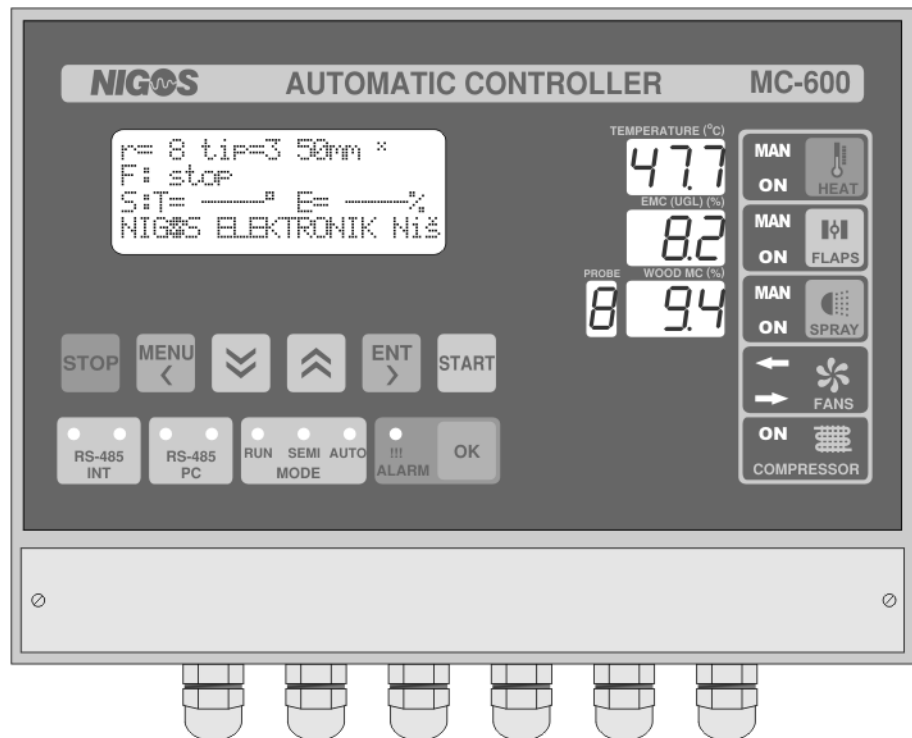


## USER'S MANUAL

### for automatic control unit MC-600

# MC 600



## 1. MC-600 MAIN CHARACTERISTICS

Automatic control unit MC-600 is a device intended for drying process control in conventional (steam) and dehumidifying dryers. It is necessary to order proper controller for proper type of wood dryer because there is a difference in software. Controller provides optimum conditions in the dryer through air temperature and humidity control.

The unit is delivered in the plastic case suitable for mounting on the wall. Measurement and communication cable entries are available from the bottom side of the case. Power supply, outputs for compressor, heating, drying, spraying, fans, communication with PC, digital and analogue inputs and communication with MKM box are connected to MC-600. Additional entries can be installed if necessary. Front side of the case is made of transparent plastic cover, which provides easy overview of front panel layout and can be opened when controller adjustment is necessary. Indicator and warning LEDs are also visible.

MC-600 can be delivered in 2 different configurations: with 1 or 2 measurement inputs for EMC and temperature and 4 or 8 wood MC inputs. Connection is the same, only number of DS-04T boxes is different (1 or 2). This manual is used for both configurations.

Controller receives information about air temperature and equilibrium moisture content (EMC) from 2 measuring points and wood moisture content (MC) from 8 points from the measurement module MKM-08 via communication line. MKM-08 receives these data from 2 measurement boxes DS-04T, transforms them and then transfers the data to MC-600 controller. Controller controls the drying process based on these data and user settings. It can operate in automatic or semi-automatic mode, depending on settings made by user. When in automatic control mode, MC-600 follows the chosen drying regime and achieves optimal drying conditions in the kiln automatically. In semiautomatic control mode, user can set desired setpoints for air temperature and humidity, based on the personal experience, and the unit only maintains those values inside the kiln at the desired point. The unit can be connected to a PC, which enables control of drying process from distance (from the office or suitable operating room). Additional capability of the MC-600 controller is manual control of the drying process. User can use buttons on the right for manual control of relay outputs. During this time the controller only displays the measured values. In all other cases, the MC-600 controls relay outputs automatically. All output adjustments are built-in, so the user has no influence on their operation during drying process. Most irregular situations that may occur are registered and resolved within the controller's program options. User intervention is required in certain situations that cannot be resolved by controller, or in case of unknown conditions.

### MC-600 TECHNICAL SPECIFICATION

Main characteristics		
	Power supply	220Vac; 50Hz; 300mA
	Number of digital inputs	2 for fans and compressor operation control
	Number of analogue inputs	1 for temperature (Pt-1000; T: - 25 ÷ 150 °C)
	Power supply	6
	Number of digital inputs	2
	Number of analogue inputs	- one LCD with 4 rows x 20 characters; - three 3-digit x 7 segment LED - one 1-digit x 7 segment LED
	Operating conditions	T: 0 ÷ 50 °C; RH: 5 ÷ 90%
	Storage	T: - 40 ÷ 85 °C; RH: 5 ÷ 90%
	Dimensions (W x H x D)	(250 x 210 x 135) mm
Weight	1200g	
Outputs		
Relay outputs	Number of outputs	6
	Characteristics	3 - pin; 8A / 250Vac, uninterrupted load 3A max
	Purpose and number of outputs	1 output for temperature control (heating valve control)
		2 outputs for fans operation and direction control
		1 output for humidity control (servo-controlled drying flaps)
1 output for spraying		
1 output for compressor		
Communication		
Digital	Communication standard	RS-485
	Protocol	S - NIGOS

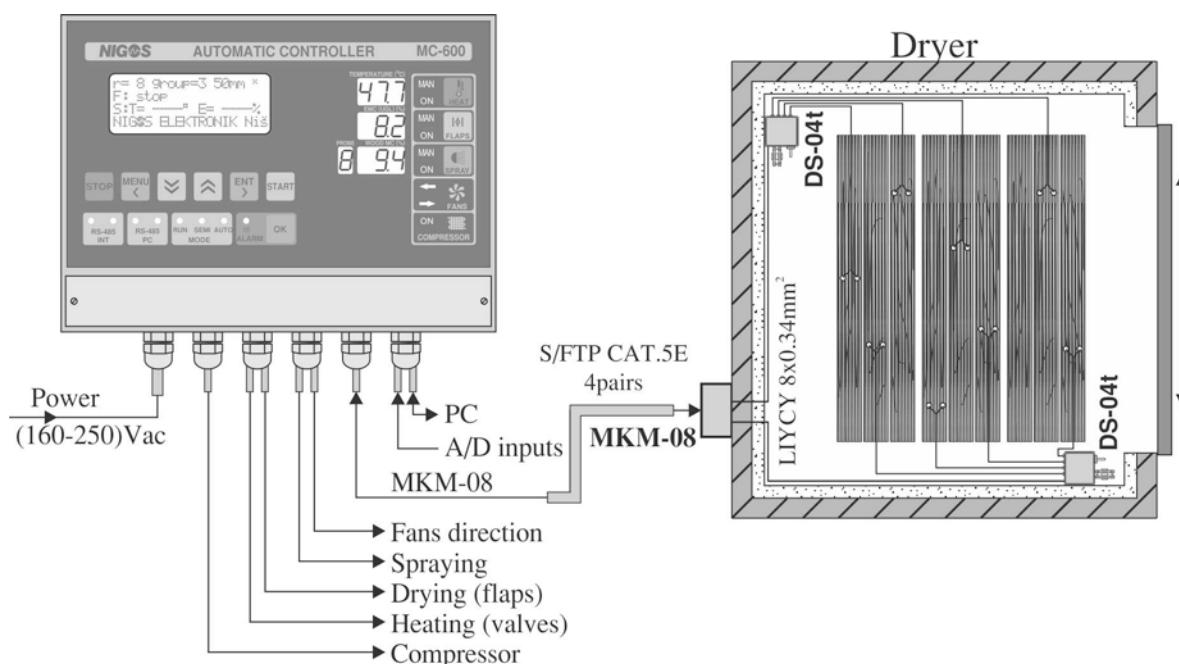
### MKM-08 TECHNICAL SPECIFICATION

Inputs		
Temperature input	Number of inputs	2
	Range	-20 ÷ 110 °C; 10mV / °C
EMC input	Number of inputs	2
	Range	2.0 ÷ 30 % EMC
MC inputs	Number of inputs	8
	Range	5 ÷ 160 %

## 2. INSTALLATION

### 2.1. CONNECTING DIAGRAM

Automatic controller MC-600 is a device intended for automatic control of drying process in conventional and dehumidifying dryers. It is very common for these systems that control and surveillance equipment for all dryers is placed in one room. Actual dryer, which is controlled by a certain controller placed in the operating room, can be at significant distance from there (up to 300 m). There are 2 types of signals that are transmitted between the controller and the equipment in the dryer. Control signals can be transmitted at that distance with no significant loss, but data signals obtained from temperature, EMC and MC probes, can be corrupted during transport. That is why the control signals can be transmitted from the appropriate clamps in power electric switch board directly to the kiln's executive equipment, while data signals must be converted at first in the form that is suitable for transmission at long distance. Converting of data signals is performed in the communication box MKM-08 that is placed near to drying chamber (usually on the chamber' wall). Software control of system configuration is fully supported. Optimal configuration of the system is achieved with the proper choice of the number of attached temperature probes, and probes for Equilibrium Moisture Content (EMC) and wood moisture content (MC).

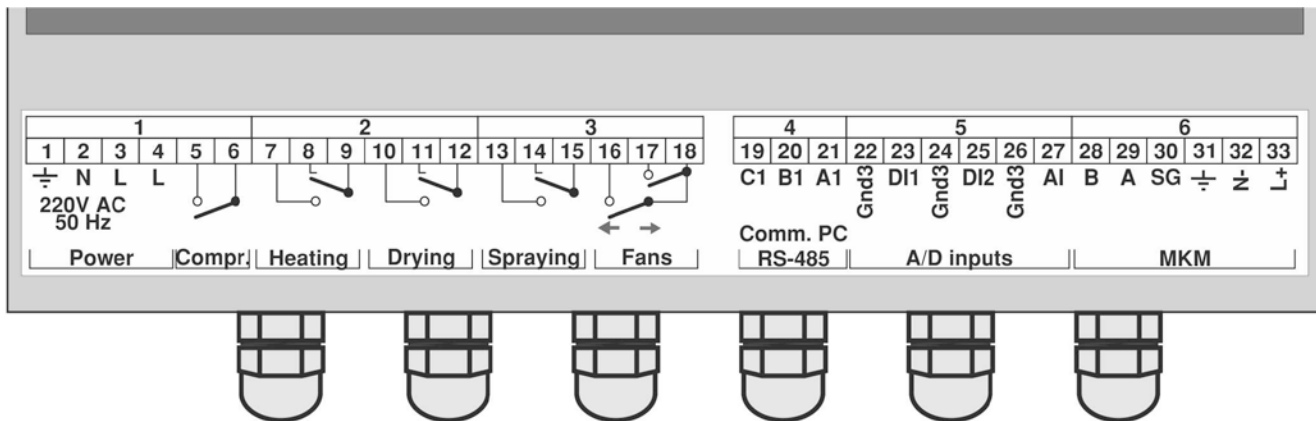


**Picture 2.1. Schematic representation of MC-600 connection in the system with 2 temperature and EMC measurement points and 8 MC measuring points**

MC-600 controller has 6 relay outputs (ON/OFF type of control):

- 1 of them is reserved for temperature control (opening and closing heating valve),
- 2 for changing air flow direction (flow fans control),
- 1 for humidity control (opening and closing flaps),
- 1 for compressor, and
- 1 for spraying system control

## 2.2. MC-600 CONNECTION



Picture 2.2. MC-600 clamps layout

Cables connection sequence:

1. Remove connector protection cover from the lower part of the MC-600 case.
2. Insert cables through cable entries on the lower part of the MC-600 case. Label cables if necessary.
3. Connect the cables to the MC-600 connectors according to given schematic representations, labels on the connectors (1 to 33), and table 2.1.
4. Return connector protection cover to its place.

