

## USER'S MANUAL

### for automatic control unit MC-411R

### for use in dehumidifying / conventional dryers

- ◆ **Automatic / semiautomatic mode**
- ◆ **Temperature indication**
- ◆ **EMC indication**
- ◆ **MC indication**
- ◆ **Average MC indication**
- ◆ **6 inputs**
  - 4 for MC
  - 1 for temperature
  - 1 for EMC
- ◆ **4 outputs**
  - 1 for heating
  - 1 for dehumidifying drying
  - 1 for cooling / conventional drying
  - 1 for humidifying

Automatic control unit MC-411R is a device intended for drying process control in conventional (steam) and dehumidifying (condensation) dryers produced by "NIGOS-elektronik". Controller provides optimum conditions in the dryer through air temperature and humidity control.

MC-411R has one input for temperature and EMC measurement each, and 4 inputs for wood MC measurement. EMC can be measured directly, with EMC probe, or indirectly using capacity method where special capacity sensor is used, or psychrometric method where moisture is calculated indirectly using data calculated via measured difference in the temperature of the dry and wet bulb.

It can operate in automatic or semi-automatic mode, depending on settings made by user.

#### MC-411R TECHNICAL SPECIFICATION

Main characteristics		
	Power supply	230 Vac; 50 / 60Hz; 4VA max
	Number of inputs	6
	Number of outputs	4
	Displays	Two 2-digit and one 3-digit x 7 segment LED, red, 13 mm, plus one 1-digit x 7 segment LED, 13 mm, green
	Operating conditions	T: 0 ÷ 50 °C; RH: 5 ÷ 90%
	Storage	T: - 40 ÷ 85 °C; RH: 5 ÷ 90%
	Dimensions (WxHxD)(mm)	96 x 96 x 145
	Mounting hole (WxH) (mm)	91 x 91
	Weight	600g

Inputs		
Temperature input	Number of inputs	1
	Range	-20 ÷ 110 °C; -200 ÷ 1100mV
EMC input	Number of inputs	1
	Range	3.4 ÷ 54% EMC; - 250 ÷ 3000 mV (EMC probes)
MC inputs	Number of inputs	4
	Range	5 ÷ 150 %

Outputs		
Relay outputs	Usage	🔥 - for heating (2 - pin; 8A/250Vac)
		🌫️ - for dehumidifying drying (2 - pin; 8A/250Vac)
		❄️ - for cooling / conventional drying (3-pin; 8A/250Vac)
		🚿 - for spraying (2 - pin; 8A/250Vac)

Communication		
Digitalna	Communication standard	EIA 485
	Protocol	S - NIGOS
	PC interconnection speed	1200 ÷ 9600 bps



## MC-411R

### 1. INSTALLATION

Dimensions of the controller and mounting hole needed are given in the technical data table. Controller itself is fitted to the front panel of the control board with Π profile.

#### 1.1. POWER SUPPLY

Power supply is connected to contacts labeled 23 i 24 on the back side of the controller. Contacts 22 and 23 are internally short-circuited. Controller will start operating immediately after power supply connection.

