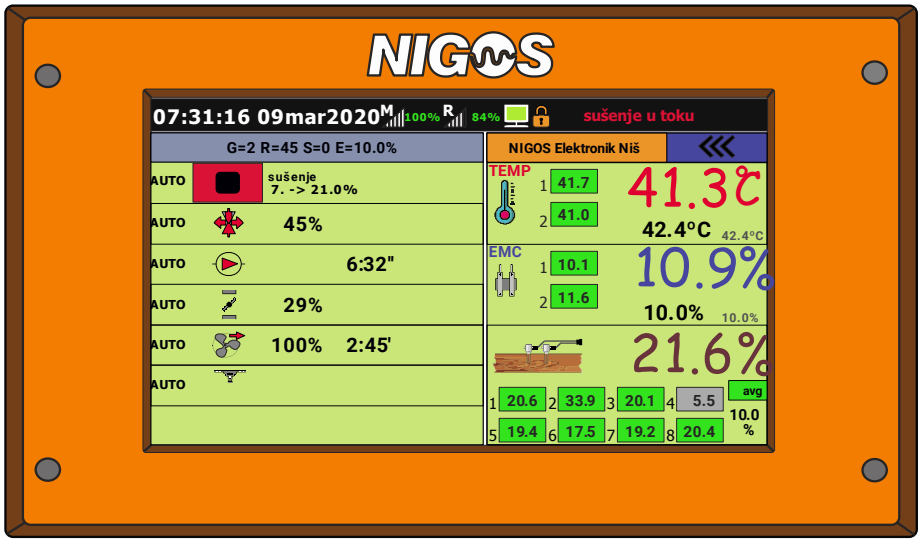
MC-3000



AUTOMATIC CONTROL UNIT

MC-3000

USER'S MANUAL

(translated from serbian to english)

TABLE OF CONTENTS

1. PURPOSE OF THIS INSTRUCTION

The MC-3000 user manual provides information for its safe use and is intended for qualified personnel.
To use the MC-3000 machine safely , read and follow these instructions. Plant it and special attention to the safety warnings and general warnings. Always will keep this instruction manuals in or neerby power electric switch board (hereinafter referred to as **KRO**) in which the MC-3000 is built-in.

This manual is updated in accordance with hardware and software changes.

Date	Manual version	SW version	HW version	Description of recent changes
17.09.2020.	v.1.1.0	1.0.0.3	3.00	New hardware solutions; universal SW for both types of dryers

Unit MC-3000, installed by NIGOS-electronik personel, is used as an integral part of a conventional or dehumidifing dryers only in industrial environments and in accordance with local laws and standards.
It is not allowed to use the controller unit for purposes that do not comply with the above operating conditions and environments..

Safety labels and notes

Explanation of the symbols in the instructions for use as well as on the labels of unit MC-3000 and relay board RB-3000:

⏚	Ground input connector.
L/+	AC phase input connector or DC hot end.
N/-	AC neutral input connection or DC mass.
	Be sure to read the entire user manual before turning on the unit controller and before using.
	Equipment containing electrical components must not be disposed of with household waste. It must be collected separately, in accordance with local and current regulations.
	Caution, warning of unsafe use that could result in personal injury, property damage and data loss.

Installation should be to carry out by authorized persons, with appliance ofprotecting equipment and safety measures for work.

Installation of the unit is performed exclusively in KRO. Provide a dry, lighted and ventilated room for cabinet installation.

Be sure to conduct the earth wire to KRO, along with conducting of phase and neutral wire of voltage and correctly ground automate.

It is mandatory to bring 20 ÷ 24V ac / dc as written in the declaration and on the label of unit. Pay most of attention not to connect high alternating voltage to digital nor analog inputs.

To avoid danger of fire or electrical shock, never exposed any unit nor KRO to influence or rain, snow or humidity. KRO cabinet is transported wrapped in stretchable, waterproof foil. If any part of the machine is damaged or there is any doubt about its correctness, use of KRO and drying system are prohibited.

Be sure to disconnect the unit from the power supply (term.clamp 2) before installing or opening the MC-3000 . All interventions on the unit must be performed by persons authorized for service or trained technical personnel. Necessary replacements are made to the original spare parts. For help, information and repair services, contact an authorized servicer or manufacturer NIGOS-elektronik. Access is banned for children and unemployed persons!

Do not install the KRO cabinet near a device that produces strong electromagnetic or mechanical interference (except for frequency regulators, which have to be electromagnetically compatible) , as is not in the areas with exploding atmosphere.

Additional security measures for correct and safe installation of system:

⚠ **The HMI panel unit and the relay board are intended for installation on the KRO cabinet in a room with operating conditions 0 ÷ 50°C, without moisture and dust.**

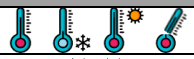
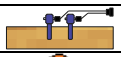
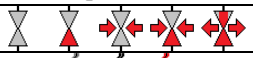
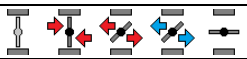
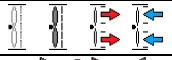
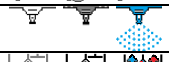
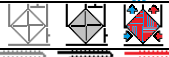
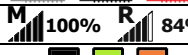
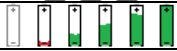
⚠ **Pay attention to installation of other equipment in the KRO in order to avoid interference from mutual influence.**

⚠ **Measuring--communication module MKM is mounted outside, on the rear wall of the dryer, above the auxiliary door. As it is exposed to external influences, it is mounted under the tin cover ("roof").**

⚠ **Installation of probes is described in section 3.4. INSTALLATION OF PROBES IN DRYING CHAMBER**

⚠ **To connect the measuring-communication module MKM, use communication cable with a shield that must not be placed in parallel with power cables at a distance of less than 30 cm . An intersection at a right angle would be ideal.**

Abbreviations and a list of symbols used on the display of unit MC-3000

Abbreviations	
Temp	Temperature
EMC (UGL)	Equilibrium Moisture Content
RH	Relative Humidity
MC	Moisture Content
SHT	Sensor of relative humidity and temperature
KRO	Komandno-razvodni ormar
RB	Relay Board modul
MKM	Measure-communication module
RF	Radio frequency or communication unit that works inside of radio frequency range
Symbols	
	Temperature measurement
	Equilibrium moisture measurement (EMC)
	Measurement of moisture content in wood (MC)
	Semi-automatic mode
AUTO	Automatic mode
	Manual mode
	Heating valve
	Electric heating (* only in dehumidifying dryers)
	Circulation pump
	Drying flaps (PI regulation)
	Drying flaps (ON / OFF regulation)
	Circulation fan
	Sprayers
	Recuperator (* only in classic dryers)
	Compressor (* only in dehumidifying dryers)
	Success of communication with measuring module / relay board
	Communication with a PC
	Access level
	Wireless probe battery charge
	RF signal strength of the wireless probe
	Alarm
	Warning
	Information

2. LITHIUM BATTERY REPLACEMENT IN MC-3000 PANEL

Table 2. **Battery technical specifications**

IEC battery label	CR2032
Type	Lithium
Rated voltage	3,0 V
Rated capacity	210 mAh
Working conditions	-20°C÷60°C
Weight	~ 3g
Dimensions	Ø20 x 3.2mm

MC-3000 unit contains a real-time clock circuit and a button battery, which provides the necessary energy to provide this circuit independence of external power. Despite constant work, consumption is low and battery life is about three years. If the drying system is often shut down, it is advised to remove 3V battery and set the time and date for the next use of the unit. It also advises replacing the battery every 3 years to avoid miscalculations of time and errors in the history records.

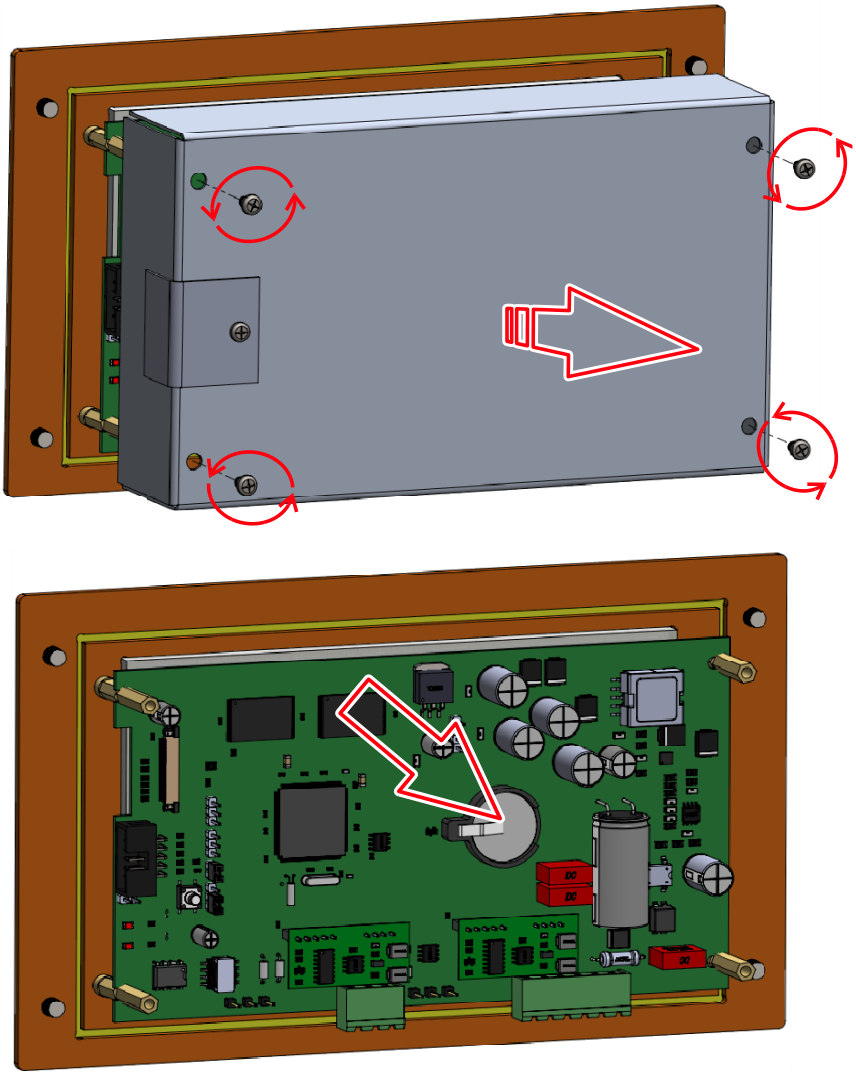


Figure 2. **Remove of metal cover on rear side of unit (up) and main printed circuit board of unit with 3V battery (down)**

- Pull out both terminal clamps (K1 PC and K2 KILN/BUS) from the rear side of unit.
- Remove 4 screws from the rear side (one at each corner) and remove metal cover.
- Battery is located in a battery holder on the main PCB of unit.
- Push the flat screwdriver under the battery and remove the battery from the battery holder.
- Use lithium battery CR2032 of 3V only as replacement !
- Replace the battery with the suitable one. Pay attention to the poles !
- Put the cover back on and tighten all screws.
- Connect both terminal clamps (K1 and K2) with the automatic controller unit.
- Put the battery in adequate packaging to avoid short-docking and take the battery to the recycling service.

3. INSTALLATION OF EQUIPMENT

The control system for wood drying with controller unit MC-3000 consists of the following parts:

1) MC-3000 main unit with touchscreen, through which mediation is made between users and equipment in dryer,

2) RB-3000 relay board, over which equipment is managed in dryer,

3) MKM measuring-communication module could be type MKM-08 (with wire probes) or MKM-RF (with wireless probes), provides measuring of temperature, equilibrium moisture content in the air and moisture content in the wood, under which the drying process is conducted,

4) TR-RB isolating transformer for supplying RB block 230/20 V ac, 50/60 Hz, max 1.25 A,

5) probes for measuring temperature, EMC in the air and MC in wood,

6) USB-RS485 adapter for PC connection (optional),

7) communication cable S/FTP Cat.7 4P or LIYCY 5 x 0.34 mm^2, for connecting MC-3000 and RB-3000 and

8) communication cable S/FTP Cat.6 4P, for connecting RB-3000 and MKM, as well as MC-3000 and PC.

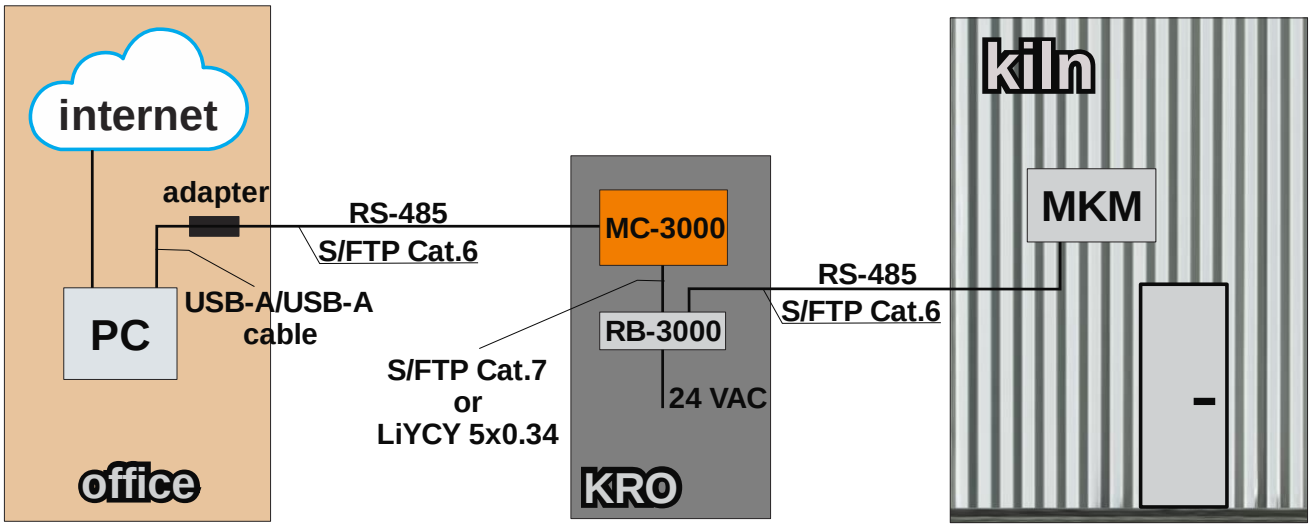


Figure 3.1. **Blok šema povezivanja sistema za sušenje sa automatom MC-3000**

MC-3000 panel unit is designed for the installation of a closet (KRO) in which the rest of the equipment is installed.

Relay board RB-3000 is mounted on rail in KRO. It is connected to power supply and consists of command relays.

Measuring module MKM is mounted on the dryer chamber's rear outer wall. Probes for temperature, EMC and wood MC are placed inside chamber. For MKM with wired probes, the cables for connecting to the measuring module are included. For MKM with wireless probes, an antenna is mounted inside chamber to receive signals.

Connection between MC-3000 and RB-3000 is cable S/FTP Cat.7 (NIGOS KRO) or LiYCY (other's KRO) (item 7).

Connection between RB-3000 and MKM is cable S/FTP Cat.6 (item 8). Length of this cable could be up to 300 m.

Connection between MC-3000 and PC-a is cable S/FTP and adapter USB-RS485, which are optional and available upon user's request.

3.1. CONNECTION BETWEEN MC-3000, RB-3000 AND MKM

For connecting MC-3000 and RB-3000 use cable S/FTP Cat.7 4P or shielded cable LiYCY 5x0.34.
For connecting RB-3000 and any MKM use standard cable S/FTP Cat.6 4P.

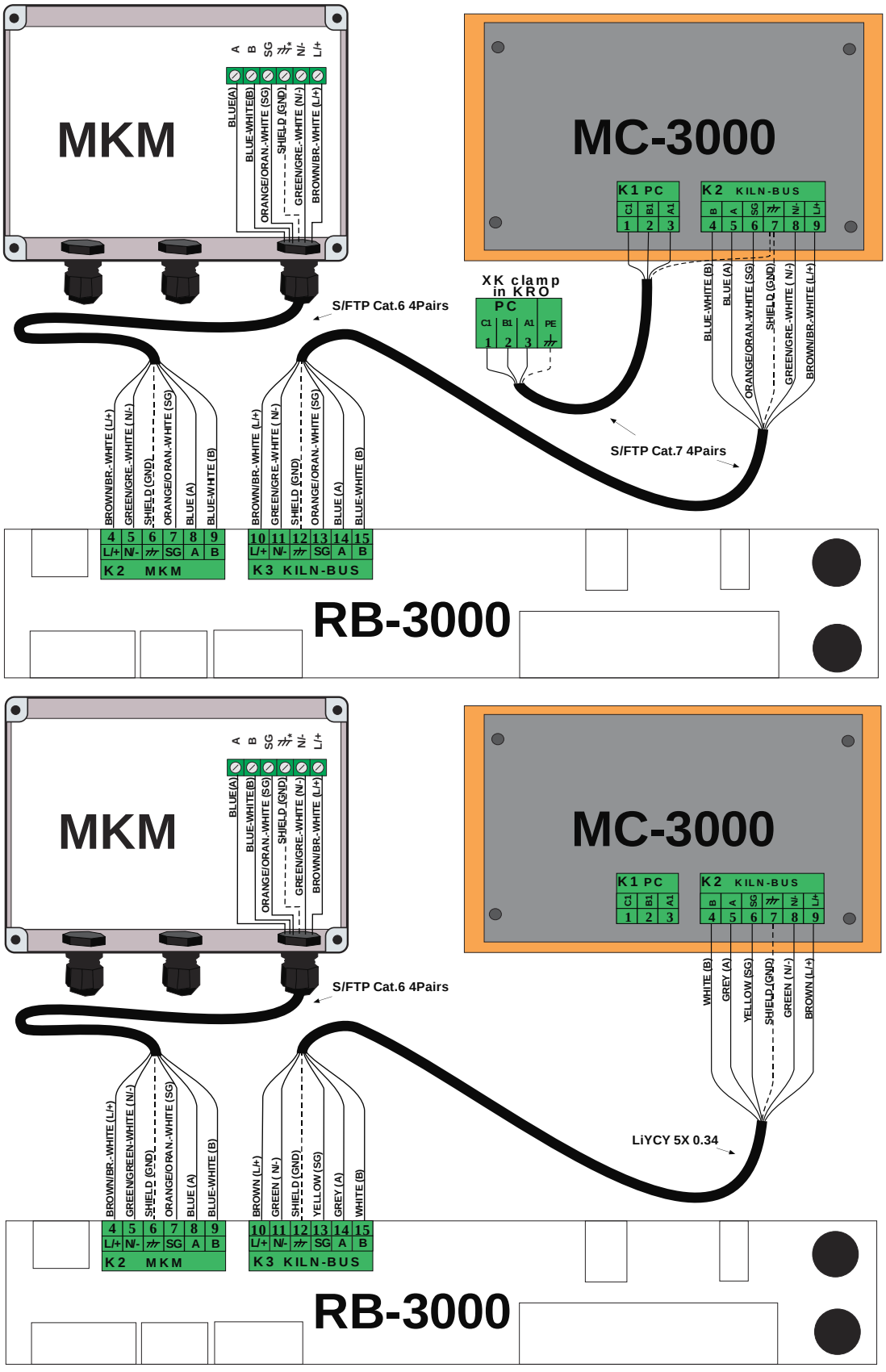


Figure 3.1. Connection diagram of MC-3000, RB-3000 and MKM

3.2. CONNECTING RB-3000

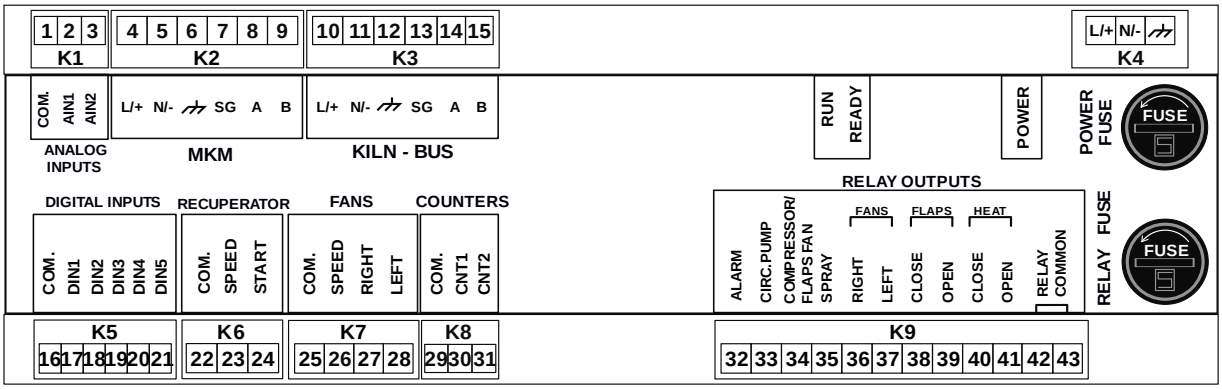


Figure 3.2.1. Overview RB-3000 clamps

Data cables and control signals inside the power electric switch board are connected to clamps marked with numbers 1 through 9 and plug into the corresponding clamps of the RB-3000 relay board. The user connects the equipment in the dryer to the appropriate clamps of the power electric switch board (KRO) according to given layouts and schematics.