Table 2.1. MC-600 clamp connection layout

CLAMP LABEL	NUMBER/ CLAMP LABEL	CONNECTED TO CLAMP	FUNCTION
<b>Power</b> 220V, 50/60Hz	1 / GND	Power cable ground	MC-600 ground
	2 / N	Power cable null	MC-600 null
	3 / L	Power cable line	MC-600 power supply
	4 / L	Power cable line; Clamps 9/12/15	MC-600 power supply
<b>Compressor</b>	5	Compressor switch	Compressor ON
	6	Command line from switch board	Command line
<b>Heating</b>	7	Heating valve	Heating valve opening
	8	Heating valve	Heating valve closing
	9	Clamps 4/12/15	Heating valve power
<b>Drying</b>	10	Servo actuator on flaps	Servo damper opening
	11	Servo actuator on flaps	Servo damper closing
	12	Clamps 4/9/15	Servo actuator power
<b>Spraying</b>	13	Spraying valve	Spraying valve opening
	14	Spraying valve	Spraying valve closing
	15	Clamps 4/9/12	Spraying valve power
<b>Fans</b>	16	Power electric board (Fans)	Contra-clockwise fans direction
	17	Power electric board (Fans)	Clockwise fans direction
	18	Power electric board (Fans)	Fans command contactor power
<b>Communication PC</b>	19 / C1	Not connected	Common contact
	20,21 / RS-485 (B1, A1)	RS-485 (B, A) on RS adapter	Communication with PC
<b>Analogue/Digital inputs</b>	22 / Gnd3	Ground	Ground
	23 / DI1	Heat pump presostat	Heat pumps operation control
	24 / Gnd3	Ground	Ground
	25 / DI2	Voltage-free contact on circulation fans switch	Fans operation control
	26 / Gnd3	Ground	Ground
	27	Temperature probe	Temperature input for incoming water, evaporator, etc...
<b>MKM</b>	28,29 / RS-485 (B, A)	RS-485 (B, A) clamps on MKM-08 box	Communication with MKM box
	30 / SG	SG clamp on MKM-08 box	Signal ground
	31 / Gnd	GND clamp on MKM-08 box	MKM box ground
	32 / N-	N- clamp on MKM-08 box	Minus power supply for MKM box
	33 / L+	L+ clamp on MKM-08 box	Plus power supply for MKM box

### 2.3. MC-600, MKM-08 AND DS-04T INTERCONNECTION

Automatic controller MC-600 support configurations with 4 or 8 wood MC measurement inputs and 1 or 2 inputs for air temperature / EMC. These configurations are made with communication box MKM-08 and 1 or 2 connection boxes DS-04T.

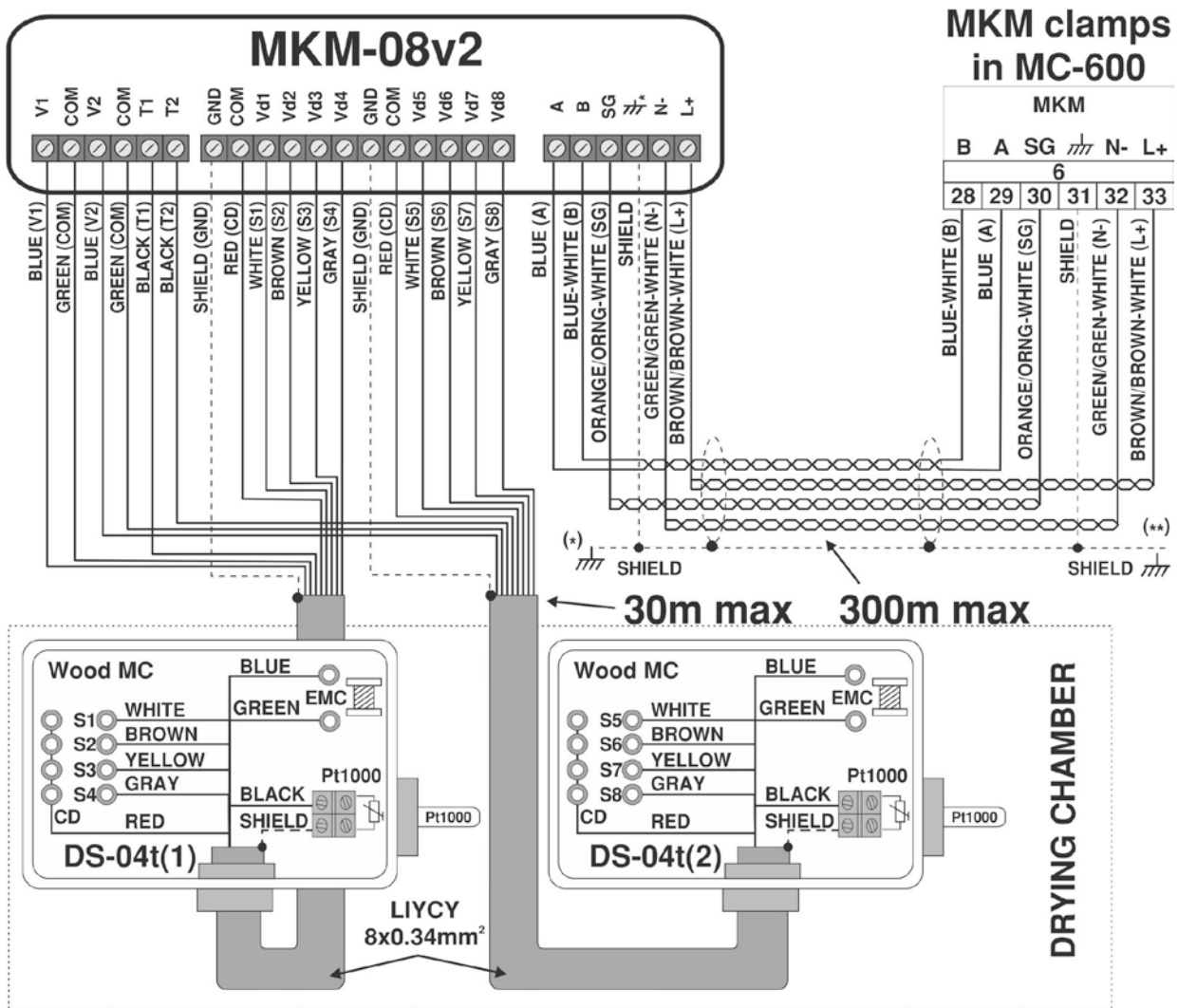
MKM-08 is a communication box that converts obtained measured values from EMC, MC and temperature probes and transfers converted data to MC-600 controller. Conversion of the measured signals from the probes into a more suitable form, performed inside the MKM-08 box, is necessary for long-distance data transfer. Connection between MC-600 and MKM-08 is carried out via communication cable S/FTP CAT.5E 4 pairs or LIYCY 3x0.5mm<sup>2</sup>, with the maximum distance between them of 300m. Special communication protocol for digital communications between these units has been developed by NIGOS developing team, according to standard RS-485.

Cables used for connecting system components (MC-600, MKM-08 and DS-04T) must have appropriate length and diameter. They are connected according to the schematic on the figure 2.4. It shows clamps layout in each box. The clamps are available after removing protection cover. Cable colors are standard for the cables that are used and delivered by NIGOS-elektronik, and that rule should be obeyed whenever it is possible.

**NOTES:**

1. Measurement and communication cables from picture below should go separately from energy cables with minimal distance between them of 30 cm. In cases where these cables must cross energy cables, it is ONLY permitted to cross them at 90° (perpendicularly).
2. MKM-08 box must be grounded! When prefabricated panel chamber is used, ground MKM-08 box nearby (\*). When brick chamber is used, ground MKM-08 box at power electric panel end (\*\*). Communication (S/FTP or LIYCY 3x0.5mm<sup>2</sup>) cable must be shielded and this shield must be connected to ground at one end only.

For standard MC-600 configuration with 8 wood MC probes, settings should be as shown on the picture below.



Picture 2.4. Schematic of DS-04T to MKM-08 connection, and MKM-08 to MC-600 communication cable connection

As shown on the picture 2.1, DS-04T boxes are installed inside the drying chamber. They are connected to MKM-08 via LIYCY 8x0.34 mm<sup>2</sup>. MKM-08 box is mounted on the outer wall of the kiln regarding that the distance (and the cable length) to both DS-04T boxes is as short as possible. Connecting boxes that way provides that all disturbances that affect data transmission of the temperature, EMC and MC data signals are reduced. Maximal length of the used connection cables is 30 m.

## 2.4. CONNECTION OF TEMPERATURE, EMC AND 8-POINTS MC MEASUREMENT SET

In the standard configuration, measuring set for temperature, EMC and 8-points MC, is included with MC-600 controller. This measuring set consists of 1 MKM-08 box, 2 boxes DS-04T, probes, sensors and appropriate cables. In case of system configuration with 6-points MC measurement, DS-03 boxes are delivered instead of DS-04T. For 4-points MC measurement, only one DS-04T box is delivered.

**DS-04T box** is made to provide connection of temperature probe, equilibrium moisture content (EMC) probe and four wood moisture (MC) probes to communication box MKM-08. DS-04T boxes are placed inside the drying chamber, MKM-08 is placed outside.

**Temperature measurement:** Temperature probe with Pt1000 sensor is used for temperature measurement. This probe is mounted inside the DS-04T box in NIGOS factory, and is connected to appropriate clamp in MKM-08 box. See picture 2.4 for LIYCY 8x0.34mm<sup>2</sup> cable connection.

**Equilibrium Moisture Content (EMC) measurement:** Two hole-plugs, marked EMC, are placed at the side of the DS-04T box. They are used for connecting EMC paper holder, as shown on picture 2.5. EMC paper is rectangular shaped and made of special hygroscopic material. Since one EMC paper-element is used for **ONE** drying cycle only, it should be discarded after it, and new one should be fitted when a new drying cycle starts. Until used, EMC paper should be stored on 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.

