**
Values: *(0, 600S)*
Default: *10S*
Description: Time after rin test in which measurement from probe will not be taken.

Parameter: **Ri test temperatureg**
Values: *(600, 850 ºC)*
Default: *700 ºC*
Description: Temperature at which rin test can be performed. If the furnace temperature is +/- 10 ºC in tolerance within this temperature, rin test is enabled. If temperature exceeds this range, device checks every 4 minutes to determine if rin test can be performed.

12.2.2.4 Inserting new probe

Inserting new probe means that device measure internal resistance of the new probe and remembers this value as minimal (initial) internal resistance.
To insert new probe user need to connect the new probe on the analog input. Then furnace control process can be started. User cannot activate *New probe* option until furnace temperature become valid due to *Ri test temperature parameter*. When the temperature is valid, after activating *New probe* command, device forces internal resistance measurement of that probe which will be used for comparing in periodically issued rin tests.

12.1.2 CO content

Parameter: **CO Source**

Values: (User defined, From input)

Default: *User defined*

Description: On this parameter user configure the CO level. If the CO level is constant value, then this parameter is *User defined*. If CO level is measured, then this parameter is *From input*.

Parameter: **CO Level**

Values: (1, 60 %)

Default: *20 %*

Description: This parameter is active only in a case when **CO Source** is *User defined* value. On this parameter user define the constant CO level value.

If user measure the CO level, then **CO Source** parameter must be configured at *From input*, and user must configure input for CO measurement:

Main Menu → Settings → Hardware → Analog inputs → Ain 3 (or 4, or 5)

Ain Type parameter must configure as (*0-20mA Rext* or *4-20mA Rext*).

Measurement parameter configure as *Furnace CO.*

Parameter: **Quench T input**

Values: (not set, Ain 1, Ain 2, Ain 3, Ain 4, Ain 5)

Default: *not set*

Description: User define analog input for measuring quench temperature (optionally, if furnace measure oil bath temperature).

Parameter: **Gas release DOUT**

Values: (not set, dout 1, dout 2, ..., dout n)

Default: *not set*

Description: Parameter where set the digital output for adding GAS into furnace.

Parameter: **Quench T**

Values: (0 - 120 ^{o}C)

Default: *60 ^{o}C*

Description: Fixed setpoint for Quench temperature.

Parameters **Quench Temp. SP+**

Values: (0 - 6 ^{o}C)

Default: *0 ^{o}C*

Description: Upper hysteresis for quench temperature.

Parameters **Quench Temp. SP-**

Values: (-6 - 0 ^{o}C)

Default: *0 ^{o}C*

Description: Lower hysteresis for quench temperature.

Parameter: **X bit mode**

Values: (Current segment, Previously seg.)

Default: *Current segment*

Description: Principle of the X bit, current or previously segment. If this parameter is set as *Current segment*, then program goes to next segment when current process value will be equal to setpoint value. If parameter is *Previously seg.* then program goes to next segment when process value achieve process values segment before.

Parameter: **Gas release temperature**

Values: (750^{o}C)

Default: *750^{o}C*

Description: Hardcode value for minimum temperature which allows to put gas and air into furnace.

12.2 Control settings

Menu path: **Main Menu → Settings → Control settings**

Control settings are separated for all 3 control loops: temperature control, C level control and Oil bath temperature control.

12.2.1 Furnace and Oil bath temperature control

Furnace temperature control and quench temperature control (quenching) parameters have similar meaning and they will be described both.

Parameter: **Control preset**

Values: *(OFF, PID preset 1, PID preset 2, PID preset 3)*

Default: *PID preset 1*

Description: Parameters for every loop are organized into 3 presets. Every preset contains all control parameters that will be used if this preset is chosen in the *Control* preset parameter. To deactivate control loop, chose *OFF* option.

Changing the PID preset parameters can be performed in:

Main Menu → Settings → Control settings → Temperature control → PID preset n

or

Main Menu → Settings → Control settings → Oil bath temperature → PID preset n

12.2.1.1 PID preset parameters

Parameter: **Control type**

Values: *(PID, On/Off)*

Default: *PID*

Description: Defines which type of control will be used when this preset is active.

Parameter: **Control output**

Values: *(Heating, Heating/Cooling, Analog)*

Default: *Heating*

Description: Heating – 2 state control output (Heating on/off)
Heating/Cooling – 3 state output (heating, cooling and off)
Analog – Output value from the control (Y) will be present on the analog output (if available). Details are described in the analog output section.

Parameter: **Deadband**

Values: *(0 -120 ºC)*

Default: *0 ºC*

Description: For the 3 state output type and PID control type, defines minimum process temperature which must be above SP to allow cooling activator activation.

Parameter: **Derivative type**

Values: *(Error, PV)*

Default: *Error*

Description: When set to Error, differential term error is calculated as difference of current and error in previous scan cycle. When set to PV, differential term error is calculated as difference of the process values in current and last cycle.

Parameter: **Upper hysteresis**

Values: *(0 – 120 ºC)*

Default: *0 ºC*

Description: Effective only for On/Off control type. For 2 state output, heating is turned off at value SP+Upper hysteresis. For 3 state output type, cooling is turned on when the PV becomes greater then SP+Upper hysteresis.

Parameter: **Lower hysteresis**
Values: *(0 – 120 ºC)*
Default: *0 ºC*
Description: Effective only for On/Off control type. Heating is turned on when the PV becomes lower than SP-Lower hysteresis

NOTE
Cooling PID parameters are only available if the control output type is set to *Heating/Cooling*

Heating and cooling PID parameters:

Parameter: **PB heating, PB cooling**
Values: *(0 – 5000 %/ºC)*
Default: *5 %/ ºC*
Description: Proportional band parameter of a PID control. Proportional factor is calculated by multiplying error with PB.
For example: If PB = *60 %/ ºC* this will produce 60% correction value (Y) when error is 1 ºC or 30% if error is 0.5 ºC etc.

Parameter: **Ti heating, Ti cooling**
Values: *(0 – 5000 % / (ºC*min))*
Default: *1% / (ºC*min)*
Description: Integration time of error. Bigger values increase system response to error duration over time. When set to 0, integration part of a PID algorithm is disabled.
For example: If Ti = *10%/(ºC*min)* this will produce 10% correction value (Y) when error is 1 ºC constant in period of 1 minute. After 2 minutes it will be 20% etc.

Parameter: **Td heating, Td cooling**
Values: *(0 – 5000 % / (ºC/min))*
Default: *0 % / (ºC/min)*
Description: Derivative constant of PID control algorithm. Greater value increase system responses to process value changing in short time. When set to 0, derivative part of a PID algorithm is disabled.

For example: If Td = *5%/(ºC/min)* this will produce 5% correction value (Y) when error change rate is 1ºC/min. If error change rate is 2ºC/min, derivative term will be 10%.

Parameter: **Cycle time heating, Cycle time cooling**
Values: *(0 – 1200 S)*
Default: *20 S*
Description: Actuators are activated when cycle time elapses. When Y = 100%, actuator will be turned on whole cycle. If the Y = 50%, actuator will be on half cycle time. For more details view control principle chapter.

Parameter: **Min. ON time heating, Min. ON time cooling**
Values: *(0 – 60 S)*
Default: *1 S*
Description: Minimum allowed time for actuator to be activated. It prevents turning on activators if for the small Y values and cycle times.

Parameter: **Cooling factor**
Values: *(0 – 2.00)*
Default: *1.00*
Description: This parameter is available only if Heating/Cooling output is set and the PID control type. Because heating and cooling PID parameters are separated it is possible to use heating parameters for cooling too depending of cooling factor value. If cooling factor is 0, cooling phase will be processed with dedicated cooling PID parameters. If cooling factor is not equal 0, cooling PID parameters will be the same as heating parameters except PB which will be multiplied with the cooling

factor. Therefore cooling factor determines difference between the response of a system in cooling and heating phases.

Parameter: **Control out1, Control out 2**

Values: *(not set, dout 1, dout 2, … dout n)*

Default: *not set*

Description: When not set, control output for heating and cooling will not be activated even the Y value will be affect during control. Contol 1 output determines digital output for heating (temperature and oil bath control). Contol 2 output determines digital output for cooling (temperature and oil bath control). For details about digital outputs assigning view the chapter digital outputs assignment.

Parameter: **Control normal out**

Values: *(not set, dout 1, dout 2, … dout n)*

Default: *not set*

Description: Activate selected digital output when “control normal” message is on the display for appropriate physical value.

NOTE

If the control output is set to 2 state or analog, Control 2 output will be automatically not set (released for other purposes). If control type is disabled both control outputs will be *not set.*

12.2.2 C level control

Parameters *Control preset, Control type*, *Derivative type*, *Upper Hysteresis* and *Lower Hysteresis* have the same meaning as for the Temperature and Oil bath temperature control. Parameters *Control out 1* and *Control out 2* have the same function. *Control out 1* put gas into furnace (such as heating in temperature control). *Control out 2* put air into furnace for 3 state regulation (such as cooling in temperature control). *Control normal out* is identical as temperature control.

Parameter: **Control output**
Values: *(Gas, Gas/Air, Analog, Motorized valve)*
Default: *Gas*
Description: Gas – 2 state control output (Gas on/off)
Gas/Air – 3 state output (gas on, air on and off)
Analog – Output value from the control (Y) will be present on the analog output (if available). Details are described in the analog output section.
Motorized valve – valve opening and closing using 2 digital outputs. Details are described in the control principles section.

Parameter: **Deadband**
Values: *(0-0.2 %C)*
Default: *0 %C*
Description: For the the 3 state output type and PID control type, defines minimum process C level which must be above SP to allow air activator activation.

Parameter: **Valve Max ON time**
Values: *(0 – 320 S)*
Default: *60 S*
Description: This the maximum time required to open or close the valve. It must be lower than motor valve run time (time from closing to opening or time from opening to closing).

Parameter: **Valve rest time**

Values: *(0 – 120 S)*

Default: *5 S*

Description: Minimum time which must elapses between two successive valve on intervals (between two closing, two opening, opening and closing or closing and opening).

Parameter: **PB gas, PB air**

Values: *(0 – 5000.00 %/ %C)*

Default: *60 %/ %C*

Description: Proportional band parameter of a PID control.

Parameter: **Ti gas, Ti air**

Values: *(0 – 5000.00 %/(%C*min))*

Default: *10%/(%C*min)*

Description: Integration time of PID control.

Parameter: **Td gas, Td air**

Values: *(0 – 5000.00 %*(%C/min))*

Default: *5 %*(%C/min))*

Description: Derivative time of PID control.

NOTE

Parameters *Valve Max On* time and *Valve rest time* are available only for C level control, PID output type and motorized output selected.

12.3 Alarms

MCON Carbo provides 4 analog alarms and one digital alarm. They can be configured into **Main Menu → Settings → Alarms** menu. There are 4 analog alarms and one digital alarm. Each alarm can be connected with digital output.

12.3.1 Analog alarms

Analog alarms are used to check analog values such as measurement results and to generate alarm (trigger appropriate digital output) if the value of monitored measurement value is not valid according to the alarm constraints.

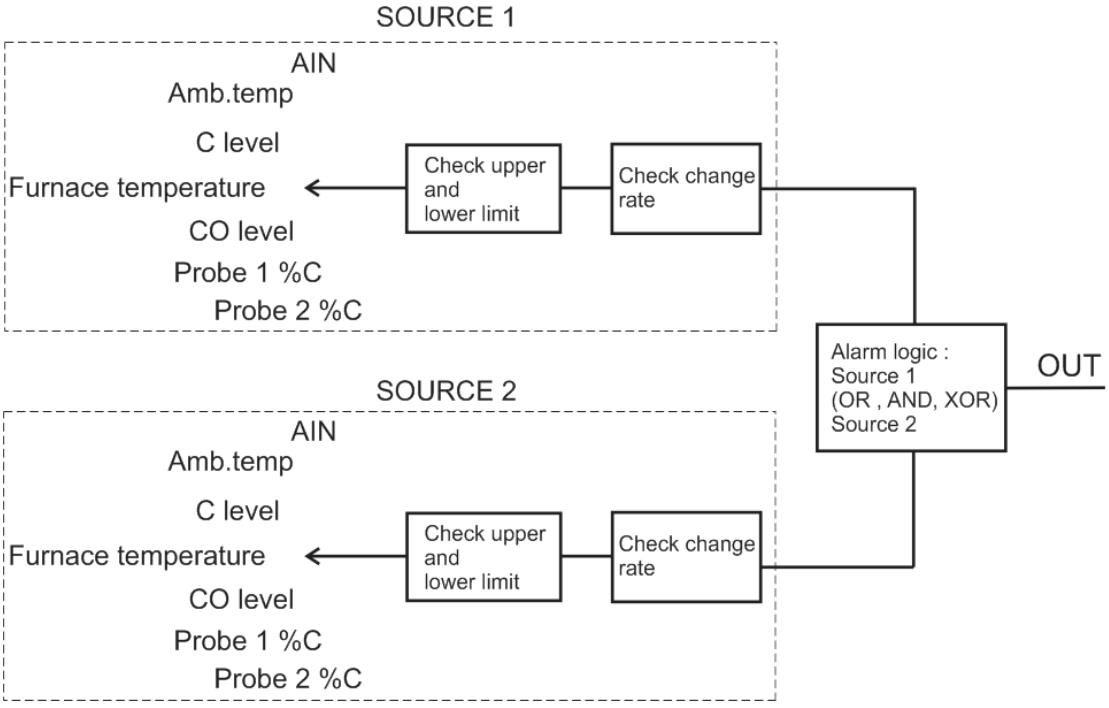


figure 12.3 Alarm configurations

Analog alarm has 2 sources of measurements which can be monitored. If the source is AIN (analog input) it can be raw value (voltage or current) or scaled value (depends of AIN configuration can be temperature or C level,…). For AIN source, user must insert which analog input is attached to alarm source.

