

## USER'S MANUAL for automatic control unit MC-504

# MC-504



### 1. MC-504 MAIN CHARACTERISTICS

Automatic control unit MC-504 is a device intended for drying process control in smaller convectional/classic kilns. Controller provides optimum conditions in the kiln through air temperature and humidity control.

Controller MC-504 is delivered in plastic enclosure, suitable for wall mounting or in metal enclosure per-connected in the power electric panel (KRO). User connects equipment in the kiln (outputs for heating system, drying, fans directions, PC communications, digital and analogue inputs) to appropriate clamps in the power electric panel.

MC-504 receives information about air temperature and equilibrium moisture content (EMC) from 1 measuring point and wood moisture content (MC) from 4. Controller controls the drying process based on these data. It can operate in automatic or semi-automatic mode, depending on settings made by user. When in automatic control mode, MC-504 follows the chosen drying regime and achieves optimal drying conditions in the kiln automatically. In semiautomatic control mode, user can set desired set-points 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-504 controller is manual control of the drying process. User can use buttons, placed in the right part of MC-504 labeled with "RELAY OUTPUTS", for manual control of relay outputs. There are no manual control of circulation fans. In all other cases, the MC-504 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-504 TECHNICAL SPECIFICATION

Main characteristics		
	Power supply	230Vac; 50Hz; 300mA
	Number of digital inputs	3 for circulation fans controls
	Number of analogue inputs	7 for temperature, EMC and MC in wood
	Number of outputs	7
	Communication lines	1
	Displays	- LCD with 4 rows x 20 characters; - triple, 3-ciphers x 7 segments LED - one, 1-cypher x 7 segments 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	7
	Characteristics	3-pins contact; 8A / 250 Vac, uninterrupted load 3A max
	Purpose and number of outputs	1 output for temperature control (heating valves)
		2 outputs for humidity control (servo-controlled flaps)
		2 outputs for fans operation and direction control
1 output for spraying		
1 output for supported drying (fan in flaps)		
Communication		
Digital	Communication standard	RS-485
	Protocol	S - NIGOS

## TECHNICAL SPECIFICATION OF MEASURED VALUES

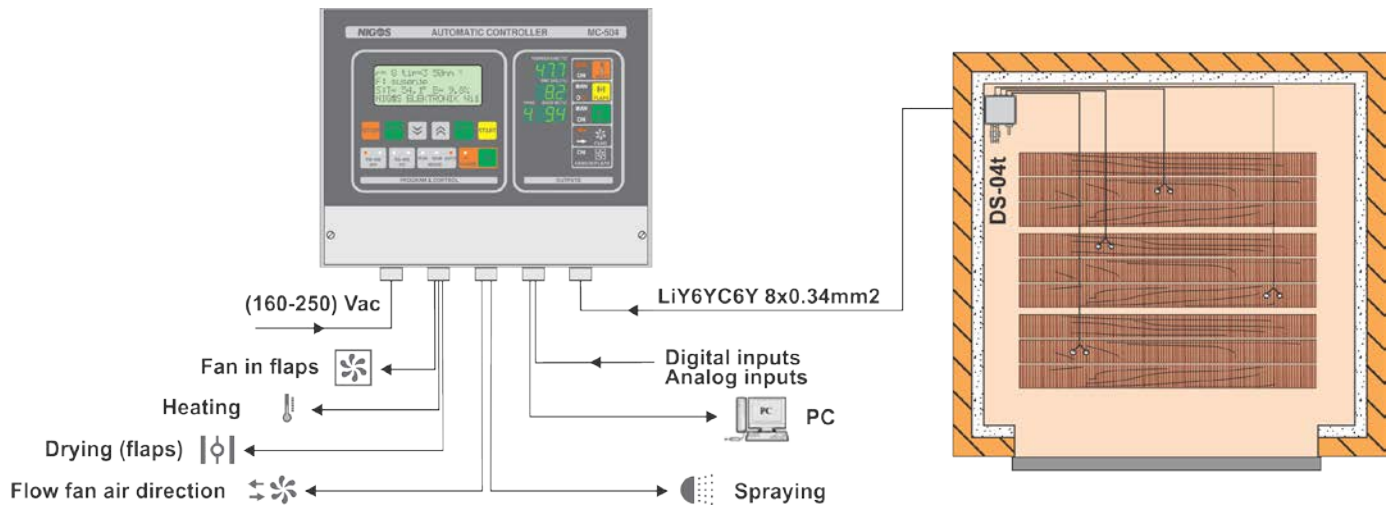
Inputs		
Temperature input	Number of inputs	1
	Range	-20 ÷ 110 °C; 10mV / °C
EMC input	Number of inputs	1
	Range	2.0 ÷ 30 % EMC
MC inputs	Number of inputs	4
	Range	5 ÷ 160 %
Control input for temperature	Number of inputs	1
	Range	-20 ÷ 200 °C; 10mV/°C

## 2. INSTALLATION

### 2.1. CONNECTION DIAGRAM

MC-504 is a controller intended for drying control in the classic kilns.

Controller is connected with measuring probes via measuring box DS-04t. Cable length from MC-504 to measuring box DS-04t is limited up to 15m and in this case is used cable with Teflon insulation FEP Li6YC6Y 8x0.34mm<sup>2</sup>.

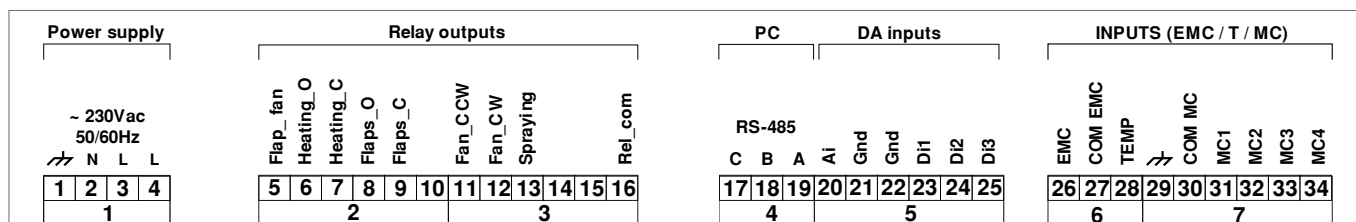


**Picture 2.1. Schematic representation of MC-504 connection in the system with 1 temperature and EMC measurement point and 4 MC measuring points in woods**

MC-504 controller has 7 relay outputs:

- 1 of them are reserved for temperature control (opening and closing water heating valve)
- 2 for humidity control (opening and closing flaps),
- 2 for changing air flow direction (flow fans control),
- 1 for humidity control (opening and closing flaps), and
- 1 for fans in flaps.