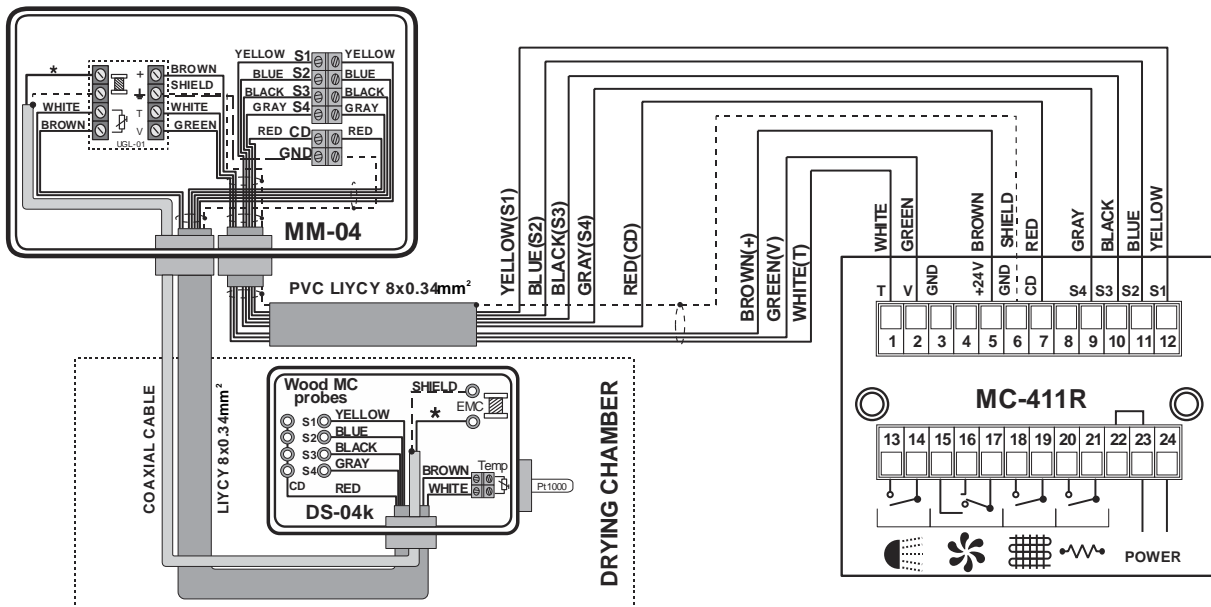
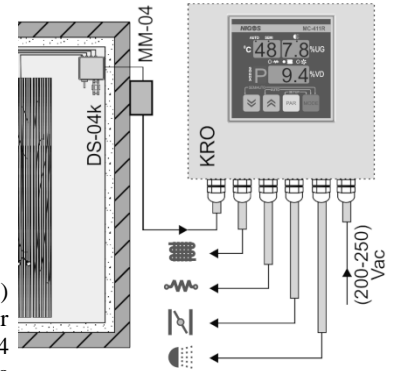
**1.2. CONNECTION**

Standard set for temperature, EMC and 4-points MC measurement delivered with MC-411R contains:

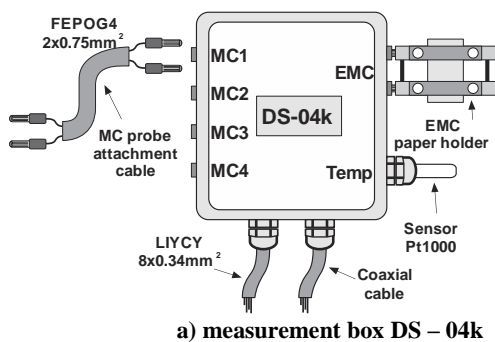
- One DS-04k box,
- One MM-04 measuring module
- Probes,
- Sensors, and
- Adequate cables

DS-04k box is made to provide connection of temperature probe, equilibrium moisture content (EMC) probe and four wood moisture (MC) probes to MM-04. DS-04k box is placed inside the drying chamber on appropriate place (on the back wall - as shown on picture on the right). Measuring module MM-04 receives and processes measuring signals from DS-04k box and sends them to automate MC-411R via LIYCY 8 x 0.34 mm<sup>2</sup> cable (see picture 1.1).

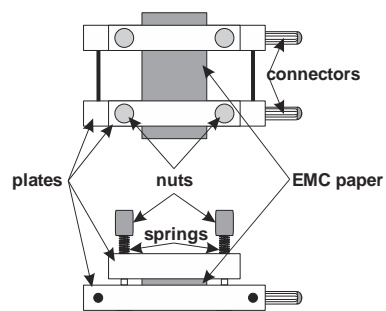
**Temperature measurement:** Temperature probe (sensor) Pt - 1000 is used for temperature measurement. This probe is mounted inside the DS-04k box by NIGOS - elektronik, and is connected to electronic board UGL-01. UGL-01 board, with other inputs, is connected to MM-04 with appropriate wires of LIYCY 8 x 0.34 mm<sup>2</sup> cable and coaxial cable.



Picture 1.1 MC-411R connection scheme on the backside



a) measurement box DS - 04k



b) EMC paper holder (top and side view)

Picture 1.2 DS-04k connection scheme

**Equilibrium Moisture Content (EMC) measurement:** Two hole-plugs, marked EMC or UGL, are placed on the top of the DS-04k box. They are used for connection of EMC paper holder and DS-04k box, as shown on picture 1.2 a). EMC paper is fitted according to picture 1.2 b).

EMC paper is made of special hygroscopic material. **ONE EMC paper is used for only ONE drying cycle and should be replaced with new one before a new drying cycle starts.** Certain amount of this paper (sufficient for exploitation in period of more than 2 years) is delivered to user. Additional amounts of the paper are provided when needed or during regular service. EMC paper should be stored in a dry and dark place.