Table 3.2. **RB-3000 clamp connection layout**

CLAMP LABEL	NUMBER/ LABEL	CONNECTED TO CLAMP OF…		FUNCTION	
		…CONVENT. DRYER	…DEHUMIDIFY. DRYER		
K1 Analog inputs	1/com.	GND for temperature probes		Common contact for probes	
	2/Ain1	Temperature probe Pt-1000		Monitored temperature 1 and 2	
	3/Ain2				
K2 MKM	4 / L/+	L+ on clamp inside MKM module		MKM module power supply	
	5/ N/-	N- on clamp inside MKM module			
	6/ GND	GND on clamp inside MKM module		MKM module grounding	
	7, 8, 9 / RS-485	RS-485 (B, A, SG) on clamp inside MKM module		Comunication with MKM module	
K3 KILN-BUS	10 / L/+	L+ on clamp of MC-3000 unit		MC-3000 unit power supply	
	11/ N/-	N- on clamp of MC-3000 unit			
	12/ GND	GND on clamp of MC-3000 unit		Grounding for MC-3000 unit	
	13, 14, 15 / RS-485	RS-485 (B, A, SG) on clamp of MC-3000 unit		Comunication with MC-3000 unit	
K4 Power supply 24V AC/DC	GND	GND for isolating transformer		GND for RB-3000	
	N/-	Neutral for isolating transformer		RB-3000 power supply	
	L/+	Phase for isolating transformer			
K5 Digital inputs	16/com.	GND for digital inputs		Common contact for digital inputs	
	17/Din1	Voltage-free contact on switch for flow fan		Flow fan's failure alarm	
	18/Din2	/	… switch for compressor fan		
	19/Din3	Voltage-free contact on circulation pump		Circulation pump's heating alarm	
	20/Din4	… switch for recuperator	… switch for compressor	Recuper.control	Compress.press.
	21/Din5	Voltage-free contact on switch for optional user's device		Defined by user	
K6 Recuperator	22/com.	Inverter for recuperator	/	DC inverter grounding	/
	23/Speed			DC inverter speed input	/
	24/Start			DC inverter start input	/
K7 Fans	25/com.	Inverter for flow (air circulation) fan		DC inverter grounding	
	26/Speed			DC inverter speed input	
	27/Right			DC inverter start CW input	
	28/Left			DC inverter start CCW input	
K8 CNT	29/com.	GND for counter inputs		Common contact for counters	
	30/CNT1	Measuring electricity consumption		Electric meter output	
	31/CNT2	Measuring thermal energy consumption		Calorimeter output	
K9 Relay outputs	32/Alarm	Alarm signal		Alarm	
	33/Circ.pump	Circulation pump start		Circulation pump	
	34/Compressor/ Flaps fan	Switch for recuperator	Switch for compressor	Recuperator ON	Compressor ON.
	35/Spray	Spraying valve		Spraying valve open	
	36/Fans_Right	Switch for CW (right) direction of flow fans (in KRO)		Right direction of fans	
	37/Fans_Left	Switch for CCW (left) direction of flow fans (in KRO)		Left direction of fans	
	38/Flaps_Close	Servo drive on flap		Servo flap closing	
	39/Flaps_Open	Servo drive on flap		Servo flap opening	
	40/Heat_Close	Heating valve	Electrical heating switch	Heating valve close	Heater ON
	41/Heat_Open	Heating valve	Water heating valve	Heating valve open	Aux. relay
	42, 43/Relay common	Control voltage from power electric switch board (KRO)		Control voltage	

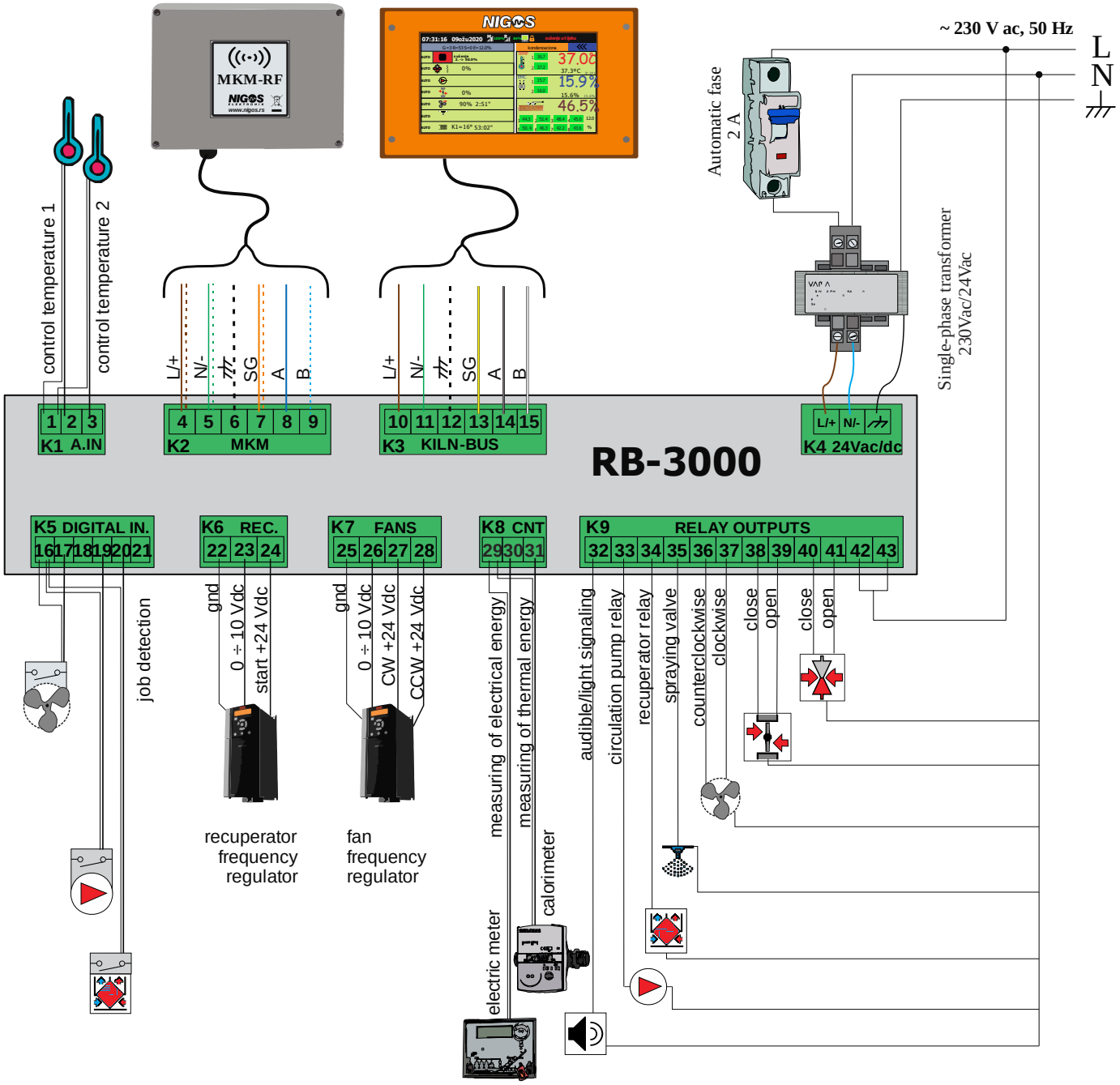


Figure 3.2.2. **Block schematics of connecting equipment of conventional dryer to RB-3000 relay board**

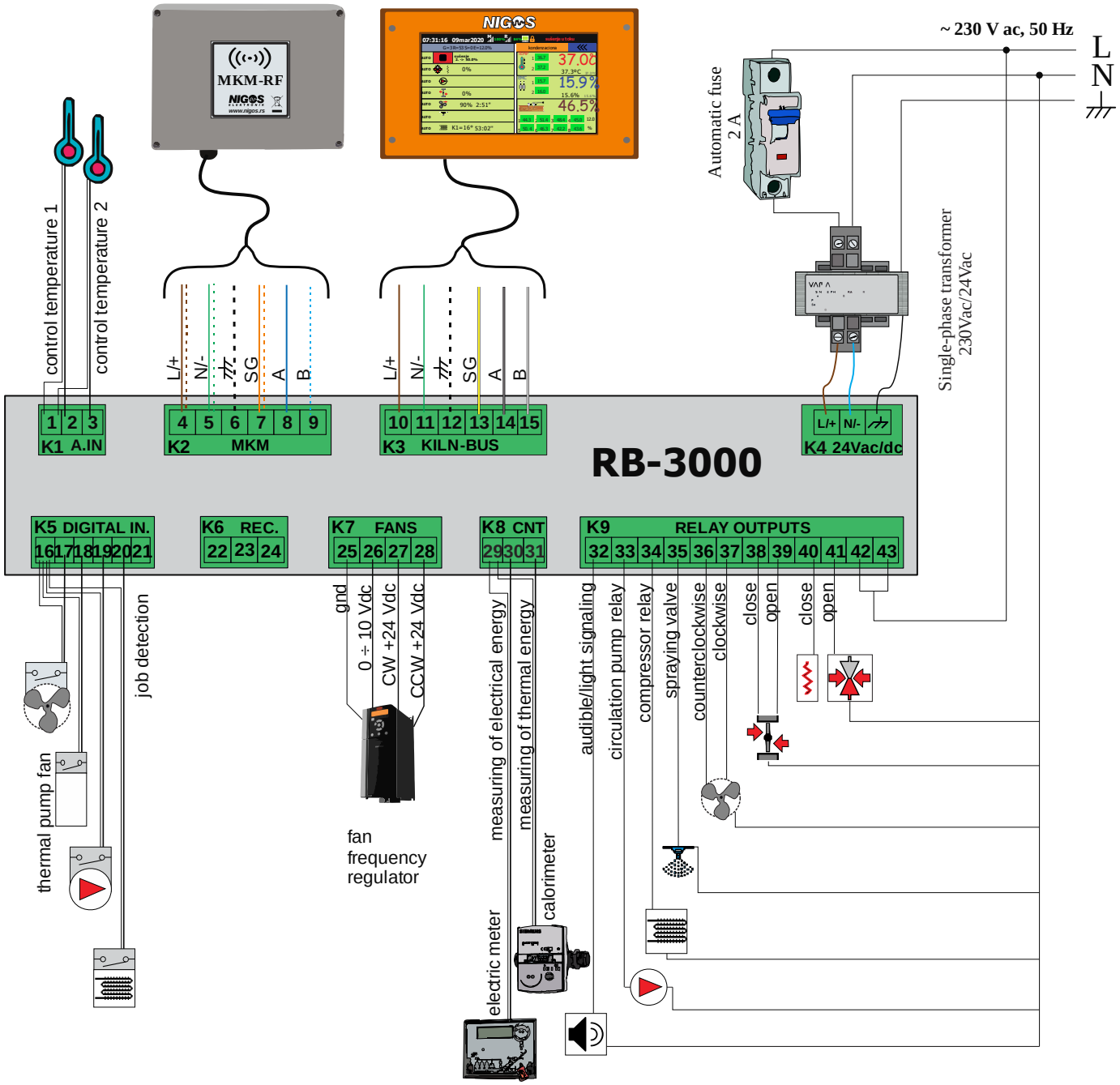
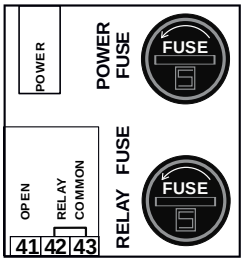


Figure 3.2.3. Block schematics of connecting equipment of dehumidifying dryer to RB-3000 relay board

⚠ **NOTE: On figures are represent example of connection of output devices, directly connected to 230 Vac power supply. The user can use devices with different power. It is recommended that user use voltage-free contacts for work with output devices !**

3.2.1. Fuse replacement of relay board RB-3000

In case that RB-3000 is connected to power supply, but POWER LED not glow, fuse marked with POWER FUSE needs to be replaced.
In case that RB-3000 can not turn on output devices, but their LED glow, fuse marked with RELAY FUSE needs to be replaced.



- Only a trained person (electrician) can replace the fuses !
- It is mandatory to pull out clamps: K4 (power supply) and K9 (relay outputs) before any replacement !
- Insert a flat screwdriver into the slot under the FUSE sign, press it and turn it to the left for about 60°.
- The fuse carrier's loose. Pull the carrier up from RB-3000 and pull the fuse out of the carrier.
- Discard old fuse, replace it with suitable one, which is given together with RB-3000 in certain quantity.
- Use T3,15A/250V fuses only as replacement! Be sure that the same type is given with RB-3000.
- Put a new fuse in the fuse carrier and return the carrier back in the fuse case in RB-3000.
- With a flat screwdriver, press the carrier into fuse case and turn it to the right for about 60°.
- Re-connect loosed clamps back to RB-3000.

3.3. INSTALLATION OF MEASURING & COMMUNICATION MODULE MKM

There are 2 types of MKM measuring-communication modules: MKM-08 with wire probes and MKM-RF with wireless probe.

3.3.1. Measuring module with wire probes MKM-08

Following equipment with MKM-08 are:

- 1 measuring-communication module MKM-08,
- 2 measurement boxes DS-04t,
- 2 EMC paper holders,
- 1 box of EMC papers (made of special hydroscopic material), sufficient for exploitation in period of 1 to 2 years,
- 8 wood MC probes attachment cables, different lengths (10 m, 8 m and 6 m),
- 1 box of prochrome (inox) probes for wood, shorter and longer and
- 1 tool for probe extraction from dried wood.

3.3.1.1. Position of MKM-08 and DS-04 boxes in the dryer chamber

Measuring module MKM-08 performs temperature and moisture measurements in the chamber and transfers that informations to MC-3000 by communication line. MKM-08 is mounted on the outside rear wall of the chamber. DS-04t boxes are mounted inside, arranged diagonally. These boxes carry on them one probe for measuring temperature, one EMC paper holder and 4 cable connections to plug in the wood moisture content measuring probes.

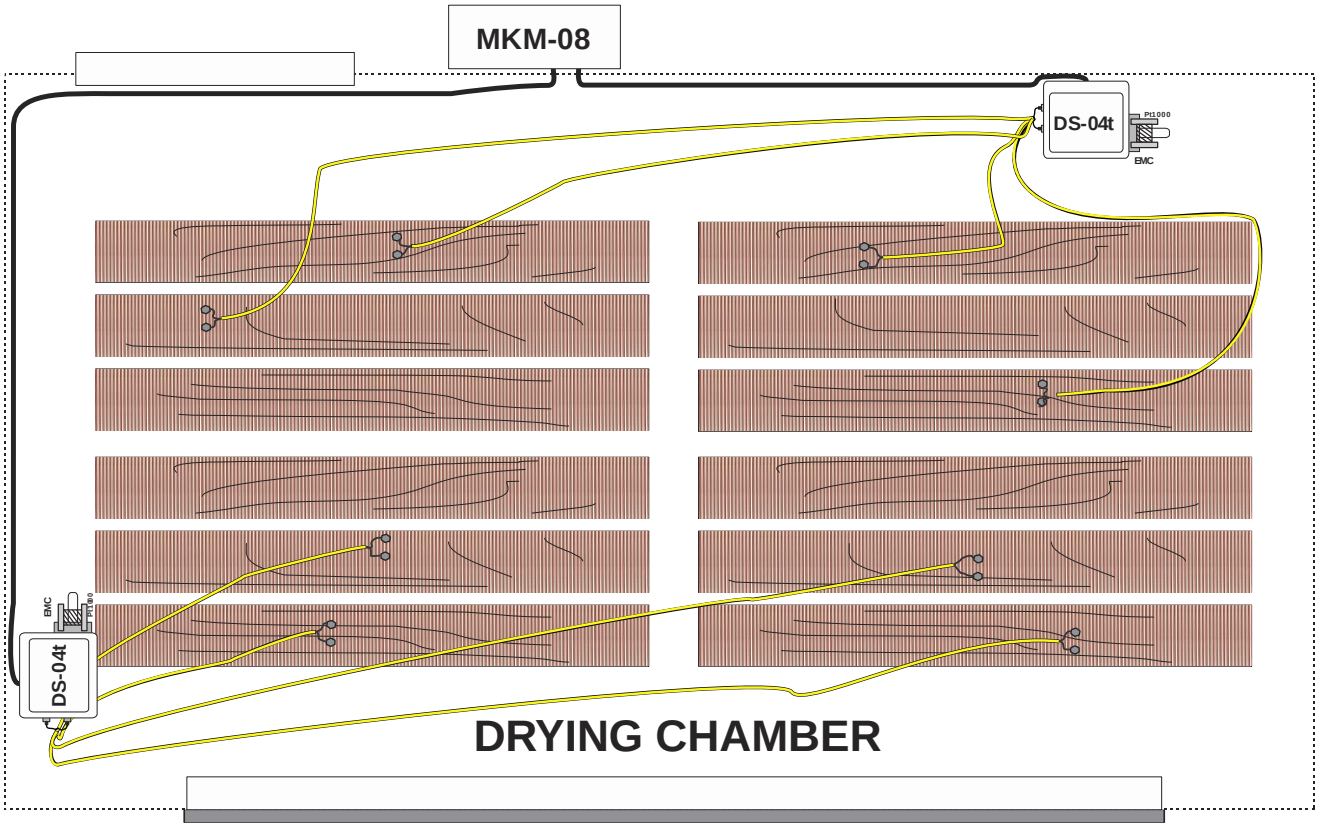


Figure 3.3.1. **Position of MKM-08 and DS-04 boxes in the dryer chamber**

3.3.1.2. Connection scheme

DS-04t boxes are connected by multi-wire cable (LI6YC6Y 8x 0.34 mm^2) to the MKM-08 terminal clamp according to the scheme provided in figure 3.3.2. The colors layout is standard for cables delivered by NIGOS-elektronik and should be adhered to whenever possible.