## 2.2. MC-504 CONNECTION



Picture 2.2. MC-504 clamps layout

Table 2.1. MC-504 clamp connection layout

CLAMP LABEL	NUMBER/ CLAMP LABEL	CONNECTED TO CLAMP	FUNCTION
<b>Mains power 230Vac</b>	1 / GND	Mains power supply grounding	MC-504 ground
	2 / N	Neutral / zero wire of cable	MC-504 zero
	3 / L	Live / phase wire of cable	MC-504 phase
	4 / L	Live / phase wire of cable	MC-504 phase
<b>Flaps fan</b>	5	Fan in flap starting switch	Fan in flap operation control
<b>Heating</b>	6	Water heating valve	Heating valve opening
	7	Water heating valve	Heating valve closing
<b>Drying</b>	8	Servo drive	Flaps opening control
	9	Servo drive	Flaps closing control
	10	- not connected -	- not connected -
<b>Fans</b>	11	KRO (Inverter for flow fan)	Left direction
	12	KRO (Inverter for flow fan)	Right direction
<b>Spraying</b>	13	Spraying valve	Spraying valve opening
	14	- not connected -	- not connected -
	15	- not connected -	- not connected -
	16	Control voltage from power switch board	Control voltage
<b>PC comm.</b>	17 / C	Communication common contact	common contact
	18,19 / RS-485 (B1, A1)	RS-485 (B, A) on PC computer (RS adapter)	PC computer communication
<b>Digital/ Analogue (DA) inputs</b>	20 / Ai	Pt1000 probe for temperature	Analogue input for measuring temperature on heating medium
	21,22 / Gnd	Ground	Ground
	23 / Di1	Voltage-free contact on switch for flow fan	DC voltage proportional to speed / Circulation fan operation control
	24 / Di2	Pressure switch of compressor	Compressor (pressure switch) control
	25 / Di3	Voltage-free contact on heating pump fan	Heating pump fan control
<b>PROBES (EMC/T/MC)</b>	26 / EMC	EMC probe in DS-04t box	EMC in drying chamber
	27 / COM EMC	EMC probe in DS-04t box	EMC common contact
	28 / TEMP	Pt1000 probe in DS-04t box	Temperature in drying chamber
	29 / GND	Measuring cable shield	Measuring cable shield shirt
	30 / COM MC	MC common in DS-04t box	MC in wood common contact
	31-34 / MC 1-4	MC in wood probes in DS-04t box	MC in wood

### 2.3. MC-504 AND DS-04t INTERCONNECTION

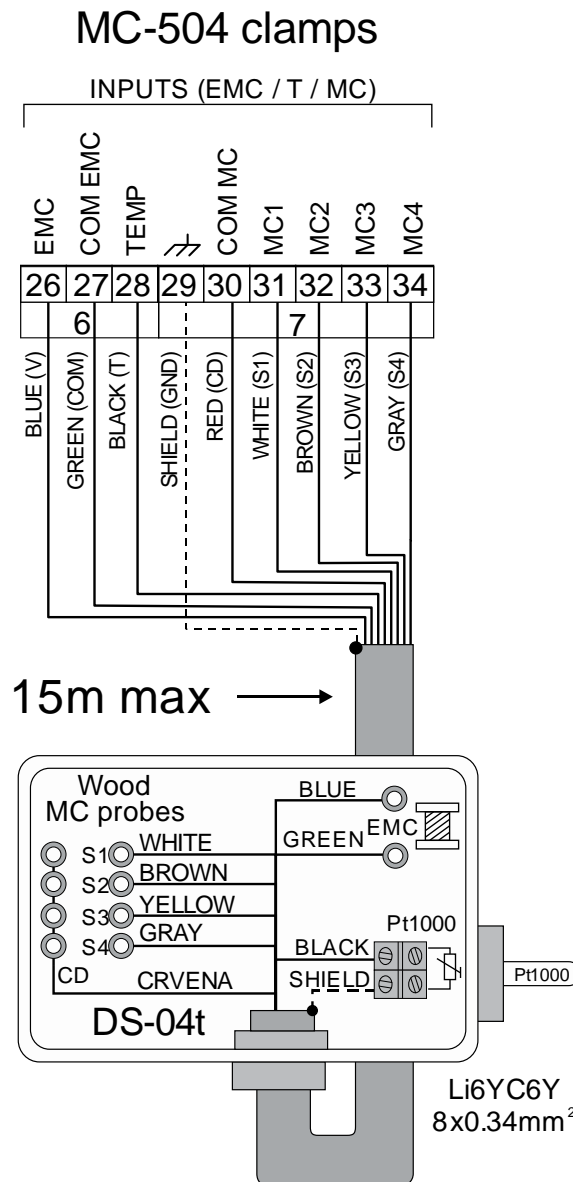
MC-504 controller has inputs for 4 probes for wood moisture content and 1 input for probe for temperature and air equivalent moisture content. Connection is carried out via DS-04t box.

For connection between system components (MC-504 and DS-04t) was used cable of appropriate cross diameter and length. 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)!

For standard MC-504 configuration with 4 wood MC probes, connecting should be as shown on the picture below.



Picture 2.4. Schematic of DS-04t to MC-504 communication cable connection

As shown on the picture 2.1, DS-04t boxes are installed inside the drying chamber. They are connected with multi-wire cable with Teflon insulation Li6YC6Y 8x0.34mm<sup>2</sup> MC-504 clamps (see Note 1.), 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.

## 2.4. CONNECTION OF TEMPERATURE, EMC AND 4-POINTS MC MEASUREMENT SET

In the standard configuration, measuring set for temperature, 4-points wood MC is included with MC-504 controller. This measuring set consists of 1 DS-04t box, sensors and appropriate cables.

**DS-04t box** is made to provide connection of temperature probe, equilibrium moisture content (EMC) probe and four wood moisture (MC) probes. DS-04t box is placed inside the drying chamber, at appropriate location.

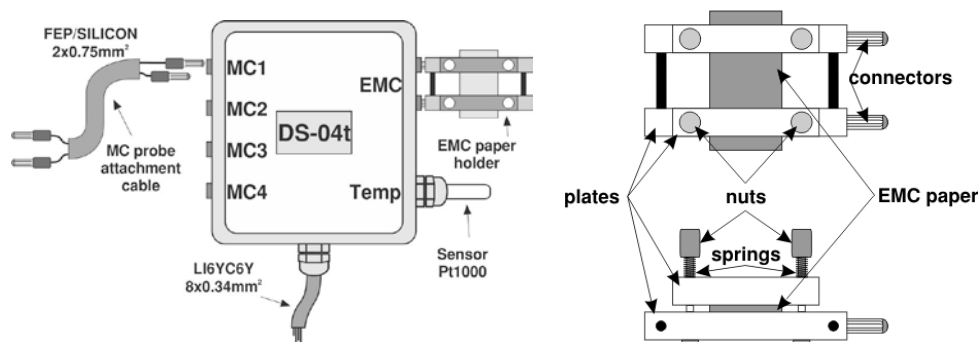
**Temperature measurement:** Temperature probe (sensor) Pt1000 is used for temperature measurement. This probe is mounted inside the DS-04t box in NIGOS factory, and is connected to printed circuit board UGL-01 which is also mounted inside the DS-04t box. See picture 2.4 for LI6YC6Y 8x0.34mm<sup>2</sup> cable connection.

**Equilibrium Moisture Content (EMC) measurement:** Two hole-plugs, marked EMC, are placed on the top of the DS-04t box. They are for connecting EMC paper holder and DS-04t box, 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. Certain amount of this paper (sufficient for exploitation in period of 1 to 2 years) is delivered to user upon delivery of other equipment. Additional amounts of the paper are provided when needed or during regular service. Unused 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.