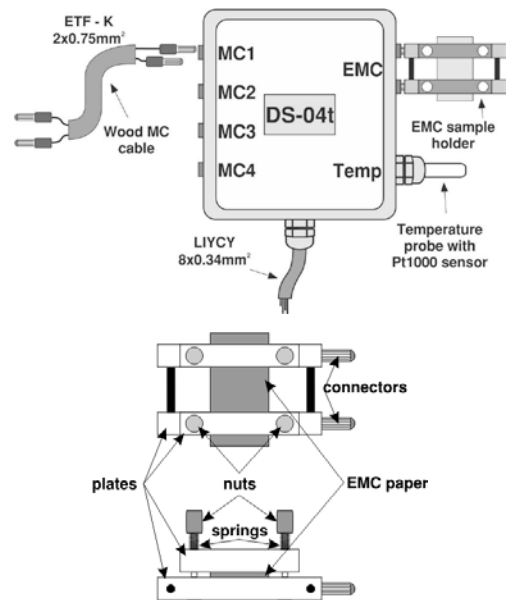
**NOTE: EMC paper is used for ONLY ONE drying cycle!!!** That means, after each drying cycle is finished, the old EMC paper should be discarded and replaced with new one according to given instructions.

**Measurement of wood moisture content (MC) in 8 points:** 8-points MC measurement set consists of 8 connection cables and a set of wood moisture probes. These probes can be for "one-time-use" (galvanized screws) or "multiple-time-use" (INOX nails).

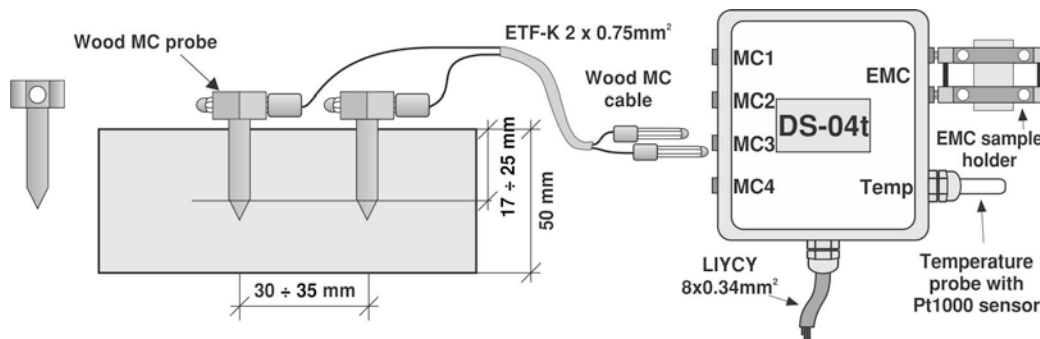
Drying process is primarily based on average wood MC that is obtained from 8 different measuring spots. Therefore, proper fitting of the probes in the wood and their symmetrical disposition inside the chamber is most important.

### STAINLESS STEEL NAIL PROBES SET-UP (probes for multiple use - non-discardable probes):

These are stainless steel (INOX) - multiple use probes. After each drying cycle they must be carefully taken out of timber and kept 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 (DS-04T) placed on the wall, inside the drying chamber.



Picture 2.5. Connection of the measurement elements to DS-04T and EMC paper holder



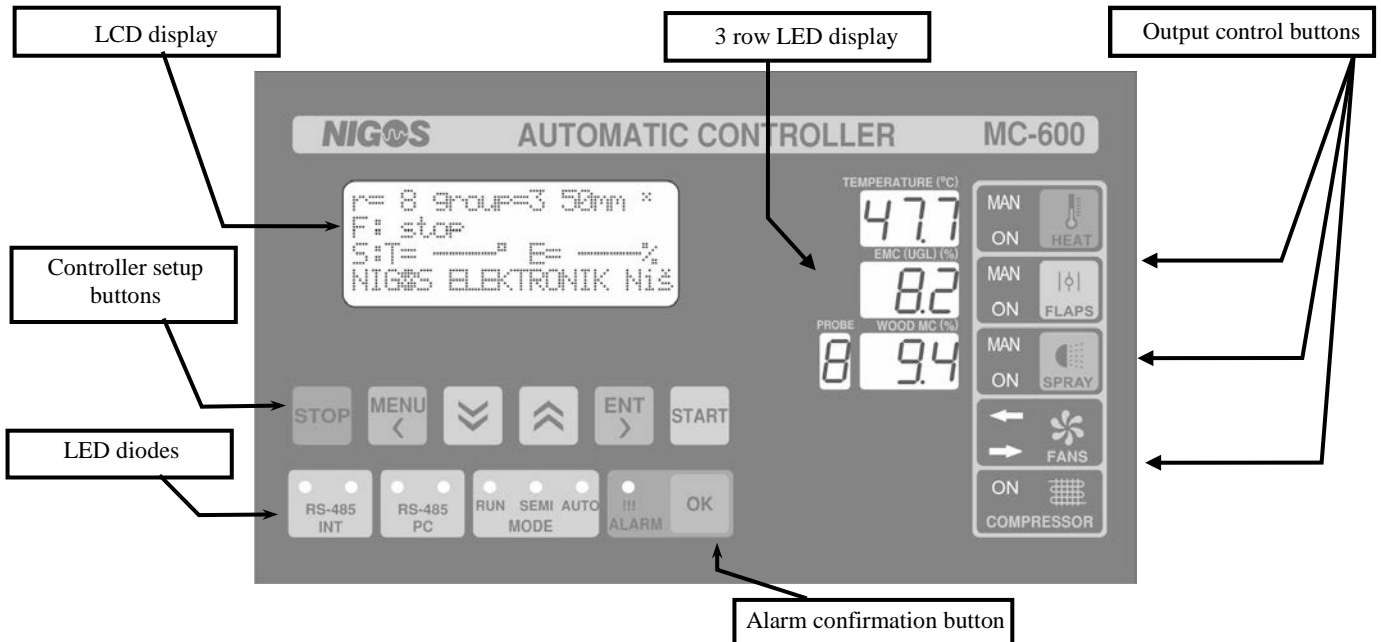
### 3. OPERATION

#### 3.1. MC-600 FRONT PANEL LAYOUT

MC-600 front panel includes:

- One 4-rows x 20-characters LCD display (2 different languages in Latin char-set supported)
- Two 3-digit - 7-segment LED displays and one 4-digit - 7-segment LED displays
- 17 LED indicators for controller state indication
- 10 buttons for controller setup and manual output control

Front panel layout is shown on the next picture, while functions of displays, buttons and diodes are given in following text.



##### 3.1.1. LCD displays functions



LCD display has 4 rows with 20 character in each row with support for Latin character set. During normal operation of the controller, this display shows all relevant messages regarding operation process for controller-user interaction.

Upon power supply connection LCD displays "NIGOS" logo, name and version of the controller. After that display switches to home display that shows:

- selected drying regime, group of wood, thickness and access level
- current process phase
- temperature setpoint and EMC setpoint
- messages regarding drying progress, warnings and alarm situations

```
r= 8 group=3 50mm *
F: stop
S:T= — ° E= — %
NIGOS ELEKTRONIK NIŠ
```

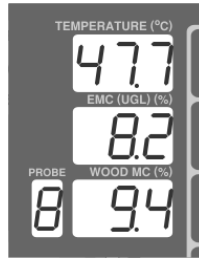
Access level to controller's options is displayed at the end of the first row. When controller is locked, label \* is displayed. If the label k is displayed, access to advanced level and its options is enabled. See chapter 3.7 for more details.

When the  button is pressed, home display is replaced with menu display. Actual display varies depending on the chosen option in the menu. Controller returns back to home display automatically if no button is pressed within 4 minutes period. To return to home display manually, press the  button again.

### 3.1.2. LED displays functions

7 - segment LED displays always show:

- Measured air temperature in the dryer
- Measured equilibrium moisture content (EMC)
- Measured wood moisture content (MC)



If a symbol **Snb** is displayed on temperature or EMC display, it indicates that the actual probe is broken, i.e. measured values are not correct. This can be temporary problem, but during this time alarm is activated.











Table 3.1. LED displays

LED DISPLAY LABEL	POSITION AND INDICATION	DESCRIPTION
Temperature	Top row; 3 digit LED; decimal point indication	Shows average value of measured air temperature obtained from active temperature probes ( 1 or 2)
Equilibrium moisture content	Middle row; 3 digit LED; decimal point indication	Shows average value of measured equilibrium moisture content obtained from active EMC probes (1 or 2)
Wood moisture	Bottom row, last 3 LED positions: moisture values lower than 100% are displayed with one decimal point; values higher than 100% are displayed without decimal point	Shows wood moisture obtained from each MC probe alternately and average value from all active probes
Measurement input	Bottom row; first position	Ordinals <b>1</b> to <b>8</b> (with decimal points) show related measurement points, i.e. number of active probe. If a probe is passive, number is shown without decimal point. When 4 MC input configuration is installed, display is shown in range <b>1</b> to <b>4</b> . <b>P</b> - average wood moisture content





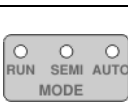






### 3.1.3. Buttons' functions

MC-600 has a total of 10 buttons divided into 2 groups. Controller setup buttons belong to first group, while buttons in the second group provide manual control of the outputs. Pressing some of the 7 buttons from first group placed on the controller's front panel activates: parameter adjustments, starting or stopping of the system, etc. Buttons for outputs control provide manual control of the outputs and can be used for activating or deactivating specific output.


	- Used for ENTER/EXIT into menus and CANCEL unwanted changes.
	- CONFIRMATION of menu option selection and parameter change acceptance.
	- INCREASES the value of currently selected parameter or LIST menu options upwards.
	- DECREASES the value of currently selected parameter or LIST menu options downwards.
	- System START-UP, i.e. starts drying process.
	- Short press cause system SHUT-DOWN, i.e. stops drying process. - Long press cause system PAUSE, i.e. drying process is temporary paused and can be resumed later
	- Resets all existing alarms when controller is in home display mode - When regime display is selected, this button copies the value of preceding point in the regime.
	- Activation/deactivation of manual operation mode for heating output (long press) - Turning heating output ON / OFF (short press)
	- Activation/deactivation of manual operation mode for drying output (long press) - Turning drying output ON / OFF (short press)
	- Activation/deactivation of manual operation mode for spraying output (long press) - Turning spraying output ON / OFF (short press)










### 3.1.4. LED diode functions

There are 16 LEDs on the front panel of controller, which indicate controller's states during drying process.

	- Diodes <b>RS-485 (INT)</b> indicate communication activity with communication unit MKM-08	
	- Diodes <b>RS-485 (PC)</b> indicate communication activity with PC	
	- Flashing of diode <b>RUN</b> indicates beginning of the drying process (measuring phase). Later, it is lit constantly until drying process is finished or system is stopped - Diode <b>SEMI</b> indicates semi-automatic operation mode of the controller - Diode <b>AUTO</b> indicates automatic operation mode of the controller	
	- Diode <b>ALARM (!!!)</b> indicates that there is some critical situation which causes the system to pause	
	- Diode <b>MAN</b> indicates that manual control of the heating output is activated - Diode <b>ON</b> indicates that heating valve is opened. Otherwise it is closed.	
	- Diode <b>MAN</b> indicates that manual control of the drying output is activated - Diode <b>ON</b> indicates that flaps (dampers) are opened. Otherwise they are closed.	
	- Diode <b>MAN</b> indicates that manual control of the spraying output is activated - Diode <b>ON</b> indicates that spraying valve is opened. Otherwise it is closed.	
	- Diode $\leftarrow$ indicates contra-clockwise direction of the fans - Diode $\rightarrow$ indicates clockwise direction of the fans	} Each change of direction starts pause period before direction change which is indicated by diode flashing
	- Diode <b>ON</b> indicates that compressor is turned on	

### 3.2. PARAMETER SETTINGS

In order to change any parameter, user must press the button  to enter main menu. Each **menu** has multiple **options** which are accessible and visible on the LCD display depending on the selected access level. Based on the label which is shown at the end of first row on LCD display, it is easy to conclude whether the controller is locked (⊗ is displayed) or advanced level access is enabled (⊗ symbol is shown here).