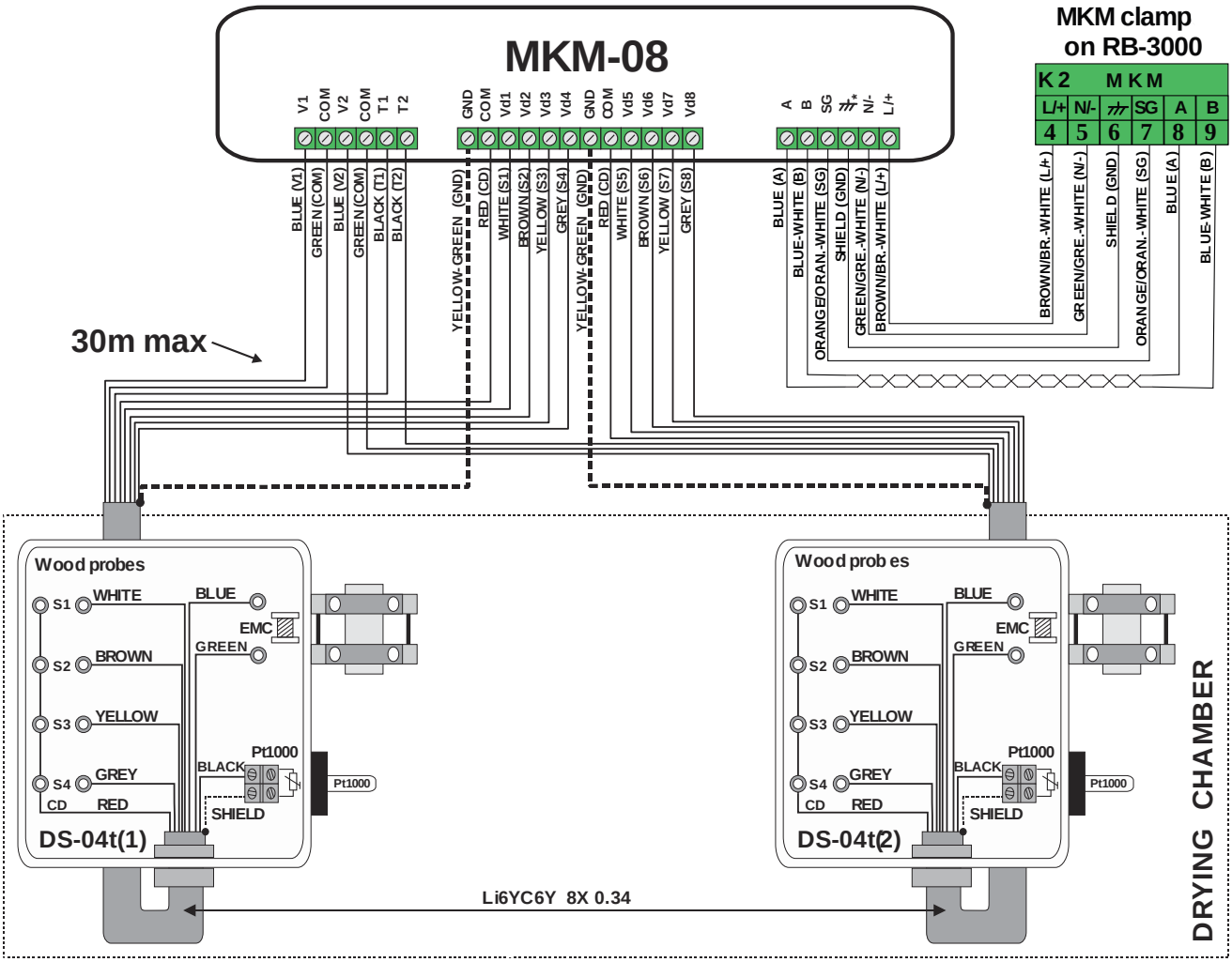


Figure 3.3.2. Connection scheme of measuring boxes DS-04t and MKM-08

EMC is measured over paper samples placed in the holder. Replace fresh new paper before each new drying cycle.
Wood MC is measured over nails hammered into the wood and they are connected via cables with crimp connectors on both sides to DS-04.

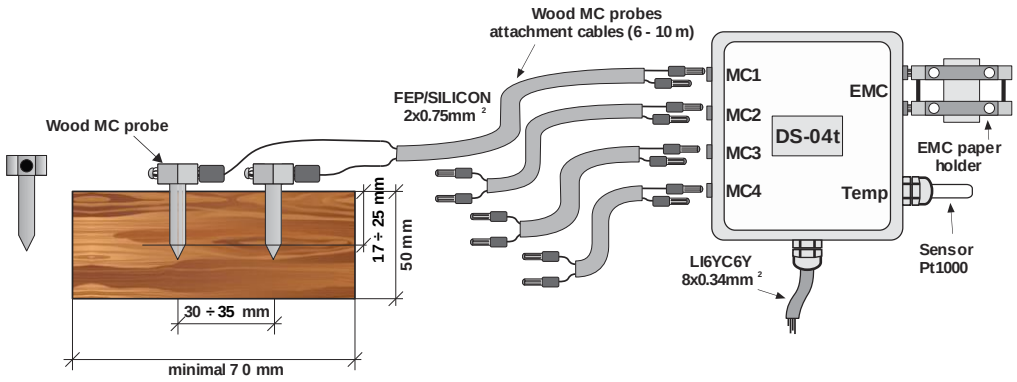


Figure 3.3.3. **Connection of measuring elements to DS-04t box: wood MC probes, sensor Pt1000 and EMC paper holder**

3.3.2. Measuring module with wireless probes MKM-RF

Following equipment with MKM-RF are:

- 1 measuring-communication module MKM-RF,
- 1 RF-antenna which receives signals from probes,
- 2 RF-EMC probes - or - 2 RF-SHT probes,
- 2 EMC paper holders (with RF-EMC probes only!),
- 1 box of EMC papers (with RF-EMC probes only!),
- 8 wireless wood MC probes RF-MC1, with built-in batteries,
- 1 box of prochrome (inox) probes for wood, shorter and longer and,
- 1 tool for probes extraction from dried wood.

MKM-RF module "listens" to probes that are in the chamber and receive measured temperature and moisture values and transmits these informations to MC-3000 by communication. MKM-RF is mounted on the outside rear wall of the chamber, and the antenna inside the dryer chamber. Probes are deployed in chamber on various spots for the best space covering and the best signal streigth to MKM-RF.

3.3.2.1. Positions of MKM-RF, antenna and wireless probes in the dryer chamber

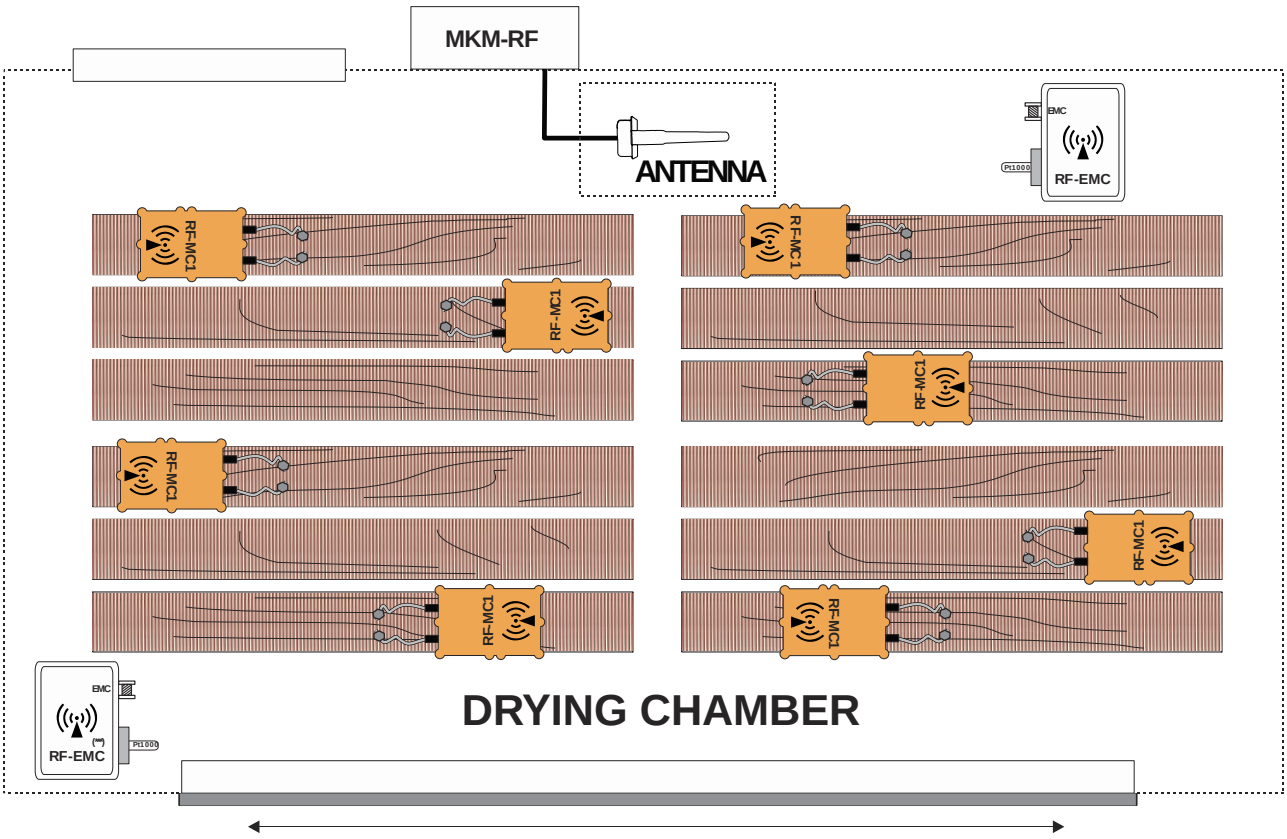


Figure 3.3.4. **Position of MKM-RF, antenna and wireless probes RF-MC1 and RF-EMC**

3.3.2.2. Connection scheme

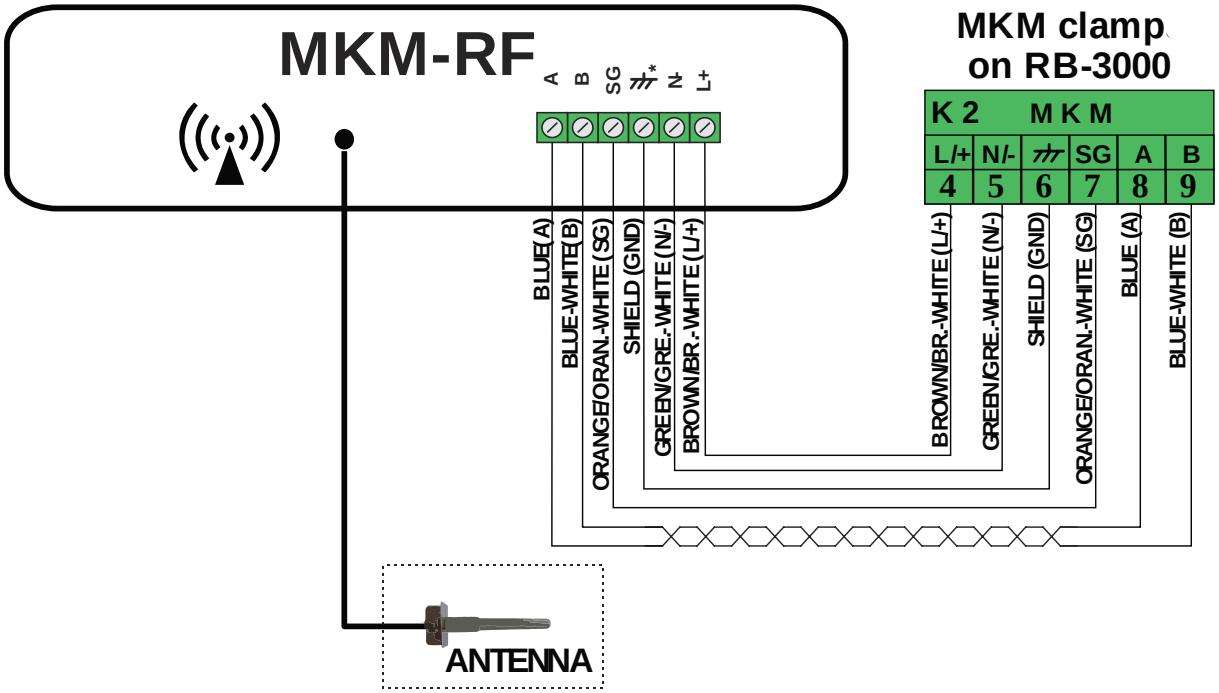


***Figure 3.3.5. Connection scheme of measuring module* MKM-RF**

RF-EMC probes have 1 temperature probe and 1 paper holder to measure EMC. EMC paper have to be renewed before each new drying cycle.

RF -SHT probes have a combined temperature and EMC probe located in a tube with an air passing filter. This filter should be cleaned every 6 months or when it is observed to be clogged.

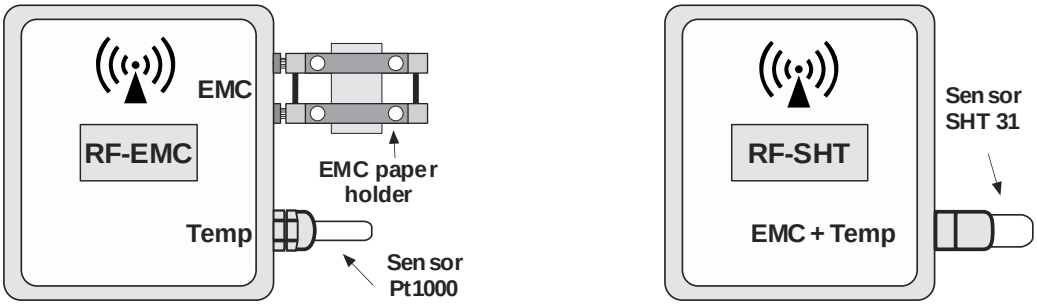


***Figure 3.3.6.* RF-EMC probe mounted on the dryer wall, with measuring elements Pt1000 sensor and sample holder (left) and RF-SHT probe mounted on the dryer wall, with capacitive sensor as measuring element (right)**

RF-MC1 probes are connected to the nails in wood (wood MC probes) via attachment cables with crimp connectors on the both sides.

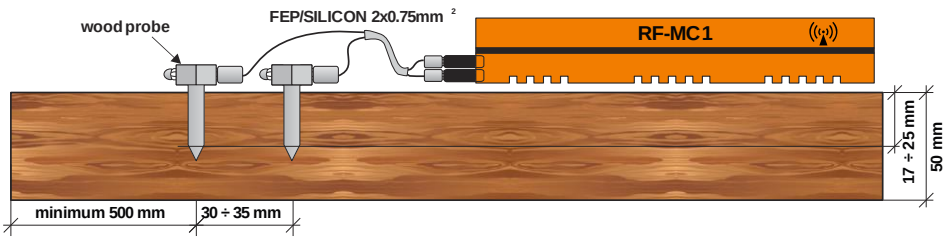


***Figure 3.3.7.* Connection of wood probes to RF-MC1 probe**

3.4. INSTALLATION OF PROBES IN DRYING CHAMBER

3.4.1. Installation of probes for measuring equilibrium moisture content in the dryer

This probe is placed in DS-04t and RF-EMC boxes. The paper holder is made of aluminum and is mounted on it according to the instructions given (Figure 3.4.1). The measuring sample has rectangular shape and it is made of hygroscopic paper.

Placement of EMC paper into holder: Unwide 4 nuts on the sample holder so that the springs become free. The sample is placed between 2 sets of plates. Wind up rolls tighten so that the tiles are well attached to the sample and the make contact between them.

NOTE:

This sample is used for **ONLY ONE** drying cycle. After each drying cycle, the paper is thrown away and renewed as written above. In case of RF-SHT probe instead of RF-EMC, not need for papers, since built-in SHT sensor unifies temperature and EMC se.

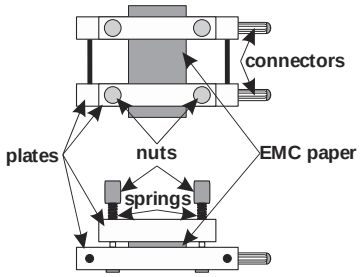


Figure 3.4.1. **EMC paper holder**

3.4.2. Installation of probes for measuring wood moisture content

The whole process of drying sawn lumber is conducted on the basis of the measured average moisture in the wood, which was obtained from eight measuring spots (probes). That is why it is extremely important to properly place and arrange the probes in the lumber stock. The same stainless steel probes are used to connect to the DS-04t boxes as for the RF-MC1 probes. Sometimes it is necessary to use stainless steel screws instead of stainless steel nails, for thin wooden materials (eg. lamellas).

The probes are made of INOX (rust-proof, stainless steel). After drying, the probes are removed with special tool and will be used for next drying. The recommended dimensions of the nails for measuring wood MC are:

30 mm for lumber up to 40 mm thick (thinner lumber) and
45 mm for lumber over 40 mm thick (thicker lumber)

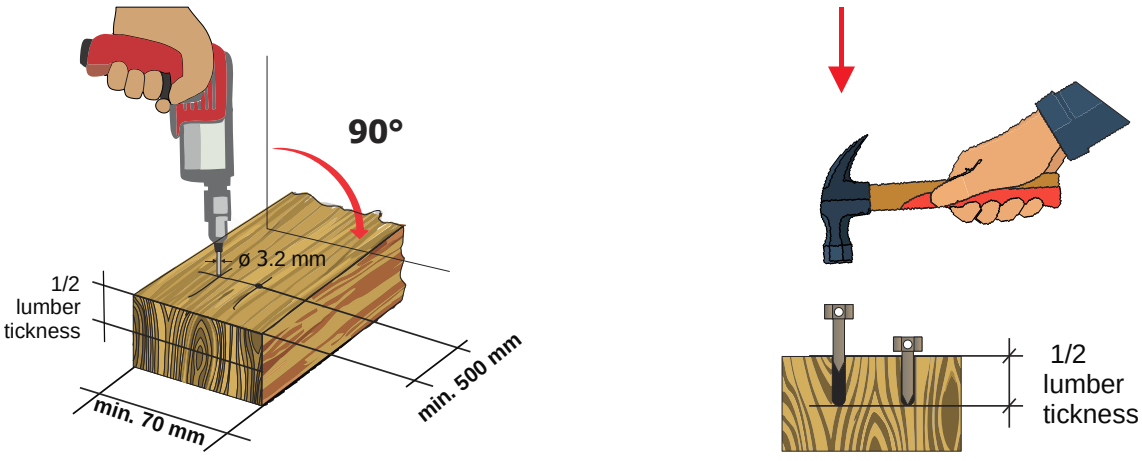


Figure 3.4.2. **Proper drilling of holes and hammering of INOX probes into the lumber**

One pair of probes is used for one wood MC measuring spot.

First at all, drill two hole in wood board with Ø 3.2 drill bit (3 ÷ 3.5 mm), up to half the lumber tickness.

Further, the probes are hammered into prepared holes, where the depth of penetration must not be less than 1/3 thickness of the lumber, and it is best to be up to 1/2 thick of lumber.

Probes are placed cross-board at a distance of 30 to 35 mm (ideally 32 mm). Thinner and softer lumber not need drilling, but probes can be hammered directly.

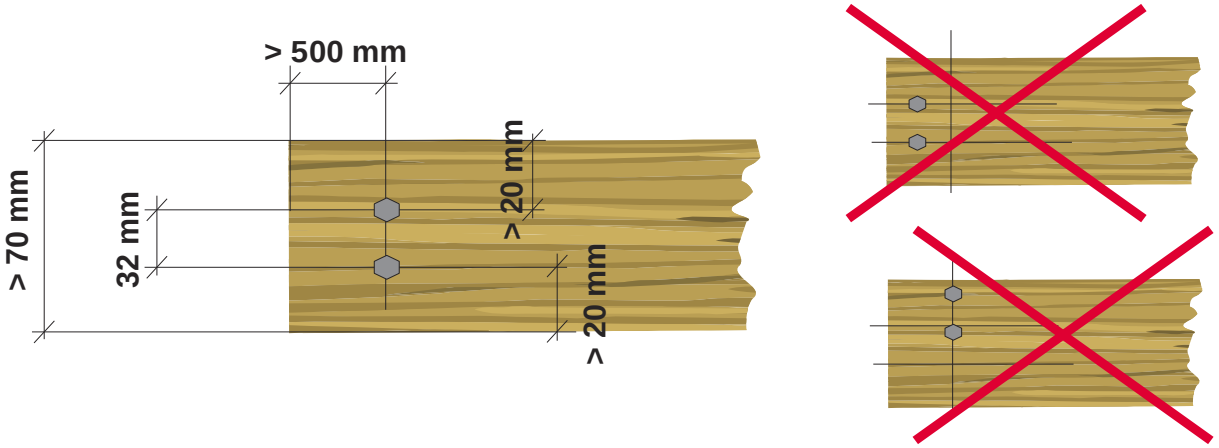


Figure 3.4.3. Probes placement in boards wider than 70 mm (top view)

NOTE: In lumber elements shorter than 103 cm, the probes are placed around the middle of the element.