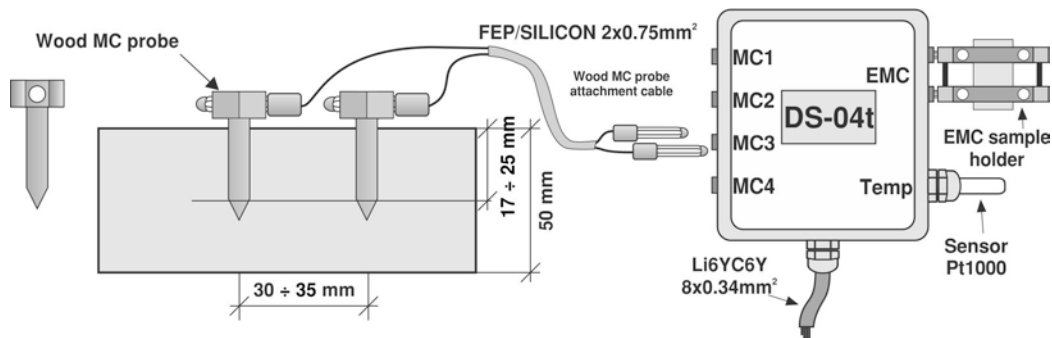


Picture 2.5. Connection of the measurement elements to DS-04t and EMC paper holder

**Measurement of wood moisture content (MC) in 4 points:** 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.

### 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 then hammered into the holes while 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 2.6. Proper placement of INOX wood MC probes in 50mm board and connection to DS-04t box

### 3. OPERATION

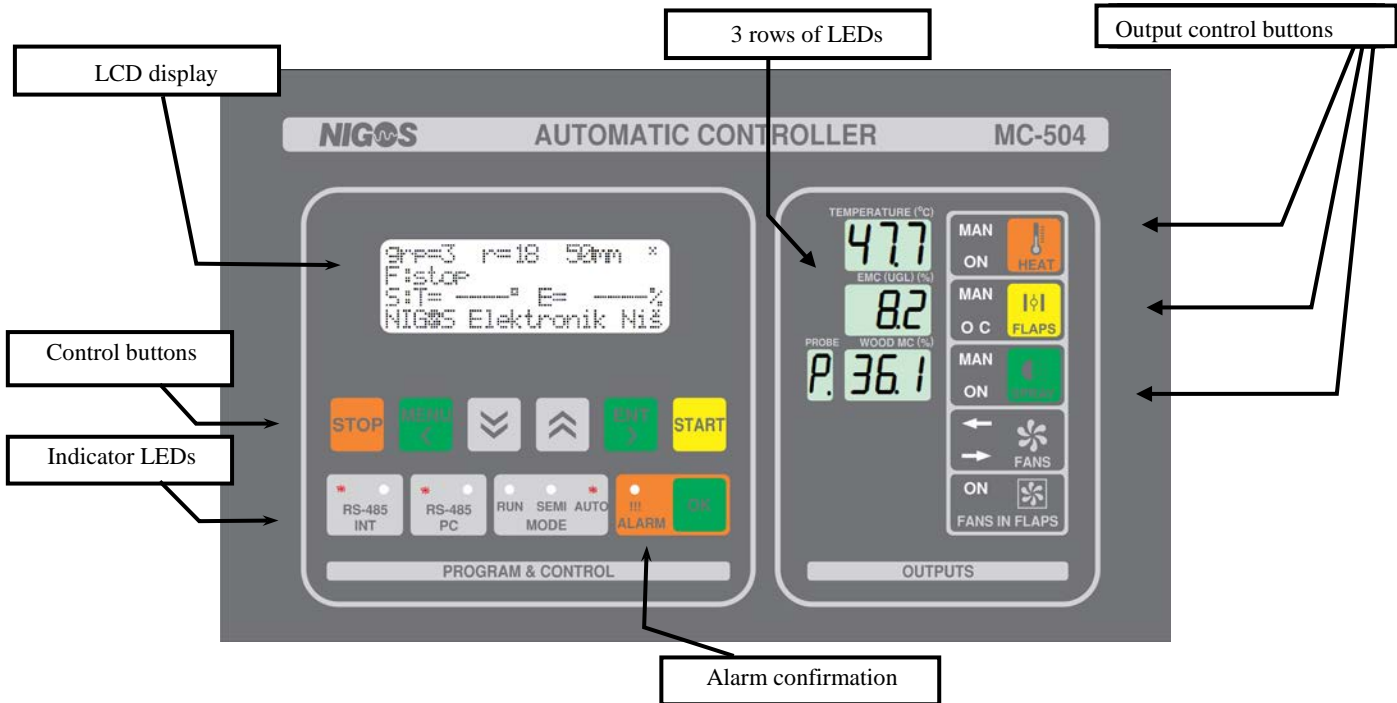
#### 3.1. MC-504 FRONT PANEL LAYOUT

MC-504 front panel includes:

In section PROGRAM & CONTROL:

- One 4-rows x 20-characters LCD display (5 different languages supported)
- Two rows of 3-cipher x 7-segments LCD display and one row of 4-cipher x 7-segments LCD display
- 18 LEDs as indicators of different controller conditions
- 10 buttons (STOP, MENU DOWN, UP, ENT, START, HEAT, SPRAY, FLAPS and FANS)

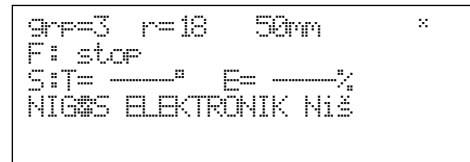
Front panel layout is shown on the next picture, while functions of displays, buttons and diodes are given in following text.



##### 3.1.1. LCD display functions

LCD display has 4 rows with 20 characters in each row. During normal operation of the controller, this display shows all relevant messages regarding operation process for controller-user interaction. Upon booting MC-504, LCD displays logo "NIGOS", name and version of controller and then go to main display which contain:

- First row shows selected current regime, type of timber, thickness of timber and access level.
- Second row describes current phase of drying process.
- Third row displays set points for temperature (T) and equilibrium moisture content (EMC).
- Forth row displays warnings and alarm situation if one occur.



Symbol at the end of the 1st row describes access level is displayed. If there is no symbol - controller is locked. If there is a symbol  shown, then access to advance settings is enabled. Look chapter 3.8 for more information and details.

Transition from main display to menu can be done by pressing button . LCD display is changing according to chosen options from menu. If nothing is chosen up to 4 minutes, operation system return main display on LCD. Returning to main display can also be done by pressing button .

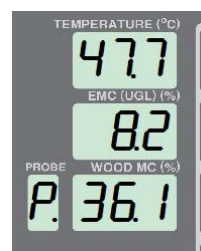
### 3.1.2. Temperature, EMC and wood MC display

Right section of LCD display always show currently measured temperature ( $T_{air}$ ),

equilibrium moisture content ( $EMC$ ) and

average wood moisture content ( $\bar{MC}$ ) in the drying chamber.

Below is a section where actual MC value from each wood MC probes is displayed.













In case displays for temperature and EMC show label **Snb** it indicates that appropriate probes are not connected, or improper values are measured. In that case alarm is activated.