Menu options is scrolled using buttons  and . Currently selected option (or parameter) is shown inverted. Press the button  in order to select an option. This enters the sub-menu which contain list of available parameters. When in this list, it is possible to scroll the parameters using buttons  and , and select the parameter for changing by pressing . When certain parameter is selected, its value can be changed using buttons  and . If certain value is changed pressing the button  will confirm the acceptance of the change.










In same situation button  has a function to cancel the any changes made and return to prior sub-menu. If the button is pressed again, controller will return to standard display. In case no button is pressed in 4 minutes, controller will also cancel the change and return to standard display.

Table 3.2. Menu options and access level

MENU			
Drying param	Drying parameter setting	}	Free access
Probes	Probes state setting		
Control	Displays measured temperature and EMC as well as control inputs		
Fans	Overview of fans state and fans parameter setting		
Access	Access level setting		
REGIMES	Regimes overview and setting	}	Code protected (advanced level access). See chapter 3.8 for more details.
SETUP	Controller setup		
KILN TYPE	Kiln type setting		

#### 3.2.1. Option: Drying param

Drying Param	
Operating mode	auto
Timber Group	3
Schedule	1
Thickness/mm	50
Heat time/h	0
Final MC	12.0
Equalization	no
Conditioning	no

This option is used for drying parameters setting. Buttons  and  are used for parameter scrolling, pressing the button  will select the parameter (display is now as shown on the picture), and changing of the parameter value is performed using buttons  and . To cancel unwanted change, press the button  and to confirm the change, press the button . After all desired changes are made and confirmed, press the button  to exit this option and return to upper sub-menu. These parameters can be changed even during drying process.

It is required to set all parameters from this option when automatic drying mode is used. For semi-automatic mode only correct setting of Timber Group parameter is required.

Table 3.3. Parameters of Drying param option

PARAMETER LABEL	DESCRIPTION	RANGE OF PARAMETER VALUES	DEFAULT VALUE
Operating mode	Operating mode	semi, auto	auto
Timber Group	Group of wood. Measurements will be made according to this value (see Table 3.3.)	1, 2, 3, 4	3
Schedule	Schedule (regime) according to which drying will be controlled	From 1 to 60	1
Thickness/mm	Lumber thickness	From 20 to 80 mm	50
Heat time/h	Time to maintain certain temperature during pre-heating phase	From 0 to 100 h (adjustable in 1 h steps)	0
Final MC	Final wood moisture that has to be achieved at the end of drying	From 5.0 % to 30.0 % (adjustable in 0.1 % steps)	12.0
Equalization	Equalization phase permission	no, 1, 1.5, 2, 3	no
Conditioning	Conditioning phase permission	yes, no	no

##### 3.2.1.1. Parameter: Operating mode

This parameter defines in which mode the controller will operate. When it is set to **automatic mode**, the controller will follow the selected drying schedule (regime). In **semiautomatic mode**, the user must set desired values for air temperature and humidity, and the controller will maintain them at the constant level. There are two diodes below LCD that display selected mode all the time (see Chapter 3.1.4).

##### 3.2.1.2. Parameter: Timber group

It is necessary to define the group 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.

Table 3.4. Table of wood groups and related groups of wood species according to which the MC measurement is made

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

### 3.2.1.3. Parameter: Schedule

Parameter **Schedule** is used to select schedule (drying regime) that will be used in drying process control. Each regime defines temperature and EMC curves (relations between chosen parameter - T or EMC, and time), temperature gradient for heating, temperature and humidity setpoints for conditioning phase and duration of the conditioning phase. here are 60 schedules and all schedules are made for lumber thickness of 50 mm. Controller MC-600 can control drying process in both conventional and dehumidifying dryers. User, according to his own needs, can change any regime and save changed regime in controller's memory.

There are 2 time based regimes. These regimes disregard average wood MC and follow only predefined time line to change temperature and EMC curve. They should be used in cases when it is not possible to accurately determine wood MC of timber which should be dried (very thin timber, firewood, etc.,...). Changing of the particular regime is available only at advanced access level, using options **Schedule** from main menu. Upon drying process start-up, controller will automatically adjust drying process to selected schedule and kiln type.

For more information, please refer to additional provided documentation. In case specific wood group is not given in the table, contact us.

Table 3.4. Table of drying regimes pre-defined by "NIGOS - elektronik"

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

CONVENTIONAL DRYER	DEDICATED REGIMES		
	Slow	Average	Fast
<b>Softwood</b>	41	42	43
<b>Beech, steamed</b>	44	45	46
<b>Oak, sessile</b>	47	48	49
<b>Douglas</b>	11	41	42
<b>Lamella &lt; 10 mm</b>	50	56	57
DEHUMIDIFYING DRYER	Slow	Average	Fast
<b>Softwood</b>	53	54	55
<b>Soft hardwood</b>	52	53	54
<b>Hard hardwood</b>	52	52	53
<b>Lamella &lt; 10 mm</b>		56	57
<b>Lamella by EMC (without wood probes)</b>		58	

### IMPORTANT WARNING FOR USING PRE-DEFINED SCHEDULES!!

Drying regimes which are inserted in controller's memory 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 faults on the timber (bent, crack, twist, etc...) or any accidental situation during drying process caused by either operator's negligence or disregarding process, even when the manufacturer's pre-defined drying regime is used.**

### 3.2.1.4. Parameter: Thickness

This parameter defines average thickness of the lumber, which is to be dried. It is necessary to set this parameter value properly for normal progress of drying process. Drying schedules 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
- values for temperature curve 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
- values for temperature curve are decreased.

Calculations are made in percentage relative to the thickness in millimeters.

### 3.2.1.5. Parameter: Heat time

Drying of certain wood species (especially certain exotic species and hard woods) require core heating, i.e. it is required to equal wood core temperature with surface temperature. When drying temperature is achieved (during heating phase), this parameter can be used to set the time for which the controller will maintain this temperature before allowing drying to start. Parameter value is in hours (0 to 100 h in steps of 1 h). After each drying cycle is over, this parameter is reset to 0 (off).

### 3.2.1.6. Parameter: Final MC

Defines desired final wood moisture content value at the end of the drying process.

### 3.2.1.7. Parameter: Equalization

Determines whether equalization phase will be performed and at which range. In case "no" is set, equalization will not occur. In case "2" is set, then controller will lead drying process in such way that all probes for wood MC are in range  $\pm 2\%$  from value set for final wood MC.


WARNING: This function can significantly extend drying time while success outcome depends on dryer ability to provide wanted conditions!






### 3.2.1.8. Parameter: Conditioning

Parameter Conditioning defines whether conditioning phase will be performed after drying phase or not. Relevant parameters that define this phase closely are given within the selected schedule.

## 3.2.2. Option: Probes



Probes		
MC 1	23.5	activ
MC 2	18.9	activ
MC 3	65.4	Passiv
MC 4	20.8	activ
MC 5	24.2	activ
MC 6	-----	activ
MC 7	-----	no
MC 8	-----	no
Calc mode/MC		avg

This option shows measured value and state of all MC probes labeled with MC1 ÷ MC8. Attached probes will be listed here with shown state for each probe (active or passive). To list probes, use 

and , and select one by pressing , after which it is possible to change the probe's state using buttons  and . To confirm change of the probe state button  must be pressed.

**Active state** of the probe indicates that information (MC or temperature) received from MKM-08 from this probe will be taken in count. **Passive state** indicates that this value is discarded in average value calculation.

When drying is selected, average value is calculated based on the data received only from active probes and drying process is controlled based on this value. Controller does not allow putting all the probes in passive state. At least one of them must be active. It is possible to turn off certain probes from poling and listing when controller is unlocked. In that case first pressing on the button

 will set the probe in passive state, and next pressing on the button  turns the probe off.

Parameter Calc mode/MC determines how average wood MC is calculated. It can be calculated as minimum (min), maximum (max) or average (avg).

## 3.2.3. Option: Control


Control		
EMC 1	8.5	activ
Temp1	48.9	activ
EMC 2	7.4	Passiv
Temp2	51.2	activ
Calc mode/Temp		avg
Calc mode/EMC		avg
Contr.temp	73.2	

LED displays always show **average value** for temperature and EMC. Option Control gives overview of current measurement values for all temperature and EMC probes and control inputs. Each probe can be set to passive or active state, with limitation that at least one temperature and at least one EMC probe must be always active. Same like in the option Probes, it is possible to turn off certain probes from poling and listing.

If only one temperature/EMC probe is installed, then for the one that is not attached, label "off" is displayed. In case the probe measure fault value, label "error" is displayed.

Parameters Calc mode/MC and Calc mode/EMC determine how average is calculated. It can be calculated as minimum (min), maximum (max) or average (avg).

Control temperatures are displayed at bottom. When the control probe is attached and measures temperature in the range -25 to 200 °C, measured value is displayed. Otherwise, label "—" is displayed. There are 4 control inputs for temperature measurement.

If the controller is unlocked, it is possible to turn off probes from listing. Press the button  to set the probe into passive state, and press it again to turn off the probe. Probes should be turned off only if they are not installed or malfunctioning.

### 3.2.4. Option: Fans

```
Fans stop
Change direct.? no
Fan Period/min 240
Fan Pause/min 3
```

This option displays status of the fans and gives options for their setup.

Parameter `Change direct.?` enables change of fans (and consequently air flow) direction. After this option is activated by setting `yes`, fans will stop, wait for pause time to pass and then start rotating in the opposite direction.

Parameter `Fan Period/min` defines time in minutes for which the fans will rotate in one direction.

Parameter `Fan Pause/min` defines time in minutes for pause between direction change. Operation of

fans is not allowed during this pause to prevent damage to motor in case direction is change before the impellers had time to stop and while they are still turning in opposite direction.

### 3.2.5. Option: Access

```
Access
Enter access code
****
locked
```

Option **Access** is used for setting access level to the unit and its options and parameters as well. Entering correct access code unlocks the unit and makes access to advanced level possible. As an indication that the control unit is locked, LCD in home view shows symbol \* at the end of the top row on LCD display. After entering correct access code there is no symbol shown there to notify that the access to advanced level is granted.

More details regarding this option are available in Chapter 3.7.

## 3.3. OPERATING MODES


### 3.3.1. Automatic, semiautomatic and manual mode

#### 3.3.1.1. Automatic mode

To select automatic mode, go to `MENU > Drying Param` option, then choose `Operating mode` parameter and select `auto`.

In automatic mode, before starting the drying process, user must set all parameters in `MENU > Drying Param` option. It means automatic mode, wood group, drying regime, lumber thickness, heat time, final wood moisture content and conditioning options must be set. All these parameters are very important, because on the basis of those data and chosen regime unit can lead the drying process and determine required setpoints in every moment. Some of these parameters can be changed during process.