**EMC paper fitting sequence:** Unscrew nuts on the paper holder, so the springs remain free. Place new EMC paper between aluminum plates. Screw nuts back to achieve good coherence between EMC paper and aluminum plates.

**NOTE:** If indirect method for EMC measurement is used (capacitive or psihrometric), appropriate boxes, probes and cables are delivered with the controller MC-411R. Connection of those boxes to the MC-411R is same as connection of the DSU-04 box (same labels are used).

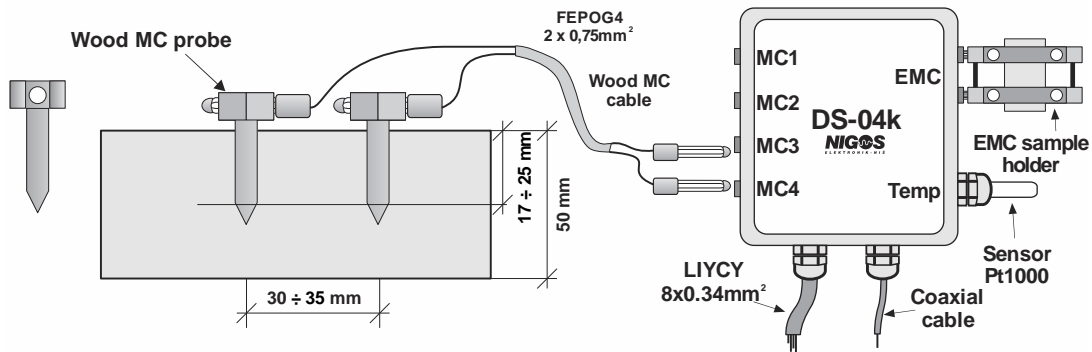
**Measurement of wood moisture content (MC) in 4 points:** 4-points MC measurement set consists of 4 connection cables and a set of wood moisture probes. Each connection cable is 6 m long. They are made of 2 twisted wires with Teflon insulation (labeled ETF – K 2 x 0.75 mm<sup>2</sup> or FEPOG4 2 x 0.75 mm<sup>2</sup>). Cable has ring connectors Ø 4 - 1 mm<sup>2</sup> at one end, which provide connection with MC probe fitted in the wood. At the other end, cable has a pair of connectors for connection with DS-04k. Example of connection of this cable is shown on picture 1.2.a). Set of probes for MC measurement consists of an appropriate plastic box and certain amount of stainless steel nails (MC probes). Drying process is primarily based on average wood MC that is obtained from 4 different measuring spots. Therefore, proper fitting of the probes in the wood and their symmetrical disposition inside the chamber is most important.

**1.3. STAINLESS STEEL NAIL PROBES SET-UP (probes for multiple use):**

These are stainless steel (INOX) - multiple use probes. After each drying cycle they must be carefully taken out of timber and saved for later use. They are replaced with new ones only in case of mechanical damage. Each MC probe has one pair of stainless steel nails. Recommended lengths of nails are:

- 30 mm used for lumber up to 40 mm thick (thin lumber);
- 45 mm used for lumber above 40 mm thickness (thick lumber).

One pair of probes is used for each MC measurement point. Probes are hammered in the lumber perpendicularly to board at distance of 30 to 35 mm (optimally 32 mm). A pair of holes Ø3.2 (3 ÷ 3.5) mm should be drilled in the lumber before hammering the probes. Depth should be 15 mm shorter than the probes' length. Probes should be than hammered into the holes whit paying attention that the depth of penetration must not be smaller than 1/3 of board depth (1/2 of board depth is best). In case when thin and soft lumber is used, user does not need to drill holes, but he can hammer the probes directly into the lumber. Probe cable is connected on the other side to the patch board of DS-04k, placed on the wall, inside the drying chamber.



Picture 1.3. Proper fitting and connecting of the wood MC probe

**NOTE:**

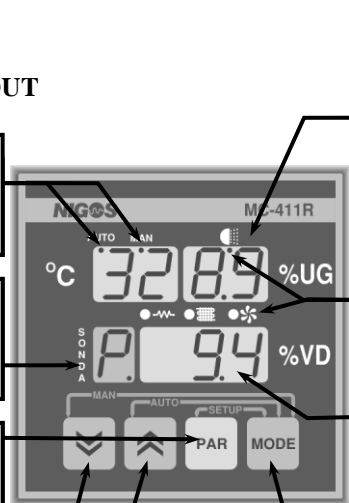
Wood probes should always be placed parallel with short side of timber (plank), but take care to keep them away from forehead minimal 50 cm or more.