**Table 3.1. Temperature, EMC and wood MC display**

LCD DISPLAY LABEL	DISPLAYS	
<b>Temperature</b> ( $T_{air}$ )	First row, 3 cipher LED display has one decimal point	Shows average value of measured air temperature obtained from active temperature probes ( 1 and 2)
<b>Equilibrium moisture content</b> ( $EMC$ )	Second row, 3 cipher LED display is in range 0.0% to 30.0% with one decimal point	Shows average value of measured equilibrium moisture content obtained from active EMC probes (1 and 2)
<b>Wood moisture content</b> ( $\bar{MC}$ )	Third row, last 3 cipher LED display is in range 0.0% to 100% with one decimal point for values under 100%	Shows measured wood moisture content for that active probe (up to 4) and average wood MC
<b>Measurement point</b>	Third row, the first cipher LED display	Show measurement point (probe 1 to probe 4) or active and passive probes. If probe is passive, than number of probe has no decimal point! Probe <b>p</b> - display average wood MC from probes

### 3.1.3. Buttons function










MC-504 has totally 10 buttons, divided on two groups. First group are buttons for controller settings and second group are buttons for relay output controlling. Pressing some of the 7 buttons for controller settings, sets certain parameters, starting or stopping of drying system. Buttons for relay output can be used for manual control of outputs and by pressing some relays can be switched ON or OFF.

	- 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.
	- DECREASE the value of currently selected parameter or LIST menu options downwards.
	- System START-UP, i.e. starts drying process.
	- Short press on the button cause system SHUT-DOWN, i.e. stops drying process. - Long press on the button cause system PAUSE, i.e. pause drying process
	- In standard display mode - resets all alarms if there are any. - In regime display mode copies the previous value.
	- Activation/deactivation of manual mode for heating output (long pressing) - Switching ON/OFF heating output (short pressing)
	- Activation/deactivation of manual mode for drying output (long pressing) - Switching ON/OFF drying output (short presses cycles next outputs: open flaps, close flaps, turn off both outputs )
	- Activation/deactivation of manual mode for spraying output (long pressing) - Switching ON/OFF spraying output (short pressing)



### 3.1.4. Signaling LED functions

Front panel of controller contains 17 LEDs which indicate certain situation during drying process.

	- Lighting RS-485 (INT) indicate internal communication activity (MC-504 and DS-04t)	
	- Lighting RS-485 (PC) indicate PC communication activity with MC-504	
	- Flashing RUN means drying process is started, and lighting RUN means process is running or it's not stopped. - Lighting SEMI means semi-automatic drying process (semiautomatic regime is running). - Lighting AUTO means automatic drying process (automatic regime is running).	
	- Lighting ALARM (!!!) indicates the presence of some alarm situation which pauses drying process.	
	- Lighting MAN means manual mode of heating control. - Lighting ON means water heating valve is open. Vice versa, valve is closed.	
	- Lighting MAN means manual mode of drying control. - Lighting O means spraying valve is opening. - Lighting C means spraying valve is closing.	
	- Lighting MAN means manual mode of spraying control. - Lighting ON means spraying valve is open. Vice versa, valve is closed.	
	- Lighting ⇐ means left direction of flow fans - Lighting ⇒ means right direction of flow fans	} There is a pause before each direction change, which is indicated by flashing of diode
	- Lighting ON means fans in flaps are turned on.	

### 3.2. PARAMETAR 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 below current date, it is easy to conclude whether the controller is locked (ë) or advanced level access is enabled (symbol k is shown). Menu options can be scrolled using buttons  and . Currently selected option (or parameter) is shown inversed. Press the button . 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 same 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 (or by pressing .









Table 3.2. Menu items and access levels

	Free access	Advanced access	
M E N U	Drying param	Drying param	Drying parameter setting
	Probes	Probes	Probes state setting
	Control	Control	Displays measured temperature and EMC from all probes as well as temperature on control inputs
	Statistics	Statistics	Displays statistical data
		REGIMES	Regimes overview and setting
	SETUP	SETUP	Controller setup
	Kiln type	Kiln type	Kiln type setting
		Oscillatory drying	Specific drying method
	Access	Access	Access level setting



### 3.2.1. Option: Drying parameters

Program drying	
Operating mode	auto
Timber group	3
SCHEDULE	18
THICKNESS/mm	50
HEAT TIME/h	0
FINAL MC	13.0
EQUALIZATION	no
CONDITIONING	no

This option is used for drying parameters setting. Buttons  and  are used for parameter scrolling (display is now as shown on the picture), pressing the button  will select the parameter, and changing of the parameter value is performed using buttons  and . To cancel performed 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.

Following table shows all parameters in this option.

**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	Type of wood. Measurements will be made according to this value (see Table 3.4.)	1, 2, 3, 4	3
SCHEDULE	Schedule (regime) according to which drying will be controlled	From 1 to 60	18
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)	13.0
EQUALIZATION	Allow equalization phase during drying	No, 1, 1.5, 2.0, 3.0	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.

For semiautomatic mode LED SEMI is lit, while LED AUTO is lit when automatic mode is selected.

#### 3.2.1.2. Parameter: TIMBER GROUP

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. In case of missing timber group, please contact NIGOS - elektronik.

**Table 3.4. 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, Poplar, Lime, Iroko, Niangon, Ebony, Olive
3	Pine, Ash, Birch, Larch, Locust, Acacia, Mahogany, Oak, Sappeli, Walnut, Maple, Chestnut, various fruit
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. Schedule can follow automatic drying based on measured wood MC or time. Each regime defines temperature and EMC curves (relations between chosen parameter - T or EMC, and time), fan's speed, temperature gradient for heating, temperature and humidity set-points for conditioning phase and duration of the conditioning phase. All schedules are made for lumber thickness of 50 mm. Changing of the regimes 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.

Table 3.5. 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

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

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

Drying regimes which are inserted in controller's memory by default (schedule 1 to 12) 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/mm

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 (more severe) and vice versa, for thicker lumber drying schedule should be slowed down (easier). Adjusting the parameter value to actual lumber thickness (if possible) provides that the controller performs all rest relevant schedule settings automatically.

**Speeding of drying process for thickness lower than 50 mm** is done by following:

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

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

**Slowing of drying process for thickness higher than 50 mm** is done by following:

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

### 3.2.1.5. Parameter: HEAT TIME/h

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 if equalization will be performed during drying and the range of equalization. It is applied on active probes only. If value **no** is selected, automatic controller will not perform equalization. If for example, value 2 is selected, then controller will try to maintain that all probes are within final wood MC  $\pm 2\%$  from it.







NOTE: This function can significantly extend drying time and successful ending depends on the ability of wood dryer to provide desired 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 MC

This option shows measured value and state of all MC probes labeled with MC1 ÷ MC4. 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.



Probes MC		
MC 1	23.5	aktiv
MC 2	---	no
MC 3	65.4	pasiv
MC 4	20.8	aktiv
MC 5	24.2	aktiv
Cut mode/MC	avg	
Auto cut off/%	40	

**Active state** of the probe indicates that information (MC or temperature) from this probe will be taken in count.

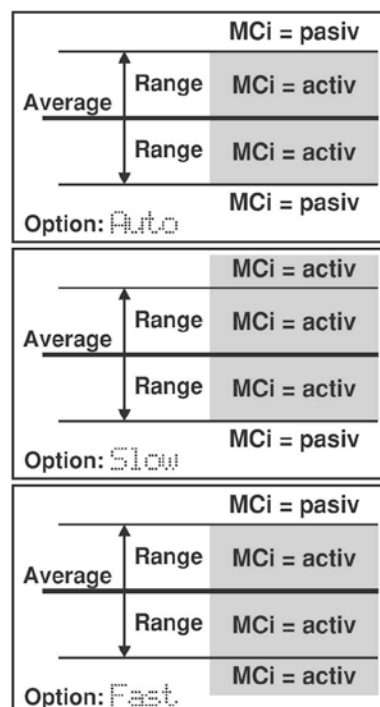
**Passive state** indicates that this value is discarded in average value calculation.