Alarm source 2 is optional and it allows that one alarm can be associated by 2 measurements in several logic combinations. It is possible to trigger alarm if both

alarm sources are activated (AND), only one of sources are active (XOR) or any of them (OR).

Value of an alarm source (temperature, C level or analog input value) is compared to the lower and upper limits. Alarm is generated if value is outside area which is defined by upper and low limits. Alarm is deactivated when value is inside area which is defined by limits and appropriate hysteresis.

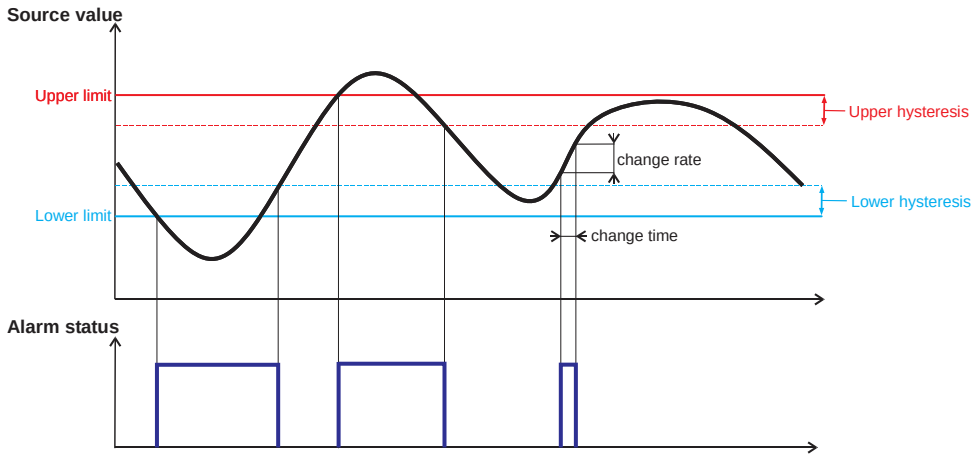


figure 12.4 Alarm activating conditions

Alarm source value also can be monitored by its change rate. When value changes faster than allowed in user defined time interval, it will be triggered. Thus change rate is value of difference in change time interval.

For example: Change rate = 20ºC and Change time is 10S. Alarm will be activated when temperature changes above 20ºC in 10 seconds therefore effective change rate is: 2ºC/S

Main Menu → Settings → Alarms → Alarm (1 to 4) → Alarm source (1 or 2)

Analog alarm parameters:

Parameter: **Alarm source**

Values: *(OFF, AIN, Amb. temp, C Potential, Furnace temp. ,CO Level, Probe1 %C, Probe 2 %C, Error type, Any Error, SP temp.)*

Default: *OFF*

Description: Value which will be monitored by the alarm.

Parameter: **Error type**

Values: *(EEPROM error, Furnace error, Amb. temp. error, AIN1 error, AIN2 error, AIN3 error, AIN4 error, AIN5 error, LOOP1 error, LOOP2 error, Invalid value, Modbus error, Ethernet error, I2C error, File error)*

Default: *EEPROM error*

Description: In the case when value in **Alarm source** is **Error type**, user can select which error will produce the alarm.

Parameter: **AIN**

Values: *(AIN1, AIN2, AIN3, AIN4, AIN5)*

Default: *AIN1*

Description: When alarm source is AIN, this parameter defines which analog input is used for alarm source.

Parameter: **Ain value**

Values: *(Raw value, Scaled value)*

Default: *Raw value*

Description: *Raw value* - analog input voltage or current value is monitored by alarm.

Scaled value - analog input scaled value (measurement) is monitored by alarm (for example temperature, C level...).

Parameter: **Upper limit**

Values: *(depending of the **Ain value**)*

Default: *depending of the **Ain value***

Description: When value is above upper limit, alarm is triggered.

Parameter: **Lower limit**

Values: *(depending of the **Ain value**)*

Default: *depending of the **Ain value***

Description: When value is below lower limit, alarm is triggered.

Parameter: **Upper hyst.**

Values: *(depending of the **Ain value**)*

Default: *depending of the **Ain value***

Description: When value is below *Upper limit - Upper hyst*, alarm is deactivated.

Parameter: **Lower hyst.**

Values: *(depending of the **Ain value**)*

Default: *depending of the **Ain value***

Description: When value is above *Lower limit +Lower hyst*, alarm is deactivated.

Parameter: **Change rate**

Values: *(depending of the **Ain value**)*

Default: *depending of the **Ain value***

Description: Maximum allowed difference of value in time period of *Change time*.

Parameter: **Change time**

Values: *(0- 60 S)*

Default: *0 S*

Description: Time quantum in which change rate is monitored.

Main Menu → Settings → Alarms → Alarm (1 to 4)

Parameter: **Alarm logic**

Values: *(OR, AND, XOR)*

Default: *OR*

Description: Activate only in case when both **alarm sources** (1 and 2) are configured. Logic function performed on both alarm sources. If only one alarm source is enabled (*Alarm source* parameter is equal OFF), this parameter will be disabled.

Parameter: **Delay**

Values: *(0- 9999S)*

Default: *5S*

Description: Time after alarm activating which must elapses before triggering digital output of alarm.

Parameter: **Duration**

Values: *(0- 9999S)*

Default: *5S*

Description: Duration of alarm active state. If this value is 0 S, alarm will be active until user stop the alarm by pressing button  in the alarms information screen. If value is not 0 S, alarm will be turned off after duration period but it will be turned on again if alarm condition still exists.

Parameter: **Inverting**

Values: *(NO, YES)*

Default: *NO*

Description: Invert the associated digital output state.

Parameter: **Alarm output**

Values: *(not set, dout 1, dout 2, … dout n)*

Default: *not set*

Description: Digital output used for alarm.

Parameter: **Confirm on DIGIN**

Values: Values: *(not set, din 1, din 2, din 3 … din n)*

Default: *not set*

Description: User can select digital input which will deactivate alarm.

Parameter: **Confirm on track**

Values: *(not set, track A, track B, track C … track O)*

Default: *not set*

Description: In the case when selected track activate, alarm will be turned of.

Parameter: **Can be quited**

Values: *(NO, YES)*

Default: *NO*

Description: When this parameter is **YES**, alarm can deactivate after selected time.

Parameter: **Quit time**

Values: *(0, 9999S)*

Default: *0S*

Description: Select time after which the alarm will turn off. Active only in case when parameter **Can be quited** is active (**YES**).

12.3.2 Digital alarm

Main Menu → Settings → Alarms → Digital alarm

Digital alarm monitors digital inputs. There are 2 digital inputs A and B.

Digital alarm parameters:

Parameter: **Alarm logic**

Values: *(Disabled, A and B, A or B, A xor B, B after A, Not A and B, A and Not B, Not A or B, A or Not B)*

Default: *Disabled*

Description: Logic operations between A and B alarms.

Parameter: **Dig. in A, Dig. in B**

Values: *(not set, din1, din2, din3, din4, … dinN)*

Default: *not set*

Description: Digital input for digital input alarm.

Parameter: **B after A delay**

Values: *(0, 60S)*

Default: *5S*

Description: Delay time between digital input A and digital input B.

Parameters: *Delay, Duration, Inverting, Alarm output, Confirm on DIGIN, Confirm on track, Can be quited* and *Quit time* are the same as in analog alarms!

If alarm logic is B after A, in the time delay for B, alarm will not be active (see this example in the fig 12.4). If delay time is “X” seconds and digital alarm A is active, alarm logic wait X seconds. If B active for X seconds, alarm will turned off. If X second elapsed, alarm will turn on.

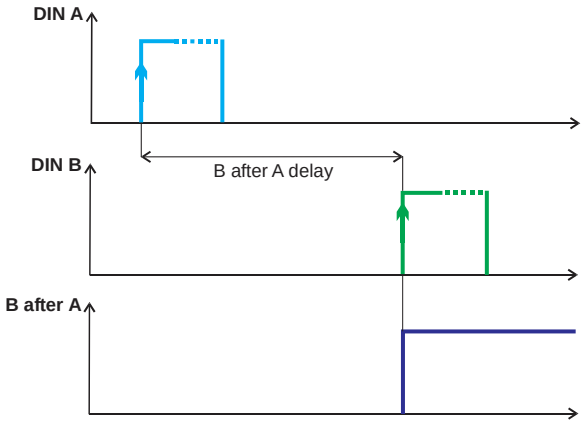


figure 12.5 Digital alarm activating condition

NOTE

For the digital alarm feature it is required that digital input module is installed in device.

12.4 Hardware

12.4.1 Analog inputs

Analog inputs can be configured in
Main Menu → Settings → Hardware → Analog inputs menu.

Note:
Optionally, each analog input can be configured and calibrated to be current or voltage input for L or O2 probe, thermocouple, CO sensor or CO2 transmitter.

12.4.1.1 Analog input 1

Analog input 1 (AIN1) is factory configured for the furnace temperature measurement. Therefore, for temperature control parameters which can be configured for AIN1 is *AIN name* and *Thermocouple type.*

12.4.1.2 Analog input 2

Analog input 2 (AIN2) is factory configured for probe connecting (C level measurement). Only *AIN name* can be changed for this analog input.

12.4.1.3 Analog inputs 3, 4 and 5

These analog inputs can be custom configured for desired sensors and measurements. To set up analog input 3, 4 or 5 follow the net procedure:

1) select analog input type depending on available hardware configuration and measurement sensor connected to that AIN
2) Optionally give the name for the analog input.
3) If the input type is *Thermocouple* select the appropriate thermocouple type.
4) Choose one of the measurements which can be performed with this analog input.
5) Configure scaling for which transfers current or voltage value in appropriate measurement value.

12.4.1.4 Analog inputs parameters

Parameter: **Ain Type**

Values: *(OFF, Probe input, Thermocouple, 0-20mA Rext*, 4-20mA Rext*,0-10V*)*

Default: *OFF*

Description: Input type which depends on hardware configuration. Only available types will be displayed

**depending of hardware configuration*

Parameter: **AIN name**

Values: *(0-15 characters)*

Default: *not set*

Description: Name of Analog input

Parameter: **Thermocouple**

Values: *(B,C,E,J,K,L,M,N,R,S,T)*

Default: *B*

Description: Type of thermocouple. Available only if input type is set to *Thermocouple*.

Parameter: **Measurement**

Values: *(Custom Scaling, Ext. C level SP, Ext. Temp. SP, Furnace CO, Furn CO2)*

Default: *Custom Scaling*

Description: If *An Type* is 0-*20mA Rext, 4-20mA Rext* or *2-10V or 0-10V* it is needed to configure parameter *Measurement*. Determines what to measure with analog input. For each measurements need to configure upper and lower limits in *Scaling* button. For *Custom Scaling* set value it is needed to set unit name and decimal points.

NOTE

After changing Measurement parameter of an analog input, correction for that input is automatically cleared. Therefore user need to do correction again for selected measurement. See Chapter *13.1 Measurements.*

12.4.2 Config tracks

This menu allows linking tracks with digital outputs. If for different tracks are connected the same digital output, *and* logic will active selected digital output. Each parameter from *track A* to *track P* can be linked to each digital output.

12.4.3 Digital IO

Main Menu → Settings → Hardware → Digital IO

Parameter: **Prog. start DIG IN**
Values: *(not set, din 1, din 2, ..., din n)*
Default: *not set*
Description: Digital input which start program automatically.

Parameter: **Prog. stop DIG IN**
Values: *(not set, din 1, din 2, ..., din n)*
Default: *not set*
Description: Digital input which stop program automatically.

Parameter: **Prog. next DIG IN**
Values: *(not set, din 1, din 2, ..., din n)*
Default: *not set*
Description: Digital input which skip current program segment.

Parameter: **Prog. run DOUT**
Values: *(not set, dout 1, dout 2, ..., dout n)*
Default: *not set*
Description: Start selected digital output when device is in run mode.

12.4.4 Communication configuration

Main Menu → Settings → Hardware → Comm. config

In the communication configirations menu there are submenus for every communication interface settings.

12.4.4.1 Com1 and Com2

Com1 is isolated communication interface which can be either MODBUS master protocol.
There are several communication protocols which is implemented. ON the table below is given overview of MCON Carbo communication protocols and their description.

PROTOCOL	Interface	Description
MODBUS Master	Com1 or Com2	Used for connecting remote peripherals such as I/O expanders, actuators and for remote setpoints.
MODBUS Slave	Com1, Com2 or Ethernet	Connecting with masters which can read and write parameters to device and monitor device statuses and measurement values remotely.
Omron (MESA)	Com1, Com2	Connecting with *Carbovis* software suite. See *Carbovis* manual and possibilities.