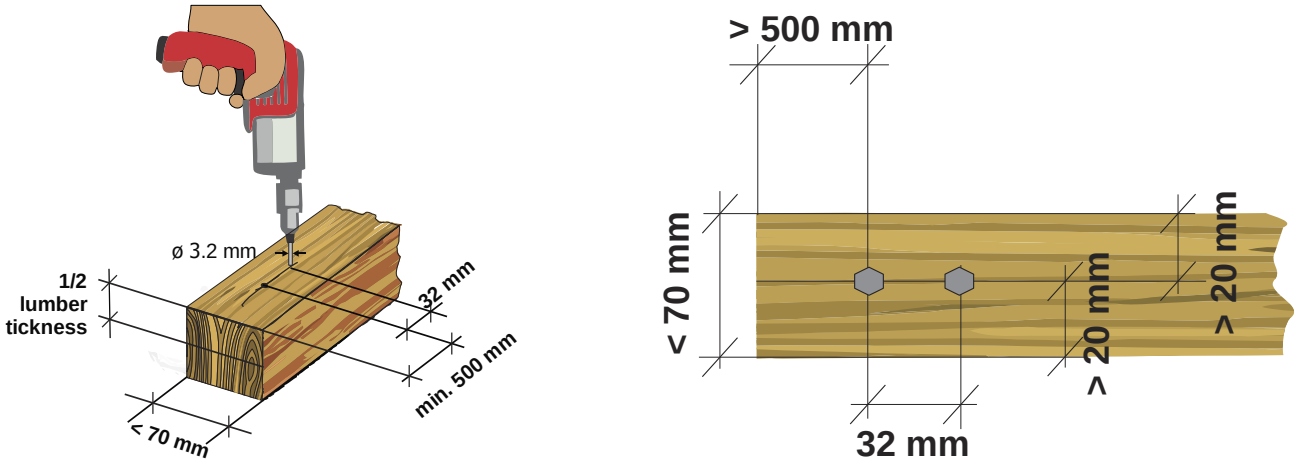


Figure 3.4.4. Probes placement in elements narrower than 70 mm (top view)

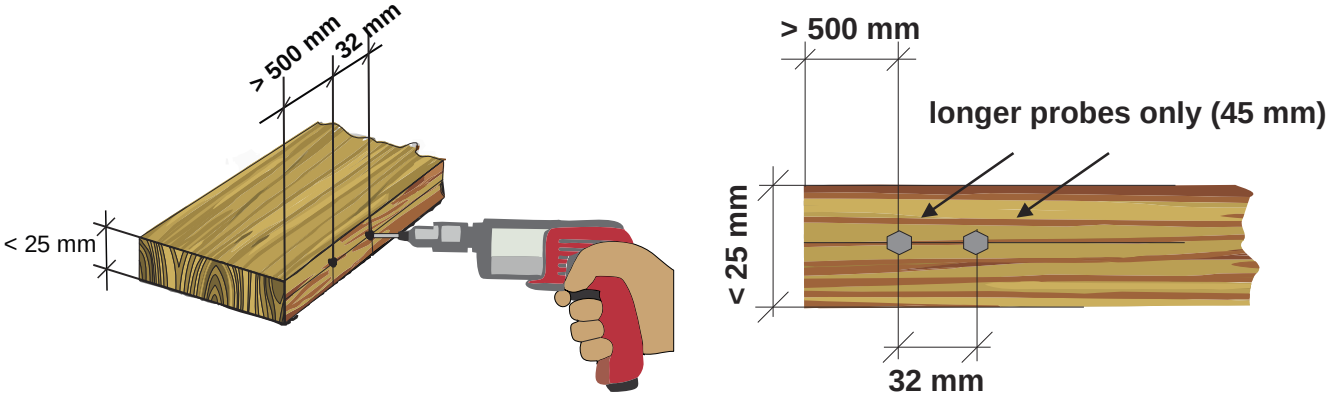


Figure 3.4.5. Probes placement in boards thinner than 25 mm (side view)

A pair of stainless steel screws are used to measure the moisture in the lamella as shown in the following figure, with the recommended dimensions of the screws 4.8 x 13 mm. The screws are placed transversely on the lamella at a distance of 30 mm to 35 mm (ideally **32 mm**). . A couple of holes are first drilled in the board with a Ø 3.2 mm drill bit. A nickel-plated ring pedal (Ø 4.8 - 1mm2) is placed on the screw as an adapter for connecting the probe cable. Then, a rubber 3 ÷ 5 mm thick, 15 ÷ 20 mm in diameter is placed (sealing plumbing rubber rings are used). After that, the screws are screwed into the prepared holes until the rubber is slightly sunken. With thinner and softer material, you do not need to drill holes, but the screws are screwed directly into the material. The following figure gives an example of placing probes. After drying, the screws have to be removed and a new pair of screws is needed for the next drying.

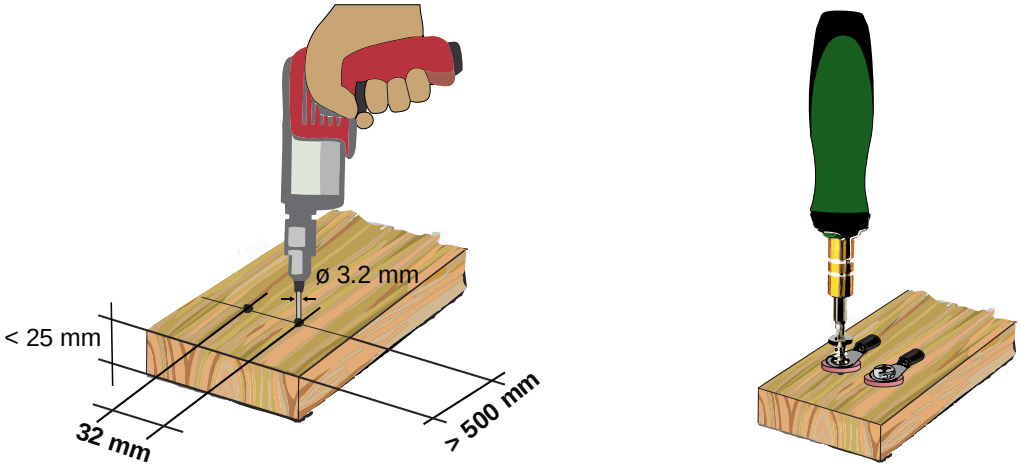


Figure 3.4.6. Placement of stainless steel screws in the lamella

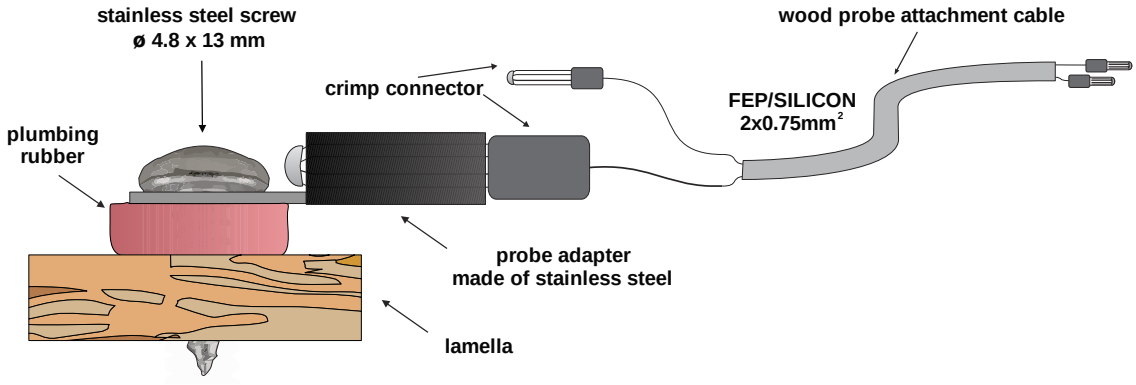


Figure 3.4.7. Connecting stainless steel screw

After installing the probes, connect the wood probe attachment cable by plugging the crimps at one end of the cable into the holes located at the top of the wood MC probes. The crimps on the other end of the cable are connected to the DS-04t junction box or to the RF-MC1 probe.

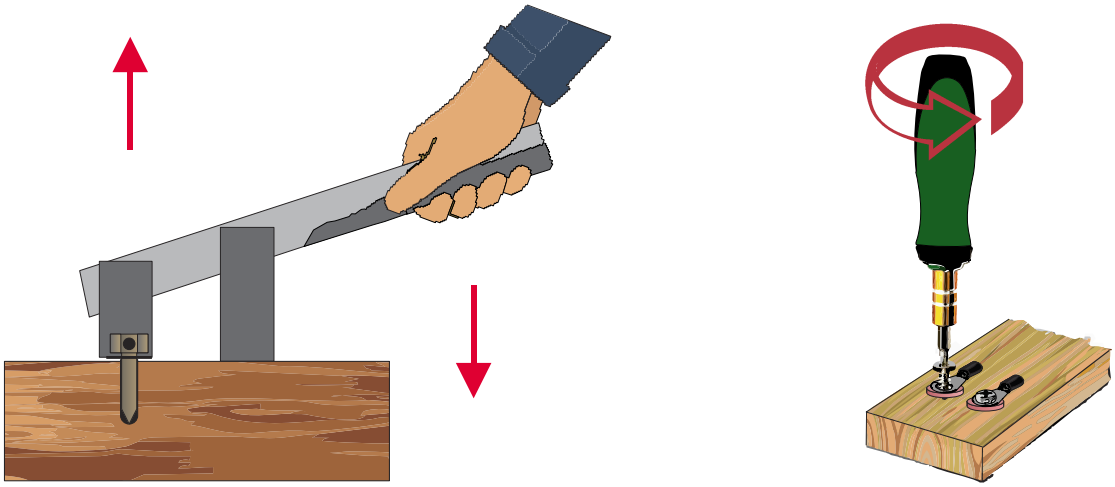


Figure 3.4.8. Extraction of INOX nails with a special tool after drying (left) and removing INOX screws (right)

3.5. WIRELESS PROBE BATTERIES

Additional safety warnings for non-rechargeable batteries:

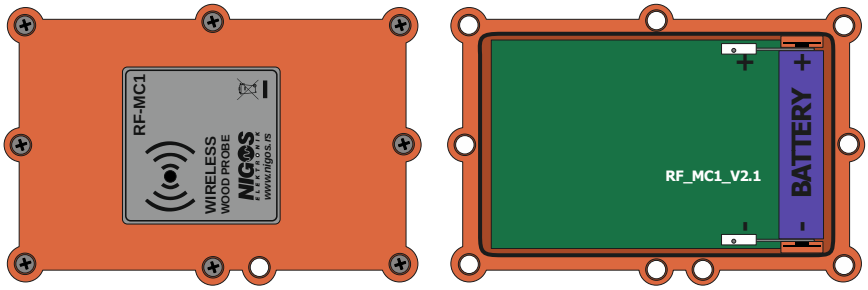
- Don't open the batteries.
- Do not store batteries at a temperature higher than 40 °C, do not heat them or expose them to flames.
- Empty and damaged batteries store under WEEE directive and local laws.
- Under extreme conditions, there may be a leak of electrolytes from the battery. In that case, wipe the battery and the interior of probe with dry cloth, while avoiding contact with the skin.
- The battery meets the standards IEC60086-4, IEC60079-11, UL1642 and directives RoHS and REACH.

Table 3.6. **Battery technical specifications**

IEC battery label	Saft LS 1xx00
Type	Li-SOCl$_2$
Rated voltage	3,6 V
Rated capacity	1.2Ah ÷17Ah
Working conditions	-60°C÷150°C
Weight	~ 10g
Dimensions	Ø12 x 40mm

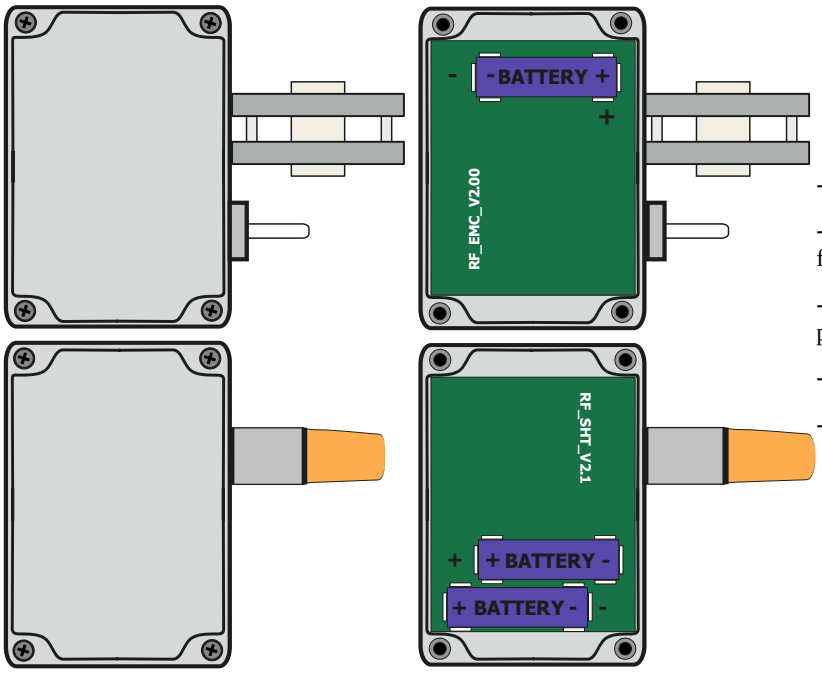
Wireless probes run on batteries at all times and send measurements to MKM-RF. Despite constant work, consumption is low and battery life is minimal two years. If the probe has not been used for a long time, it is advised to remove the batteries from the probes. It also advises replacing batteries every two years to avoid miscalculation results.
It is preferable to replace batteries before drying process starts, but if the battery runs out or leaks during drying, passivise probe on controller screen. A more detailed description follows.
Disconnect RF-MC1 probe from the silicon cables or disconnect RF-EMC and RF-SHT probes from the chamber wall. Remove a cover and replace a battery (see below for more details). Close the cover and restore the silicone cables to the RF-MC1 probe or return RF-EMC and RF-SHT to the wall. Activate probes on MC-3000 unit and check measures after a few minutes. Put the batteries in adequate packaging to avoid short-docking and take them to the recycling service.

3.5.1. Battery replacement in RF-MC1



- Pull out 2 silicone cables from the side of RF-MC1.
- Remove 8 screws from the top of probe and remove cover.
- Use a sharp tool to press the tooth in each white battery contact holder to release the contact.
- Replace the battery with a suitable one, paying attention to the poles, using a sharp tool.
- Return upper cover, making sure that the silicone rubber is well fitted and that the opening on the cover matches LED from PCB and tighten screws.
- Connect 2 silicone cables.
- Return RF-MC1 on the wood, if the battery is changed during drying process.

3.5.2. Battery replacement in RF-EMC and RF-SHT



- Remove probe from a wall of the dryer chamber.
- Remove 4 screws on the back of the box and remove front cover.
- Replace battery with suitable one, paying attention to the poles.
- Return front cover, tighten the screws on the back.
- Return the probe on the wall of the dryer chamber.

3.6. CONNECTING THE COMMUNICATION LINE

The communication of the machine with a PC allows monitoring and control of the drying process via a computer. Supplied as an option at the request of the customer.

Communication between the computer (PC) and the control unit is performed by the communication standard RS - 485. The drying process control unit and the computer are connected with an S / FTP CAT7 cable. The length of this cable can be up to 1000 m.

This equipment is used not only to connect the machine to the computer but also to connect communication boxes, inverters, sterilization boxes, etc ... The last device on the line must have a terminating resistor between communication connections A1 and B1 or A and B. A resistor of 120 is used Ω. The devices supplied by NIGOS-elektronik have terminals for communication with the factory-mounted resistor. If the controller unit is connected somewhere in the middle of the cable, the resistor is removed. If the controller unit is located at the end of the cable, the resistor must remain connected between A1 and B1.

Figure 3.6. shows the connection method where the MC-3000 unit is placed first on the master (and on the slave) line and the resistor is removed, the next controller unit continues on it and so on. Terminal resistor lefts on the last unit.

As for grounding, it is enough to connect the shield to the ground only at one end of the cable. Cable shield connects only to the ground of the PC (housing), and no need to connect with other devices on the line, just passes through the cable. At the cable break point, the shield is short-circuited as shown in the cable joining scheme between the two MC-3000 units.

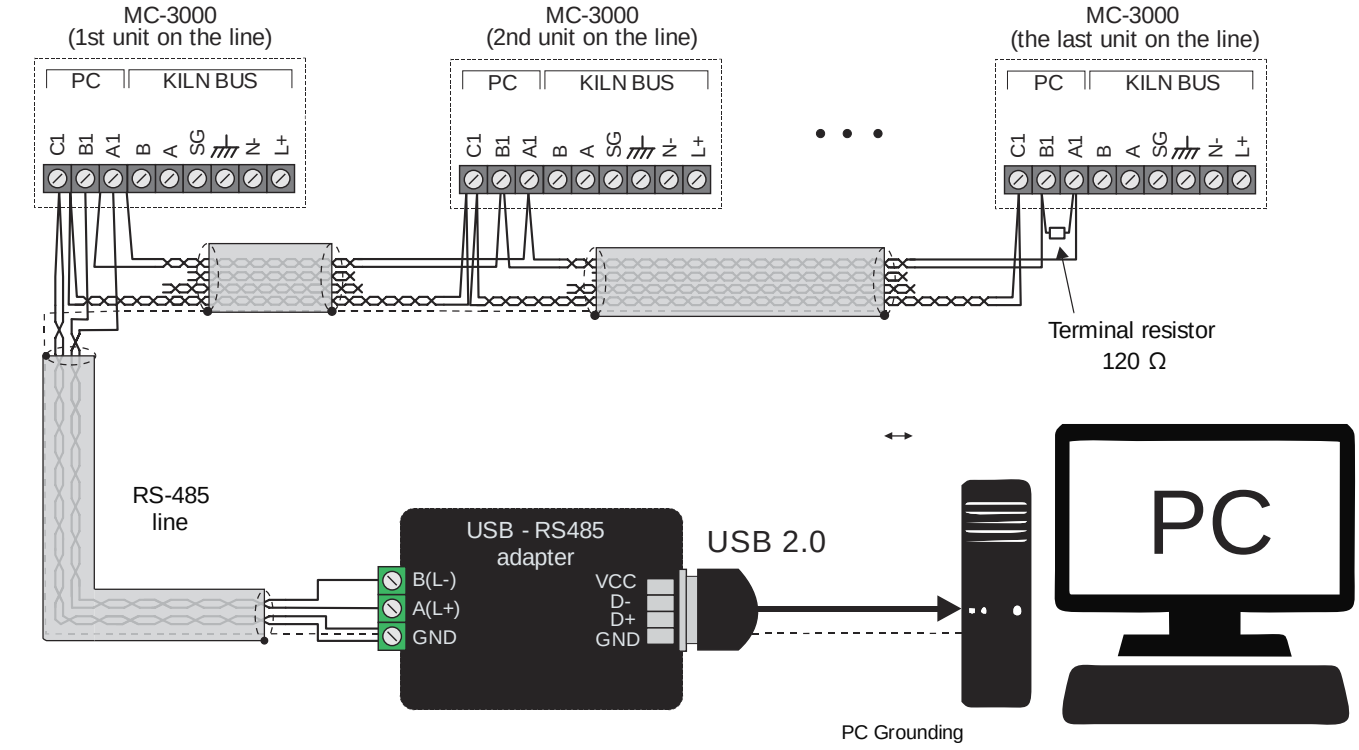
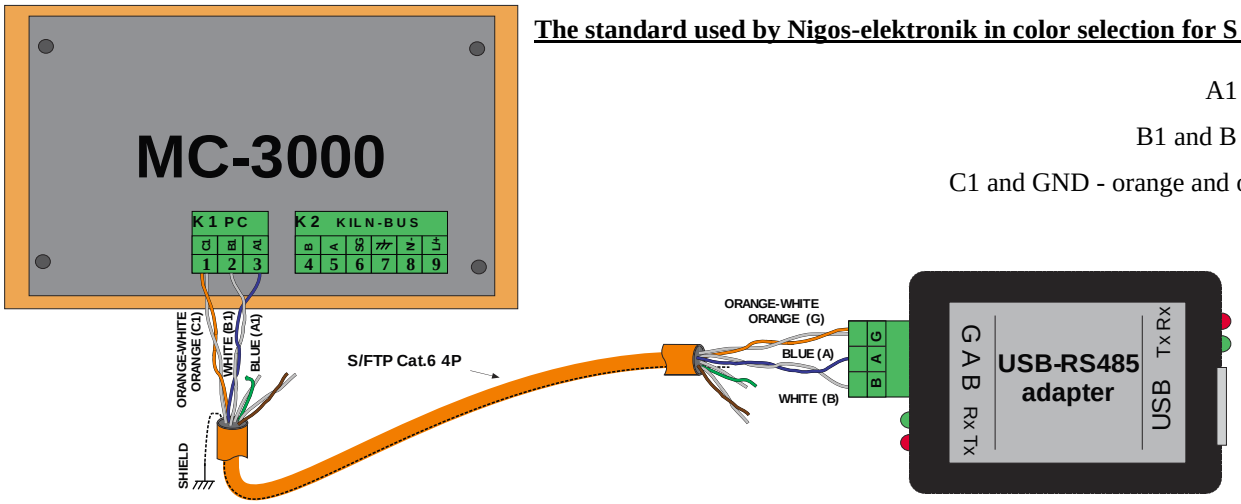


Figure 3.6. **Scheme of connection of communication cables between the units with a PC**



<u>The standard used by Nigos-elektronik in color selection for S / FTP cable</u>:

A1 and A - blue,

B1 and B – blue-white,

C1 and GND - orange and orange-white.