Drying process runs according to chosen drying regime. 20 different regimes can be defined, but only 8 of them are user-programmable. On advanced access level, user or authorized person can define drying regimes according to expert's claims. After the start of drying process

(performed by pressing the button , and confirming start by selecting - `yes`), user should survey system periodically. It is recommended that user register any alarm situation timely, and to take action in accordance with emergency procedure (described in Chapter 3.6) if the situation is urgent.

#### 3.3.1.2. Semiautomatic mode

To select semiautomatic mode, go to `MENU > Drying Param` option, then choose `Operating mode` parameter and select `semi`.

In semiautomatic mode, user must set only two parameters in `MENU > Drying Param`. Semiautomatic mode and wood group must be selected. Remaining parameters in this option are not relevant for controller operation in semiautomatic mode. Immediately after semiautomatic mode is selected, controller gives the user opportunity to adjust set values for temperature and EMC (`SET= — EMC= —`). User must set these parameters based on the personal experience and wood MC measured by controller. To enable parameter setting, LCD display must be in home display mode.

Pressing the button  cycles through selection of temperature and EMC which is labeled in inverse color of selected parameter. Value adjustment is performed using buttons  and . To confirm parameter change, button  must be pressed. After desired values for temperature and EMC in semiautomatic operation mode are entered, user must press button  to exit adjustment option, which is automatically happening if no button is pressed for 4 minutes.

In semiautomatic mode, user must periodically check actual values for temperature and EMC in the chamber and wood MC and based on these data, update set values for temperature and EMC. Set value for temperature can be in range 0 °C to 70 °C (up to 100 °C on user request), while EMC can be set in range 0% EMC to 30% EMC. In semiautomatic mode, there is no heating phase - drying phase starts immediately. User himself decide when to end drying, and weather he wants conditioning phase (and sets conditioning parameters).

MC-600 will control heating valves and drying flaps on his own, so alarm situations may occur, and if does, user should register them and if necessary make interventions according to instructions given in Chapter 3.6.

### 3.3.1.3. Changing of operating mode (auto to semiauto and vice versa)

Changing of operating mode is available in MENU > Drying param option by choosing Operating mode and selecting desired mode as parameter. When you change operating mode **from automatic to semiautomatic**, controller preserves last calculated temperature and EMC setpoints from automatic mode, so activity of control outputs stays same like before the change. When you activate **automatic mode from semiautomatic**, controller turns off all outputs for about 20 seconds (reduced measuring phase) and after that it calculates new setpoint values and proceed with operation.

### 3.3.1.4. Manual mode


Manual mode is available through the group of buttons located on the right part of the controller. Disregarding current operating mode, at any time of drying process you can choose manual control of **heating, drying or spraying** function by pushing corresponding button (long press) for each output separately. LED diode "MAN" is lit to indicate manual control of selected output. Short pressing of the button always change the state of output (turn on/off). If the output is turned off, and button is pressed, output will become active. LED diode "ON" is lit to indicated that appropriate output is active. If button is pressed and hold down again, output will be deactivated (turned off).

There is no need to set all outputs to manual mode, but only the one that is related to output we want to control manually. During this time, automatic control unit stays in selected operating mode (automatic or semiautomatic).



## 3.4. DRYING PROCESS START UP


```
Oak slow      50mm
auto          3      12.0%
Oh           Cond:  no
Start dryer ?  yes
```

When all required parameters for drying process are set, system can be started by pressing the button

. After this, all parameters are displayed above the question Start dryer ?. Default value is always no. User can check all relevant parameters once more and if everything is all right, use the


buttons  and  to change the answer to yes and confirm the change by pressing the button



. After that system is started. If you do not want to start drying, you can either choose answer no and press the  button or press the




 button no matter which answer is chosen.

## 3.5. STOPPING DRYING PROCESS

```
Oak slow      50mm
auto          3      12.0%
Oh           Cond:  no
Stop dryer ?  yes
```

While system is running, you can stop the drying process by pressing the  button. After pressing this button, automatic control unit responds with showing drying parameters and question: Stop

dryer? Default answer is no. You can refuse to stop drying by pressing either  or  button, or


choose answer yes using button  or  and confirm it by pressing the  button to immediate

stop drying process. After that, all control outputs turns off and process is stopped.


**We emphasize that the system should be stopped this way only if user considers the drying process is finished. If you want to stop drying process temporary, you can switch off power supply to stop the drying. After restoring power, the unit continues process automatically from where it was interrupted.**


## 3.6. WARNINGS AND ALARM SITUATIONS

During drying process some unwanted situations could occur. The unit is programmed so that it could recognize some irregular situations and announce them by showing certain messages on LCD. If the unit can identify the problem, it shows a proper message in the last row of LCD. These warnings do not stop drying process, but make user pay attention to the situation and take action. Warnings are shown on display as long as the situation is present, or until the message is revoked.

The warning can be cancelled by pressing the  button.

**Alarm situation causes** pause of the drying process, because the ensued situation does not allow the process to be continued. Simultaneously with announcing the situation on LCD display, LED indicator !!! (ALARM) blinks and built in buzzer turns on. In that case, user must intervene to revive the system, if possible. In case user can not find out a reason for alarm, user should contact manufacturer or authorized

person that maintain the system. Pressing the  button once resets buzzer output.

Alarm message is present on LCD until the reason of alarm is resolved. Pressing the  button can clear the alarm message, but it will be activated again if the reason of alarm persists. In that case, user should apply defined procedure for eliminating alarm situation that is

presented in table 3.6. After the alarm reason is eliminated, the unit passes a new measuring phase and continues the drying process until desired values are reached.

If more than one either warnings or alarms ensue during process at the same time, they will be displayed on LCD alternately every 2 seconds. All alarm and warning messages that can appear on LCD during drying process are given in next table. Also, there are some procedures that the unit performs independently, or either user or authorized person should perform to eliminate the problem.

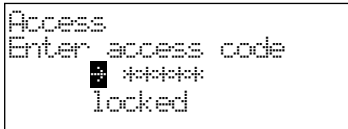
**Table 3.6. List of possible warning and alarm messages:**

MESSAGE	MESSAGE DESCRIPTION AND RECOMMENDED ACTIONS
fan failure ?	These messages notify that there is a problem (or problems) in functioning of one or more fans. These messages don't cause the system pausing. Authorized person should check notified fans. Activities of fans are always checked by system at start of drying process.
temp holdback HI temp holdback LO	In case that measured value exceeds allowed deviation of setpoint, one of these warnings on LCD appears. All outputs are operational, but drying process is stopped until the warning is active. In that case, you should compare temperature value in the kiln, shown on LCD, with a manually obtained value, if it is possible. Check the temperature probes and the rest of equipment in the kiln. If needed, consult authorized person.
-overheat	This alarm activates when temperature in the kiln becomes higher than maximal drying temperature (Max drying temp) for more than 10 °C. It causes system pausing. Only cooling is enabled during that state. When temperature drops to Max drying temp + 2 °C, controller will continue drying. Check the heating valve. Consult authorized person.
-underheat	This alarm activates when temperature in the kiln becomes lower than minimal drying temperature (Min drying temp) for more than 2 °C. It causes system pausing. Both cooling and drying are disabled. Check the heating boiler. Consult authorized person.
temp low for sprayin	Temperature has dropped below minimum at which spraying is allowed. Find the reason for temperature drop.
diff temp1-temp2 ?	If both temperature probes are active, this warning will signal that there is great difference between them. User must check the temperature probes and find possible cause for this difference.
temp probe 1 ? temp probe 2 ?	Signalizing that one of the temperature probes is measuring improper value. If the other probe is working properly, the system discards the first one and continue working.
-temp probe ?	Warning that both temperature probes failed and measurement is wrong. It causes system pausing and all equipment is shut down. Service is obligatory!
enc holdback HI enc holdback LO	These messages appear when measured EMC exceeds allowed limits. Check EMC probes, flaps and sprinklers.
diff enc1-enc2 ?	If both EMC probes are active, this warning will signal that there is great difference between them. User must check the EMC probes and find possible cause for this difference.
enc probe 1 ? enc probe 2 ?	Signalizing that one of the EMC probes is measuring improper value. If the other probe is working properly, the system discards the first one and continue working.
-enc probe ?	Warning that both EMC probes failed and measurement is wrong. It causes system pausing and all equipment is shut down. Service is obligatory!
wood probe x ? (x = 1 ÷ 8)	Signalizing that one of the wood MC probes (1 of 8) is measuring improper value. Set this probe to passive state and continue working. At least one probe must stay active.
-wood probes error	All wood MC probes measure incorrect values. Check wood MC probes, connection cables and connection boxes. In semiautomatic mode, this alarm has no influence.
max-min temp comfr	Temperature in the chamber is below minimal temperature at which compressor operation is allowed. Find the reason for temperature drop.
comfr. malfunction	Warning that compressor x (from 1 to 3) is malfunctioning. Call authorized service or NIGOS. Service is obligatory!
-compress error -compress malfunction	Compressors won't start or they have turned off during operation. Call authorized service or NIGOS. Service is obligatory!
-com error M01 -com error PC	Messages reporting error in communication between controller and PC computer. Possible causes are equipment malfunction (appropriate communication box) or split communication cable.
-code error -CSM memory error -SPI error	System messages. User has no influence and if these messages are reported by the controller, authorized service or NIGOS must be contacted immediately. Service is obligatory!
! Paused !	Drying process has been started, but system is paused due to an alarm appearance. This message is shown on LCD whenever a warning that causes system pause is present.

### 3.7. ADDITIONAL ADJUSTMENTS

Controller MC-600 has a number of functions that provide some additional adjustment. Due to possible irregular operation of the controller these functions are hidden, and regular user cannot access them, but only experience users and authorized personal. Access to this advanced access level is possible after a correct code is entered in the Access option.

#### 3.7.1. Option: Access



Option Access is used for setting access level to the unit and its options and parameters as well. Entering correct access code unlock the unit and progress to advanced level is possible. As an indication that the control unit is locked, LCD in home view shows symbol \* placed at the end of first row. After entering correct access code, symbol \* is not displayed anymore, and is replaced by symbol k to notify that the access to advanced level is granted.

When this option is activated, LCD shows message: Enter access code, 5 asterisks (\*\*\*\*\*), and current access level state (locked / unlocked). If none of buttons is pressed within 4 minutes, system gets locked automatically. When

user wants access to advanced level to be granted, correct value for access code must be set using the or buttons, and pressing the button after that. Default value for access code (set by manufacturer) is 600 and user can change it by using parameter Access Code, in the option MENU>Setup>System. If the entered code is correct, message unlocked is displayed on LCD. In any other case the unit remains locked and home view is shown on LCD.

**User should use this option with extreme caution, because there are only three chances to enter the correct code. If you fail three times, controller will get permanently locked and you will not be able to unblock it at all (even entering correct code can not unblock it!). In that case you should contact either NIGOS or authorized person.**

#### 3.7.2. Option: Regimes

Option Regimes becomes visible when the controller is unlocked (correct code is entered in option Access). This option defines regimes used in automatic operation mode for appropriate wood specie. There are 60 drying regimes for conventional dryers and 40 for dehumidifying. Changing of the particular regime is available only at advanced access level, using options Regimes.