List of addresses for the MODBUS Slave can be found in the MCON *Communication protocols* reference manual. For Modbus Slave, addresses and commands are the same regardless of communication interface.

Com1 and Com2 parameters

Parameter: **Protocol**

Values: *(OFF, Modbus Master, Modbus Slave, Omron (Mesa))*

Default: *OFF*

Description: When *OFF*, this communication interface is not used. Com1 protocol can be *Modbus Master, Modbus Slave, Omron (Mesa)* if device with RS485/422 is ordered.

Parameter: **Baud rate**

Values: *(2400 bps, 4800 bps, 9600 bps, 19200 bps, 38400 bps, 57600 bps, 11520 bps)*

Default: *2400 bps*

Description: Communication speed protocols.

Parameter: **Parity**

Values: *(even parity, odd parity, no parity)*

Default: *even parity*

Description: Parity bit configuration.

Parameter: **Stop bits**

Values: *(1 stop bit, 2 stop bits)*

Default: *1 stop bits*

Description: Number of stop bits in the serial communication frame.

Parameter: **Address**

Values: *(0-255)*

Default: *1*

Description: Device address for the on the communication interface. When MODBUS Master is set, this address determine address of a remote device which is pooled to obtain remote setpoints.

12.4.4.2 Ethernet communication

Ethernet communication interface provides connectivity to the MODBUS network as a slave or web server access to the device via web browser.

Parameter: **Protocol**
Values: *(OFF, Modbus Slave,Webserver)*
Default: *OFF*
Description: When *OFF*, this communication interface is not used.

Parameter: **DHCP**
Values: *(checked, unchecked)*
Default: *checked*
Description: If checked, then IP address, Gateway and subnet mask are obtained from the DHCP server (automatically). When unchecked, user must insert these values manually.

Parameter: **IP address**
Values: *(127.0.0.1 – 255.255.255.254)*
Default: *192.168.1.110*
Description: IP address of device

Parameter: **Gateway IP**
Values: *(127.0.0.1 – 255.255.255.254)*
Default: *192.168.1.110*
Description: Address of a gateway on which device is connected

Parameter: **Subnet**
Values: *(127.0.0.1 – 255.255.255.254)*
Default: *192.168.1.110*
Description: Subnet mask for the network on which the device is connected.

Parameter *Address* is the same as Com 1 and Com 2.

NOTE

When used as MODBUS Slave, Ethernet interface provides the same MODBUS services on the same addresses as when used on the Com1 or Com2 interface.

To access the MCON Carbo via web server first check the device IP address (either entered or assigned by DHCP). Then type this address on the web browser and web page with measurements will appear.

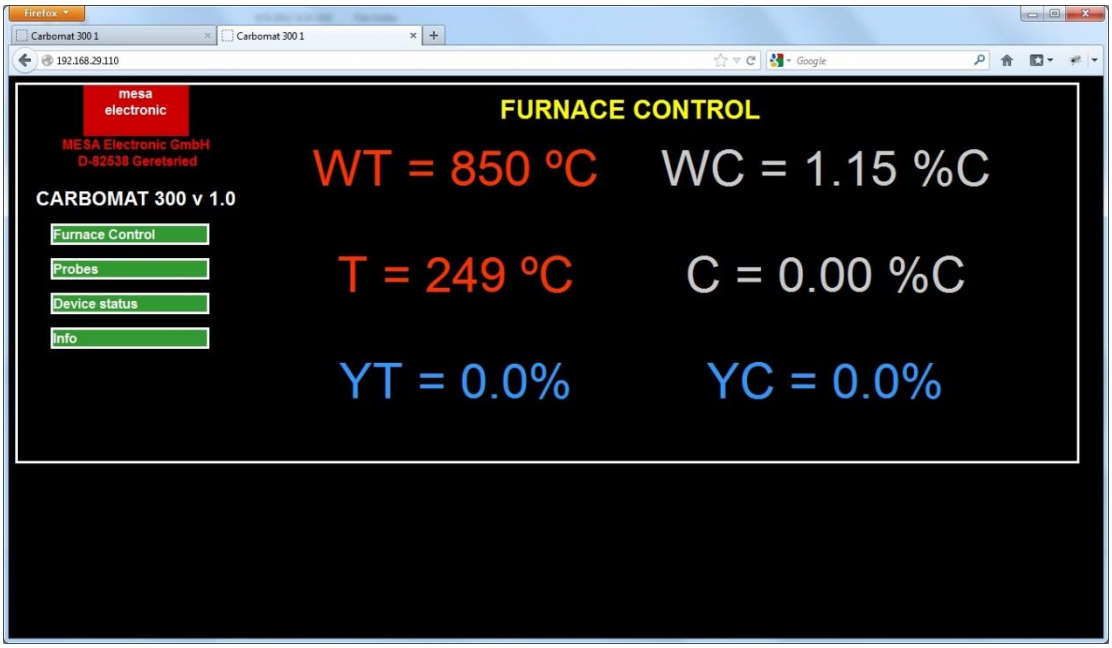


figure 12.6 Web server window

On the left side of screen are placed menu with next items:

- Furnace control – shows furnace control information (setpoints, process values and control output values for both furnace temperature and C level)
- Probes – shows measurements obtained from both probes
- Device status - errors, warnings and alarms information
- Info – Page with general informations about device : software version, ambient temperature, date and time and serial number

12.5 System

12.5.1 System informations

To show informations screen about device press the *System informations* button in *Settings* menu.
System informations screen shows user level, software version, current ambient temperature, date and time, serial number, device identification number, and Build date of software version. On the second page are displayed installed modules in+ the device. Press  button to switch between pages. On third screen is presented status of internal memory of the device.

12.5.2 Language

Parameter: **Language**
Values: *(English, German and other depending on order)*
Default: *English*
Description: System language used to display all the informations on the screen.

12.5.3 Load and save on USB

MCON Carbo has a feature to save and load parameters values to USB stick.
To save or load parameters, USB stick must be inserted, otherwise an error message "USB stick is not inserted!" will be shown. This feature is forbidden in RUN mode.

To load parameters from the USB stick press **Main Menu → Settings → System → Load from USB→ Load config from USB** button. Then the device will search for the c300_cfg.bin file and load file data to restore all parameters settings. After loading parameters, device will automatically restart.

To save configuration parameters of device to USB stick press **Main Menu → Settings → System → Save to USB→ Save config to USB** button. It will save all parameters value into specific *.bin* file. This allow fast service and support.

Programs backup are similar to the parameters backup. It can be performed with *Save programs to USB* and *Load prog. from USB* buttons in identical steps. This feature is also forbidden if device is in RUN mode.
After loading programs, device will not restart!

It is possibility to load language from USB flash also in *Load from USB* menu. After loading language, device will automatically restart!

12.5.4 Users

Device has 6 user levels (from zero to five) which determine functions availability depending on logged user privileges. After starting device, user need to login to the device. Logging process requires inserting appropriate username and password.
If no user logged, the only enabled menu is User Login available in the
Main Menu → Settings → System → Users menu.

In this menu, operator can insert valid user name and password and thus get the appropriate user level privilege which allows access to certain functions and parameters changing. After inserting username and password, press *Submit* button to login with inserted data. If the username and password are incorrect, an error message appears. Access level of logged user is visible in the *System informations* screen.

NOTE

If there is no users defined (when device is new), default User level is always Level5 until you create some users. If there are some users defined, device will always start with lower privilege and you must log in to get higher access level. After 15 minutes out of *Settings* menu, device will automatically log as lower user privilege.

Logged user has its own user privilege which can be one of those: *Level5*, *Level4*, *Level3*, *Level2, Level1* or *Level0*. *Level5* has the highest priority and user with that privilege has all access rights. On the other side, *Level0* allows only small amount of functionalities to the user and it is used to prevent changing critical system parameters by the unauthorized persons.

On the next table are listed device features and required user level for them to be accessible.

Feature(Action)	L 5	L 4	L 3	L 2	L 1	L 0
View Proces data	X	X	X	X	X	X
Chose setpoint(SP1,SP2…)	X	X	X	X	X	
Edit setpoints	X	X			X	
Change programs data (segments and programs name)	X	X	X			
Run programs	X	X	X	X	X	
Pause programs	X	X	X	X		
Start production	X	X	X	X		
Change production steps (add, remove, edit)	X	X	X			
Backup parameters	X	X	X	X		
Backup programs	X	X	X	X		
Change PID preset	X	X	X	X		
Edit PID preset	X	X	X			
Factory reset settings	X					
Change communication parameters	X	X	X			
Change analog inputs parameters	X	X	X			
Change alloy factor	X	X	X			
Change probes settings	X	X	X			
Change CO value and settings	X	X	X			
Change H2 value and settings	X	X	X			
Change analog output settings	X	X	X			
Change language	X	X	X			

Change temperature unit	X					
Change date and time	X	X	X			
Correct measurement	X	X				
Foiltest	X	X	X			
Edit foiltest correction points	X					
Start/Stop logging	X	X	X	X	X	
Edit loging settings	X	X	X		X	
Transfer logged data to USB stick	X	X	X	X	X	
Edit alarms	X	X	X	X		
Fast edit setpoints(on screen typing)	X	X				
Create new user	X					
Delete user	X					
Change user password	X					
Change own password	X	X	X	X	X	
Change user access level	X					
Change probe flushing settings	X	X	X			
Start probes flushing	X	X	X			
Insert new probe (in Ri test menu)	X	X				
Touch screen calibration	X	X				
Assign digital outputs to alarms, tracks etc	X					
Test digital outputs	X					

User with highest privilege (*Level5*) has the ability to add new users, delete or change user privilege of the existing users. Therefore for those users menu item *Users* in the **Main Menu → Settings → System → Users** menu is enabled. Pressing *Users* button opens Users screen where red displayed all user accounts created on the device. There are maximum 10 users which can be created. To create new user, press the button Add new and insert desired username, password and access level for new user and then press *Save* button. New user will be presented. To change user's password or user level, press Edit button which opens the screen where you can insert new password or to select new user level.

Existing users can be deleted from the system by pressing the button. After confirmation, user will be deleted from the system.

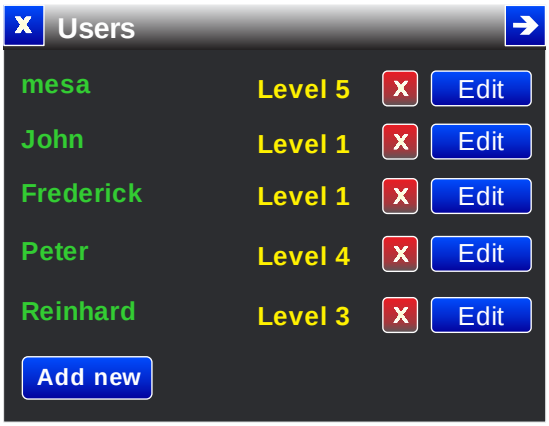


figure 12.7 Users screen

12.5.5 Touch screen calibration

To improve touch screen accuracy it is good practice to calibrate the screen. On the calibration screen, press the cross which appears on the upper-top position of the screen. After pressing button, cross moves to the center of the screen and then again on the bottom-right. After pressing third calibration point, device automatically returns from the calibration screen and remembers calibration data. Therefore calibration will take effect immediately (without restarting the device).

If the screen is not calibrated properly, user may not be able to activate calibration. In that case, a keyboard must be used to go to the *System* menu and to press the *Calibration screen*.

To achieve better calibration accuracy it is good practice to use a pen for calibration when pressing the calibration points.

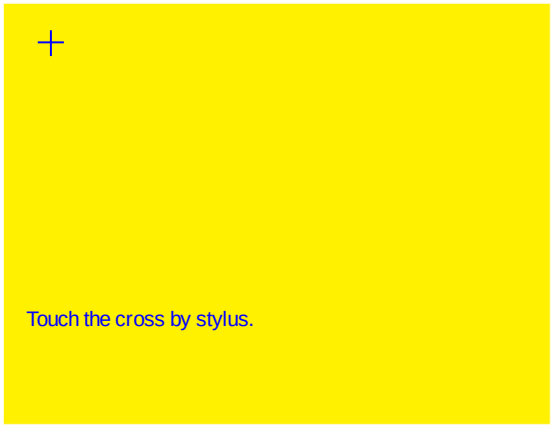


figure 12.8 Touch screen calibration

12.5.6 Temperature unit

Parameter: **°C or °F**
Values: *(Celsius °C, Fahrenheit °F)*
Default: *Celsius °C*
Description: Selects temperature unit which will be used for all temperature measurements and displaying the results.

12.5.7 Date and time

Parameter: **Date/Time**
Values: *(01/01/1970 – 19/01/2038)*
Default: *31/12/2011 12:00*
Description: System date and time. To see the current date and time go to **Main Menu → Settings → System informations** screen.

12.5.8 Device code

This parameter allows changing type of device MCON Carbo to MCON Nitro or Unicontroller (ex 3 different temperatures), or Dew Point controller.

System settings are available in the **Main Menu → Settings → System** menu. In the System menu user can set next parameters:

12.5.9 Reset and Factory Settings

Reset button provide reset device. After reset, device will continue the last status point. For reset user privilege must be higher.

Press *Factory settings* button in *System* menu to reset all parameters to default values. This will also delete all foiltest correction data, and all user accounts and calibration settings for all modules.
When loading factory settings is complete, device will resets automatically.