In the case of a material that is narrow (parquet frieze and similar), humidity measurement probes are placed longitudinally. If they were positioned transversally, they would be too close to the edge of the material, so there would be mistakes in the measurement of moisture in the wood, and hence the poor management of the drying process.

**2. OPERATION**

**2.1. MC-411R FRONT PANEL LAYOUT**


- LED dots that show operating mode:**
  - when **AUTO** is lit - automatic mode is on
  - when **SEMI** is lit - semiautomatic mode is on
- DISPLAY SONDA shows:**
  - probe number and average MC label (*P.*)
  - parameter symbols (*t*, *r*, and *d*)
- Button PAR** is used for parameter selection
- Buttons UP and DOWN** are used for decreasing / increasing of the value of selected parameter





- TOP DISPLAYS show:**
  - measured air temperature and EMC
  - temperature and EMC setpoints
  - symbol  $\bar{E}_r$  on specific display when an error on specific signal is detected
  - parameter values in **SETUP** mode
- LED diodes and LED dot on top display** show controller's commands
- BOTTOM DISPLAY** shows:
  - measured MC, drying phase and average MC
  - parameter value
  - parameter symbol in **SETUP** mode
- Pressing **MODE** and **DOWN** or **UP** simultaneously toggles automatic / semiautomatic mode. Pressing **MODE** and **PAR** simultaneously enters the **SETUP** mode.

## 2.2. LED functions

LED  signals that controller has issued **heating** comand.

LED  signals that controller has issued **dehumidifying drying** comand.

When LED  is constantly lit, it signals that controller has issued **conventional dryer** comand. If LED blinks, **cooling** comand is given.

When LED dot on top display (labeled with %UG) below the sign  is constantly lit, it signals that controller has issued spraying comand. If this LED dot blinks, it signals spraying pause in progress.

## 2.3. LED DISPLAYS

**Temperature and EMC** are shown on top two displays labeled with °C - for temperature and %UG - for EMC. Temperature display is without decimal point in range -9 to 99, but if the temperature is lower than 10 °C, display has decimal point.

If an error occur on temperature or EMC inputs these displays will show blinking symbol  $E_r$ . Maximal value that can be shown on these displays is 99, so any value above this is shown as 99.

If an error occur in temperature signal, drying is imposible and all relay outputs are off.

If an error occur in EMC signal and temperature is below minimum temperature for drying (ie heating phase is active) controller will continue to operate normally. If the temperature is higher then minimum temperature for drying (ie drying phase is active) controller will stop the drying and turn off all outputs. Imidiately after this error is resolved controller will start with operation.

**Wood MC** is shown on bottom display labeled with %VD, with one decimal point in range 0.1 to 999. Higher values (above 99.9%) are shown without decimal point.

Display labeled with **SONDA** shows **MC probe number** in range 1 to 4, kao i P, which represent average MC value. If the probe number is shown with decimal point it means that the probe is **active** (in ON mode). If the number is shown without the decimal point then that probe is **pasive** (in OFF mode) and its value is not calculated in average calculus.

## 2.4. OPERATING MODES

### 2.4.1. Automatic mode

For automatic operation mode, user must choose automatic mode and set all user's parameter to desired values before the drying process starts. This means that the user must choose adequate wood type, regime (schedule) and wood thickness. All this parameters are apsolutelly vital for good drying because controller controls the drying process and calculates setpoints according to these parameters. Parameters can be changed after the drying has started. After drying has started, user activity is only to acasionly monitor the system. The controller will follow choosen drying regime.

When desired final wood moisture content (MC) is reached, user must stop the drying proces manually (switch off the main switch on power electric board), or continue with conditioning phase in semiautomatic mode.



### 2.4.2. Semi-automatic mode



For semi-automatic mode, user must choose semi-automatic mode and adjust the value for wood type.

The difference between automatic and semi-automatic mode is that in automatic mode the controller calculates necessary values for temperature and EMC automatically, while in semi-automatic mode user must set these values himself, and the controller will only maintain these values. Setting of the values for temperature and EMC is done according to procedures described in chapter 2.5.