Each regime defines temperature and EMC curves (relations between chosen parameter - T or EMC, and time), temperature gradient for heating, temperature and EMC setpoints for conditioning phase and duration of the conditioning phase. All regimes are made for lumber thickness of 50 mm. User regimes must be also made for lumber 50mm thick because controller automatically change EMC curve, temperature gradient for heating and conditioning time. The thinner the boards, the faster the regime will be (EMC curve is steeper), and vice versa - for thicker boards, regime will be slowed down (EMC curve becomes milder).

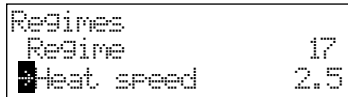
Special situation occur when user has no data for lumber 50mm thick, but only for some other thickness he uses all the time. In that case he can make a regime using that data for that specific wood group and that specific thickness. But, in order to avoid change of the regime data, he must select thickness of 50 mm for parameter Thickness (mm) in option Drying Param. Regime defined in this manner should be used ONLY for drying of that specific wood group and thickness.

#### USER REGIME ADJUSTMENT PROCEDURE:



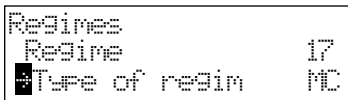
Option REGIMES displays symbolic name and regime ordinal: Regime 17.

- In case different regime is wanted, use button to list through to wanted regime. Then use buttons and to adjust the values and confirm the selection by pressing button .

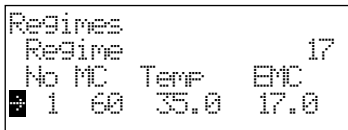


- After regime number is selected use button to advance to parameter Heat speed. Heat speed is temperature gradient during heating phase i.e. temperature increase speed in °/h.

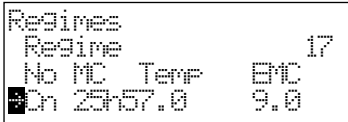
- After that type of regime is shown. It can be depending on wood MC (MC) or time based (time)



- Use button to advance to wood MC selection (60, 55, 50, ..., 10, 5) and adjust values for



temperature and EMC for each of them. Use button to advance from wood MC to (MC) to temperature (Temp), then EMC (EMC) and back to wood MC. Adjust the values for each parameter using buttons and , confirm with button and cancel change using button .



- Below are data for conditioning: duration (Duration/h), temperature (Temp) and EMC (EMC).

- After all parameters are adjusted and there was an error, it is possible to load default factory settings for each regime. In case we decide to cancel all changes choose answer yes for last option Load defaults.

**In case user wants to store newly made regime, choose answer no for last option Load defaults.**

As precautions measurement, controller displays message changed for each modified regime.

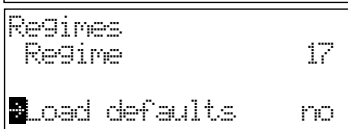




Table 3.7. Parameters of Regimes option

PARAMETER LABEL	DESCRIPTION	RANGE OF PARAMETER VALUES	DEFAULT VALUE
Regime	Regime ordinal	From 1 to 60 (40)	1
Heat speed	Rate at which heating temperature will raise (heating temperature ramp rate) given in °C per hour	From 0.1 °C/h to 10.0 °C/h	2.5
Type of regime	Regime type description. It can depend on wood MC or time	MC, TIME	MC
No	Column number in the regime. Values 1 to 12 are for regime parameters, Cn is for conditioning parameters	From 1 to 12, Cn	1
MC (in 5% steps)	Specific wood MC for which temperature and EMC data is used	From 60.0 %MC to 5.0 %MC	60
Temp	Temperature for selected wood MC	From 10.0 °C to 60.0 °C	30
EMC	EMC for selected wood MC	From 2.0 % to 30.0 %	14.6
Duration	Duration of conditioning phase in hours	From 5 h to 50 h	30
Temp	Temperature during conditioning phase	From 10.0 °C to 60.0 °C	45
EMC	EMC during conditioning phase	From 2.0 % to 30.0 %	7

### 3.7.3. Option: Setup

```

M E N U>Setup
  Language
  System
  Out spraying
  IO device
  
```






This option is submenu that provides access to various adjustments of the controller. After controller is unlocked, following options are available with user access level.

### 3.7.4. Option: Language

```

Language
  Serbian      5006
  English      5006
  Choose version
  
```

Selection of display language. There are 2 languages for user to select from. New language can be installed upon user request. Only languages with Latin characters are supported due to LCD limitation.

Use buttons  and  to select desired language and confirm the change with button . In addition, use button  to confirm language change and press button  again.

### 3.7.5. Option: System

```

System
  User code      600
  Dry T RampRate 10.0
  Max temp/*     70.0
  Temp end/*     -10.0
  Cool T RampRate 2.0
  Temp holdback% 20
  EMC holdback%  20
  Diff T1-T2     10
  Diff EMC1-EMC2 7
  
```

Option **System** provides adjustment of certain system parameters. Each change of these parameters should be taken with extra caution and change should be documented. This especially apply to change of access code (parameter **User code**), because access to any advanced settings of the controller will become impossible if access code is changed and then forgotten.

Table 3.8 shows all parameters in this option. Initial values (default values) are different depending on the chosen dryer type. If "default value" column contains two values, first always apply for conventional and second for dehumidifying dryer.

Note: In case there are 2 values in default value column, first is regarding to conventional, and second to dehumidifying drying mode.

(\*) – In dehumidifying dryers, parameter **Max temp (°C)** can be set to maximum 65.0°C.

Table 3.8. Parameters of System option

PARAMETER LABEL	DESCRIPTION	RANGE OF VALUES	DEFAULT VALUE
User code	Access code for advanced level	0 to 65535	600
DryTempRampRate	Temperature ramp rate in drying phase	0.1 °C/h to 10.0 °C/h	10.0
Max temp/* (*)	Maximal temperature in drying phase	30.0 °C to 60.0 °C	65.0 / 56.0
Temp end/*	For how much to lower the temperature at the end of the drying before stopping the dryer	-20.0 °C to -0.1 °C	-10.0
Cool T RampRate	Temperature decrease rate in cooling phase (°C/h)	-20.0 °C to -0.1 °C	-10.0
Temp holdback%	Measured/set temperature deviation ratio (in %). When the value is exceeded, system freezes at its current point, waiting for process to catch up.	1 % to 50 %	20
EMC holdback%	Measured/set EMC deviation ratio (in %). When the value is exceeded, system freezes at its current point, waiting for process to catch up.	1 % to 50 %	20

Diff T1-T2	Allowed difference of temperature reading between installed probes	0 °C to 25 °C	10
Diff EMC1-EMC2	Allowed difference of EMC reading between installed probes	0 % to 10.0 %	7

### 3.7.6. Option: Out spraying

Out spraying	
Min time/min	10
Max time/min	60
On/sec	30
Off/sec	30
Hold time/min	30

Option `Out spraying` enables user to set main parameters which define operation of spraying output. Picture shows available parameters on user access level. There are several situations that allow/forbidden activation of spraying. For instance, spraying is not allowed if compressor or drying outputs are active. Once started, spraying will work regardless of spraying condition for `Min time`. After this time, spraying condition is checked again, and if needed, spraying will remain active for as long as defined in `Max time` parameter.

Spraying output operate in impulses defined by parameters `On` and `Off`. After Spraying has stopped, system pauses for time defined by `Hold time` parameter. Automatic controller MC-600 has one relay output for spraying. Spraying must be enabled and properly performed to achieve best drying quality.

Table 3.9 shows list of parameters accessible on user level. Change these parameters with extreme precocious, or leave them on default setting.

Table 3.9. Parameters of **System option**

PARAMETER LABEL	DESCRIPTION	RANGE OF PARAMETER VALUES	DEFAULT VALUE
Min time/min	Minimal possible time of spraying	1 min to 240 min	10 / 5
Max time/min	Maximum possible time of spraying in case conditions are not met	1 min to 240 min	10 / 5
On/sec	Time of spraying (output on)	1 sec to 240 sec	30 / 30
Off/sec	Time when spraying is forbidden (output off)	1 sec to 240 sec	30 / 30
Hold time/min	Pause time between 2 spraying intervals when spraying is forbidden	1 min to 240 min	10 / 5

### 3.7.7. Option: IO device

IO device	
Address MC	1
Baud rate MC	57600
Time out MC	10

All parameters for communication with input and output devices are set from this option.  
 - Label MC corresponds to MC-600 controller setup during communication with PC.

Table 3.10 shows all parameters and their possible values.




Table 3.10. Parameters of **IO device option**

PARAMETER LABEL	DESCRIPTION	RANGE OF PARAMETER VALUES	DEFAULT VALUE
Address MC	Unique device address in communication	1 to 63	1
Baud rate MC	Communication speed	4800, 9600, 14400, 19200, 28800, 57600, 115200	57600
Time out MC	Parameter defines how long will controller wait for specific device to answer	10 to 255 (ms)	10

### 3.7.8. Option: Kiln type

Kiln type	
Kiln type	conv
Econ mod(cond)	no
Inic residues	no

This option provides selection of kiln type (and controller operation mode), compressor operation and parameter initialization. Parameter `Kiln type` can be conventional (`conv`) or dehumidifying (condensation) (`cond`). Other parameters have `yes/no` value.

Button  sets currently selected value to "yes", button  to "no". Use button  to confirm


action, and button  to cancel the action.

Any performed action is verified with message "done".

## 4. OPERATING PRINCIPLES (DRYING PRINCIPLE)

At the start of each process it is required to set parameters relevant to that process. For conventional drying user must set: MENU>Access>Access code (600); MENU>Kiln type>conv. For dehumidifying drying (when compressor is used), dehumidifying kiln must be selected: MENU>Access>Access code (600); MENU>Kiln type>cond. It is recommended to select conventional drying when heat treatment (sterilization) is used. Once these settings are made, they are saved in controller's memory until changed (even after power loss).




After these settings, Drying param option must be set. Each parameter can be changed during drying process. After all parameters are set,

process is started with a pressing on the button . Selected parameters are then displayed and confirmation is required.

In case something must be changed, it can be done through MENU>Drying param. All parameters are memorized for next drying cycle, except parameter Heat time which is reset after each drying cycle and should be set again if needed.

```

Regime    25
auto      3    12.0%
Oh        Cond:  yes
Start drying  no
  
```

To start drying, use button  to change the value to yes and then button  to confirm selected action. After this, selected process is started. Button  cancels started action. When some process is active, LED indicator **RUN** will lit.

### NOTES:

- If average wood MC is lower than Final MC, drying process will end immediately.
- If there is some alarm warning it makes no sense to start drying until it is resolved.
- When power failure occur, controller will memorize all data and continue drying upon power reconnection.

### 4.1. DRYING

Drying is performed in several phases depending on the user selection. Possible phases are: measurement, heating, core heat, drying, conditioning, cooling and end.

#### 4.1.1. PHASE: measurement

```

PHASE measure
  
```

blink.

Every process starts with this phase. Controller waits for some time for measurement stabilization. After **measurement phase**, controller will automatically advance to appropriate phase depending on the received data. During this phase LCD will display shown message and LED indicator **RUN** will

#### 4.1.2. PHASE: heating

After completion of measuring phase, if the temperature inside kiln is lower than start temperature from drying regime **heating phase** starts. Temperature increases by temperature ramp rate for heating phase for the chosen regime. Wood thickness also influence this parameter. Temperature deviation does not pause this process.