12.5.10 Firmware update

MCON Carbo software can be updated with new one by using USB memory stick. It is recommended that user checks if there is new version of device software for updating. To find the newest firmware version contact the producer.
To start firmware update reset the device (turning on then off power supply or by pressing *Reset* button in *System* menu) then immediately press and hold *Enter* taster. Device will show white screen and TX LED on. Then insert USB stick with firmware file which will automatically start updating process. During firmware updating process, TX led will flashes fast until the end of the updating. After update finishes, device will started automatically running new firmware.

13. Maintenance

Maintenance is feature for monitoring system measurements and probes.

13.1 Measurements

Measurements screen is presented on
Main Menu → Maintenance → Measurements.

Measurements screen shows measurement values on the presented analog inputs. On the each page of the *Measurements* screen are displayed measurements for one analog input.

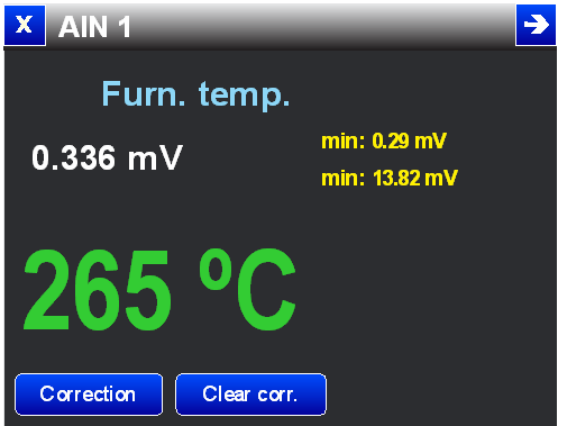


figure 13.1 Measurements screen for AIN1

NOTE

Correction feature is only available if logged user has enough privileges.

NOTE

Correction is not presented for analog inputs on which are attached probes (probe 1 or probe 2) because *Foiltest* function is used for the correction of C level measurements.

Press → button to switch to the next analog input.

To correct current measurement value, press Correction button and enter correct value. Therefore a correction point will be formed and further measurements will be corrected using this correction point.

When entering correction value, as a default value is offered uncorrected value.

To clear correction, press Clear corr. button which is shown only if there are existing corrections of measured value.

13.2 Probes maintenance

Probes maintenance screen can be shown by pressing

Main Menu → Maintenance → Probes button.

Probes maintenance screen has several pages. On the first page are displayed measurement values obtained from both probes (if installed). In the upper left corner is displayed current furnace temperature which is measured with the analog input 1.

CO value is changed only when there is external CO sensor otherwise it will be entered by user.

Activity value shows ratio (in percent) of measured C level and maximal possible C level at current temperature. Value of 100% means that furnace is saturated and the C level in the atmosphere is maximal possible at furnace temperature.

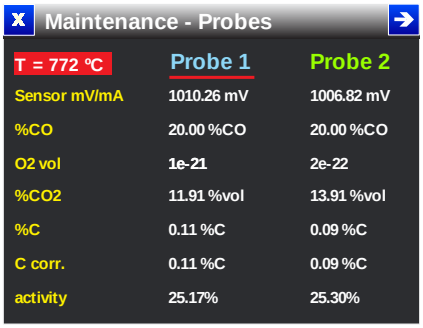


figure 13.2 Probes measurements comparision

If not two probes are installed it is not presented values for second probe.

When two probes are used, there is red underline mark (_____) which marks the primary probe which is currently used as main source for C level measurements.

Next page in the maintenance screen displays information about probes status and flushing and rin test times.

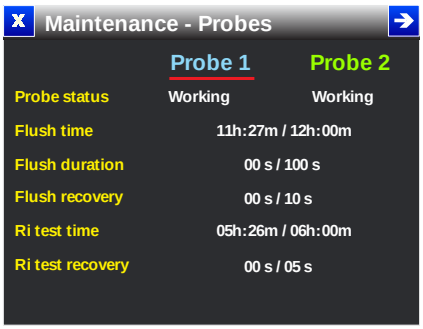


figure 13.3 flushing and Ri testing times

Probe status can be one of the following:

Working – probe can be used for measurement, no flushing, internal resistance measurement or recovery phase is active. This status will be changed after flush, or ri test time elapses

Flushing – probe is in flushing until flush duration time elapses.

Flush recovery – After flushing, flush recovery phase is active

Ri test – This phase is very short and it takes 5 seconds to measure internal resistance of a probe when ri test time elapses.

Ri test recovery – phase after Ri test after which probe is not yet working (similar as *Flush recovery*)

Next page in maintenance screen shows informations about probes internal resistance measurements.

Rin value of probe internal resistance from the last measurements.

Rin T is temperature on which is last internal resistance measurement performed.

min Rin is value of initial measurement after inserting new probe (see *New probe* function)

min Rin T is temperature on which the new probe is inserted (see *New probe* function)

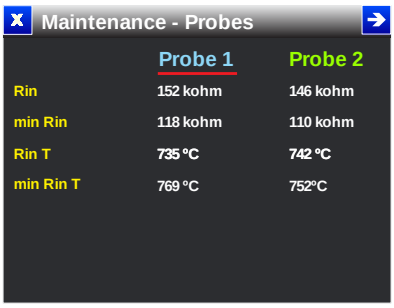


figure 13.4 Probes Ri test results

13.3 I/O overview

I/O review is used to show all analog and digital inputs and outputs in the device which are installed. I/O screens are available in the

Main Menu → Maintenance → I/O Overview menu.

13.3.1 Terminals

Terminals screen shows all the connections from the back side of the device. There are 4 rows of terminals. Pressing the screen area on the each row shows the screen with terminals description for that row of terminal.

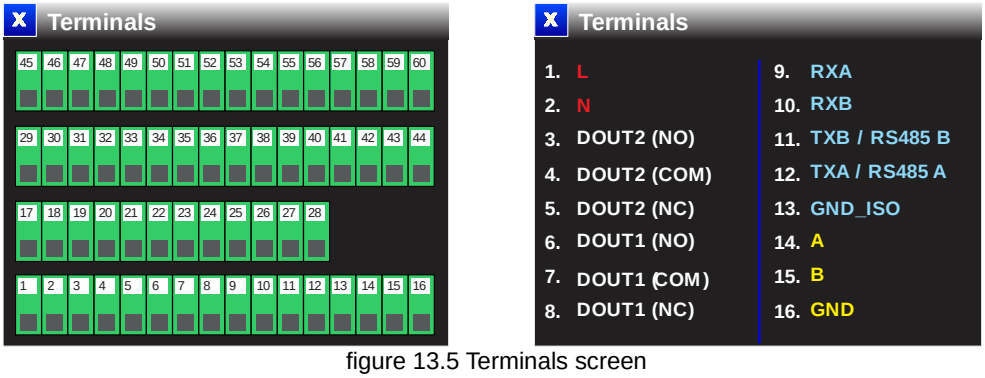


figure 13.5 Terminals screen

13.3.2 Digital outputs

This screen shows all digital outputs which are installed in the device and their assigned function and status.

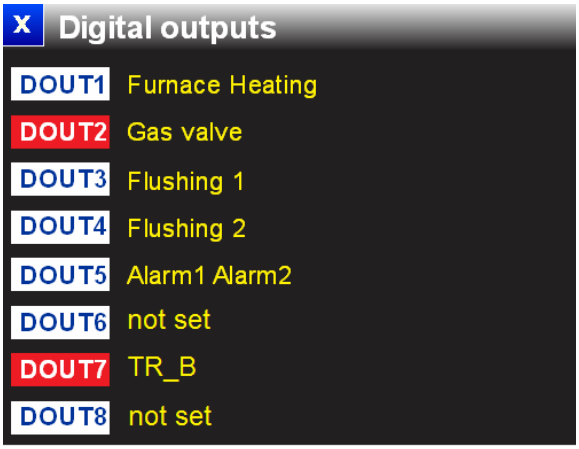


figure 13.6 Digital outputs assignments and status

Digital outputs can be used for more than one function so they are all displayed (for ex. Alarm1 and Alarm2 on DOUT5). If a digital output is unassigned, there is *not set* written.

When the digital output is active, it is colored with red (DOUT2, DOUT7). Inactive digital outputs are white.

13.3.3 Digital inputs

Digital inputs screen shows all digital inputs statuses and meanings. Active digital inputs (those with high input state) are colored red.

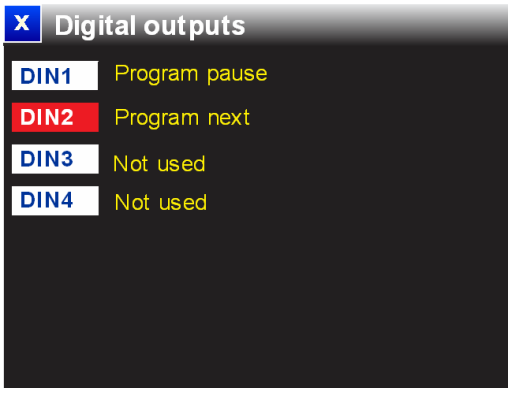


figure 13.7 Digital inputs functions and status

13.3.4 Analog inputs

On the analog inputs screen are shown all installed analog inputs, their functionalities and calibration date.

13.3.5 Analog outputs

Analog outputs screen shows all analog outputs which are installed in the device. For every analog output are displayed current configuration parameters (output type, AOM select), calibration date and value in mA or Volts.

13.3.6 Test relays

On this step is possible to test all relays manually (relay module 1, module 2, module 3, OC12 and relays A1/A2).

14. Control principle

Process can be controlled using 2 types of control algorithms: PID and On/Off. When PID is used, actuator can be controlled by one digital output (2 state output), 2 digital outputs (3 state output) or with analog output (if present). For On/Off control type, only digital outputs are available for controlling the actuator.

14.1 PID control

For PID control desired process value or setpoint (SP) is compared with current process value measured from the process (PV). According to difference between SP and PV and PID parameters, PID loop output is generated (Y). Output value (Y) can be from -100 % to +100%. Y is negative when the PV is greater than the septoint (SP) and the 3 state output is selected in PID preset parameters.
Positive Y (with range from 0 to 100%) is directly proportional to the amount of drive which must be applied to the actuator on output 1 (heater or gas valve).
Negative Y (from 0 to -100%) is directly proportional to the amount of drive which must be applied to the actuator on output 2 (cooler or air valve).
When the Y = 0 no actuator will be activated.

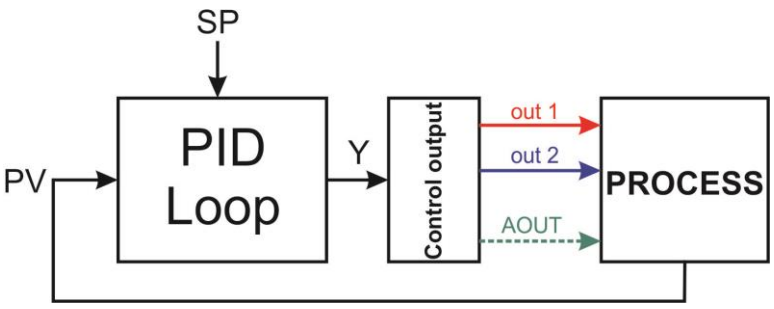


figure 14.1 Control block diagram

PID value Y depends on error and PID parameters:

$$Y = P + I + D$$

where:

P – Proportional term which depends on current error

I – Integral term which depends on error duration in the integral time interval

D – Derivative term which depends on the short time error fluctuations

PID terms are calculated using process error e and parameters.
Error is defined as:

$$e = SP - PV$$

Proportional term P

Proportional term is proportional to the process error (e) multiplied with proportional band (PB)

$$P = e * PB$$

For increasing sensitivity to error, PB must be increased.
There are 2 proportional band parameters. One is required for heating/gas and second is only effective for 3 state outputs (cooling/air) in the cooling/air phase.

Example for C level control:
If PB1 = 100%/%C, PB2 = 50%/%C and SP = 1 %C for the measured C level of 0.8 %C, error will be 0.2 %C and P term 0.2*100 = 20%
If measured %C is 1.2 error will be also 0.2 %C but in air phase, and P term will be 0.2*50 = 10%

Integral term

Integral term is very important for the process control in order to avoid “steady state” error which occurs when controller cannot reach setpoint value if only proportional term is used. For that reason integral term will add extra control which will compensate steady state error.

Integral term depends on integral time (Ti) parameter and error sum during time.

Integral term is calculated using next equation:

$$I = e * Ti$$

Integral time (Ti) is parameter which determines how the system reacts to error during the certain time period. Therefore, increasing the Ti will increase the response to accumulated error.

For example if Ti is 25%/(%C*min), integral term I will be 25% when error is 1 %C for 1 minute time period.
Good practice is to set Ti = 0 (disable integral term) and adjust gain with PB parameter (Y = P term) to have minimal steady state error with no oscillating. Then turn on I term by set Ti parameter to a value on which the system will control the process with minimal over/under shoot and minimal oscillating.