4. OPERATIONS OF AUTOMATIC CONTROLLER UNIT

After switching on the machine to the power supply, the software first automatically performs an internal memory check, resets the equipment in the dryer and displays the home screen - main menu.

4.1. MAIN MENU ON PANEL OF MC-3000

The MC-3000 is equipped with a touch screen. All settings are made by a short and light touch on the field with the desired symbol or the desired text displayed on the screen. In case of damage on the sensitive layer, the contoller can no longer be used.

From the main menu, selectables are: graphic view , textual view , history , regimes , settings and access level .

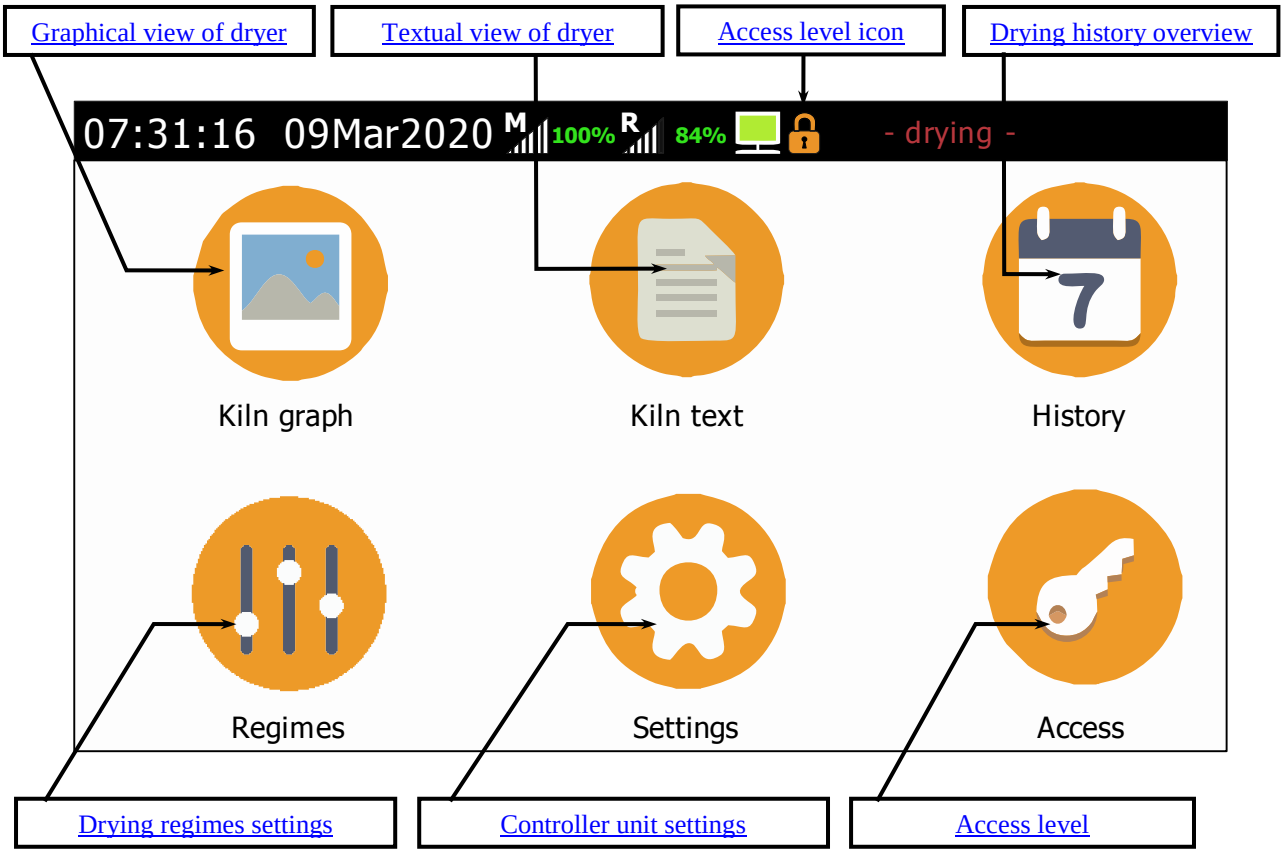


Figure 4.1. **Main menu on the panel of automatic controller unit MC-3000**

4.2. GRAPHICAL VIEW OF DRYER

In the current version of the software, the graphical display function has not yet been developed and its description will follow in one of the further versions.

4.3. TEXTUAL VIEW OF DRYER

By touching the field "**Kiln text**" goes to the screen with a text display of the current state of the dryer and it is used to monitor the entire operation of the dryer. It shows the status line at the top, controls on the left and measurements on the right.

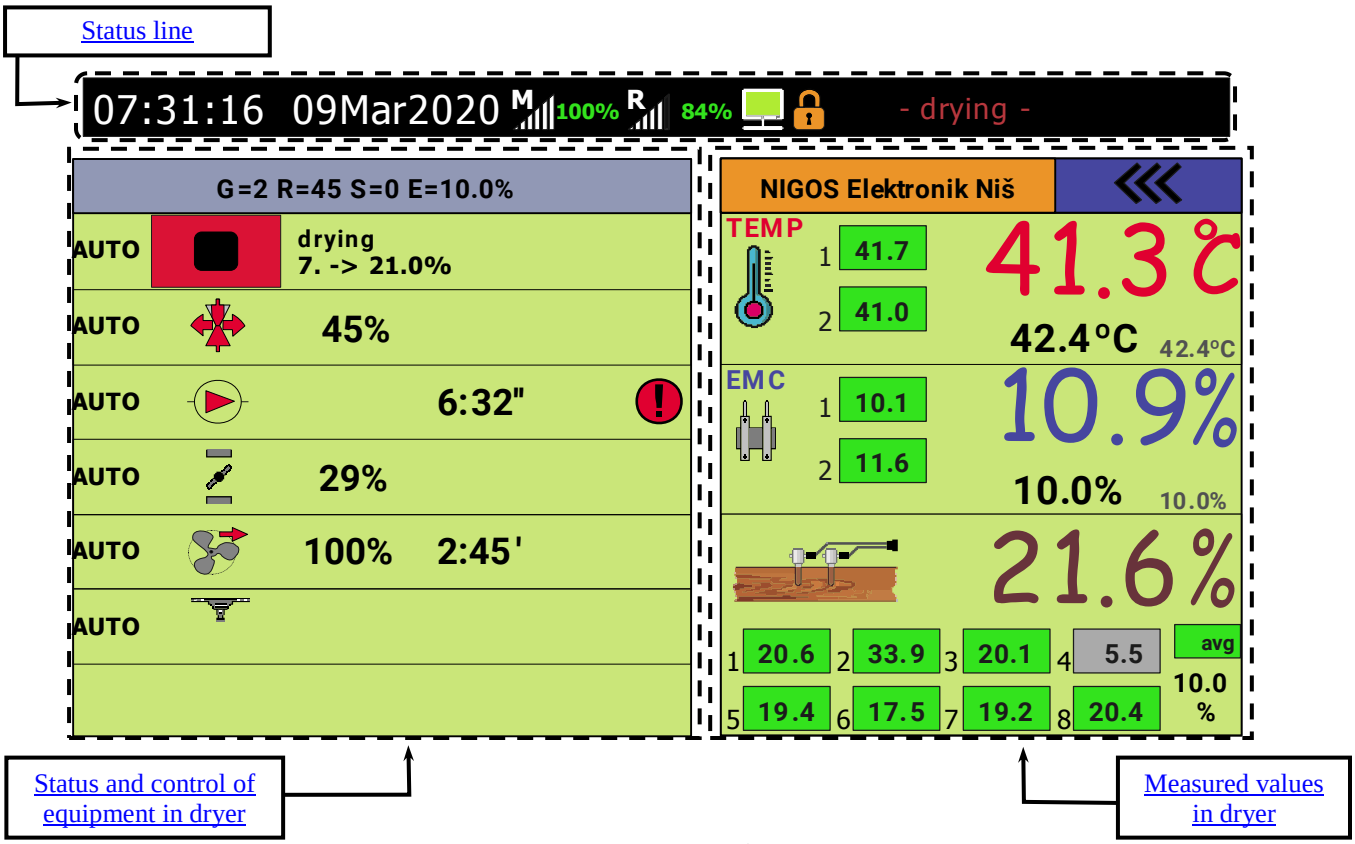
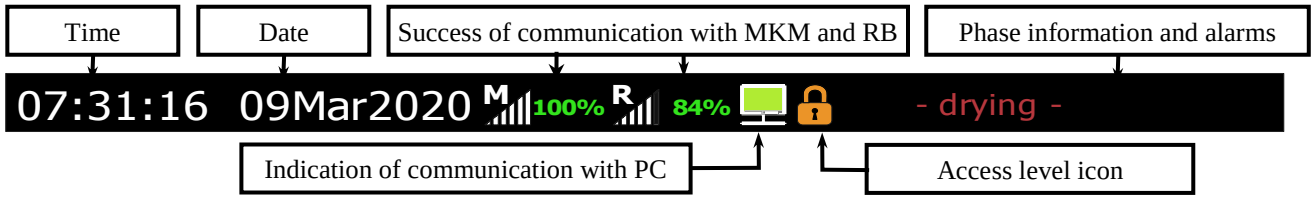


Figure 4.3. Textual view of dryer

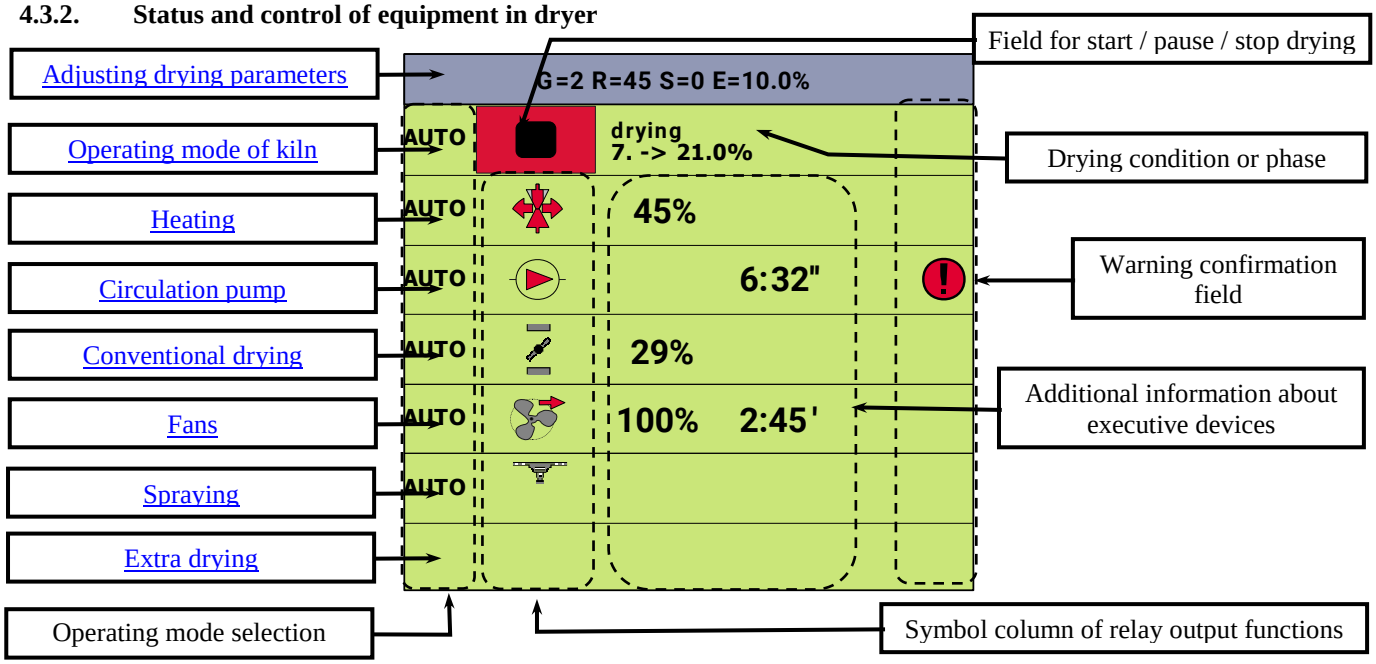
4.3.1. Status line of panel



The basic information what status line displays is given in the following table:

Display on the status bar	Type of information	Function description
07:31:16 09Mar2020	Time and date	Displays the current time (24-hour) and date
M 100%	Signal level (MKM)	Communication quality with measuring-comm. module MKM
R 84%	Signal level (RB)	Communication quality with relay moduleRB-3000
	Indication of communication with PC	1. Communication off (black). 2. Communication established (green). 3. Communication error (orange).
	User access level	1. Free access (orange) 2. User access (green) 3. Blocked access (red)
- drying -	Informations	Displays the current phase and active alarms. When not started, displays the manufacturer's name.

4.3.2. Status and control of equipment in dryer



4.3.2.1. Adjusting drying parameters

Setting the desired drying parameters, the letters shown in the figure are:
G – Group of timber;
R – Regime of drying;
S – Speed of drying;
E – Ending value of ideal moisture content.
A detailed description and setting is in the chapter 4.6.1. Option: Drying parameters

4.3.2.2. Operating mode of kiln

Touch on field to select operating mode, a window opens with the ability to select an automatic ***AUTO*** or semiautomatic mode. Next to it is a symbol where a drying control window opens (start, stop, pause). Additional information in this line is the state of drying process (stop or pause) or drying phase (measuring, heating, drying, conditioning, etc.)

4.3.2.3. Heating

Touching heating operating mode selection field, heating mode selection window will be opened (automatic and manual).

Conventional dryer - heating valve in manual mode can be turned off, opened or closed.

Dehumidifing dryer - heating valve and an electric heater in manual mode can be both turned off, both turned on or single turned on. Additional information here is how open the water heating valve is, in percentage.

4.3.2.4. Circulation pump

Touch on field to select mode, a window opens where user can select auto or manual mode. In manual mode, the circulation pump can be turned on or turned off .

4.3.2.5. Drying

Touch on field to select mode, a window opens where user can select auto or manual mode. Depending on the type, PI regulation is represented by flap which can be opened, closed or turned off in manual mode, and ON/OFF regulation is represented by fan in flap , which can be turned on or off in manual mode. Additional information shows how much the flap is open in percentage.

4.3.2.6. Fans

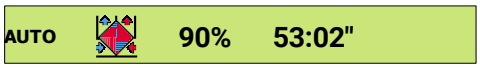
Touch on field to select mode, a window opens where user can select auto or manual mode. In manual mode, fans can have „**left direction**“ , „**right direction**“ or to be „**turned off**“ . By touching the field with fan symbol, you can choose fan settings. Additional information on the right shows the percentage of fan spin speed and the time since the fan was activated.

4.3.2.7. Spraying

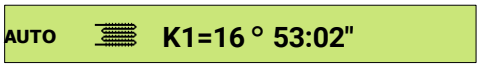
Touch on field to select mode, a window opens that user can select auto or manual mode. In manual mode, spraying can be „**turned on**“ ; „**turned off**“ or „**test**“ (sprinkler testing at certain intervals). Touch on field with the sprinkler symbol, it opens a window to further adjust the spraying in the drying chamber. Additional information shows the time since spraying is turned on.

4.3.2.8. Extra drying

Depending on the type of dryer, the display differs here:

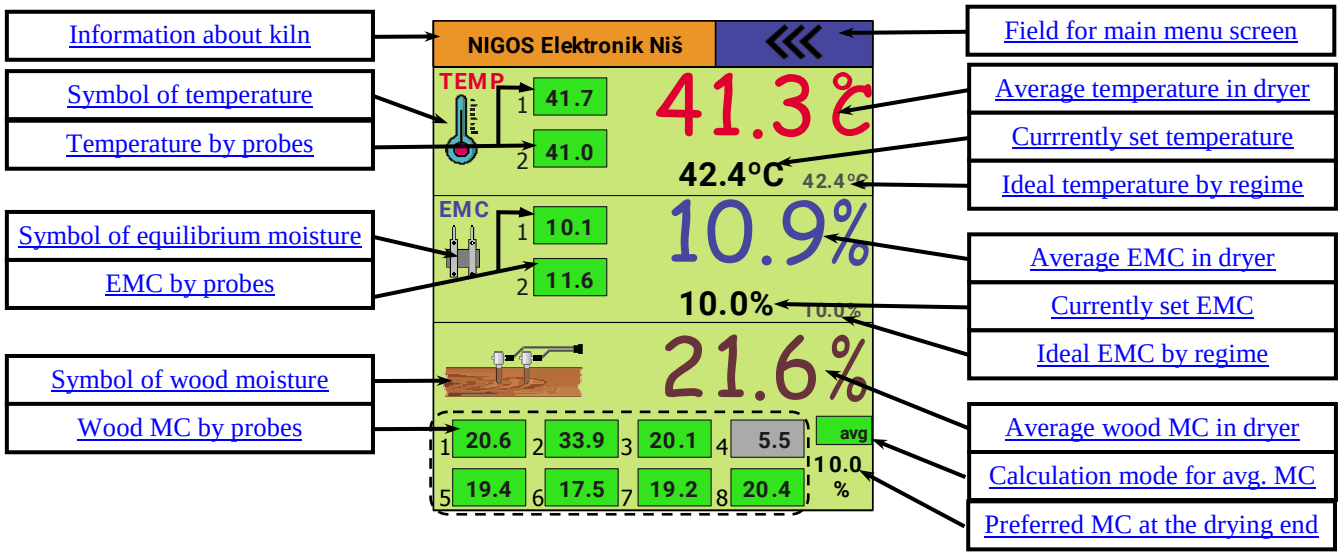


Conventional dryer manages the recuperators or additionals fan in flaps . They can be manually turned on or off..
Additional information is view of the recuperator's work level and running time. When a dryer don't have a recuperator, this field is empty.



Dehumidifying dryer manages the compressor , which **can not** be manually operated.
Additional information is measured control temperature at vaporizer's output and compressor running time.

4.3.3. Measured values in dryer



4.3.3.1. Information and field for the main menu screen

Touch on Information field, it goes to yellow info screen: the logo and name of manufacturer, unit model, HW and SW versions.
Menu field provides the ability to switch to the main menu or exit the selected items (views, history, settings)).

4.3.3.2. Temperature

Symbol of temperature shows that the probes are properly connected. Symbol of a broken thermometer indicates an error or lack of probe (eg. sensor break).

Current measured temperature by probes represents a measured value in one of the 2 measuring spots. Touch one of the fields that show the measured temperature changes the condition of the probe (active or passive). Passive probes are not considered for average temperature.

Average temperature in dryer represents the average of the currently measured values of active probes, touching this field opens up a window with temperature calculate mode with options: **minimum**, **averaged** or **maximum value**.

Currently set temperature represents temperature value that MC-3000 is looking for at a given time. In automatic mode, this is determined through the selected regime or in semiautomatic regime is determined by the user. Touching field opens a window where user can set the value that he wants and the time that will maintain that value.

Ideal temperature represents the finale temperature to be reached during current phase.

4.3.3.3. Air humidity in dryer

Symbol of equilibrium moisture content in dryer indicates that the probes are properly connected. If the symbol is missing a gray cardboard this indicates a lack of a UGL fork or that the cardboard (EMC sample) should be replaced.

Current measured equilibrium moisture content by probes represents a measured value in one of the 2 measuring spots. Touch one of the fields that show the measured moisture changes the condition of the probe (active or passive).

Average EMC in dryer represents the average of the currently measured values of active probes. Touch on this field opens up a window for EMC calculate mode with options: **minimum, averaged** or **maximum value**.

Currently set EMC represents moisture that MC-3000 is looking for at a given moment. Touching field opens a window where user can set EMC value that he want and the time that will maintain that value.

Ideal EMC by regime represents the finale EMC value to be reached during current phase.