### 2.4.3. Changing of operating mode (auto to semi-auto and vice versa)


There is a possibility of change from automatic to semi-automatic mode at any point of operation. After the change, drying process starts from beginning. In semi-automatic mode, currently measured values become setpoints, while in automatic mode they are calculated according to the program.



To switch from automatic to semi-automatic mode, user must press the buttons  and  simultaneously.


To return to automatic mode, user must press simultaneously buttons  and .


After each mode **alternation from semi-automatic to automatic mode**, all relay outputs are turned off for about 20 seconds (shorten measurement phase), after which the controller calculates setpoints.


## 2.5. PARAMETER SETTINGS

Button  is used for parameter viewing and seting. When this button is pressed, parameters shown on addequate displays are changed.


Buttons  and  are used for increasing and decreasing of the currently selected parameter.

When button  is first time pressed, **temperature setpoint** starts to blink on the °C display (values and range are given in the table 2.3).

When button  is pressed again, **EMC setpoint** starts to blink on EMC display (values and range are given in the table 2.3) In automatic mode these parameters can only be viewed. In semi-automatic mode, user can change these parameters and set it to desired value (up to 30% for EMC, up to 58 °C for temperature in dehumidifying dryer and up to 70 °C in conventional dryer).


With next pressing of the button , probe number blinks on SONDA display and probe state blinks on MC display. These states can be: ON for active state or OFF for passive state, and can be changed. This process should be repeated for all 4 probes with notice that it is not possible

to put all 4 probes in passive state. Active state means that value obtained from that probe is calculated in the average MC calculus, while values from passive probes are disregarded.

After the state of probes is adjusted, with next pressing of the button , parameter  $\xi$  is shown on the *SONDA* display. Now, user can make selection of the wood type. Possible values are in range 1 to 4, depending of the actual used wood type. It is necessary to define the type of the wood that is dried in order to achieve proper wood moisture content (MC) measurement. All wood species are divided into 4 groups, which are given in the next table (2.1).

**Table 2.1. Table of wood types and related groups of wood species according to which the MC measurement is made**

WOOD TYPE	WOOD SPECIES
1	Zebrano, Cork, Rubber Tree
2	Beech, Lime, Niangon, Ebony, Olive, Iroko
3	White Beech, Pine, Ash, Birch, Larch, Locust, Acacia, Mahogany, Oak, Poplar, Sappeli, Walnut, Maple, Chestnut, fruit trees...
4	Dibetou, Kapur, Sipo, Utile


When button  is pressed again, parameter  $\tau$  is shown on the *SONDA* display. This parameter defines drying regime (schedule) according to which will MC-411R control the drying process in automatic mode. Each regime defines temperature and EMC curves (relations between chosen parameter - T or EMC, and time), temperature gradient for heating, minimal drying temperature, temperature and humidity setpoints for conditioning phase and duration of the conditioning phase. All regimes are made for lumber thickness of 50 mm. User can select any regime between 12 possible. Adequate regime is chosen according to the *table of drying regime* (table 2.2). These are factory-defined regimes and cannot be changed.

**Table 2.2. Table of drying regimes pre-defined by "NIGOS - elektronik"**

WOOD SPECIES	Group	FACTORY REGIMES				
		Very slow	Slow	Average	Fast	Very fast
Fir, Spruce	3	17	22	27	28	30
Pine	3	16	21	22	28	30
Larch	3	16	21	22	28	30
Beech, steamed	2	16	17	18	19	24
Beech, natural	2	11	12	13	14	15
Beech, white	2	/	3	4	5	10
Oak, slavonian	3	6	11	12	13	19
Oak, sessile	3	2	3	4	9	14
Ash	3	7	11	12	14	20
Poplar	2	11	17	21	22	28
Linden	2	11	16	17	18	23
Birch	3	11	16	17	18	23
Cherry	3	11	12	17	18	20
Acacia	3	11	12	17	18	19
Walnut	3	11	12	17	18	19
Mahogani	3	11	12	17	22	23
Samba	2	21	22	27	28	34

**WARNING!** Drying regimes which are inserted in controller's memory by default (schedule 1 to 60) are based on both significant practice knowledge of drying wood and laboratory testing made in well-known wooden industries. Since there are many factors that can influence drying process such as wood origin, quality of wood, wood surface conditions, stock height, stock assemblage, etc... - drying characteristics for certain lumber can differ from the one used for creating schedule. That is why we recommend strict monitoring of drying process to achieve both maximum efficiency in drying progress and proper parameter settings for **your** type of wood.