Derivative term

Derivative term is used to control short term fluctuations in PV. Derivative term is proportional to error or PV change rate:

$$D = Td * \Delta e$$

or

$$D = Td * \Delta PV$$

Δe - Error change rate

ΔPV - Process value change rate

Td parameter defines how the error or PV change rate will be emphasized, For example if Td is 400%*(%C/min), derivative term will be 100% when %C is changed by 0.25 %C in one minute or 1%C in 15 seconds.
Depending on *Derivative type* parameter derivative term calculation will be perform with error or process value change rate.
Td parameter (derivative time) emphasizes control output when error or process value rising or falling rapidly. For that reason, Td should not be very long because system will oscillate if process value is noisy. Main function of derivative term is to prevent overshot and to faster the system response.

14.2 Discrete control output

Control output value Y (in literature well known as MV – manipulation value) is given in percents which must be translated to digital outputs states. For this transformation, important parameter is *Cycle time.* Cycle time defines how Y value is translated to actuator activation time.

For ex. if Y=40% and Cycle time is 10 seconds, digital output for heating or gas valve will be activated for 4 seconds and turned off 6 seconds.

When 3 state output is set (heating/cooling or gas/valve) Y can be negative. In that case is used another *Cycle time* (cooling or air cycle time) parameter which is scaled to Y absolute value.

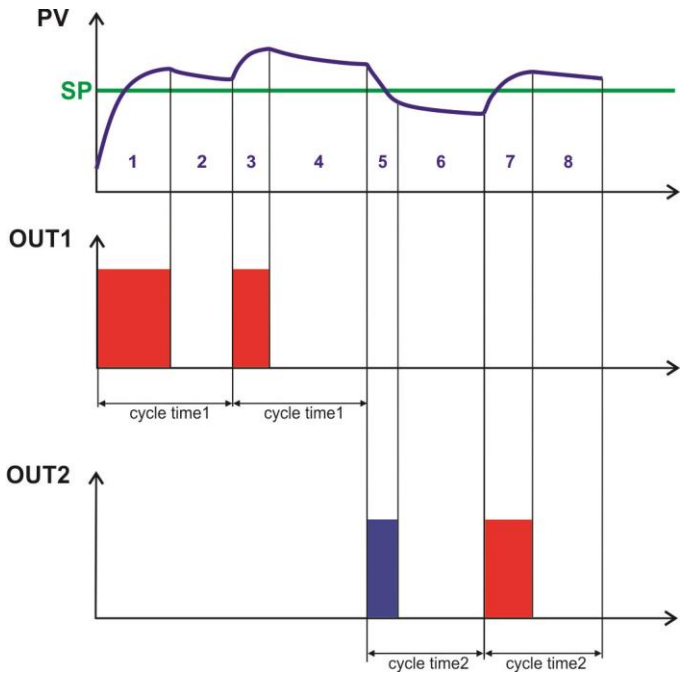


figure 14.2 Control outputs activation

In the example controlling diagram above is showed how the actuators are turned on and off depending on difference between process value and setpoint. In the time interval (1), PV is much lower than setpoint, so heating output must be turned on more than half of the cycle time. During heating, temperature (process value) raises above setpoint but in the interval (2) heater is turned off and temperature stars to fall until expiration of *cycle time1* which is defined for heating only. At the beginning of second cycle (3), process value is slightly above setpoint value but heating will again turned on because of accumulated error in integral term. This cause shorter

activation the heating actuator until interval (4) when temperature starts to fail again. After second cycle time expired (5), process value is notably greater than setpoint including dead band (see *Deadband* parameter). This means that system must activate cooling actuator in cycle time 2 (which is defined for cooling and air actuator as parameter). Cooling cause the temperature lowers faster than in case when no cooling is activated which can be noted by comparing interval (5) and (6) process value trend. In the interval (7), after first *cycle time2* interval, temperature is again below setpoint and heating must be turned on again. Out 2 is only activated if proper control output is set (3 state output).

14.3 On/Off control

This is the simplest control type which is implemented in the device. When this control type is used, all PID parameters will be disabled because they have no meaning for this type of control. For On/Off control type is important only *Upper Hysteresis* and *Lower Hysteresis* parameters. For temperature control loops these parameters are in ºC unit and for C level loop in %C.

When loop output is configured to 2 state, control output (heating or gas valve) will be on when process value (temperature or C level) is below setpoint (SP) + *Lower_Hysteresis.* Actuator will be turned off when PV becomes greater than SP + *Upper Hysteresis*.

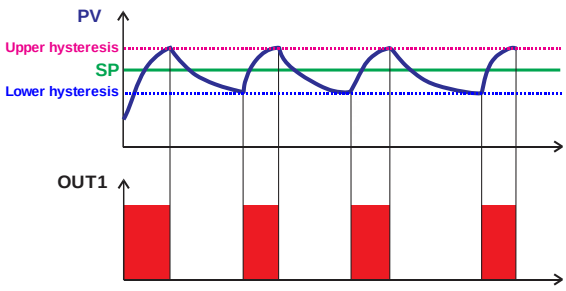


figure 14.3 On/Off control for 2 state output

When 3 state control output type is set then heating/gas and cooling/air actuators are used for control. Heating/gas is activated when PV is below SP –

Lower_Hysteresis and cooling/air is activated when PV becomes greater than SP + *Upper_Hysteresis.* Actuators are turned when PV reach setpoint.

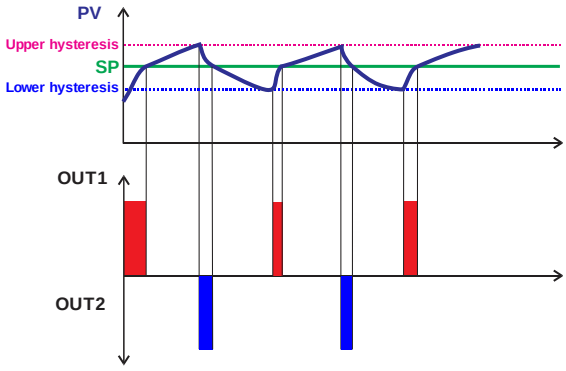


figure 14.4 On/Off control for 3 state output

Upper and lower hysteresis parameters must be set properly to achieve compromise in relays activating frequency and process value stability. If hysteresis value if very low then relays will be activated very frequently and if hysteresis is very high then process value will oscillate between unaccepted minimum and maximum values.

14.4 Motorized valve control

C level control loop allows motor valve control which use 2 control outputs for opening and closing motorized valve. Direction of valve moving depends of Y value rate. When Y increases, valve is opened by activating open control output 1 and vice versa, when decreasing Y, control output 2 is activated. Therefore valve motor moves in both directions in order to increase or decrease gas flow and regulate C level in the furnace atmosphere.

Control output is activated proportionally to the Y value change rate and parameter Valve *Max ON time*. Every activating control outputs (either for opening or closing) shorter than 0.5 S will be avoided to prevent unnecessary movements of the motor.

For this purpose is also used parameter *Valve rest time* which define minimal time between two successive valve activations.

Cycle time is in this type of output sum of actuator activating time (which is calculated) and *Valve rest time* parameter. Change rate of Y is calculated between two successive valve activating cycles.

For example : if Y changes for 5% and Valve *Max ON time is 60* and *Valve rest time* is 15 seconds second, then gas valve will be open 12 seconds. During valve opening, process value (C level) is changing as well as Y (manipulation value). After 12 seconds, valve is turned off and through the valve flows constant amount of gas which is defined by valve current position. When *Valve rest time* elapse (27 seconds from opening the valve and 15 seconds from turning off valve motor) valve can be activated again. If at that moment Y is lower than at the moment when valve is starting to open (before 27 seconds) value must be closed proportionally to that Y value difference which decrease gas flow and C level as well.

14.5 Analog control

This type of output control is available for all 3 control loops. To use analog output as control output, at least one analog output module must be installed. In the analog output settings for the *AOM select* parameter has to be selected *Control out* and for *Loop* desired control loop (PID1, PID2 or PID3). Also for selected loop must be set *Control output type* to *Analog.*

When all is properly configured, on desired analog output will be present Y value as current/voltage where the scaling can be custom defined in analog output settings.

Analog output value will be changed on time intervals defined with *Cycle time* parameters. Therefore when cycle time expires, analog output value will be updated with the current Y value which will be presented on analog output until next cycle.

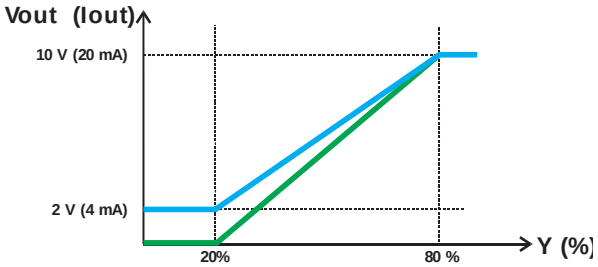


figure 14.5 Analog control output

15. Specifications

Construction:
- ABS DIN ¼ case for front mounting
- Type of protection IP54
- Dimensions 96 x 96 x 111 mm

Power supply:
- AC 85VAC…265VAC, 50-60Hz or DC 10VDC…36VDC. Power consumption 15VA

Display:
- Color TFT display, 320 x 240 px, 16it, 3.5’ with resistive touch screen

Operation:
- Touch screen menu guided and and/or four keys (up/down/enter/escape)

Control loops:
- 3 control loops
- 3 control parameters preset per each loop
- PID or On/Off control type
- Control output types: heating/cooling, gas/air, valve control or analog output
- Custom assigning digital outputs for control

Setpoints:
- 4 fixed setpoints, external and remote setpoint
- 99 programs with quenching temperature and C level and furnace temperature setpoints.
- Up to 24 segments per program
- 16 tracks per segment
- Custom assigning digital output for every track

C level measurement:
- Sensor for measurement: O2, lambda probe or CO2 analyzer
- One or two sensors can be used
- Fixed or measured CO value.
- C level measuring range: 0 – 2.0 %C
- Correction with up to 5 correction points and spline interpolation for both probes

Alarms:
- Up to 4 user defined alarms for monitoring measurement values and change rates.
- Custom assigning digital outputs for alarms

Logging:
- Logging sample time from 1 to 1000 seconds
- Up to 20 log files can be stored to internal memory.
- Logging on user demand or time activated.
- Transferring log data to USB stick

- Special software for viewing log data

User access levels:
- Up to 10 user accounts can be stored
- 6 access level to grant privilege to users

Communication interfaces:
- Ethernet
- isolated RS485/422 (optional)
- non isolated RS485/422 (standard)

Supported protocols:
- MODBUS Master RTU or TCP
- MODBUS Slave RTU or TCP
- Carbovis communication interface

Analog inputs: 5
- AIN1 : thermocouple (B,C,E,J,K,L,M,N,R,S,T) / voltage 0-100mV
- AIN2: Lambda or O2 probe / voltage 200 – 1300 mV
- AIN3, AIN4 and AIN5: Lambda or O2 probe or CO2 analyzer or external set point / current or voltage input

Thermocouple input ranges:

Type		Measuring range	Generating accuracy	resolution
B	PtRh-Pt6%	250...1820°C	<3ºC	0.15ºC
C	W5%Re-W26%Re	0...2315°C	<2°C	0.2ºC
E	NiCr-CuNi	-200...1000°C	<2ºC	0.05ºC
J	Fe-CuNi	-210...1200°C	<2ºC	0.06ºC
K	NiCr-Ni	-200...1350°C	<2ºC	0.06ºC
L	Fe-CuNi DIN	-200...900°C	<2ºC	0.06ºC
M	NiMo/NiCo	-50...1410°C	<2ºC	0.06ºC
N	Nicrosil-Nisil	-200...1300°C	<2ºC	0.1ºC
R	PtRh-Pt13%	-50...1760°C	<2ºC	0.1ºC
S	PtRh-Pt10%	-50...1760°C	<2ºC	0.1ºC
T	Cu-CuNi	-200...400°C	<2ºC	0.1ºC
Cold junction sensor		-25ºC…+85ºC	1,5ºC	0.1ºC

Analog inputs ranges

Type	Measuring range	Measuring accuracy	resolution
Voltage (0 – 10 V)	-0.5V…+10V**	0.1%	10 uV
Voltage	0- 100 mV	0.1%	0,2 mV
Current	-5mA…+25mA	0.1%	1uA
Lambda or O_2 probe	-200 – 1300 mV	0.1 %	1 uV

Analog outputs:
- 2 or 4 isolated analog outputs depending on installed modules
- Scaled to: setpoint, control output, C level, atmosphere temperature or quenching temperature

Analog outputs ranges

Type	Ratings	Max. Load	Resolution	Accuracy
Voltage output	0V…+10V 2V…+10V	>2kΩ	16 bit	0.05%
Current output	0mA…20mA 4mA…20mA	<500Ω	16 bit	0.05%

Digital inputs:
- 3 isolated digital inputs
- Trigger voltage > 8V
- Hysteresis 2V

IN0: program pause
IN1: switch to next segment
IN3: inputs disable (lock user interface)

Digital outputs:
- 2 fixed digital outputs: NO/ 24V/ 3A
- Up to 24 additional digital outputs depending on installed modules, 24V

Digital outputs functions:
- control outputs (heating/cooling, gas/air and motor valve control), alarm outputs, program tracks, probe flushing.