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 polling and listing when controller is unlocked. In that case pressing button  will set probe in passive state, and next pressing on button  turns probe off.

Parameter **Calc mode/MC** determines how average wood MC is calculated. It can be calculated as average (**AVG**), auto (**Auto**), slow (**Slow**) and fast (**Fast**). Additional calculation of average wood MC according to which drying process is run as well as setting the state of wood MC probes in either active or passive state depends on value of parameter **Auto cut off/%** according to following principle:



- Avg: Value for wood MC is calculated as average value of probes that are set in active state. Passive probes are not taken into calculation. **User sets probes in active or passive state by himself (manually).**
- Auto: This option will automatically put in passive state all probes that measure too high or too low values. Principle is following: Controller will collect values from all probes and calculate average of all probes. This value is increased and decreased by value of parameter Auto cut off/% to define upper and lower range. All probes (MC1 to MC6) which have values within this range are set in active state, while all probes that are outside this range are set into passive state. New average is then calculated based on active probes and it becomes valid average for running the drying process. **Controller puts probes in active or passive state automatically.**
- Slow: This option is used to slow down drying process. When selected – it will automatically set to passive state all probes that measure too low moisture content. Those are probes that measure MC below lower range defined by parameter Auto cut off/%.
- Fast: This option is used to speed up drying process. When selected – it will automatically set to passive state all probes that measure too high moisture content. Those are probes that measure MC above higher range defined by parameter Auto cut off/%.

Option Probes MC can be accessed directly with pressing of the button .

### 3.2.3. Option: Control

```
Control
+EMC 1 8.5 active
Temp1 48.9 active
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. Below this, control temperatures are displayed. When the control probe is attached and measures temperature in the range -25 to 200 °C, measured value is displayed. Otherwise, label "—" is displayed.

### 3.2.4. Option: Statistics


```
Statistics
No. cycles 0
Last cycle 0: 00
Total work time 0: 00




Statistics
Spraying
Last cycle 0: 00
Total work time 0: 00

Statistics
Assisted drying
Last cycle 0: 00
Total work time 0: 00
```

This option gives drying working time and working time of particular outputs. By entering this option, first screen shows following:

No. cycles - Number of finished cycles of drying  
 Last cycle - Duration of the last cycle of drying  
 Total work time - Total duration of drying on this controller from start. Also it is fans work time.

By pressing button , display shows next screen of statistics: working time of spraying valve.

Another pressing button , shows last screen of statistics: working time of output for assisted drying (also fan in flap working time). By pressing button , display returns to statistics parameters. Button  leaves displaying of statistics.

### 3.2.5. Option: MENU > Setup

```
M E N U > Setup
+Fan
```

By entering option M E N U > Setup, display opens submenu, with option: Fan

#### 3.2.5.1. Option: Setup > Flow fans

This option sets parameters for fans setup. Parameter Change direct. ? enables change of fans (and consequently air flow) direction.

```
Fan 0: 00
+Change direction? no
Revers.time/min 240
Direction.pause/min 3
Revers.in.spray. no
```

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. Reverse time - define time in one direction. Direction pause is time between two opposite direction starts. Reverse in spraying - define time in spraying phase (available only if fans are controlled by inverters).

### 3.2.6. Option: Access

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. Symbol which describes access level is displayed as \*. If there is no symbol - controller is locked. If there is a symbol k shown, then access to advance settings is enabled.

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

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 type, 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 set-points in every moment. Some of these parameters can be changed during process.

Drying process runs according to chosen drying regime. 60 different regimes can be defined. 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 choose semiautomatic mode, go to MENU > Drying Param option, then choosing OPERATING MODE parameter and select semi.

In semiautomatic mode, user must set only two parameters in option MENU > Drying Param. Semiautomatic mode and wood type 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:T= ——— 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 text or graphic basic 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-504 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 semi-auto 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 set-points 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 set-point values and proceed with operation.



##### 3.3.1.4. Manual mode

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  for each output separately. Long pressing of the button activate manual mode. Short pressing of the button always change the state of output (turn on/off). If the output is turned off, and button is pressed and hold down, output will become active (turn on). As soon as the button is released, 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.

There are two buttons related to output for heating valve (one for opening, one for closing the valve), two for output for flaps (opening and closing) and also two for fans direction change (left and right).




Spraying system has a little different setting. Button  for spraying has double function: first pressing activates spraying system (LED diode is lit constantly), while second pressing will evoke spraying test (LED diode flashes) during which output will be automatically turned on and off until button  is pressed again and spraying test ended.




All outputs are activated (turned on) after first press of appropriate button (LED diode is lit), and stay active until they are deactivated after second press of button (LED diode is turned off).

### 3.4. DRYING PROCESS START UP

```

Resine 18      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

```


Resine 18      50mm
 auto      3    12.0%
 Oh      Cond: no
Stop drying  no
  
```

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 asks: **Stop dryer?**

Default answer is no. You can accept offered answer by pressing either  with selected answer no, or  button to continue the process, 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 that 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. PAUSING DRYING PROCESS


Sometimes is needed to pause drying process without stopping whole system. Pausing just drying can be done by long pressing button  when drying is already active and when controller displays main menu. Pressing this button, pause drying process and display current phase as Phase: pause as well as text ! Paused ! at bottom of display. After that, all outputs are turned off and drying process is paused. Valves and flaps will be closed. System leaves paused mode and continues process after process start-up as it is described in Chapter 3.5 in this manual.

### 3.7. 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. Simultaneously, LED indicator ! (WARNING) blinks to notify the warning state. These warnings don't stop drying process, but make user pay attention to the situation and take action. Simultaneously with light indication, controller activates sound alarm output. Sound alarm is active certain period of time, and then deactivated, while light warnings are shown on display as long as the situation is present, or until the message is revoked.

The warning can be canceled 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, LED indicator !!! (ALARM) blinks and alarm output (that can activate either sound or light signalization) 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  button resets alarm output.

Alarm message is present on LCD until the reason of alarm is eliminated. Pressing the button  can revoke 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.

Whenever an alarm situation is ensued, some data are stored in system archives. This leaves an option for subsequent examination of archive, which can help discovering the problem.

If more then 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.

In following table are described all alarms and warning situations as well as procedures which are done by automatic controller or procedures which have to be done by user or authorized personals for removal of those unwanted situations.