EMC is set to value equal to first EMC value in selected regime increased by 2% and calculated according to selected wood thickness. EMC can be manually set in this phase. Fan speed is set to first value in the regime. This value can also be set manually. Manually set values are kept even after power loss. This phase allows active heating, fans, drying, spraying and compressor outputs.

```

PHASE heating
  
```

LCD in home view shows phase label.

When set temperature reach first temperature in the regime, core heating phase will start if Heat time is different than 0. If this parameter equals 0, controller will advance to drying phase.

#### 4.1.3. PHASE: core heating

During this phase, controller will keep (maintain) reached temperature and EMC after heating phase for the time set by user in parameter: Drying param> Heat time. EMC is also maintained, but can also be altered manually. All outputs can be activated.

```

PHASE core heat 1:42
  
```

LCD displays label core heat and remaining time.

If power loss occur during this phase, controller advance straight to this phase after measurement phase and continues in it for remaining time.

#### 4.1.4. PHASE: drying

```

PHASE drying
  
```

In this phase controller starts to follow selected drying regime. This phase lasts until average wood MC drop to the value set in parameter Drying param> Final MC.

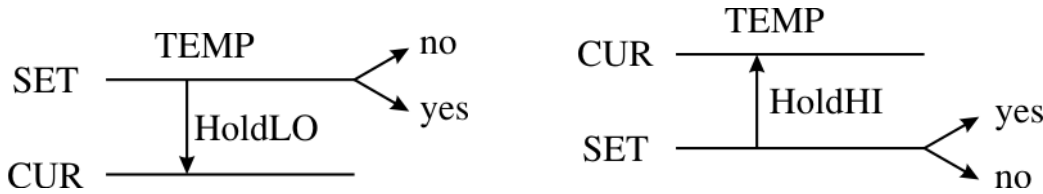
LCD displays phase label.

Set values will change according to time increase ratio (gradient) defined in SETUP>System>Dry T RampRate. Thickness influence the value of this parameter (thickness to heat ramp rate). When new values are required, according to average wood MC and chosen regime, controller will determine required temperature and EMC.

All outputs are allowed in this phase with exception that compressor output is active only when dehumidifying drying is selected.

**NOTE:** For dehumidifying dryer: If the temperature in the chamber is higher than 38°C, and EMC is higher than SET EMC by 1%, controller will not allow further increase of the temperature.

When HI temperature deviation warnings occur (SET Temp is lower than current) controller will stop temperature decreasing. When LO temperature deviation warnings occur (LO Temp is higher than current) controller will stop temperature increasing.



Parameter for wood thickness influence speed of drying, so by altering the parameter `Drying Param>Thickness` it is possible to speed up, or slow down drying. Reducing the thickness evoke lowering of EMC and thus speeding up of drying process. Vice versa, increasing the thickness evoke raising of EMC and thus slowing down of drying process.

EMC can be up to 30.0%, and temperature is limited by parameter `SETUP>System>Max temp`. User regime can be made with even higher temperature, but this parameter will cut the temperature curve to maximum value given by this parameter.

When average wood MC drops to a value given by user in parameter `Drying Param>Final MC`, controller will consider drying phase complete. If conditioning phase is enabled (parameter `Drying Param>Conditioning` is set to `yes`), controller will advance to conditioning phase, and if conditioning is disabled it will advance to cooling phase.

#### 4.1.5. PHASE: conditioning

PHASE condit 18:34

This phase, as the last phase of drying process, provides equalization of wood moisture content inside the wood and on the wood surface. Flaps (dampers) will close. Controller will allow activity of heating, fans and spraying outputs, and block activity of cooling and compressor outputs. Duration of the conditioning phase is defined by time parameter in selected regime, but it is recalculated depending on selected thickness. If the lumber thickness is less than 50mm, conditioning phase lasts a bit shorter than it is specified by regime, and vice versa, if the thickness is greater than 50mm, the phase lasts a bit longer. Phase label and remaining time are displayed on LCD.

Set temperature and EMC are given in regime and can not be changed. Fan speed is also given in regime, but can be manually altered.

After power loss and reconnection, this phase will continue for remaining time in the moment of power loss. Next phase is cooling phase.

#### 4.1.6. PHASE: cooling

PHASE cooling 00:23

During cooling phase, only fans output can be activated. Valves and dampers are shut. Set temperature is equal to last given temperature decreased for value of parameter `SETUP>System>Temp end`. EMC and fan speed will remain at same value as in last phase before cooling. LCD displays elapsed time.

After power loss and reconnection, this phase will continue until set temperature is reached. Once the temperature drops to required value, drying has ended.

#### 4.1.7. PHASE: end

Fans are stopped, and valves and dampers shut. Controller shuts down all outputs. Message `end` is displayed at the bottom of the LCD.

### 4.2. SETPOINT DEVIATION

Whenever some process is active, controller will compare deviation (difference) between measured and set points. Allowed deviations are given in percent values. If actual value is higher than set value for given deviation percentage, HI deviation will be reported. Vice versa, if the actual value is lower than set value for given deviation percentage, LO deviation will be reported.

HI Temperature deviation warning will stop increase of temperature in automatic mode. LO temperature deviation will cause dampers to shut. In semi-automatic mode, these warnings are only informational. EMC deviation is only informational.

### 4.3. POWER FAILURE DURING DRYING PROCESS

If power is lost and then restored, while the drying process is running in automatic mode, MC-1000 performs measuring of wood moisture content, calculates average MC and then determines temperature and EMC setpoints. After that, the unit determines proper point for resuming the process, and continues it. In semiautomatic mode, after restoring power, all parameters, including setpoints for temperature and EMC will be restored to their power-down values and process will be continued from where it was interrupted when power was lost.

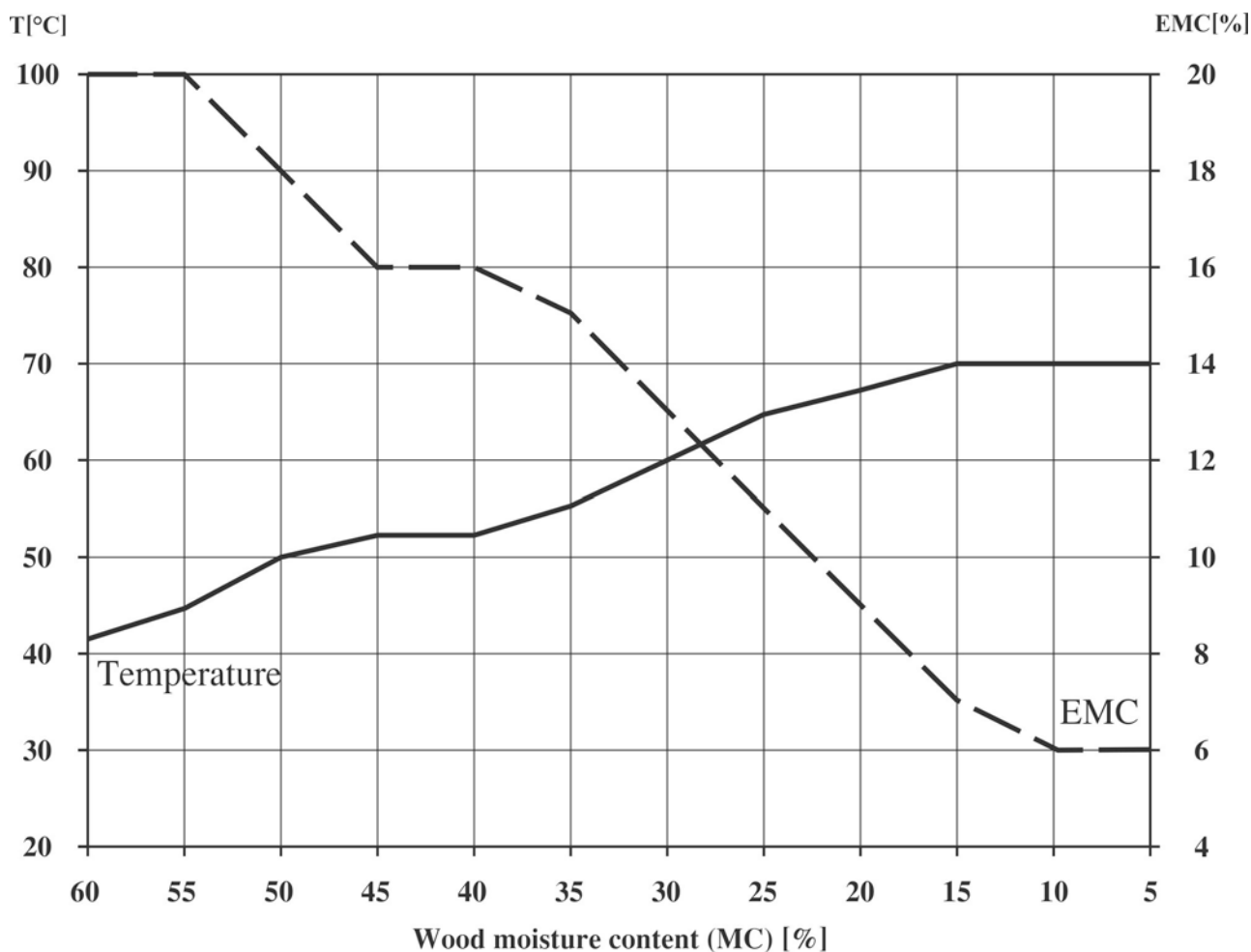
### 5. DRYING REGIME

As mentioned in chapter 1, automatic control unit MC-600 has 20 drying regimes, 12 of which are factory pre-defined and cannot be changed, while remaining 8 regimes user can change according to his own needs. Here is given an example of how drying regime should be defined. On the next page, there is a blank table which user can copy and make regimes on his own. Send a filled copy to NIGOS - elektronik factory and a microprocessor with new regimes will be delivered.

**NOTE:** Minimal drying temperature MUST BE LOWER than the first temperature value in the selected regime. Other ways, the drying will not start. It is recommended that it is set to be 5 ÷ 10 °C lower than the first temperature value in the regime (in this example minimal drying temperature is set to 33 °C, and the first value for temperature in the regime is 39 °C).