Digital output modules (up to 6 modules can be installed)

Type	Standard / option	Ratings
REL1	4 common Relays, NO, contact	24V/3A
REL2	2 separate Relays, NO/NC contacts	24V/3A
REL3	3 common relays, NO contacts	24V/3A
OC12 module	12 open collector outputs with common ground	24V/100 mA

Climate:
- Storage: -10 ºC - + 60 ºC
- Operation: 0 ºC - + 50 ºC

Optional accessories:
- Auxiliary unit REL45 (only if OC12 module is used)
- Carbovis 3.4 visualization software
- Mesa View log viewer software

15.1 Isolation diagram

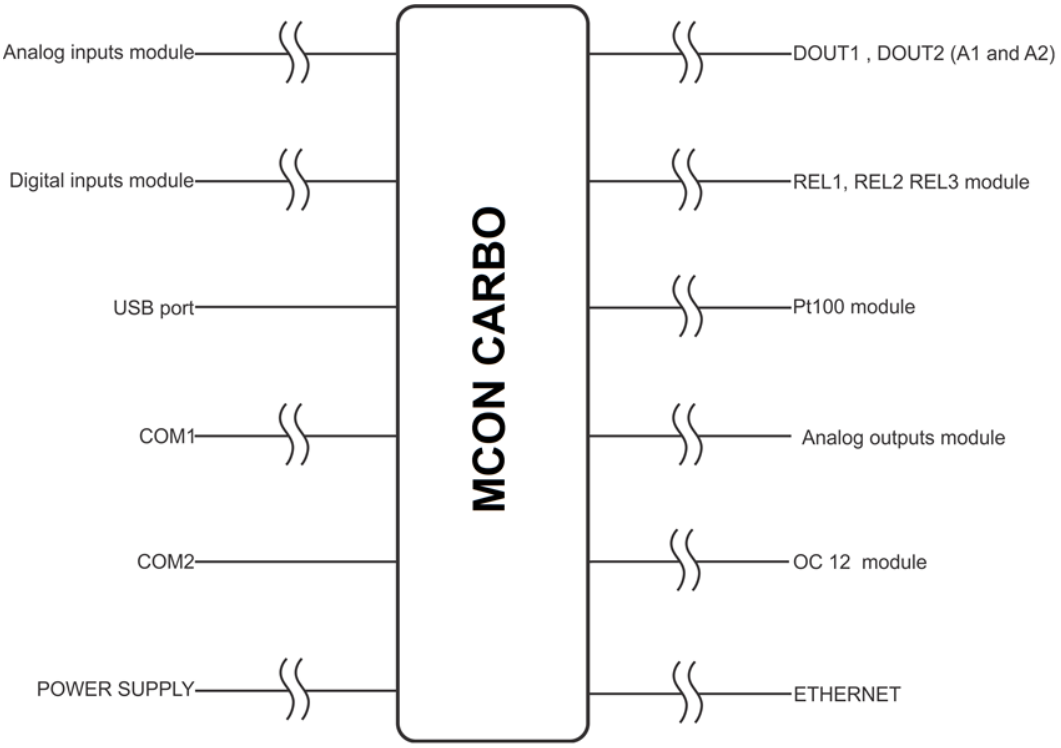


figure 15.1 MCON Carbo isolation diagram

Appendix: Profibus-DP Communication

General

Profibus-DP is a Multi Master Network. Depending on the selected protocol variation, it supports Master/Slave, Master/Master and Slave/Slave communications. Profibus is optimized to transmit cyclic process data very fast and efficient between Master and Slaves but can also handle acyclic Parameter data and iso synchronous Real time transmissions.

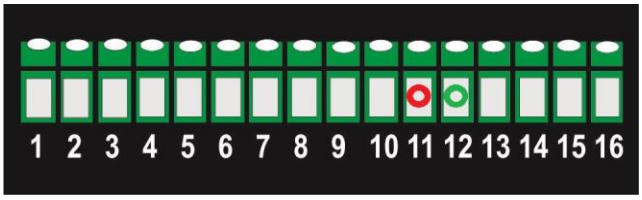
Up to 32 Profibus stations may be wired to a single network segment. Use of RS-485 repeaters allows of up to 127 stations.

Version DP-V0

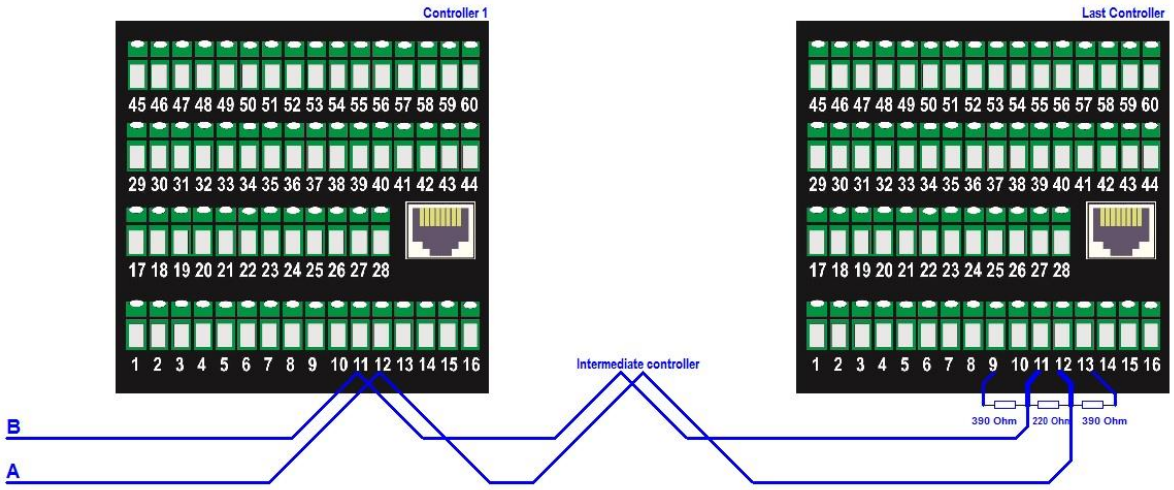
Provides the basic functionality of DP, including cyclic data exchange, station, module and channel-specific diagnostics and four different interrupt types for diagnostics and process interrupts, and for the pulling and plugging of stations.

Electrical Connections

RS-485 is the transmission technology used in Mcon Carbo PROFIBUS-DP controller. Connections are made to the real terminal block as follows:



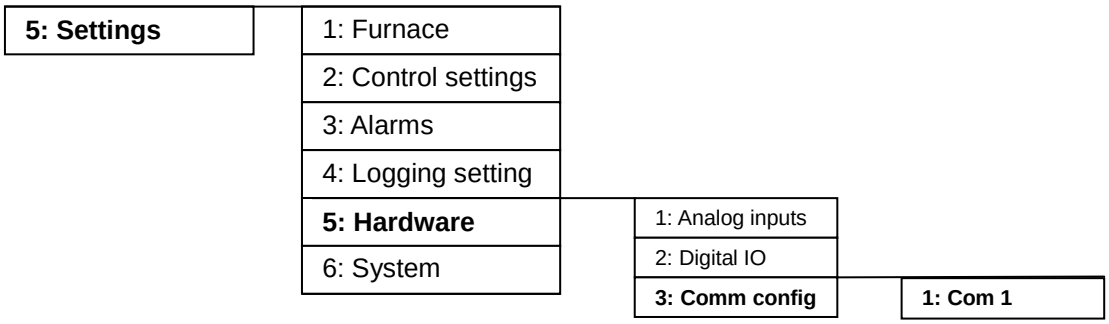
TERMINAL #	Signal	Description
9	+5V	Termination
10	RTS	Repeater
11	RS485 B	PROFIBUS-DP
12	RS485 A	
13	GND	Termination



Connection diagram for up to 32 Slaves

Controller Set Up

Every device on the network must have its own unique address to distinguish it from any other. Having connected the controller to the network, it must be configured for Profibus communication and a node address assigned. From the **Main menu**, choose the option **Settings**, sub option **Hardware**, sub option **Comm.config**, sub option **Com 1.**



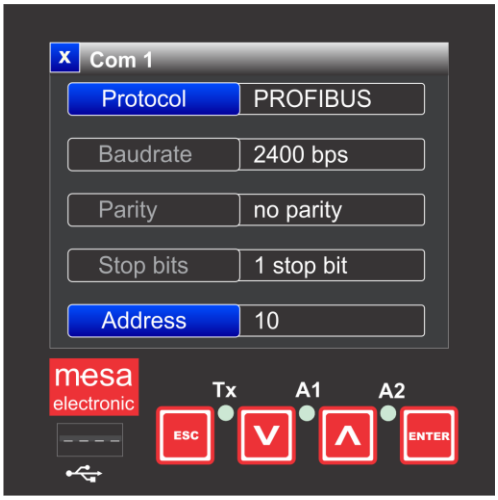
Protocol configuration

In the protocol menu select the option PROFIBUS

Assigning a Node Address

In the address menu enter the node address 0 – 126.

Note: The baud rate is automatically selected by the master.



Network configuration

During the setup phase of the Profibus network, the Profibus Master must be configured with a special configuration tool such as Step7 from Siemens or similar configuration tool.
The configuration process is based on electronic device data sheets (GSD-Files) which are required for each Profibus device.

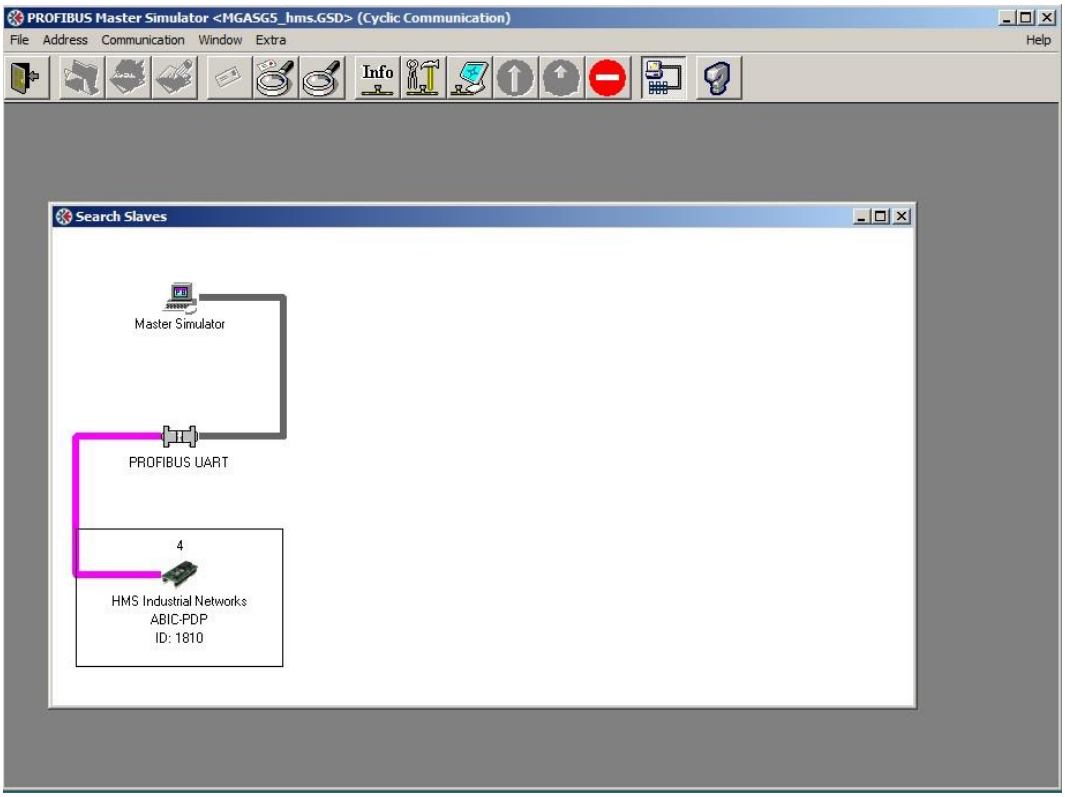


Figure 1.0
In figure 1.0 is shown an example of configuration look of the Mcon Carbo device with Profibus address 4.

GSD-File provided for Mcon Carbo device is based on HMS Profibus-DP modul and contain electronic descriptions all relevant communication parameter of the Profibus device.