Table 3.6. List of possible warning and alarm messages

MESSAGE	MESSAGE DESCRIPTION AND RECOMMENDED ACTIONS
fan failure?	There is a problem (or problems) in functioning of one or more fans. Activities of fans are always checked at start of drying process. These messages don't cause the system pausing. Authorized person should check notified fans.
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.
temp low for spraying	Temperature has dropped below minimum at which spraying is allowed. Find the reason for temperature drop.
-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!
EMC holdback HI EMC holdback LO	These messages appear when measured EMC exceeds allowed limits. Check EMC probes, flaps and sprinklers.
-emc 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 ÷ 4)	Signalizing that one of the wood MC probes (1 of 4) 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.
-fan in flap ?	Fan in flap won't start or they have turned off by switch.
-circulation pump ?	Circulation pump won't start or there are no pump reply.
-comm error PC	Messages reporting error in communication between controller and PC computer. Possible causes are equipment malfunction or split communication cable.
-code error -CSM memory error -SPI error	Those are system warnings on which user can not influence and therefore immediately call authorized personal or NIGOS!
! 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.

### 3.8 ADDITIONAL ADJUSTMENTS

Controller MC-504 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.

#### 3.8.1. Option: Access




Option Access is used for setting access level to the unit and its options and parameters as well. Entering correct access code makes unlocking of the unit and progress to advanced level possible. As an indication that the control unit is locked at the end of the first line of LCD in main

```
Access
Enter access code
  *
  *****
  Locked
```

menu is showed symbol ✕. After entering correct access code on the same place there is other symbol that shows access to higher level (k - for user level).

When option **Access** 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

```
Access
Enter access code
  + 504
  OK
  user level
```

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 **504** and user can change it by using parameter **Access Code**, in the option MENU > SETUP > System. If the entered code is correct, message **user level** is displayed on LCD. In any other case the unit remains locked and home view is shown on LCD.

**NOTE:** 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.



### 3.8.2. Option: REGIMES

Option **REGIMES** becomes visible when the controller is unlocked (correct code is entered in option **Access level**).





This option defines regimes used in automatic operation mode for appropriate wood specie. Total of 60 or 40 regimes can be defined depends on the type of the kiln (dehumidifying or combined). 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 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 type and that specific thickness. But, in order to avoid change of the regime data, he must select thickness of 50 mm for parameter **THICKNESS** in option **Drying paran**. Regime defined in this manner should be used **ONLY** for drying of that specific wood type and thickness.

Regimes	18	
Regime	18	
Heat speed	2.5	
Type of regime	MC	
No MC	Temp	EMC
1 60	35.0	17.0
Kn 25h	57.0	9.0
Load defaults	no	


#### PROCEDURE FOR ADJUSTMENT USER REGIME:






Option **REGIMES** displays symbolic name and regime ordinal: Regime 18.

- Press the button  to change regime number what is want to be changed and use buttons  and  to change value and confirm it with by pressing button .

- After selected number of regime, with button  jump to parameter **Heat speed**. Heat speed is rate at which heating temperature will raise (heating temperature ramp rate) given in °C per hour.

- Next parameter is **Type of regime** what can be dependable od wood moisture content (MC) or time based (TIME).

- By button  jump to next parameter **MC (%)** what set specific wood MC for which temperature and EMC data is used, with step 5, like (60, 55, 50, ..., 10, 5).

Use button  to jump from (MC) to temperature (Temp) and then to equilibrium MC (EMC) and finally wood moisture content. Use buttons  and  to set the parameter value, and confirm the change by pressing button . Pressing the button  will cancel any change made to selected parameter and return to previous menu.

- Next parameters are about conditioning (Kn): duration of conditioning phase (duration cond), instead of MC, temperature (Temp) and equilibrium moisture content (EMC).

- After setting all parameters, there is a possibility to restore factory defaults settings if wrong entry occurs. If user want to leaves all made changes, on question **Load defaults** should change answer to **yes**.

**If user want to save newmade regime then on question **Load defaults** should choose answer **no**.**

For every changes regime, controller displays text **changed**.

**Table 3.7. Parameters of REGIMES option**

PARAMETER LABEL	DESCRIPTION	RANGE OF PARAMETER VALUES
Regime	Regime ordinal	From 1 to 60
Heat speed (°C/h)	Rate at which heating temperature will raise (heating temperature ramp rate) given in °C per hour	From 0.1°C/h to 25.0°C/h
Type of regime	Description of type of regime. Can be wood MC or time based.	MC/TimeH/TimeM/EMC
No	Number of column in selected regime. 2 columns are displayed. Ordinals 1 to 12 show parameters of regime, while last column (Cond) show conditioning parameters. NOTE: When conditioning parameters are shown, first value is duration of conditioning phase (instead of MC).	From 1 to 12, Cond
MC (%) (in 5% steps)	Specific wood MC for which temperature and EMC data is used	From 99%MC to 0%MC
Temp (°C)	Temperature for selected wood MC	From 10.0°C to 90.0°C
EMC (%)	EMC for selected wood MC	From 1.0% to 30.0%
Duration cond. (h)	Duration of conditioning in hours	From 1h to 99h
Temp cond. (°C)	Temperature in conditioning	From 10.0°C to 90.0°C
EMC cond. (%)	Equilibrium MC (EMC) in conditioning	From 1.0% to 30.0%
Load defaults	Loading of default settings	no/yes

### 3.8.3. Option: SETUP

```

MENU > SETUP
System
Out spraying
Recuperator
Fan
IO device
  
```

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

### 3.8.4. Option: System

```

System
Language english
User code 504
DryTempRampRate 10.0
Max temp/° 70.0
Temp end/° -10.0
CoolTempRampRate 2.0
Temp holdback/% 20
EMC holdback/% 20
Warning delay/m 10
Alarm delay/m 3
  
```

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, below, 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.

**Table 3.8. Parameters of System option**

PARAMETER LABEL	DESCRIPTION	RANGE OF PARAMETER VALUES	DEFAULT VALUE
Language	Choose one of five built-in languages		
User code	Access code for advanced level	0 to 65535	504
DryTempRampRate	Temperature ramp rate in drying phase	0.1°C/h to 30.0°C/h	10.0
Max temp/°	Maximal temperature in drying phase	30.0°C to 90.0°C	65.0
Temp end/°	Defines how much temperature should reduce when drying ends	-40.0°C to -0.0°C	-10.0
CoolTempRampRate (°C/h)	Temperature ramp rate in cooling phase	0.1°C/h to 10.0°C/h	2.0
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%	25
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%	30
Warning delay/m	Delaying warning announcement in minutes	0 min to 120 min	10
Alarm delay/m	Delaying alarm announcement in minutes	0 min to 60 min	3

### 3.8.5. Option: Out spraying

```

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

Automatic controller MC-504 has one relay output for opening spraying valve. Spraying have to activated in any type of kiln.

Table 3.9 shows all parameters which are visible on user level. Change it only if have to and do it very carefully, otherwise leave default values.

**Table 3.9. Parameters of Out spraying option**

PARAMETER LABEL	DESCRIPTION	RANGE OF PARAMETER VALUES	DEFAULT VALUE
Min time/min	Minimal time for spraying	1 min to 240 min	5
Max time/min	Maximal time for spraying in case the conditions are not met	1 min to 240 min	10
On/sec	Spraying on time	1 min to 240 min	60
Off/sec	Spraying off time	1 min to 240 min	30
Hold time/min	Holdback time (pause) after spraying during which it is impossible to start it again	1 min to 240 min	30
Min time/min	Minimal time for spraying	1 min to 240 min	15

### 3.8.6. Option: Recuperator

```

Recuperator
Function ?      no
    
```

Enable/disable function of recuperator/fan in flaps can be set in this option.

### 3.8.7. Option: Fan

This option applies that same function as option Fan on locked automatic controller, described in Chapter 3.2.5.

### 3.8.8. Option: I/O device

```

IO device
Address MC      1
Baud rate MC   57600
    
```

All parameters for communication with input and output devices are set from this option. Address is unique device address in communication, baud rate is communication speed.

Label MC corresponds to MC-504 controller setting and it's communication with PC. Next table shows all parameters and their possible values.

Table 3.10. Parameters of I/O 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

### 3.8.9. Option: Kiln type

```

Kiln type
Kiln type      clas
Inic regimes    no
    
```


This option provides selection of kiln type (and controller operation mode) and parameter initialization. Parameter Kiln type can be only classic (CLAS). 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..




Drying Fanon 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 Fanon. All parameters are memorized for next drying cycle, except parameter HEAT TIME/h which is reset after each drying cycle and should be set again number of hours, if needed.