**NIGOS - elektronik do not accept responsibility for any accidental situation during drying process caused by either operator's negligence or disregarding process, even if the manufacturer's pre-defined drying regime is used.**

When button  is pressed again, parameter  $d$  is shown on the *SONDA* display, and current value of this parameter is shown on the *wood MC display (%VD)*. This parameter defines average thickness of the lumber, which is very important for normal drying process. Regimes and curves are pre-defined for lumber 50 mm thick. Thinner lumber require faster schedule and vice versa, for thicker lumber drying schedule should be slowed down. Adjusting the parameter value to actual lumber thickness (if possible) provides that the controller performs all rest relevant schedule settings automatically.

Speeding of the regime for **thickness lower then 50 mm**

is done by following:

- values for moisture curve are decreased
- temperature ramp ratios are increased.

Slowing of the regime for **thickness higher then 50 mm**

is done by following:

- values for moisture curve are increased,
- temperature ramp ratios are decreased.


Calculations are made in percentage relative to the thickness in millimeters. Next pressing of the button  will reset display to home display mode. If no button is pressed within 10 sec, the controller returns to home display mode automatically.

Table 2.3. User's parameters table

PARAMETER LABEL	DESCRIPTION	RANGE OF PARAMETER VALUES	DEFAULT VALUE
	temperature setpoint	1 ÷ 80	35
	EMC setpoint	0.1 ÷ 30	25
1	state of wood MC probe 1	on, off	on
2	state of wood MC probe 2	on, off	on
3	state of wood MC probe 3	on, off	on
4	state of wood MC probe 4	on, off	on
t	type of the wood	1, 2, 3, 4	3
r	regime (schedule)	1 ÷ 12	9
d	lumber thickness	20 ÷ 80 mm	50 mm

## 2.6. STARTING AND STOPPING OF THE DRYING PROCESS

As soon as the power is connected to controller MC-411R (main switch on power electric board is switched on), it will start to operate.

Since automatic control unit MC-411R has no option for automatic stopping of the drying process, user must do it manually. When user concludes that timber is dried to desired level (based on measured values for each MC probe and average value) he can switch off the controller by switching off the appropriate switch on the main power electric board. It is recommended that fans continue to work for some time longer, and then to turn off entire equipment in the dryer by switching off the main switch on power electric board. Main door can be opened a little then and after certain amount of time when timber is cooled off, it can be taken out of the dryer.



User can also decide to perform **conditioning**. **Conditioning** is performed at the end of drying process with main intention to equal moisture content at the surface and inside the boards. During this process, temperature is gradually (following given gradient) lowered from current temperature to *conditioning temperature*, while EMC is increased from current until *conditioning EMC* is reached (also following given gradient). Conditioning process is as follows:

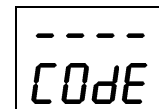
- When the end of drying is reached, user must switch off heating pumps and switch the controller to semi-automatic mode.
- Now temperature and EMC for conditioning phase should be set. These values are set according to type of the wood, thickness of the boards and user experience. Table 2.2 shows most commonly used values. It is recommended that these values are set gradually instead of setting them at once. User should set new values every 30 min starting from current values in order to reach conditioning values after 3 to 4 hours. When conditioning values for temperature and EMC are reached, they should be maintained until conditioning time expires (determined by the type of wood and board thickness). After this time expires (user must measure it himself), controller is turned off, chamber can be opened and after timber is cooled down it can be taken out of the dryer.




## 2.7. SYSTEM PARAMETER SETTING

System parameters describe operation of some output devices. These parameters are adjusted only once, upon controller installation.

**User should change these parameter values only if manufacturer permits it. In other cases, user should not start this option because only authorized persons are permitted to change parameter's values!!!**

Access to these parameters is possible when buttons  and  are simultaneously pressed. Afterwards, the displays are showing:



Use  and  buttons to set activation code (initially it is set to 411) and press  button. If correct code is set, controller enters into mode for system parameter setting. **Upper row of LED display is used for parameter values displaying, while the symbols of parameters are displayed on the lower row of display.**




Pressing the button  will list the parameters, and buttons  and  are used for adjusting their values to desired. The controller will lock itself if no button is pressed within 50 seconds. Table below shows the list of system parameters.