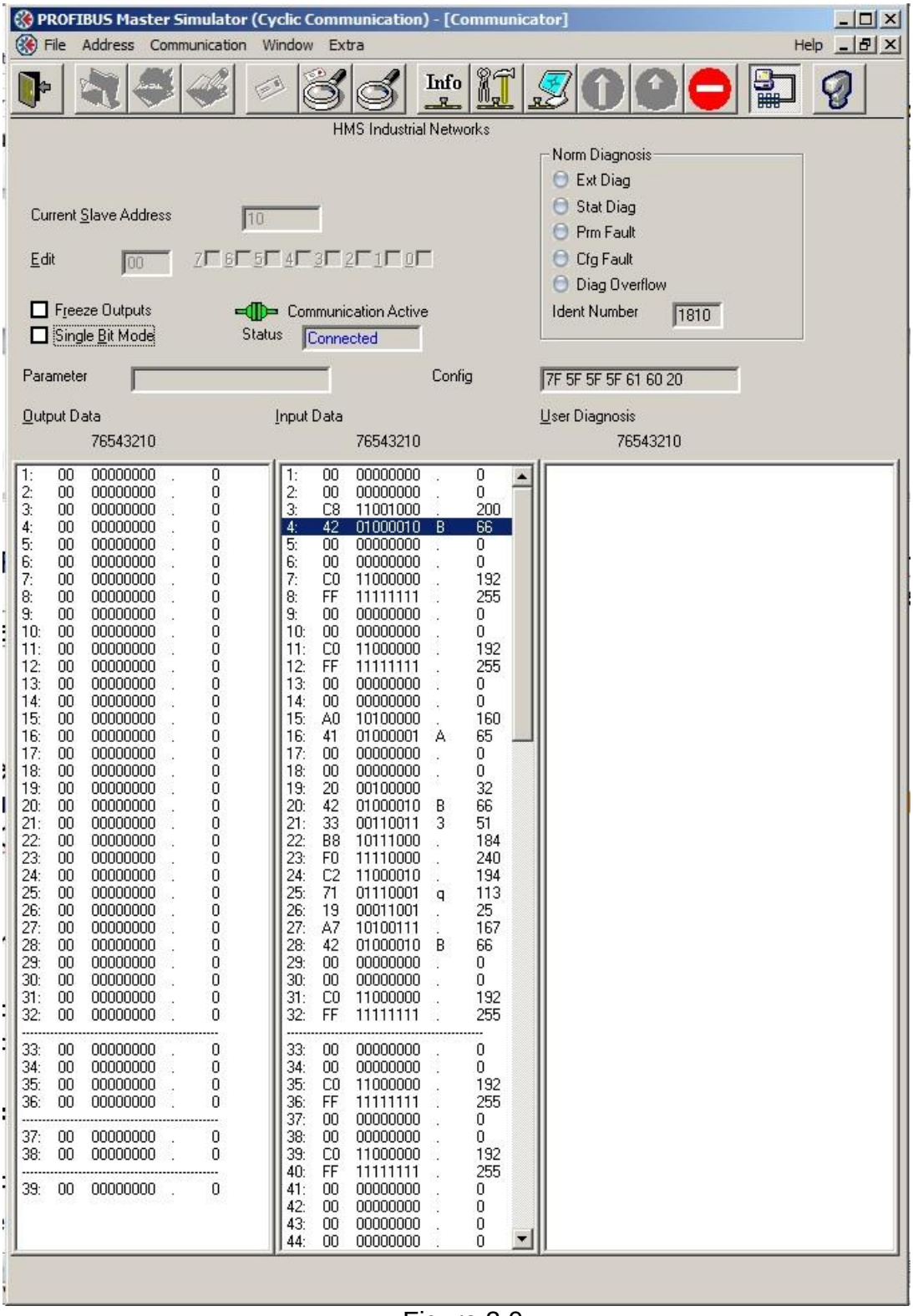


Figure 2.0

In figure 2.0 is shown an example of I/O parameter access, defined with MconC_hms.GSD file.

Address I/O map and data format

PROFIBUS Input buffer = Values sent from a device to a master controller or PLC,
PROFIBUS Output buffer = Values sent from a master controller or PLC to a device

PROFIBUS read data

PROFIBUS-DP Input buffer is 128 bytes long and it contains device variables.
IN memory map is given on the table below:

ADDRESS	VARIABLE	TYPE
0	furnace_temperature	float (4B)
4	furnace_clevel	float (4B)
8	quench_temperature	float (4B)
12	furnace_co	float (4B)
16	furnace_h2	float (4B)
20	ain1_val	float (4B)
24	ain2_val	float (4B)
28	ain3_val	float (4B)
32	ain4_val	float (4B)
36	ain5_val	float (4B)
40	digital_inputs	int (2B)
42	digital_outputs	int (2B)
44	loop1_sp	float (4B)
48	loop2_sp	float (4B)
52	loop3_sp	float (4B)
56	device_mode	byte
57	error_status	bitfield 0-32 / (4B)
61	warning_status	bitfield 0-32 / (4B)
65	alarm_status	bitfield 0-8 / (1B)
66	access_level	byte
67	ambient_temperature	float (4B)
71	module0_type	byte
72	module1_type	byte
73	module2_type	byte
74	module3_type	byte
75	module4_type	byte
76	module5_type	byte
77	program_status	byte
78	current_program	byte
79	current_segment	byte
80	tracks_status	long (4B)
84	segment_time	int (2B)
86	production_step	byte

87	step_repeats	byte
88	production_run	bool(1B)
89	O2 mv	float (4B)
93	O2 %	float (4B)
97	CO2 %	float (4B)
101	activity %	float (4B)
105	Foiltest number of point	byte
106	RESERVED	1B
107	parameter_value*	20B

Floating Point Data Formats

Floating point data number is transferred as four bytes (4B).
Example: float value 100.0 has a byte representation (hex) as 00 00 C8 42, and is in Input data packed as:
1: 00
2: 00
3: C8
4: 42
See figure 2.0 above.

Profibus write data

Profibus-DP Output buffer is 39 bytes long.
Output buffer memory map is described on the table below:

ADDRESS	VARIABLE	TYPE
0	profibus_command	INT
2	parameter_address	INT (4B)
6	parameter_bytes	BYTE
7	parameter_data	BYTE_ARRAY (20B)
27	remote_sp1	FLOAT (4B)
31	remote_sp2	FLOAT (4B)
35	remote_sp3	FLOAT (4B)

profibus_command – on this location PROFIBUS master can write command to execute. Possible command values are:

NO_COMMAND = 0
RESET = 1
PASSWORD = 2
READ_PARAMETER = 3
WRITE_PARAMETER = 4
START_CONTROL = 5
STOP_CONTROL = 6
START_LOGGING = 14
STOP_LOGGING = 15

parameter_address – address of a device parameter which read or write (*READ_PARAMETER, WRITE_PARAMETER* commands)

parameter_bytes – device parameters are up to 20B long and Profibus master must define parameter size (in bytes) when reading or writing the parameter (*READ_PARAMETER, WRITE_PARAMETER* commands)

parameter_data – byte array which holds value of parameter which is about to be written or some data which is associated with another commands.

remote_sp1, remote_sp2 and remote_sp3 – Profibus master can write values for setpoints sp1, sp2 and/or sp3.
Actual setpoints sp1, sp2 and sp3 are updated only if Remote SP option is activated in Controlx.Working SP (x=1,2,3).

Profibus commands description

RESET(1) – Profibus resets the device after sending the RESET (1) command.

PASSWORD(2) – Profibus password command enters the password needed to unlock the other commands.
parameter_data – password string up to 15 characters

READ_PARAMETER (3) – read parameter at specified address
parameter_address - address of a parameter
parameter_bytes - parameter size in bytes

Parameter value can be read from the *parameter_value* locations in Profibus IN buffer.

WRITE_PARAMETER (4) – write parameter value
parameter_address – address of a parameter
parameter_bytes – parameter size in bytes
parameter_data – value of parameter

START_CONTROL (5) – starts the control function of the device

STOP_CONTROL (6) – stops the control function of the device

NOTE: Profibus ***WRITE_PARAMETER*** command is protected with password. If Profibus master do not enter valid Profibus password (after device reset) every ***WRITE_PARAMETER*** to Profibus OUT memory is ignored and take no effect. When Profibus OUT is not unlocked, the only command which is enabled is ***PASSWORD***.

START_LOGING(14) – starts logging the data according to logging settings and create new log file

STOP_LOGGING(15) – stops logging the data and close current log file

Address of parameters is given in the table below:

ADDR	NAME	TYPE	MIN	MAX	DEFAULT
0	AIN1.Ain Type	enum 1	0	7	0
1	AIN1.AIN name	string	0	15	0
29	AIN1.Scaling dp	int	0	20	0
30	AIN1.Unit name	string	0	16	0
48	AIN1.Amb. sens. External	boolean	0	0	0
50	AIN1.Thermocouple	enum 3	0	10	0
51	AIN1.Measurement	enum 4	0	8	0
100	AIN2.Ain Type	enum 1	0	7	0
101	AIN2.AIN name	string	0	16	0
129	AIN2.Scaling dpt	enum 2	0	20	0
130	AIN2.Unit name	string	0	15	0
148	AIN2.Amb. sens. external	boolean	0	0	0
150	AIN2.Thermocouple	enum 3	0	10	0
151	AIN2.Measurement	enum 4	0	8	0
200	AIN3.Ain Type	enum 1	0	7	0
201	AIN3.AIN name	string	0	15	0
229	AIN3.Scaling unit	enum 2	0	20	0
230	AIN3.Unit name	string	0	16	0
248	AIN3.Amb. sens. external	boolean	0	0	0
250	AIN3.Thermocouple	enum 3	0	10	0
251	AIN3.Measurement	enum 4	0	8	0
300	AIN4.Ain Type	enum 1	0	7	0
301	AIN4.AIN name	string	0	15	0
329	AIN4.Scaling unit	enum 2	0	20	0
330	AIN4.Unit name	string	0	16	0
348	AIN4.Amb. sens. external	boolean	0	0	0
350	AIN4.Thermocouple	enum 3	0	10	0
351	AIN4.Measurement	enum 4	0	8	0
400	AIN5.Ain Type	enum 1	0	7	0
401	AIN5.AIN name	string	0	15	0
429	AIN5.Scaling unit	enum 2	0	20	0
430	AIN5.Unit name	string	0	16	0
448	AIN5.Amb. sens. external	boolean	0	0	0
450	AIN5.Thermocouple	enum 3	0	10	0
451	AIN5.Measurement	enum 4	0	8	0
1000	Furnace1.Furnace name	string	0	15	0
1008	Furnace1.Temp. sensor	enum 5	0	4	0
1009	Furnace1.Main O2 Probe	enum 5	0	4	0
1010	Furnace1.Probe type	enum 6	0	1	0
1012	Furnace1.sensor1.K1	float	-300	300	50
1014	Furnace1.sensor1.K2	float	-200	200	0
1033	Furnace1.Sec. O2 Probe	enum 5	0	4	0

1034	Furnace1.Probe type	enum 6	0	1	0
1036	Furnace1.sensor2.K1	float	-300	300	50
1038	Furnace1.sensor2.K2	float	-200	200	0
1064	Furnace1.Flush time	float	0	600	30
1066	Furnace1.Flush duration	int	0	300	100
1068	Furnace1.Flush recovery	int	0	600	10
1074	Furnace1.Flush input	int	0	65535	0
1075	Furnace1.Flush.sensor1.Out	enum 7	0	16	0
1076	Furnace1.Flush.sensor2.Out	enum 7	0	16	0
1077	Furnace1.Ri test time	int	0	100	2
1079	Furnace1.Ri test recovery	int	0	600	10
1081	Furnace1.Ri test temperature	float	600	850	700
1083	Furnace1.CO Source	enum 8	0	2	0
1084	Furnace1.CO Input	enum 5	0	4	0
1085	Furnace1.CO Level	float	15	25	20
1087	Furnace1.H2 Source	enum 8	0	2	0
1088	Furnace1.H2 Input	enum 5	0	4	0
1089	Furnace1.H2 Level	float	0	9999.99	0
1111	Furnace1.Gas release temperature	float	700	750	700
1113	Furnace1.Furnace type	enum 9	0	4	0
1131	Firnace1.Fix temperature	float	0	2000	
2000	Control1.Loop name	string	0	15	0
2008	Control1.PV Source	enum 5	0	4	0
2009	Control1.MV Out1	enum 7	0	16	0
2010	Control1.MV Out2	enum 7	0	16	0
2011	Control1.Control preset	enum 10	0	2	0
2012	Control1.Working SP	enum 11	0	6	0
2400	Control2.Loop name	string	0	15	0
2408	Control2.PV Source	enum 5	0	4	0
2409	Control2.MV Out1	enum 7	0	16	0
2410	Control2.MV Out2	enum 7	0	16	0
2411	Control2.Control preset	enum 10	0	2	0
2412	Control2.Working SP	enum 11	0	6	0
2800	Control3.Loop name	string	0	15	0
2808	Control3.PV Source	enum 5	0	4	0
2809	Control3.MV Out1	enum 7	0	16	0
2810	Control3.MV Out2	enum 7	0	16	0
2811	Control3.Control preset	enum 10	0	2	0
2812	Control3.Working SP	enum 11	0	6	0
8125	Foiltest avg. temperature	float	750	1300	800
8127	Foiltest avg. C% peobe 1	float	0.0	2.0	0.5
8129	Foiltest avg. C% probe 2	float	0.0	2.0	0.5
8131	Foiltest corrected c%	float	0.0	2.0	0.5
8149	Foiltest avg. temperature	float	750	1300	800
8151	Foiltest avg. C% peobe 1	float	0.0	2.0	0.5
8153	Foiltest avg. C% probe 2	float	0.0	2.0	0.5
8155	Foiltest corrected c%	float	0.0	2.0	0.5
8173	Foiltest avg. temperature	float	750	1300	800
8175	Foiltest avg. C% peobe 1	float	0.0	2.0	0.5
8177	Foiltest avg. C% probe 2	float	0.0	2.0	0.5
8179	Foiltest corrected c%	float	0.0	2.0	0.5

8197	Foiltest avg. temperature	float	750	1300	800
8199	Foiltest avg. C% peobe 1	float	0.0	2.0	0.5
8201	Foiltest avg. C% probe 2	float	0.0	2.0	0.5
8203	Foiltest corrected c%	float	0.0	2.0	0.5
8101	Foiltest avg. temperature	float	750	1300	800
8103	Foiltest avg. C% peobe 1	float	0.0	2.0	0.5
8105	Foiltest avg. C% probe 2	float	0.0	2.0	0.5
8107	Foiltest corrected c%	float	0.0	2.0	0.5

Example of Profibus *READ_PARAMETER* **command**:

- Reading *of furnace fix temperature* (address 1131) (00 00 04 6B hex), float representation (4 bytes to read).
Response in INPUT buffer from address 108 as (00 00 48 43 hex) float value 200.0 (ºC). See figure 3.0

Example of Profibus *WRITE_PARAMETER* **command**:

- Writing *of Control1 working SP* (address 2012) (00 00 07 DC hex), int representation (2 bytes to write), enum value 6 (for Remote SP)
Remote SP1 in OUTPUT buffer from address 28 as 900.0 (ºC) float value (00 00 61 44 hex). See figure 3.1
NOTE: when write_parameter command is one set, remote SP can be set up without write command.