```

Resine         25
auto           3    12.0%
Oh             Cond: yes
Start dryer   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 heating, drying, equalization, conditioning, cooling and end..

#### 4.1.1. PHASE: measurement

```
PHASE measure
```

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 following message and LED indicator **RUN** will blink.

#### 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. LCD shows phase label:

```
PHASE heating
```

When set temperature reach first temperature in the regime, core heating phase will start if `HEAT TIME/h` 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/h`.

EMC and fan speed are also maintained, but can also be altered manually. All outputs can be activated.

LCD displays label `keeping` and remaining time:

```
PHASE keeping 1:42
```

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

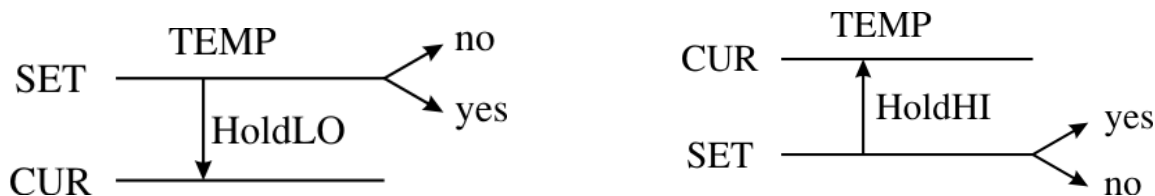
#### 4.1.4. PHASE: drying

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 following:

```
PHASE drying
```

According to set values Temp and EMC, current values will change, by gradient 0.1 up/down toward set values. In this phase, every output relay is enabled and changeable to manual mode.

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.



Set EMC value will change toward optimal EMC calculated from average MC measured from wood, from chosen regime and from timber thickness. Calculation for EMC, if timber thickness is not 50mm are shown in following formula:

$$EMCd = EMC50 + EMC50 * ((d-50) / 100) * CoefEMC$$

EMCd - equivalent moisture content for timber thickness d [mm]

EMC50 - equivalent moisture content for timber thickness 50 mm ( can be read out from chosen diagram for EMC)

CoefEMC - coefficient for changing EMC with changed thickness (fixed parameter, it is 0.3)

Parameter for wood thickness influence speed of drying, so by altering the parameter `Drying Param > THICKNESS/mm` 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.

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 = yes`), controller will advance to conditioning phase, and if conditioning is disabled - to cooling phase.

#### 4.1.5. PHASE: equalization

This phase is intended for the equalization of the moisture between the wood of all the probes for measuring the moisture content of wood. If any of the probes to measure low humidity - which means that the tree is dry to limit moisture - automat moves to phase equalization to invest in other probes dropped on that limit value. After equalization, the process returns to the drying phase.

PHASE equalization

Phase equalization is possible only if the final moisture is set to less than 15% MC. During the drying process it is possible this phase turned on or off at any time. We recommend using this phase in cases where it is required the best possible quality of dried material.

**Please note that there is a possibility to extend the drying process a lot if this phase enabled!**

#### 4.1.6. PHASE: conditioning

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. Remaining time is displayed on LCD.

PHASE condit 18:34

Optimal temperature and EMC can be read out from chosen regime description and those values are reached by slowly changes of current values of temperature and EMC from drying phase. Temperature changes with rate **6°C/h**, and EMC changes with rate **1%/h** and those rates are fixed. Fan speed is also given in regime, but can be changed.

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

#### 4.1.7. PHASE: cooling

During cooling phase, only fans output can be activated. Valves and flaps are shut. Set temperature is equal to last given temperature decreased for value of parameter **SETUP > System > Temp END<sup>o</sup>**.

EMC and fan speed will remain at same value as in last phase before cooling. LCD displays elapsed time.

PHASE cooling 00:23

During this phase LCD displays elapsed time after phase name.

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

#### 4.1.8. PHASE: end

Fans are stopped, and valves and flaps 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 flaps to shut. In semi-automatic mode, these warnings are only informational. EMC deviation is only informational.

### 4.3. POWER FAILURE DURING DRYING PROCESS

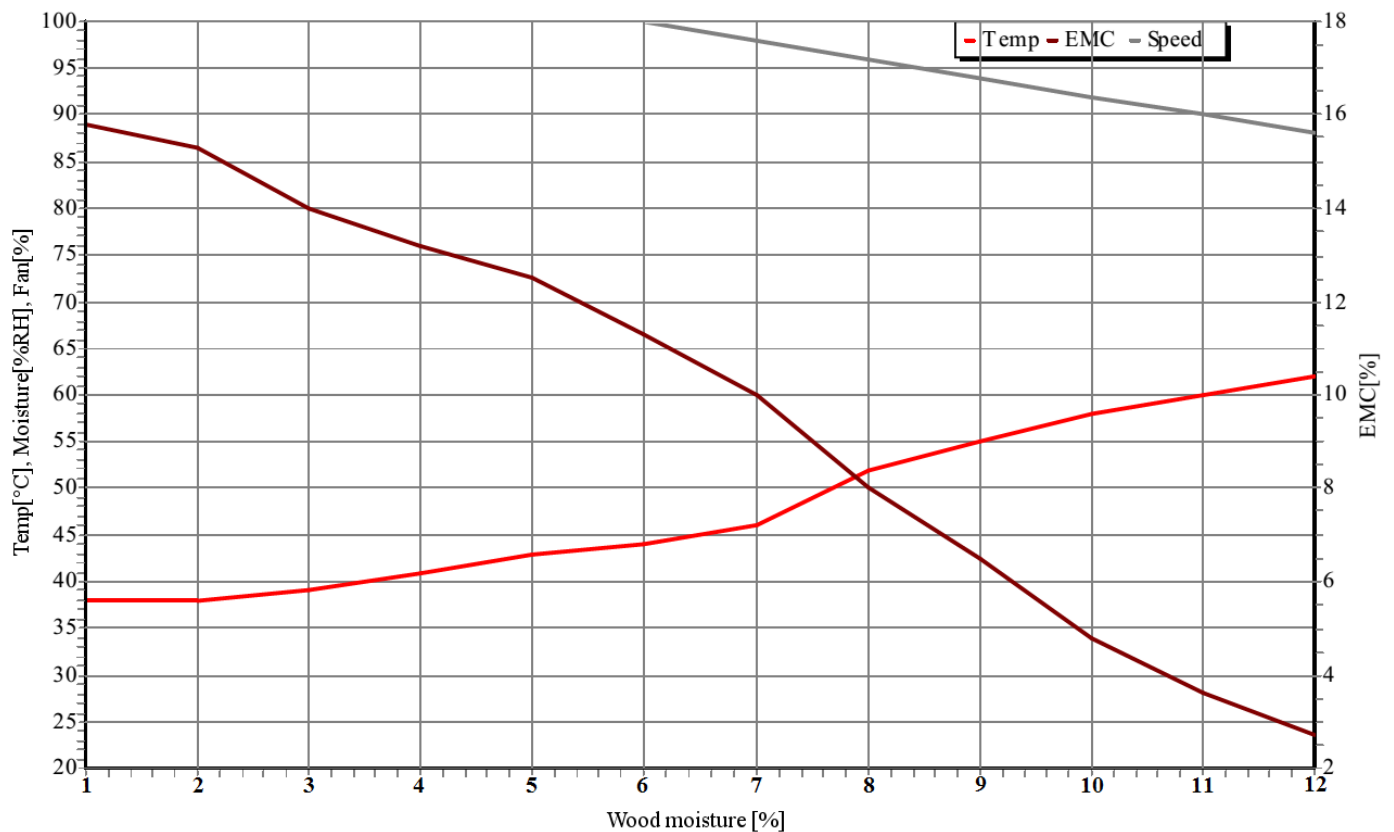
If power is lost and then restored, while the drying process is running in automatic mode, MC-504 performs measuring of wood moisture content, calculates average MC and then determines temperature and EMC setpoints. After that, the unit determines proper point for resuming the process, and continues 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-504 has 60 drying regimes, all are factory pre-defined but user can change any of them 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.