4.3.3.4. Wood moisture content

Symbol of wood moisture content indicates that the probes are properly connected.

Wood moisture content by probes are measured using 8 wood probes. Touching one of the fields that show measured moisture can be toggle to activate or passive state.

Average wood MC in dryer represents the average of the currently measured values of active probes. Touch on this field opens up a window for wood MC calculate mode with options: **minimum, averaged, maximum, auto cut, slow** and **fast value**.

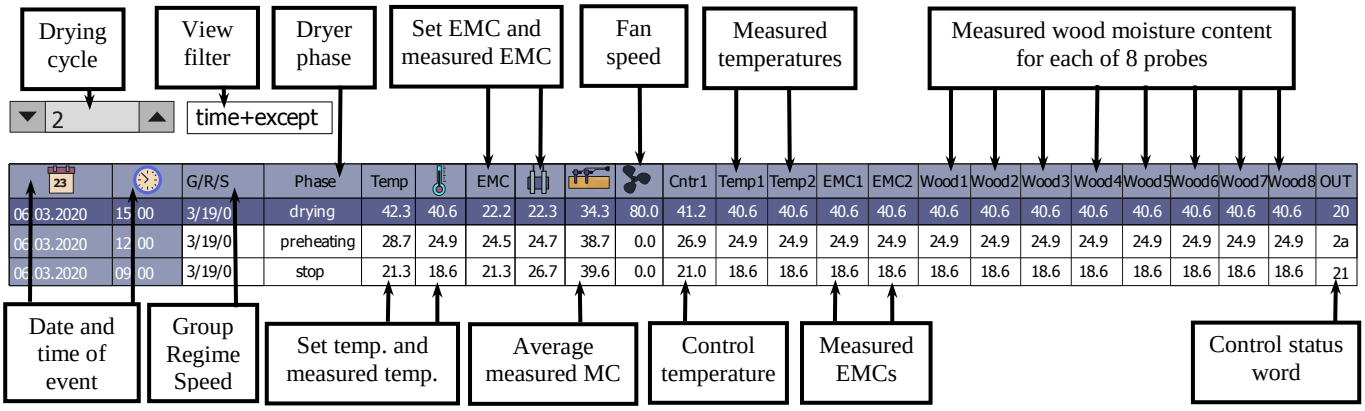
Preferred MC at the drying end represents the finale moisture in wood to be achieved at the end of drying process.

4.4. DRYING HISTORY OVERVIEW

This chapter shows the conditions in the dryer during earlier drying cycles. There's a drying cycle selection field in the upper-left corner. When user opens a fullscreen window, the current cycle is always shown first.
To the right of it is the history view filter box. Possible selection fields are:

- ☑ **Time** – list of all parameters, recorded in specified time intervals,
- ☑ **Except** – list of all warnings, alarms, adverse events and system errors, at the time of occuring,
- ☑ **Reset** – list all the time when the controller unit is turned on and serves to monitor times of power outage and its power return.

Description of the record elements follows.



		G/R/S	Phase	Temp		EMC				Cntr1	Temp1	Temp2	EMC1	EMC2	Wood1	Wood2	Wood3	Wood4	Wood5	Wood6	Wood7	Wood8	OUT
06.03.2020	15:00	3/19/0	drying	42.3	40.6	22.2	22.3	34.3	80.0	41.2	40.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6	20
06.03.2020	12:00	3/19/0	preheating	28.7	24.9	24.5	24.7	38.7	0.0	26.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	2a
06.03.2020	09:00	3/19/0	stop	21.3	18.6	21.3	26.7	39.6	0.0	21.0	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	21

Table header element in order: event date, event time, group of timber (G) / regime (R) / speed (S), drying phase, set temperature by regime, measured temperature, set EMC, measured EMC, average measured wood MC, fan speed, control (monitoring) temperature 1, measured temperatures 1 and 2, measured EMCs 1 and 2, measured wood MC 1 to 8 and control hex-response for programmer statistics. If there is no warning or alarm, the data is recorded for a period of time. That time is set to 3 hours by default.

For checked **except** in history view filter, the lost or alarming values will be displayed in red or with questionnaires (**???**) or blanks (**---**) :

2 except

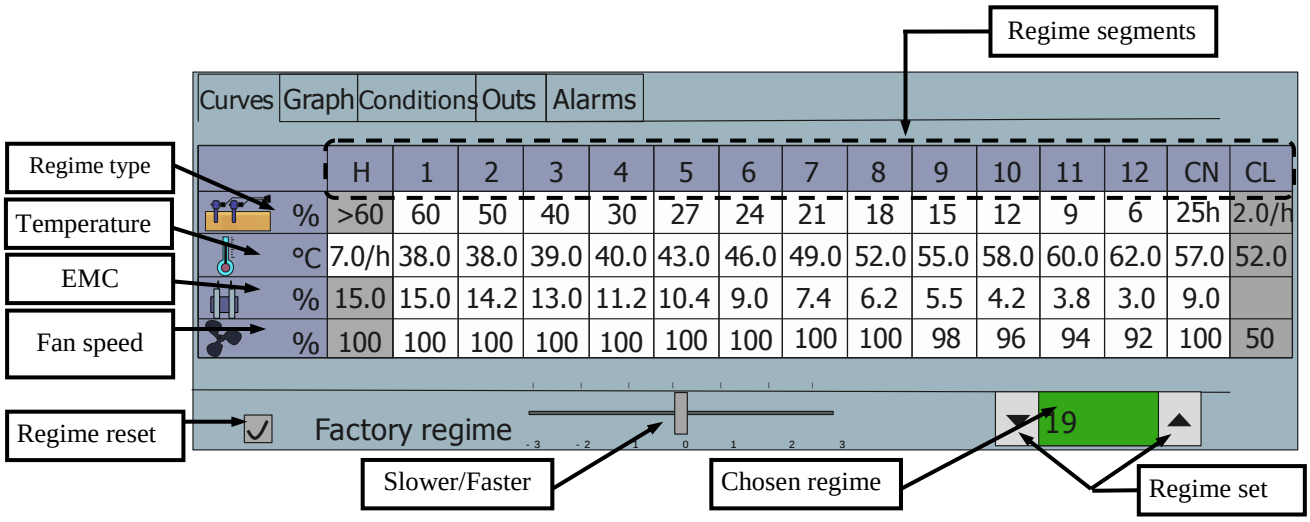
		G/R/S	Phase	Temp		EMC				Cntr1	Temp1	Temp2	EMC1	EMC2	Wood1	Wood2	Wood3	Wood4	Wood5	Wood6	Wood7	Wood8	OUT
06.03.2020	12:44	3/19/0	drying	42.3	40.6	22.2	22.3	34.3	80.0	???	40.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6	20
06.03.2020	11:56	3/19/0	preheating	28.7	???	24.5	???	38.7	0.0	???	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	2a

For checked **reset** in filter, in Group/Regime/Speed column will contain text **reset** and Phase column will contain codes (known to programmer) like **f0**, **2f0** or **1f1**, which is important for insight at the time of power outage and power ruturn:

		G/R/S	Phase	Temp		EMC				Cntr1	Temp1	Temp2	EMC1	EMC2	Wood1	Wood2	Wood3	Wood4	Wood5	Wood6	Wood7	Wood8	OUT
06.03.2020	12:47	reset																					
06.03.2020	10:08	reset	power on:f0																				
06.03.2020	09:53	reset	1f1																				

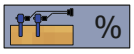
MC-3000 memorizes the data that is important for the reconstruction of the drying process. The time interval of data archiving (in user option **System**) during drying process can be 1, 2, 3, 4, 6, 12 or 24 hours. In addition, the unit memorizes time of every start, and every alarm situation that occurs and causes the drying process to pause. There is memory space for more than 20,000 records, which is more than enough for a year of continuous drying processes. When the archive is filled up, the following records will overwrite the oldest records first.

4.5. DRYING REGIMES SETTINGS



This fullscreen window defines the unit's regimes (schedules) in automatic mode for the appropriate type of wood. Up to 60 regimes can be defined. Each regime contains the following data by the rows: regime type, temperature curve, EMC curve and fan speed.

Regime types could be:

- Wood MC-driven regime, 

- Time driven regime by hours, 

- Time driven regime by minutes, 

- EMC-driven regime. 

Columns/segments in **Curves** tab are: Curve parameters in heating **H**, parameters in segments **1-12**, parameters in conditioning (**CN**) and parameters in cooling phase (**CL**). All those curve parameters could be seen as two-dimensional plot, if user touch tab **Graph**.

With user level access, user can change any value (white) that is not defined by parameter. Touch the field and change value. Values defined by parameters (gray) can be changed only in option "Drying parameters" or "System", and this change applies to all regimes. A new value can be set in newly opened window. This modified regime can be used for drying and the new parameters written in user's regime table at the end of chapter 6. DRYING REGIMES.

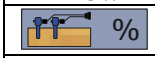
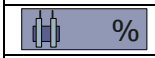
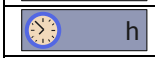
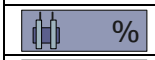
Below the table, on the left is a square for **Factory regime**. User, with its access level, can touch the square to return all values to factory setup and the square becomes "checked."

On the right is the slider to represents how would regime changes if user changes **Slowdown/acceleration** parameter.

On the far right are selected regime field and arrow fields that can be used to select a different regime, and no user access is required.

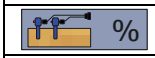
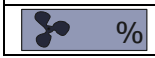
By touching the tab **Graph** screen changes to graphical view of chosen regime. Red line represents temperature, blue line represents EMC, and black line represents fan speed, for every segment of regime each.

4.5.1. Explanation and range of parameters values

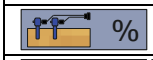
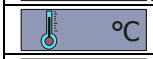
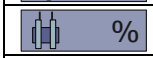
PARAMETER LABEL PER ROW	PARAMETER DESCRIPTION	RANGE OF PARAMETER VALUES
	Wood MC-driven regime - wood moisture per segment	From **0** to **100 %**
	EMC-driven regime – wood moisture per segment	From **0** to **100 %**
	Time-driven regime – segment duration in hours	From **0** to **100 h**
	Time-driven regime - segment duration in minutes	From **0** to **100 min**
	Column **H** – Temperature rise rate in heating phase (**°C/h**)	From **0.1** to **25.0 °C/h**
	Colomns **1** ÷ **12**, **CN**, **CL** – Set temperature for current segment	From **10.0** to **90.0 °C**
	Equilibrium moisture content (EMC) for current segment	From **1.0** to **30.0 %**
	Fan speed for current segment	From **10.0** % to **100.0** %

4.5.2. Heating phase

It is described by a **H**.column. This phase got only one variable – temperature rise rate.

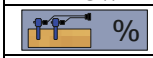
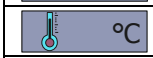
PARAMETER LABEL PER ROW	PARAMETER DESCRIPTION	RANGE OF PARAMETER VALUES
	Wood MC values above which heating phase is defined	**---**
	Temperature rise rate (temperature gradient) in chamber **°C/h** The temperature in heating phase is equal to the one from segment 1	From **0.1** to **25.0 °C/h**
	Set EMC is set EMC from segment 1 higher for parameter „**EMC offset in heating**“	EMC value of seg.1 + Offset
	Fan speed is equal to the one from segment 1	Fan speed value of seg. 1

4.5.3. Phase by segments 1 to 12

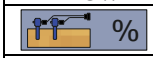
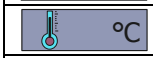
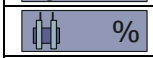
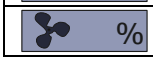
PARAMETER LABEL PER ROW	PARAMETER DESCRIPTION	RANGE OF PARAMETER VALUES
	Wood moisture content value for current segment	From **60** to **5 %**
	Segment duration for time-driven regimes, in hours or minutes	From **0** to **100**
	Temperature for current segment	From **10.0** to **80.0 °C**
	Equilibrium moisture content (EMC) for current segment	From **2.0** to **30.0 %**
	Fan speed for current segment	From **10** to **100 %**

4.5.4. Conditioning phase

In conditioning phase, additional parameters are conditioning time, temperature, EMC in conditioning and Fan speed in conditioning.

PARAMETER LABEL PER ROW	PARAMETER DESCRIPTION	RANGE OF PARAMETER VALUES
	Conditioning time in hours	From **1** to **99 h**
	Temperature in conditioning	From **10.0** °C to **80.0** °C
	Equilibrium moisture content (EMC) in conditioning phase	From **2.0** to **30.0 %**
	Fan speed in conditioning phase.	From **10** to **100 %**

4.5.5. Cooling phase

PARAMETER LABEL PER ROW	PARAMETER DESCRIPTION	RANGE OF PARAMETER VALUES
	Parameter “**Temperature gradient in cooling**“ value	From **0.1/h** to **10.0/h**
	Temp. of seg.12 subtracted by par. “**Temperature end of drying**“	Temp.value of seg.12 – T.e.o.d.
	/	/
	Parameter “**Fan speed in cooling**“ value	From **0** to **100 %**

4.6. CONTROLLER UNIT SETTINGS

Any settings that a user wants to check or change are done by entering the main menu by touching field "**Settings**" and switching to the next screen. On this screen are the appropriate options (as in figure 4.6.0), available to the user and visible depending on the access level to MC-3000 unit. Based on the icon standing on the right side of the status line, the screen defines whether it is free-access to unit with closed orange padlock, or user has user access level with open green padlock . To change access level, see chapter 4.7. CHANGING ACCESS LEVEL. To select an option, user need to touch the option name field. This opens a new screen that contains a submenu with new parameters or a screen with current values associated with that option and control to change them.

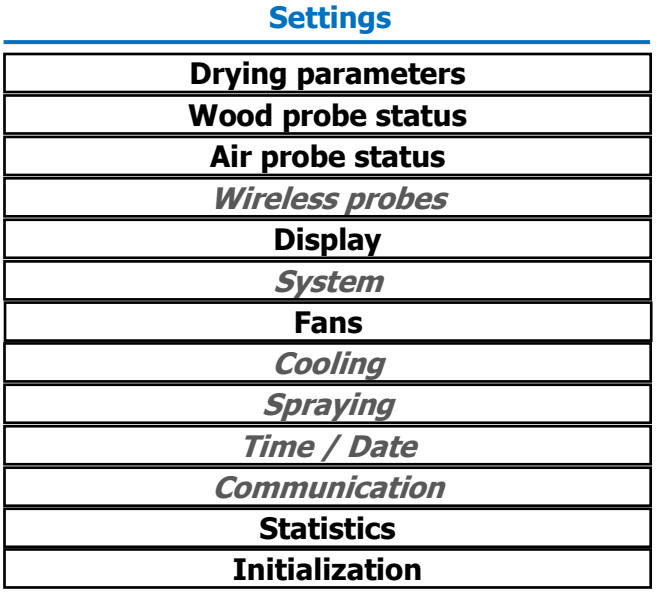


Figure 4.6. **Overview of menu "Settings" (greyed items are visible only with user access)**

Table 4.6. **Parameters of option Settings**

	PARAMETER LABEL	PARAMETER DESCRIPTION
Settings	**Drying parameters**	Drying parameters settings
	Wood probe status	Defining statuses for measuring of wood MC probes
	Air probe status	Defining statuses for measuring of air moisture (EMC) probes
	Wireless probes **(*) (**)**	Wireless probes address settings
	Display	Display appearance settings (figures and letters size)
	System **(*)**	Controller unit settings
	Cooling **(*)**	Cooling phase settings
	Fans	Flow fans settings (pause duration, speed, direction)
	Spraying **(*)**	Sprinklers settings (preparation, operating time and pause)
	Time/Date **(*)**	Time and date adjustment
	Communication **(*)**	Address for connection toward PC.
	Statistics	Preview of drying consumpsion of the last cycle and the total time
	Initialization **(*)**	Restore of factory default values for user parameters and regimes

(*) – Visible only with user access
(**) – Visible only with MKM with wireless probes

4.6.1. Option: Drying parameters

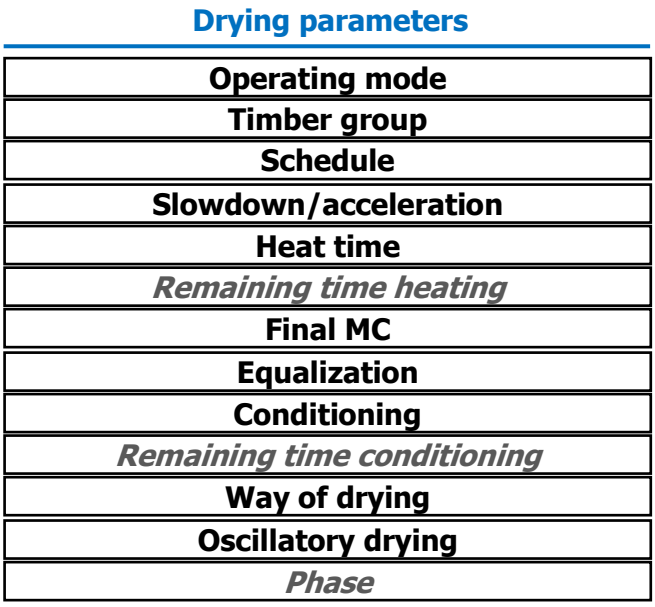


Figure 4.6.1. **Overview of menu "Drying parameters" (greyed items are visible only with user access)**

This option is used to adjust drying parameters. The parameter value is given on the right side of the screen, and the value can be changed by touching the parameter name field. That will open a new window with the current parameter value and one of the controls for changing it. User confirms the new value by touch on "**Accept**" field, if he do not want change, preserve old value and close window by touch on "**Cancel**" field. The following table lists all of the parameters in this option, that can be adjusted.

Table 4.6.1. **Drying parameters menu**

PARAMETER LABEL	PARAMETER DESCRIPTION		RANGE OF PARAMETER VALUES	DEFAULT VALUE
Operating mode	Drying process is conducted with or without user reactions		**semi / auto**	**auto**
Timber group	Group of timber in drying chamber on which measurement are made See Table 4.6.2 for more details.		**1 / 2 / 3 / 4**	**3**
Schedule	Regime on which drying process is based on		From **1** to **60**	**19**
Slowdown / acceleration	Define a trade-off between quality and speed of drying process		From **-3** to **+3**	**0**
Heat time	Time to maintain temperature between heating and drying phase		From **0** to **100 h** of core heating	**---**
Remaining time heating *	Core heating time remained, visible only in heating phase.		From **0** to **3600 min**	**---**
Final MC	The final desired wood MC to dry the lumber in chamber		From **5.0 %** to **30.0 %**	**12.0 %**
Equalization	Permit to use equalization phase during drying process		**no / 1 % / 1.5 % / 2 %/ 3 %**	**no**
Conditioning	Permit to use conditioning phase at the end of drying process		**no / yes**	**no**
Remaining time conditioning *	Conditioning time remained, visible only in heating phase.		From **0** to **3600 min**	determined by selected regime
Way of drying	Choice of devices in drying process	… in conventional dryer	**flaps only / recuperator and flaps**	**recuperator and flaps**
		… in dehumidifying dryer	**conventional / condensational**	**condensational**
Oscillatory drying	Use of an experimental drying method		**no / yes**	**no**
Phase *	Manually change of drying phase		**stop / measure / heating / core heating / drying / equalization / conditioning / cooling**	**stop**

(*) – Visible only with user access

4.6.1.1. Parameter: Operating mode

This parameter defines whether MC-3000 will conduct the drying process according to the selected mode – **automatic operating mode**, or whether the user will set the specified values for temperature and EMC based upon his experience, and MC-3000 will only maintain the user's specified values - **semi-automatic operating mode**. The selected automatic mode displays text ***AUTO*** on the left of the first line in the textual view of the kiln (dryer). Semi-automatic mode displays an icon of an outstretched hand  .

4.6.1.2. Parameter: Timber group

It is necessary to define the type of the wood that is drying, in order to achieve proper wood moisture content (MC) measurement. All wood species are divided into 4 groups, which are given in the following table.