<b>Regime number:</b>	<b>1</b>	
Heating temperature ramp rate:	<b>4.0</b>	°C / h
Conditioning temperature:	<b>70</b>	°C
Conditioning humidity:	<b>10.0</b>	%EMC
Conditioning time:	<b>12</b>	h

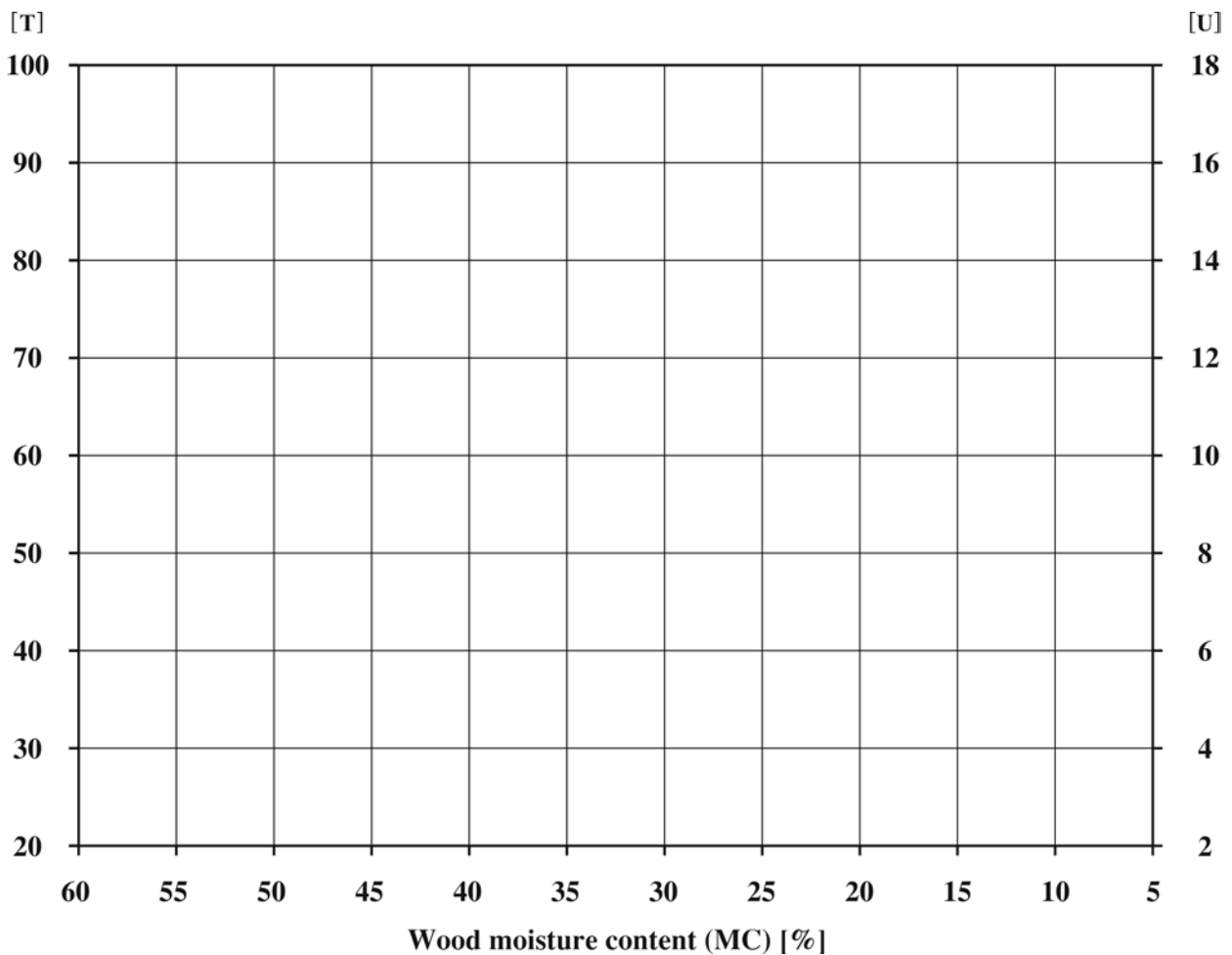
	60	55	50	45	40	35	30	25	20	15	10	5
T	42.0	45.0	50.0	52.0	52.0	55.0	60.0	65.0	68.0	70.0	70.0	70.0
EMC	20.0	20.0	18.0	16.0	16.0	15.0	13.0	11.0	9.0	7.0	6.0	6.0



**5.1. USER'S DRYING REGIME**

<b>Regime number:</b>	
Heating temperature ramp rate:	°C / h
Conditioning temperature:	°C
Conditioning humidity:	%EMC
Conditioning time:	h

	60	55	50	45	40	35	30	25	20	15	10	5
T												
U												



## 5.2. TABLE OF PREDEFINED DRYING REGIMES

No	TEMP	EMC	Type	Heat ramp (°C/h)	Drying						Conditioning		
					Temp	EMC	Temp	EMC	Temp	EMC	Time (h)	Temp (°C)	EMC (%)
					60% MC		30% MC		9% MC				
1	01	01	MC	2,5	28,0	21,0	30,0	16,8	48,0	5,0	40	46,0	9,0
2	01	02	MC	3,0	28,0	20,0	30,0	15,5	48,0	4,5	35	46,0	9,0
3	01	03	MC	3,5	28,0	19,0	30,0	14,5	48,0	4,5	30	46,0	9,0
4	01	04	MC	4,0	28,0	17,5	30,0	13,5	48,0	4,0	30	46,0	9,0
5	01	05	MC	5,0	28,0	16,0	30,0	12,5	48,0	3,8	25	46,0	9,0
6	02	02	MC	3,0	32,0	20,0	34,0	15,5	55,0	4,5	35	52,0	9,0
7	02	03	MC	3,5	32,0	19,0	34,0	14,5	55,0	4,5	30	52,0	9,0
8	02	04	MC	4,0	32,0	17,5	34,0	13,5	55,0	4,0	30	52,0	9,0
9	02	05	MC	5,0	32,0	16,0	34,0	12,5	55,0	3,8	25	52,0	9,0
10	02	06	MC	7,0	32,0	15,0	34,0	11,2	55,0	3,8	25	52,0	9,0
11	03	03	MC	3,5	35,0	19,0	38,0	14,5	58,0	4,5	30	55,0	9,0
12	03	04	MC	4,0	35,0	17,5	38,0	13,5	58,0	4,0	30	55,0	9,0
13	03	05	MC	5,0	35,0	16,0	38,0	12,5	58,0	3,8	25	55,0	9,0
14	03	06	MC	7,0	35,0	15,0	38,0	11,2	58,0	3,8	25	55,0	9,0
15	03	07	MC	8,0	35,0	14,0	38,0	10,0	58,0	3,5	20	55,0	9,0
16	04	03	MC	3,5	38,0	19,0	40,0	14,5	60,0	4,5	30	57,0	9,0
17	04	04	MC	4,0	38,0	17,5	40,0	13,5	60,0	4,0	30	57,0	9,0
18	04	05	MC	5,0	38,0	16,0	40,0	12,5	60,0	3,8	25	57,0	9,0
19	04	06	MC	7,0	38,0	15,0	40,0	11,2	60,0	3,8	25	57,0	9,0
20	04	07	MC	8,0	38,0	14,0	40,0	10,0	60,0	3,5	20	57,0	9,0
21	05	04	MC	4,0	42,0	17,5	44,0	13,5	62,0	4,0	30	60,0	9,0
22	05	05	MC	5,0	42,0	16,0	44,0	12,5	62,0	3,8	25	60,0	9,0
23	05	06	MC	7,0	42,0	15,0	44,0	11,2	62,0	3,8	25	60,0	9,0
24	05	07	MC	8,0	42,0	14,0	44,0	10,0	62,0	3,5	20	60,0	9,0
25	05	08	MC	9,0	42,0	13,0	44,0	9,2	62,0	3,4	15	60,0	9,0
26	06	04	MC	4,0	46,0	17,5	48,0	13,5	64,0	4,0	30	62,0	9,0
27	06	05	MC	5,0	46,0	16,0	48,0	12,5	64,0	3,8	25	62,0	9,0
28	06	06	MC	7,0	46,0	15,0	48,0	11,2	64,0	3,8	25	62,0	9,0
29	06	07	MC	8,0	46,0	14,0	48,0	10,0	64,0	3,5	20	62,0	9,0
30	06	08	MC	9,0	46,0	13,0	48,0	9,2	64,0	3,4	15	62,0	9,0
31	07	05	MC	5,0	50,0	16,0	52,0	12,5	69,0	3,8	25	65,0	9,0
32	07	06	MC	7,0	50,0	15,0	52,0	11,2	69,0	3,8	25	65,0	9,0
33	07	07	MC	8,0	50,0	14,0	52,0	10,0	69,0	3,5	20	65,0	9,0
34	07	08	MC	9,0	50,0	13,0	52,0	9,2	69,0	3,4	15	65,0	9,0
35	07	09	MC	10,0	50,0	12,0	52,0	8,5	69,0	3,0	10	65,0	9,0
36	08	05	MC	5,0	55,0	16,0	55,0	12,5	72,0	3,8	25	68,0	9,0
37	08	07	MC	8,0	55,0	14,0	55,0	10,0	72,0	3,5	20	68,0	9,0
38	08	09	MC	10,0	55,0	12,0	55,0	8,5	72,0	3,0	10	68,0	9,0
39	13	07	MC	8,0	55,0	14,0	60,0	10,0	80,0	3,5	20	75,0	9,0
40	14	08	MC	9,0	65,0	13,0	70,0	9,2	85,0	3,4	15	80,0	9,0

CONVENTIONAL DRYING SCHEDULES

Note: During heating phase, EMC is 2% higher that starting EMC in drying phase.

**SHORT TABLE OF DRYING PROGRAMS (continued)**

		No.	TEMP	EMC	Type	Heat ramp (°C/h)	Drying						Conditioning			
							Temp	EMC	Temp	EMC	Temp	EMC	Time (h)	Temp (°C)	EMC (%)	
							60% MC		30% MC		9% MC					
CONVENTIONAL SCHEDULES	softwood	41	03	12	MC	7.0	35,0	18,0	38,0	14,0	58,0	4,0	30	55,0	9,0	
		42	05	05	MC	5.0	42,0	16,0	44,0	12,5	62,0	3,8	25	60,0	9,0	
		43	06	11	MC	7.0	46,0	17,0	48,0	11,0	64,0	3,5	20	62,0	9,0	
	beech	44	12	12	MC	7.0	36,0	18,0	36,0	14,0	57,0	4,0	30	55,0	9,0	
		45	12	04	MC	4.0	36,0	17,5	36,0	13,5	57,0	4,0	30	55,0	9,0	
		46	04	05	MC	5.0	38,0	16,0	40,0	12,5	60,0	3,8	25	57,0	9,0	
	oak	47	09	02	MC	3.0	28,0	20,0	30,0	15,5	58,0	4,5	35	55,0	9,0	
		48	09	03	MC	3.5	28,0	19,0	30,0	14,5	58,0	4,5	30	55,0	9,0	
		49	09	10	MC	7.0	28,0	17,5	30,0	13,0	58,0	4,0	35	55,0	9,0	
		lamella <10mm	50	10	12	MC	7.0	32,0	18,0	32,0	14,0	46,0	4,0	30	44,0	9,0
DEHUMIDIFYING SCHEDULES	plank	very slow	51	12	12	MC	7.0	36,0	18,0	36,0	14,0	57,0	4,0	30	55,0	9,0
		slow	52	12	03	MC	3.5	36,0	19,0	36,0	14,5	57,0	4,5	30	55,0	9,0
		average	53	15	04	MC	4.0	36,0	17,5	40,0	13,5	56,0	4,0	30	50,0	9,0
		fast	54	15	05	MC	5.0	36,0	16,0	40,0	12,5	56,0	3,8	25	50,0	9,0
		very fast	55	15	06	MC	7.0	36,0	15,0	40,0	11,2	56,0	3,8	25	50,0	9,0
	lamella <10mm	56	11	02	MC	3.0	35,0	20,0	36,0	15,5	46,0	4,5	35	44,0	9,0	
		57	11	03	MC	3.5	35,0	19,0	36,0	14,5	46,0	4,5	30	44,0	9,0	
		58	11	12	EMC											
	TIMED SCHEDULES		59	10	10	Time (h)										
			60	10	12	Time (h)										

**Note: During heating phase, EMC is 2% higher than starting EMC in drying phase.**



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