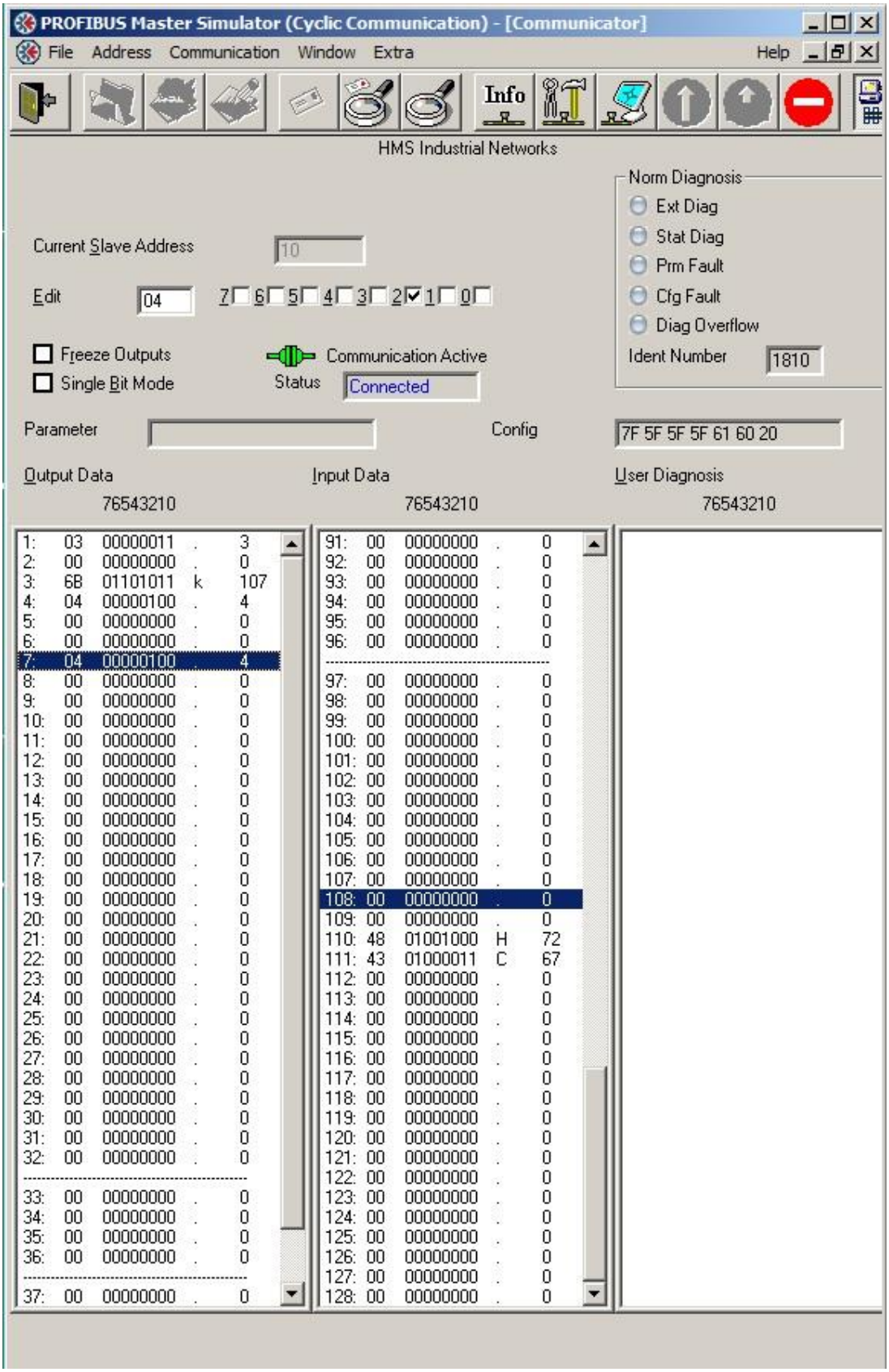

PROFIBUS Master Simulator (Cyclic Communication) - [Communicator]
File Address Communication Window Extra Help
Info
HMS Industrial Networks
Norm Diagnosis
Ext Diag
Stat Diag
Prm Fault
Cfg Fault
Diag Overflow
Ident Number 1810
Current Slave Address 10
Edit 04
7 6 5 4 3 2 1 0
Freeze Outputs
Single Bit Mode
Communication Active
Status Connected
Parameter
Config 7F 5F 5F 5F 61 60 20
Output Data
Input Data
User Diagnosis
76543210
76543210
76543210

Figure 3.0

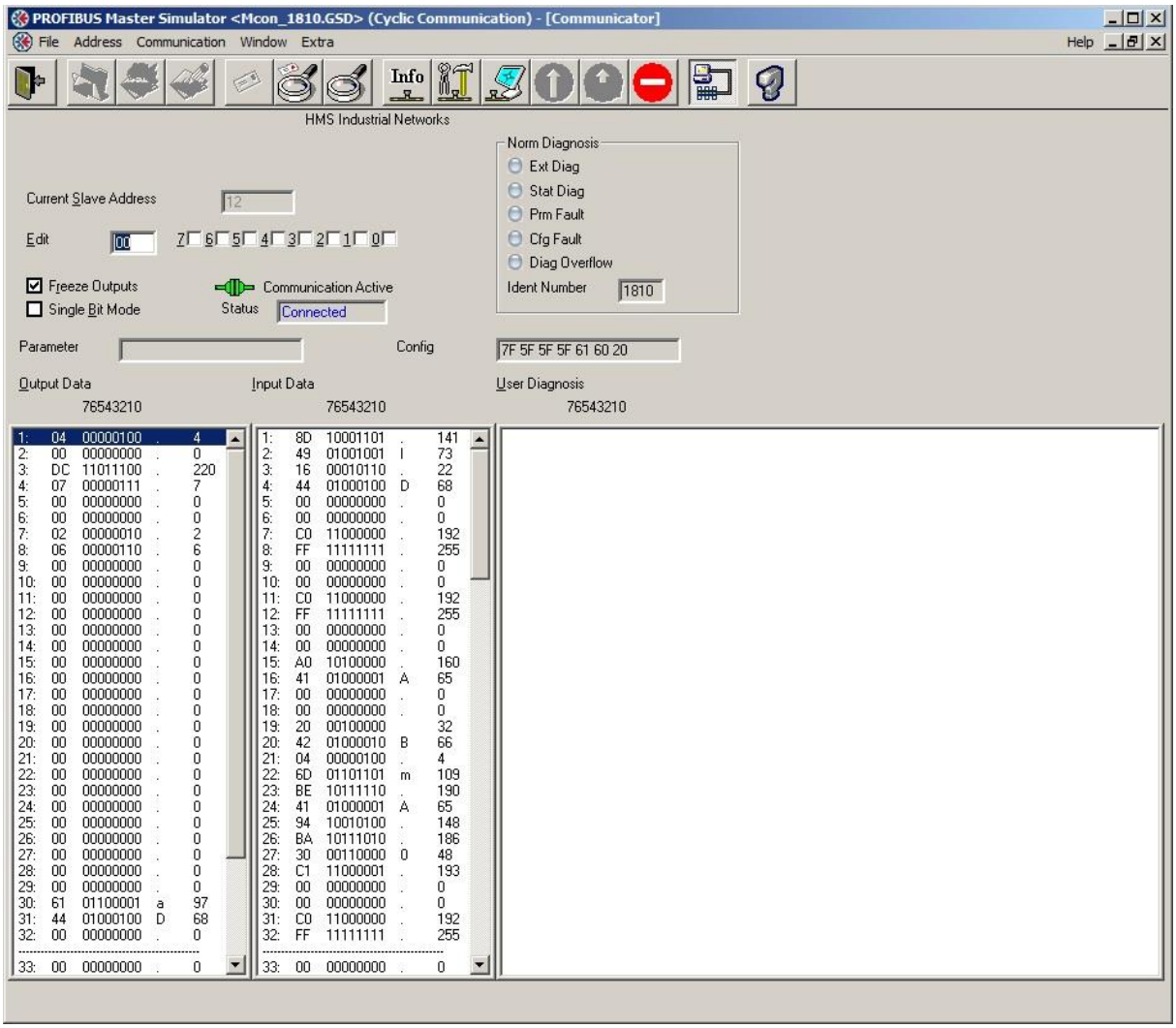

PROFIBUS Master Simulator <Mcon_1810.GSD> (Cyclic Communication) - [Communicator]
File Address Communication Window Extra
Help
Info
HMS Industrial Networks
Norm Diagnosis
Ext Diag
Stat Diag
Prm Fault
Cfg Fault
Diag Overflow
Ident Number 1810
Current Slave Address 12
Edit 00
7 6 5 4 3 2 1 0
Freeze Outputs
Single Bit Mode
Communication Active
Status Connected
Parameter
Config 7F 5F 5F 5F 61 60 20
Output Data
Input Data
User Diagnosis
76543210
1: 04 00000100 . 4
2: 00 00000000 . 0
3: DC 11011100 . 220
4: 07 00000111 . 7
5: 00 00000000 . 0
6: 00 00000000 . 0
7: 02 00000010 . 2
8: 06 00000110 . 6
9: 00 00000000 . 0
10: 00 00000000 . 0
11: 00 00000000 . 0
12: 00 00000000 . 0
13: 00 00000000 . 0
14: 00 00000000 . 0
15: 00 00000000 . 0
16: 00 00000000 . 0
17: 00 00000000 . 0
18: 00 00000000 . 0
19: 00 00000000 . 0
20: 00 00000000 . 0
21: 00 00000000 . 0
22: 00 00000000 . 0
23: 00 00000000 . 0
24: 00 00000000 . 0
25: 00 00000000 . 0
26: 00 00000000 . 0
27: 00 00000000 . 0
28: 00 00000000 . 0
29: 00 00000000 . 0
30: 61 01100001 a 97
31: 44 01000100 D 68
32: 00 00000000 . 0
33: 00 00000000 . 0
1: 8D 10001101 . 141
2: 49 01001001 I 73
3: 16 00010110 . 22
4: 44 01000100 D 68
5: 00 00000000 . 0
6: 00 00000000 . 0
7: C0 11000000 . 192
8: FF 11111111 . 255
9: 00 00000000 . 0
10: 00 00000000 . 0
11: C0 11000000 . 192
12: FF 11111111 . 255
13: 00 00000000 . 0
14: 00 00000000 . 0
15: A0 10100000 . 160
16: 41 01000001 A 65
17: 00 00000000 . 0
18: 00 00000000 . 0
19: 20 00100000 32
20: 42 01000010 B 66
21: 04 00000100 . 4
22: 6D 01101101 m 109
23: BE 10111110 . 190
24: 41 01000001 A 65
25: 94 10010100 . 148
26: BA 10111010 . 186
27: 30 00110000 0 48
28: C1 11000001 . 193
29: 00 00000000 . 0
30: 00 00000000 . 0
31: C0 11000000 . 192
32: FF 11111111 . 255
33: 00 00000000 . 0

Figure 3.1

Table of ENUM values

Name	0	1	2	3	4	5	6	7	8	9	10
ENUM 1	OFF	Probe input	Thermo couple	0-20 mA	4-20 mA	0-20 mA Rext	4-20 mA Rext	0-10 V			
ENUM 2	Volts (V)	Milivolts (mV)	Miliamps (mA)	Ampers (A)	Celsius (%C)	Farenheit (%F)	C Potential	CO Level	O2 Level	Ohms	
ENUM 3	B	C	E	J	K	L	M	N	R	S	T
ENUM 4	OFF	Furnace temp.	Furnace O2	Quench T	Ext. C level SP	Ext. Temp. SP	Furnace CO	Furn CO2	Furnace H2		
ENUM 5	Ain 1	Ain 2	Ain 3	Ain 4	Ain 5						
ENUM 6	L Probe	O2 Probe									
ENUM 8	From input	User defined									
ENUM 7	not set	dout 1	dout 2	dout 3	dout 4	dout 5	dout 6	dout 7	dout 8	dout 9	dout 10
ENUM 9	Chamber furnace	Shaft furnace	Batch furnace	Rotary furnace							
ENUM 10	PID perset 1	PID perset 2	PID perset 3								
ENUM 11	SP1	SP2	SP3	SP4	Program SP	Ext. SP	Remote SP				