Table 2.3. Table of system parameters

Symbol	Description	InitCond	InitConv	Range
UEr	Controller and software version	Controller dependant	Controller dependant	3480-
ESuS	Type of dryer	Hond	HLAS	Hond, HLAS
h,SH	Heating hysteresis (°C)	02	10	00 ÷ 100
dELH	Heating delta (°C)	-07	05	- 100 ÷ 10
h,SC	Cooling hysteresis (°C)	02	02	00 ÷ 100
dELC	Cooling delta (°C)	0	30	00 ÷ 100
h,SD	Conventional drying hysteresis (%)	01	06	00 ÷ 10
dELU	Conventional drying delta (%)	03	-h,SD / 2	-20 ÷ 20
h,SD	Dehumidifying drying hysteresis (%)	10	/	00 ÷ 20
dELd	Dehumidifying drying delta (%)	- 10	/	-20 ÷ 00
SEPU	Minimal temperature for heat pump operation (°C)	28	/	10 ÷ 50
ErPU	Minimal time for heat pump operation (min)	60	/	4 ÷ 240
h,SP	Spraying hysteresis (%)	18	18	10 ÷ 255
EuPr	Time until spraying start up (min)	30	/	1 ÷ 240
SEPr	Minimal temperature for sprayers (°C)	28	28	10 ÷ 60
ErP	Minimal spraying time (min)	5	5	1 ÷ 240
ErP	Maximal spraying time (min)	15	15	1 ÷ 240
EPru	Active sprayers time - sprayers on (sec)	15	15	1 ÷ 240
EPri	Inactive sprayers time - sprayers off (sec)	25	25	1 ÷ 240
EPPr	Duration of pause after drying/spraying (min)	15	15	1 ÷ 240
SESu	Drying temperature gradient (°C/h)	100	100	10 ÷ 100
UESu	Maximal drying temperature (°C)	55	65	35 ÷ 70
odSt	Temperature delta (°C)	20	20	1 ÷ 50
Filt	Measurement filter	32	32	1, 2, 4, 8, 16, 32, 64, 128
Sond	MC probe type	UGL	UGL	cAPA, P5 ih, UGL
EuIU	MC displaying type	UGL	UGL	rh, UGL
EOFS	Temperature offset	0	0	- 125 ÷ 125
oEnc	EMC offset (EMC%)	100	100	1 ÷ 200
o-nc	Wood MC offset (MC%)	100	100	1 ÷ 200
AcES	Access code	411	411	0 ÷ 9999

### 3. IRREGULAR SITUATIONS

During operation certain irregular situation can occur. These situations signal that there is some kind of error in measured data and are not necessarily signal for hardware malfunction on measurement equipment or controller. These situations can be recognised when both LED dots for operating mode (AUTO, MAN) on the top display of MC-411R are turned off. Possible causes and controller reaction for these situations are:

- If MC-411R operate in automatic mode and all MC probes are pasive, or probe for temperature or EMC does not measure values regularly (in any operating mode), MC-411R controller will shut off all relay outputs.
- If temperature inside the kiln has exceeded maximal drying temperature + 5 °C, all relay outputs are turned off except output for cooling. This state is automatically ended when temperature falls below maximal drying temperature +3 °C.
- If temperature inside the kiln is below manimal drying temperature - 5 °C, all relay outputs are turned off except output for heating.

When irregular situation is over, controller will continue starting from measurement phase. During this phase LED dot for operating mode (AUTO, SEMI) will blink.

## Table of Contents

1.	INSTALLATION .....	1
1.1.	POWER SUPPLY .....	1
1.2.	CONNECTION .....	2
1.3.	STAINLESS STEEL NAIL PROBES SET-UP (probes for multiple use): .....	3
2.	OPERATION .....	3
2.1.	MC-411R FRONT PANEL LAYOUT .....	3
2.2.	LED functions .....	4
2.3.	LED DISPLAYS .....	4
2.4.	OPERATING MODES .....	4
2.4.1.	Automatic mode .....	4
2.4.2.	Semi-automatic mode .....	4
2.4.3.	Changing of operating mode .....	4
2.5.	PARAMETER SETTINGS .....	4
2.6.	STARTING AND STOPPING OF THE DRYING PROCESS .....	6
2.7.	SYSTEM PARAMETER SETTING .....	6
3.	IRREGULAR SITUATIONS .....	7