Regime number:	<b>18</b>	
Heating temperature ramp rate:	<b>5.0</b>	<sup>o</sup> C / h
Type of regime:	<b>MC</b>	

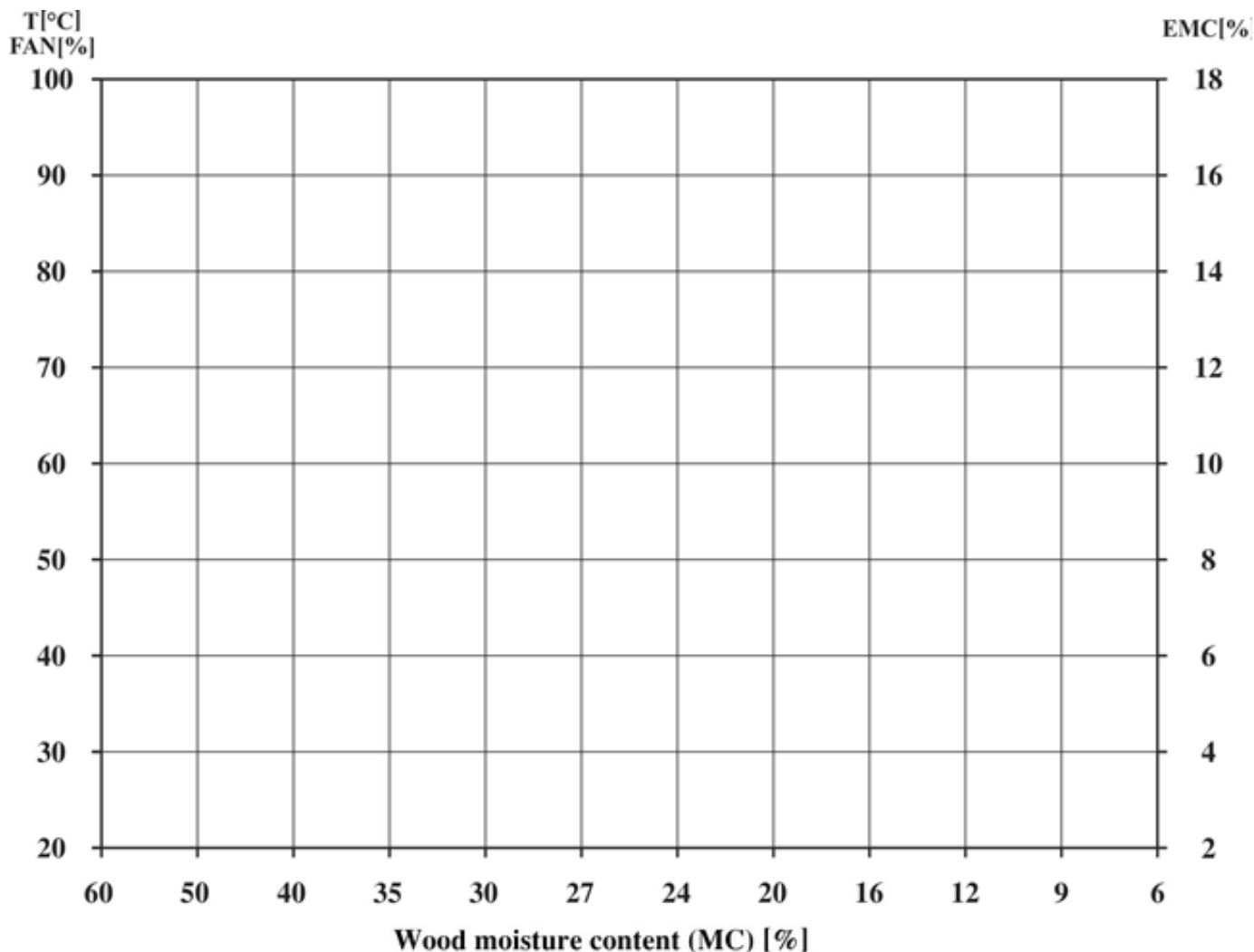
Segment	1	2	3	4	5	6	7	8	9	10	11	12	Cond
MC	<b>60</b>	<b>50</b>	<b>40</b>	<b>35</b>	<b>30</b>	<b>27</b>	<b>24</b>	<b>20</b>	<b>16</b>	<b>12</b>	<b>9</b>	<b>6</b>	<b>25</b>
T	<b>38.0</b>	<b>38.0</b>	<b>39.0</b>	<b>41.0</b>	<b>43.0</b>	<b>44.0</b>	<b>46.0</b>	<b>52.0</b>	<b>55.0</b>	<b>58.0</b>	<b>60.0</b>	<b>62.0</b>	<b>57.0</b>
EMC	<b>15.8</b>	<b>15.0</b>	<b>14.0</b>	<b>13.2</b>	<b>12.5</b>	<b>11.3</b>	<b>10.0</b>	<b>8.0</b>	<b>6.5</b>	<b>4.8</b>	<b>3.6</b>	<b>2.7</b>	<b>9.0</b>



**5.1. USER'S DRYING REGIME**

<b>Regime number:</b>		
Heating temperature ramp rate:		°C / h
Type of regime:		

Segment	1	2	3	4	5	6	7	8	9	10	11	12	Cond
MC													
T													
EMC													





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: In heating phase EMC is 2% higher than starting EMC in drying phase.

### DEDICATED 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					
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 (min)											

Note: In heating phase EMC is 2% higher than starting EMC in drying phase.

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