Table 4.6.2. **Table of wood species and related groups of wood species according to which the MC measurement is performed**

TIMBER GROUP	WOOD SPECIES
1	Cork; Eva; Irocco, Rubber tree; Titola; Zebrano.
2	Abachi; Abonos, african; Afrormosia; Ash, american; Atlas; Beech; Elm, american; Hickory; Ivory, pink; Linden; Mansonia; Niangon; Oak, white and red american; Okume; Olive; Padauk, african; Palisander/Rosewood; Pear; Poplar; Ramin; Teak; Willow, white.
3	Abura; Accacia; Afara, white; Alder; Ash; Atlas, nigerian; Balsa; Birch; Camphor; Cedar, african and red; Cherry tree, Cherry; Chestnut; Cypress; Douglass; Elm, european; Eucaliptus; Fir, silver/red/noble; Hornbeam; Larch; Laurel; Magnolia; Mahagony; Maple; Meranti; Merbau; Morus; Oak, european; Pine; Plum; Samba; Sequaya, canadian; Shimshir; Spruce; Teak, rhodesian; Walnut, white and european; Yew; various conifer timbers; various fruit timbers...
4	Dibetour; Kapur; Sipro; Utile; Walnut, american and african;.

4.6.1.3. Parameter: Schedule

Parameter **Schedule** defines the regime by which the drying process is conducted in automatic mode for appropriate type of wood. Changing of the regimes is available only at user access level, using **Regimes** on main screen menu. Tables with predefined factory regimes numbers and recomemded regimes are in chapter 6. DRYING REGIMES.

4.6.1.4. Parameter: Slowdown / acceleration

With this parameter, the user can slow down or accelerate the drying process, affecting the speed and quality of the drying. The standard thickness of the material is 50 mm at **0** speed.
By choosing negative values, the process slows down, the drying time is longer, the temperature changes become milder. The value **-1** corresponds to slightly slower regime, such as drying 60 mm thick material, while **-3** corresponds to a **10%** weaker temperature gradients and **10%** sharper humidity gradients than **0** speed.
By choosing positive values, the process accelerates, the drying time is shorter, the temperature changes become moderate. Value **+1** corresponds to slightly faster regime, such as drying 38 mm thick material, while **+3** corresponds to a **10%** sharper temperature gradients and **10%** weaker humidity gradients than **0** speed.

Regime acceleration:
- values for moisture curve are decreased,
- temperature ramp ratios are increased,
- values for temperature curve are increased

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

NOTE: Acceleration shortens the drying process with the risk of damage that may occur during process. The slowdown prolongs the drying process, but gains higher quality dried timber.

4.6.1.5. Parameter: Heat time

During drying certain types of wood (especially some exotic species and hardwood) it is necessary to heat the tree into the depths, i.e. equate the core temperature with the surface temperature of the tree. When the heating phase reaches drying temperature, this parameter can set a time to maintain that temperature before drying begins. The parameter is given in a hours range (**0** to **100**). After each drying cycle, this parameter is reseted to **0** i.e. **---** .

4.6.1.6. Parameter: Remaining time heating

During core heating phase, visible at the user access level, this parameter appears, that can change the duration of the initiated phase. The parameter is given in minutes range (**0÷3600**).

4.6.1.7. Parameter: Final MC

It defines finale average wood moisture of dried timber in the dryer chamber. This parameter also defines the end of the drying process.

4.6.1.8. Parameter: Equalization

This specifies whether wood moisture will be equated in all measure spots and with what range during drying. If **no** is chousen, no equalization will be performed. For example, if **2** is specified, then MC-3000 will thus lead the drying process to keep all wood moisture probes in the range of ± 2% of the value of the finaly specified moisture (%).

NOTE: This function can significantly prolong the drying cycle and the success of execution depends on the ability of the dryer to achieve the desired conditions!

4.6.1.9. Parameter: Conditioning

This 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 / regime.

4.6.1.10. Parameter: Remaining time conditioning

During conditioning phase, visible at the user access level, this parameter appears, that can change the duration of the initiated phase. The parameter is given in minutes range (**0÷3600**).

4.6.1.11. Parameter: Way of drying

Conventional dryer - a choice of drying methods:
- with flaps only,
- with recuperator and flaps (recuperator has priority during drying, and flaps will open if the recuperator reach level 100%).

Dehumidifying dryer - a choice of drying methods:
- conventional (drying with flaps only),
- condensational (compressor as major drying part, and flaps are included as needed).

4.6.1.12. Parameter: Oscillatory drying

Oscillation drying is experimental way of drying which is developed by professor Goran Milic from Forestry Faculty in Belgrade designed to speed up drying time and improve quality of dried timber.

NOTE: NIGOS-elektronik supports exploration of new drying technologies, but at this moment we lack information to support successful use of this method. It is let to customer to use this option at his own decision. We recommend extra care when this option is used! NIGOS-elektronik do not suggest use of this option while it is still in development phase! NIGOS-elektronik do not take any responsibility for any damage or unwanted faults (bents, cracks, warps, etc.) which may occur on timber due to use of oscillation drying.

4.6.1.13. Parameter: Phase (visible only with user access)

Drying is process in several stages, depending on whether some stages are allowed by the user or not. These are the phases: measurement, heating, core heating, drying, equalization, conditioning, cooling and stop, which marks the end of the drying round or preparation for the start of a new drying cycle. With this parameter, the user can skip or repeat one of the phases or continue drying from a certain phase if an unwanted interruption has occurred due to an alarm situation. For detailed information on phases, see the section **5.1. DRYING**.

4.6.2. Option: Wood probe status

This option gives an overview of all wood MC probes. The probes are labeled as **MC1 ÷ MC8**. Depending on how many probes are set in this option, probes appear with the measurement and description of their state (off, active or passive) on the right side of the screen. Changing the state of the probe could be done by touching the field with the name of the probe.

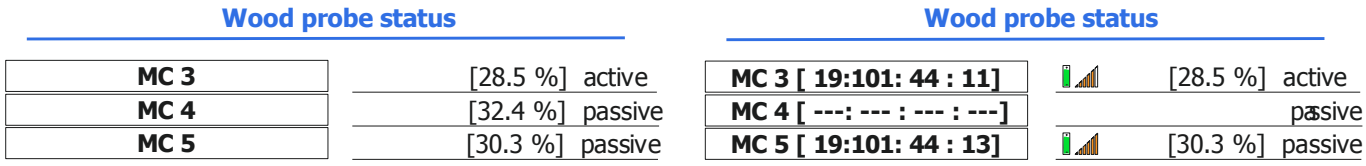


Figure 4.6.2. **View of measuring module with wire probes (MKM-08) and view of measuring module with wireless probes (MKM-RF)**

At MKM-RF, in field with the probe's name also visible is it's address. The description describes the battery remained and signal strength..

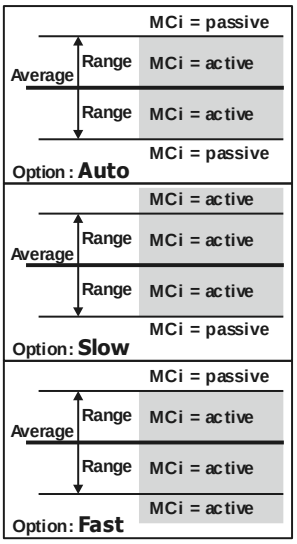
Active probe means condition of selected one, indicates that information obtained by measuring module from the corresponding probe is taken into consideration for calculating average wood moisture content.

Passive probe indicates that the value of that probe is not taken into consideration, but its value is visible on the screen and the field is grayed out on panel screen.

Off state where the probe is not seen or taken into calculation, and its field is grey and empty on panel screen.

When drying is initiated, the average wood MC obtained from all active probes is calculated and is guides the drying process. Not all probes can be placed in a passive state - at least one must be active.
Parameter **Calc mode MC** determines how the average wood MC is calculated. Possible values of this parameter are: minimal, average, maximum value, auto cut, slow and fast value. The set calculation is displayed with English abbreviation on the text kiln view of MC-3000, in 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** according to following principle:

- **minimum value (min)**: The lowest value of active probes is taken for the value of wood MC.
- **averaged value (avg)**: Value of wood MC is calculated as average value of active probes. Passive probes are not taken into calculation. **User sets probes in active or passive state manually for min / avg / max.**
- **maximum value (max)**: The highest value of active probes is taken for the value of wood MC.
- **auto cut (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** to define upper and lower range. All probes 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. **MC-3000 puts probes in active or passive state automatically.**
- **slow value (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 bellow lower range defined by parameter **Auto cut**.
- **fast value (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**.



4.6.3. Option: Air probe status

On the right side of MC-3000 screen always shown is average value for temperature and EMC. Option **Air probe status** gives overview of current measurement values for all temperature and EMC probes and control inputs, too. 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.

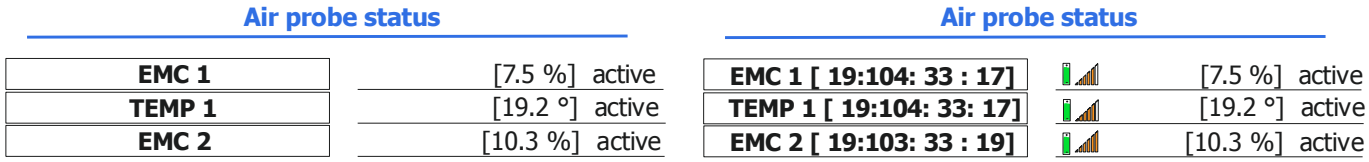


Figure 4.6.3. **View of measuring module with wire probes (MKM-08) and view of measuring module with wireless probes (MKM-RF)**

It is possible to turn off certain probes, of both types, from listing in kiln text view. If only one temperature/EMC probe is installed, then for the one that is not attached is displayed grey, empty field. In case the probe measures fault value, alarm symbol is displayed next to value.

Parameters **Calc mode TEMP** and **Calc mode EMC** determine how average temperature and EMC will be calculated. It can be calculated as minimum, average or maximum value.
There are two control temperature probe inputs (**AIN1** i **AIN2**) in drying chamber, control room, circulation and thermal pump etc.

4.6.4. Option: Wireless probes (*only for MKM-RF and with user level*)

This option appears only in system that uses measuring module with wireless probes. MKM-RF can support up to 4 wireless probes for temperature and EMC (whether moisture is measured by hygroscopic cardboard, either by capacitive probes) and up to 10 wireless wood MC probes. In these probe fields, the user connects the probes to the MKM-RF by manual enters of probe addresses from the label on the probe. On the right side are displayed responses of the connected probes: each probe sends battery voltage, MKM-RF connection quality data and its address in short periodes. A defected or unrelated probe will have no written fields.

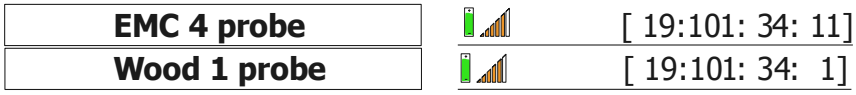


Figure 4.6.4. **Sample from menu of "Wireless probes"**

Battery overview describes the state of the battery in the probe. When the battery symbol appears, battery is at the end and needs to be replaced. The procedure is detailed in chapter 3.5. WIRELESS PROBE BATTERIES of this manual.

Signal strenght overview shows the reach of a wireless probe. Symbol indicates that the signal from the probe is out of the range.

4.6.5. Option: Display

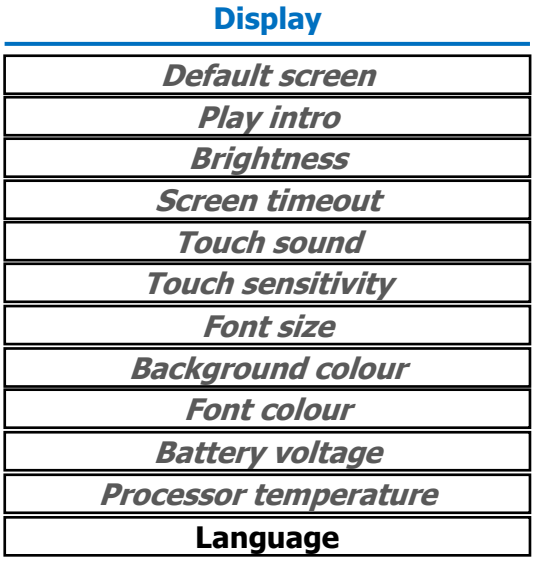


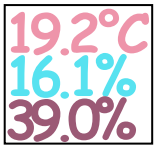
Figure 4.6.5. **Menu "Display" (greyed items are visible only with user access)**

This option is used to adjust the display parameters of controller unit. The user sees only **Language** parameter at the free access level and can select one of the following, for now: srpski, english, ру́сский, español.

Table 4.6.5. **Parameters of option Display**

PARAMETER LABEL	PARAMETER DESCRIPTION	RANGE OF PARAMETER VALUES	DEFAULT VALUE
Default screen **(*)**	Defining start screen upon controller power on.	**kiln graph, kiln text, main menu**	**kiln text**
Play intro **(*)**	Display introduction screen upon controller power on.	**yes**, **no**	**no**
Brightness **(*)**	Screen brightness according wish and needs of user.	**10 %** to **100 %**	**80 %**
Screen timeout **(*)**	Reduction of electricity consumption. **(**)**	**---** to **300 sec**	**30 sec**
Touch sound **(*)**	Buzzer responds by every press on touchscreen.	**yes**, **no**	**yes**
Touch sensitivity **(*)**	Adjust panel sensitivity to touch strength.	**5** to **2000**	**50**
Font size **(*)**	Selection of font size according to user.	**small** , **medium**, **big**	**medium**
Background colour **(*)**	Selection of ABGR value for background according to user.	**0,0,0,0** to **255,255,255,255**	**0,128,255,255**
Font colour **(*)**	Selection of ABGR value for letters according to user.	**0,0,0,0** to **255,255,255,255**	**0,0,0,0**
Battery voltage **(*)**	Graphical display of the panel's battery capacity and voltage.	**0** to **3000 mV**	**---**
Processor temperature **(*)**	Processor temperature, only as information.	**---**	**---**
Language	Selection of interface language.	**srpski, english, ру́сский, español**	**english**

(*) – Visible only with user access
(**) If the **Screen timeout** is turned on, screen saver is running on after the expiration of the specified time – dark screen with dynamic values of temperature , EMC and wood MC. If timeout is set to **0** i.e. **---** screen won't goes dark. Touch on dark screen, returns to normal screen.



4.6.6. Option: System (*visible only with user access*)

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

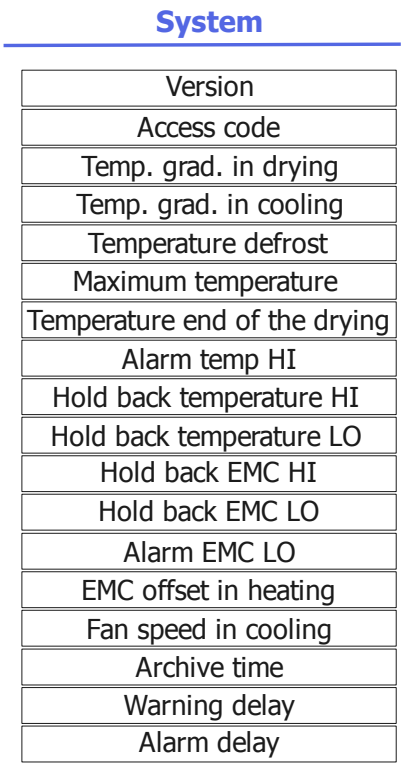
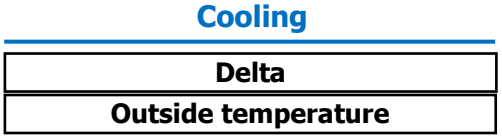


Table 4.6.6. **Parameters of option System**

PARAMETER LABEL	PARAMETER DESCRIPTION	RANGE OF PARAMETERS VALUES FOR … DRYER		DEFAULT VALUE	
		CONVENT.	DEHUMIDIF.	CONV.	DEHU.
Version	Controller software version, not a parameter but information	---		---	
Access code	Access code for advanced level	From **0** to **99999**		**3000**	
Temp. grad. In drying	Temperature ramp rate in drying phase	From **0.1 °C/h** to **30.0 °C/h**		**10.0 °C/h**	
Temp. grad. In cooling	Temperature ramp rate in cooling phase	From **0.1 °C/h** to **10.0 °C/h**		**2.0 °C/h**	
Temperature defrost	Temperature at which preheating is activated if drying is not started	From **-20.0 °C** to **20.0 °C**		**2.0 °C**	
Maximum temperature	Maximum possible set temperature	From **30.0 °C** to **90.0 °C**	From **30.0 °C** to **60.0 °C**	**70.0 °C**	**56.0 °C**
Temperature end of drying	Defines how much temperature should reduce when drying ends	From **-40.0 °C** to **0.0 °C**		**-10.0 °C**	
Alarm temp HI	By how much temperature in drying chamber have to rise above the set value to activate the alarm	**0.0 °C** to **Hold back temp. HI**		**10.0 °C**	
Hold back temperature HI	Measured temperature deviation above set value (in degrees).	From **0.0 °C** to **Alarm temp HI**		**3.0 °C**	
Hold back temperature LO	Measured temperature deviation below set value (in degrees)	From **0.0 °C** to **10.0 °C**		**5.0 °C**	
Hold back EMC HI	Measured EMC deviation above set value (in per cents).	From **0.0 %** to **10.0 %**		**3.0 %**	**5.0 %**
Hold back EMC LO	Measured EMC deviation below set value (in per cents)	From **0.0 %** to **10.0 %**		**1.0 %**	**2.0 %**
Alarm EMC LO	Too low humidity in dryer chamber to activate alarm	From **0.0 %** to **30.0 %**		**5.0 %**	
EMC offset in heating	Starting point for EMC in the heating phase, offset from preheating	From **-10.0 %** to **10.0 %**		**0.0 %**	
Fan speed in cooling	Manual fan speed in the cooling phase	From **0 %** to **100 %**		**50 %**	
Archive time	Data archiving interval	**---**, **1 h**, **2 h**, **3 h**, **6 h**, **12 h**, **24 h**		**3 h**	
Warning delay	Delay for warning report	From **0 sec** to **3600 sec**		**60 sec**	
Alarm delay	Delay for alarm report	From **0 sec** to **3600 sec**		**120 sec**	

4.6.7. Option: Cooling (*visible only with user access)*



1.) Change of cooling start conditions. Possible values are **0.0 °** to **10.0 °**. Default is **10.0 °** for convencional or **2.5 °** for dehumidifing dryer.
2.) Outside temperature is not a parameter. It is seen as a readable value, but only if an outside temperature probe is defined.

4.6.8. Option: Fans

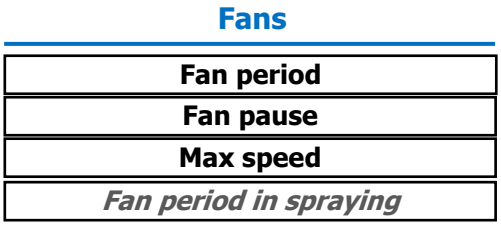


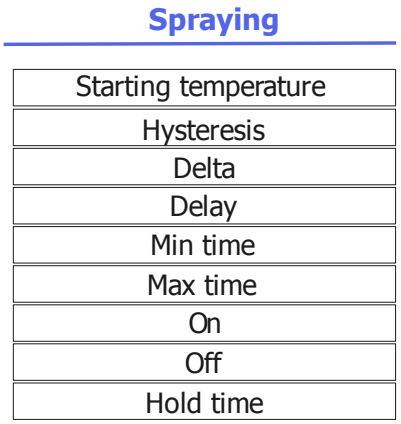
Figure 4.6.8. **Option "Fans" (greyed items are visible only with user access)**

Table 4.6.8. **Parameters of option Fans**

PARAMETER LABEL		RANGE OF PARAMETER VALUES	DEFAULT VALUE
Fan period	Fan time operating in single direction	**10** to **1080 min**	**180 min**
Fan pause	Pause duration between changing fan direction	**2** to **60 min**	**2**
Max speed	Maximum fan speed (100% = 50 Hz)	**0** to **100 %**	**100 %**
Fan period in spraying **(*)**	(* *Visible only with user access*) Moguće drugačije vreme promene smera u toku vlaženja	**---**, **10** to **60 min**	**20 min**

This option provides the ability to manipulate the work of fans through multiple parameters. Each time a fan direction changes between the two working stages, a mandatory pause is determined. In order not to change direction while the fans are still spinning, and therefore damage to the engine and fans, a long enough pause should be adjusted to stop the fans completely before changing direction. If the user manually changes the direction of the fan, the controller sets the break time to 2 minutes. During breaks, the controller prohibits the spinning of fans and turn off sprayers.

4.6.9. Option: Spraying (*visible only with user access*)

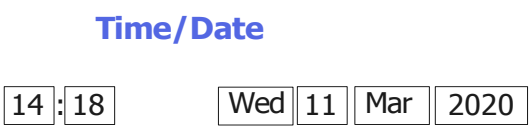


This option provides the option to set up parameters for moisture management output control (sprinklers/sprayers). In table 4.6.9 are the parameters of these options.

Table 4.6.9. **Parameters of option Spraying**

PARAMETER LABEL		RANGE OF PARAMETER VALUES	DEFAULT VALUE	
			CONV.	DEHU.
Starting temperature	Lowest temperature allowances for sprayer activation.	**10.0 °C** to **60.0 °C**	**22.0 °C**	
Hysteresis	Humidification continues when the humidity is less than the set humidity deducted for percentage of hysteresis value.	**0.0 %** to **10.0 %**	**1.0 %**	
Delta	Change condition for spraying start against set humidity value.	**-10.0 %** to **10.0 %**	**0.5 %**	
Delay	When condition for spraying is created, postpone start for set time.	**1 min** to **240 min**	**1 min**	**2 min**
Min time	Minimum spraying time	**1 min** to **240 min**	**5 min**	**10 min**
Max time	Maximum spraying time, if the final condition is not met.	**1 min** to **240 min**	**60 min**	
On	Duration of the active output period in activated spraying.	**1 sec** to **240 sec**	**45 sec**	**30 sec**
Off	Duration of the passive output period in activated spraying.	**1 sec** to **240 sec**	**30 sec**	
Hold time	Time after spraying when output cannot be activated again	**1 min** to **240 min**	**5 min**	

4.6.10. Option: Time/Date (*visible only with user access*)

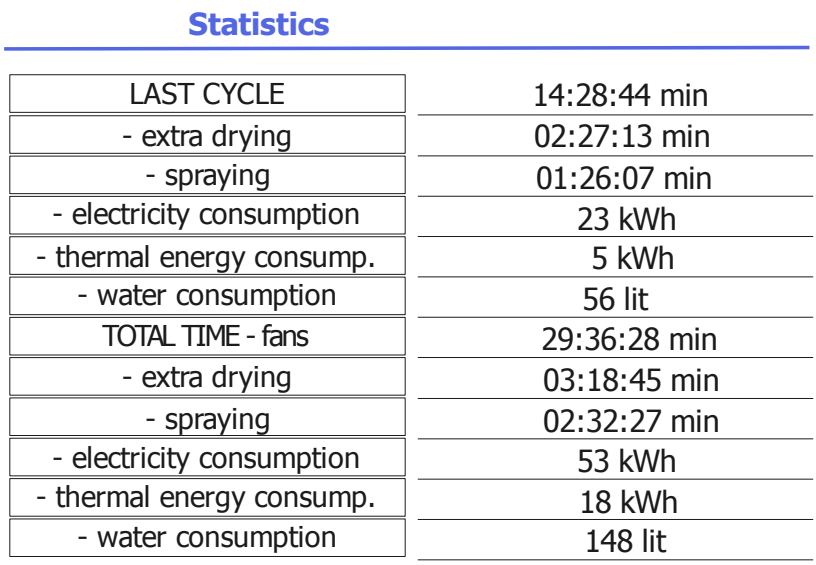


This option allows user to adjust RTC. This clock does not have the automatic setup feature when switching between daylight saving time and vice versa. In this case, the exact time should be manually adjusted. Touching each field opens a window for setting numbers with arrows or selecting words and accepting choices, and the fields are in order.: **hours, minutes, day of the week, day of the month, month and year**.

4.6.11. Option: Communication (*visible only with user access*)

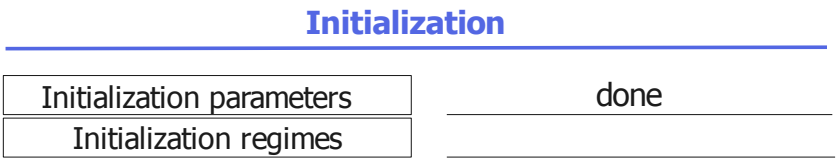
This option sets only a parameter related to the communication of MC-3000 unit with PC via USB-485 adapter. If there's only one unit connected, it's got address **1** in the communication line. It is virtually possible to parallel up to 32 automatic controller units to one communication cable, but each must have a unique address in the range **1 ÷ 95**.

4.6.12. Option: Statistics



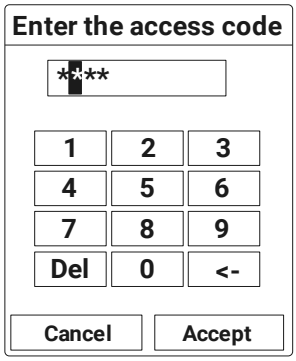
This option does not have variable parameters, but serves to review the consumption of various resources in the last drying cycle as well as the total time from the start of the first drying. The values we have insight into are: time consumption (min), extra drying time (min), spraying time (min), electricity consumption (kWh), thermal energy consumption (kWh) and water consumption in liters.

4.6.13. Option: Initialization



This option is used to restore settings to factory defaults for parameters and regimes. Upon completion of initialization, it will text „**done**“.
Field **Initialization parameters** - returns all user parameters to factory values, after confirmation.
Field **Initialization regimes** - returns all regimes to factory values, after confirmation..

4.7. CHANGING ACCESS LEVEL



Fielde „**Access**“ is used for the allocation of levels of access to additional options and parameters of unit. Entering the correct code enables the unlocking of unit, ie access to the advanced level is enabled. As an indication that the system is locked to the right side of the top line in the top of the screen is a symbol of a closed padlock in orange color. After entering the correct code, the green open padlock symbol appears in this place as an indicator of access to the advanced level.

Touching this field opens window with message: **Enter the access code**, below is space for entered code . And below it are the fields with the digits for entering, deleting the selected digit (**Del**) and deleting last digit (**<-**).

At the bottom of the window are fields **Cancel** and **Accept**, to discard entry is no confirmation code entry e . If nothing is pressed for 4 minutes or after starting the screen saver, a window automatically closes off, the unitt remains locked. When you want to achieve an advanced access level, you need to enter the access code, and then touch **Accept** field. The default setting for the passcode is **3000**. After entering the correct code, the padlock icon at the top of the screen will change, with the message that the user level is open . If the code is not entered correctly, the unit remains locked and a notification will be displayed in the window ..

⚠ **The user should not unnecessarily driven this option, because if it is three times wrong code is entered , the system is blocked and can no longer be unlocked is not the correct code (printed message "The system is blocked!" and padlock is red in the status bar).**

In this case, you should contact the manufacturer or an authorized service technician!!!

⚠ **The system can be blocked by entering the reset code 64000 , but it is still advisable to contact the manufacturer to avoid unwanted data loss of the current drying cycle.**

4.8. OPERATING MODES

4.8.1. Automatic, semiautomatic and manual operating mode

4.8.1.1. Automatic mode

At the start of each process it is required to set all parameters relevant to that process in option **Settings** > **Drying parameters**. This implies that, with automatic mode, he chooses the appropriate group (type) of wood, schedule, tree thickness, heat time, final MC to which the lumber is dryed and choose whether to perform conditioning after drying phase is over. All of these parameters are very important, because based on them and the selected mode of operation, controller unit conducts the drying process correctly and calculates the required values. Parameters can also be changed during the initial drying process. The drying process takes place according to the selected schedule. An advanced user, or technical persons and authorized servicers can adjust the schadules according to the requirements defined by the technologist. After starting the drying process by pressing the green **START** field, described in chapter 4.9. STARTING UP DRYING PROCESS , user activity is down to intermittent system monitoring. It is desirable for the user to register all alarm situations that appears and eventually intervene in accordance with the described procedures in the chapter 7. DESCRIPTION OF ALARMS, INFORMATIONS AND WARNINGS.

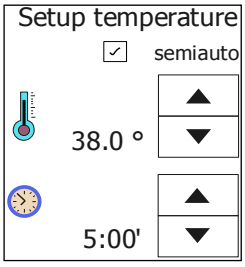
4.8.1.2. Semiautomatic mode

For semiautomatic mode, the user should set in **Settings** > **Drying parameters**, with the selected semiautomatic mode, only group of wood (timber group). Other parameters are not required for this operating mode. Immediately after the semiautomatic confirmation, controller gives user the ability to adjust the specified values for temperature and equilibrium moisture content. The user sets these parameters based on experience and measured moisture in the wood archived in controller. After entering the desired values for the temperature and EMC in semiautomatic mode, then need to return to the kiln text screen and select green **START** field and confirm it.
In semiautomatic mode, the user periodically checks the actual values for temperature and EMC in the dryer and wood MC and adjusts the specified values for temperature and EMC based on these values, and controller unit maintains these specified values. The specified temperature value can be set between 0 °C and the value of parameter **Maximum temperature**, while EMC value can be adjusted between 0 % and 30 % EMC.
There is no heating phase in the semiautomatic mode, but the drying phase begins immediately. The end of drying is determined by the user, as well as the phase of conditioning and temperature and EMC in which the conditioning is performed.
Controller unit manages the water heating valves and heaters for electrical heating, as well as drying flaps, and therefore alarm situations related to exits may occur, which is why the user should register all alarm situations that appears and eventually intervene in accordance with the described procedures in the chapter 7. DESCRIPTION OF ALARMS, INFORMATIONS AND WARNINGS.

4.8.1.3. Changing of operating mode (auto to semiauto and vice verse)

Transition from one mode to another is done through **Settings** > **Drying parameters** > **Operating mode** by choosing other mode. When switching **from automatic to semiautomatic mode**, the specified temperature and EMC values that the controller unit had calculated before switching are retained, so the output activity of the equipment in the sum remains unchanged. When switching **from semiautomatic to automatic mode**, all outputs are turned off in about 20 seconds (abbreviated phase of measurement), and then the controller unit calculates the specified values and resumes operations.

4.8.1.4. Semiautomatic control of temperature and/or EMC in automatic mode



In the automatic mode, it is possible to set the temperature and/or EMC to semiautomatic regulation, time indepentant or time-limited. The touch on the value specified field opens a window in which user can specify value and the time that semiautomatic specified value should last, after which it returns to auto-run by the selected regime. When one of the values changes, the screen displays the finger  38.0 °C as a mark that the value is set manually.

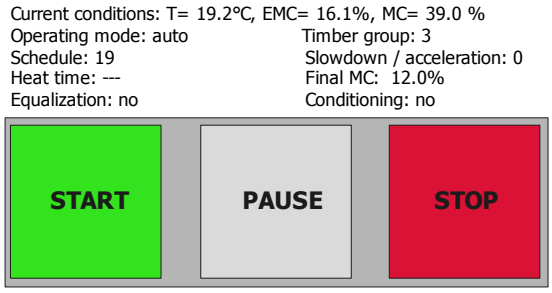
4.8.1.5. Manual mode

Regardless of whether the controller unit works in automatic or semi-automatic mode, manual management of the heating, drying, fan and spraying feature can be selected at any time, each by touching the field for the appropriate output located at the far left of the MC-3000 screen. Only thermal (condensation) pump can not be manually managed. Touch on one of these fields always opens a window to change the state of the output organ (turned on, off, tested, or selecting between multiple outputs) that is then required and confirmed by touching "**Accept**" field. The user does not have to choose manual management for all five features, but only for those output devices to which he wants to act manually in the regulation process, without the influence of the controller unit. Meanwhile, MC-3000 remains in automatic or semi-automatic mode depending on its setting.

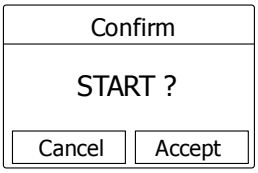
4.9. STARTING UP DRYING PROCESS

If all parameters related to the drying process are set up, the system starts by touching the green field for start/pause/stop  .

After this, a new screen opens with basic data about the selected schedule and options: green **START**, (disabled) light grey **PAUSE** and red **STOP**.



If everything is ready to start, tap the **START** field. After this, another window will open for the final start confirmation.



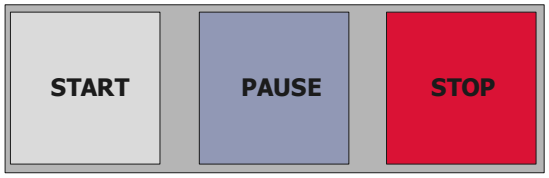
If you have confirmed, the system is started and the machine returns to the previous screen where instead of the green sign and the **stop** status, there is a red field and phase **measure**.

If you canceled start, the window will close and the system will remain in the measurement phase.

4.10. STOPPING DRYING PROCESS

If the process is started, stopping could be done by touching the red pause/stop field  .

After this a new screen opens with options: (disabled) light grey **START**, dark grey **PAUZA** and red **STOP**.



If you want to stop the drying process, select **STOP** field. After this, another stop confirmation window appears, similar to the start of the process.

If user confirmed, all exits are turned off and the process is stopped. If not, the system still works without stopping.

Each stop and restart of the drying process increases the number of cycles completed in the archive and database in DryManage software. This counter does not increase if the system is paused and started or power failure occurs, but the data about events is recorded in **History**.

⚠ **NOTE: We emphasize that stopping in this way is done only if the user considers it to be the end of the dryer process. If user needs to turn off the dryer during the drying process, it could be done by pausing drying process or cut the power off, not stopping process. Then, upon re-establishing power, the controller unit resumes the drying processsušenja.**

4.11. PAUSING DRYING PROCESS

Sometimes it is necessary to pause drying without stopping the whole system by touching the red field for pause/stop  .

After this, the options screen opens as in the case of stopping: disabled **START**, dark grey **PAUSE** and red **STOP,** but in this case touch field **PAUSE**. Controller pauses drying process and red field is replaced by a dark grey pause field  . After this, all outputs are turned off and the process is paused. Valves and flaps close. Re-selecting the pause field and selecting green **START**, system exits pause and resumes process.

⚠ **NOTE: Pausing system is very similar to power cut off. The difference is that starting inverters and fans is gradual if the system pauses. The most important difference between pausing and stopping drying process is that the drying cycles counter does not increase when the system pauses and increases if the system stops.**

5. OPERATING PRINCIPLES (DRYING PRINCIPLE)

Starting a process on a machine starts by selecting parameters related to a specific process. **Drying parameters** should be set. All parameters can be changed both after the start of the process and during the process. After starting the drying process, parameters for the current process are written on the display..
If something needs to change, it can be done in **Settings > Drying parameters**. All parameters that are set are also remembered for the next drying cycle. Only Heat time parameter is reset after each drying cycle and should be set to the desired number of hours as needed.

⚠ **NOTES:**
- If the average moisture in the wood is lower than parameter **Final MC**, drying process will end immediately without even starting.
- If there is an alarm situation, there is no reason to start the process until the alarm situation is resolved.
- In power outage, controller unit remembers all the relevant parameters and by power on continues the process if it has already been started.

5.1. DRYING

Drying is performed in several phases, depending on whether some phases are allowed by the user or not. These are phases of measurement, heating, core heating, drying, equalization, conditioning, cooling and stop.

5.1.1. PHASE: measurement

Any process that is started starts with the measurement phase. At this stage, controller waits for a certain amount of time, to allow MKM measuring module to measure and stabilize measurements. After the measurement phase, it advances to a phase appropriate for measured values, or continues with the phase in case that process was initiated earlier and interrupted for some reason. On the screen, to the right of the start/pause/stop field, the phase name is written.

5.1.2. PHASE: heating

After measurement phase, if the temperature in the chamber is less than specified temperature for selected regime, heating phase starts.
The temperature increases according to the temperature rise gradient given for the selected regime. The speed of warming up is also affected by parameter **Slowdown/acceleration**. Temperature deviation does not pause the temperature raising process. EMC is set to a value equal to the initial EMC according to regime, enlarged by value of parameter **EMC offset in heating** and calculated according to **Slowdown/acceleration**. Fan speed is set at the starting speed according to the diagram. At this phase, heating, fans, drying, spraying and compressor outputs are allowed if it is a dehumidifying type of dryer.

When the set temperature reaches the first temperature according to the regime, if parameter **Heat time** is higher then zero, core heating phase will start (lumber core heating in depth). If it is zero, controller will skip core heating and will advance to the drying phase.

5.1.3. PHASE: core heating

During this phase, controller maintains reached temperature and EMC iafter heating phase, for time interval specified by the user in **Heat time**. Executive devices are allowed as in heating phase: heating, fans, drying, spraying and compressor if it is a dehumidifying dryer. During this phas, the remaining maintenance time is written on the screen next to the phase name. If the power outage occurs, controller after the measurement phase immediately advances to this phase and continues until the remaining time is up.

5.1.4. PHASE: drying

In this phase, controller starts to follow selected regimet. This phase lasts until average wood MC drops to the value specified by parameter **Final MC**. Changes take place at a rate defined by parameter **System** > **Temp. grad. in heating**. When the new set values need to be calculated, controller, according to the average wood MC and the selected regime, determines what temperature, EMC and fan speed in the dryer should be. Based on this data, temperature and EMC increase or decrease by 0.1 according to those desired values, and the fan speed is set to the value specified for that wood MC. At this phase, all executive devices are allowed to operate.

NOTE: In dehumifying dryerss there is a limit to raising temperature depending on the concentration of moisture in the drying chamber. This applies to all regimes.

Table 5.1.4 **Limit for rising temperatures in dehumidifying dryer**

EMC in chamber [%]	Limit for rising temperatures [°C]
> 25	38
20 do 25	40
15 do 20	45
10 do 15	50
< 10	by selected schedule (regime)

The EMC set moves according to the required EMC calculated according to the average MC, selected regime and lumber thickness.
By changing parameter **Slowdown/acceleration** it is possible to slow down or speed up the drying.
Fan speed is always based on the average wood MC. If fan speed is set manually, as much as possible during the entire drying process, then the data specified by the user is considered.
Fan speed can not be set to a greater value than 100.0%, EMC can not be greater than 30.0%, and temperature is limited by the parameter **Maximum temperature**. Regime could be made with a higher temperature, but this parameter limits the temperature curve to the value given by this parameter.
When average wood MC drops to a value given by user in parameter **Final MC**, controller will consider drying phase complete. If conditioning phase is enabled (parameter **Conditioning** is **yes**), controller will advance to conditioning phase, and if **Conditioning** is **no** - to cooling phase.

5.1.5. 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 gramičnu value. After equalization, the process returns to the drying phase.
Phase equalization is possible only if the final MC is set to less than 10%.
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.

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

5.1.6. 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 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.

During this phase, the remaining time of conditioning is written next to the phase name.
Set temperature and EMC are in the description of the selected regime. Reach toward set temperature and EMC in the conditioning phase occurs gradually from the current values obtained from drying phase. The set temperature changes with a gradient of 7°C/h, and set EMC changes with gradient of 1%/h and those values are fixed. Fan speed is also given in regime, but can be manually altered.
After power outage and restore, this phase will continue for remaining time in the moment of power loss. Next phase is cooling phase.

5.1.7. PHASE: cooling

During cooling phase, only fans output can be activated. Valves and flaps are shutted down. Set temperature is equal to last given temperature decreased for value of parameter **Settings > System > Temperature end of drying**. EMC will remain at same value as in last phase before cooling. Fan speed is given with parameter **Fan speed in cooling**. During cooling, a passed time is written next to the phase name.

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

5.1.8. PHASE: stop

Fans stop and valves close. A message written in the status line is – **end drying**.

5.1.9. PHASE: pause

Pausing drying process. All executive devices are off, fans are stopped and valves and flaps are shutted down. A message written in the status line is - **pause**.

This is a phase set and interrupted by the user and does not included into standard drying phases that the controller goes through.

5.2. SET VALUES DEVIATIONS

While a process is started, the machine checks the deviations of the given values from the actual values. Allowed deviations are given as a percentage or degree. If the actual value is greater than the specified deviation, the HI deviation is reported, if the actual value is less than the specified deviation, LO deviation is reported. Deviation for EMC does not count during the heating and core heating phase.

Warning Temp.holdback LO provokes:

- prohibits drying (flaps, recuperator)
- in wood MC regimes no longer raise the temperature more, if a higher temperature is required by the regime
- in time-based regimes pauses timekeeping

Warning Temp.holdback HI provokes:

- no longer lowers the temperature if the mode requires lowering

Warning EMC holdback LO provokes:

- prohibits drying and cooling

Warning EMC holdback HI provokes:

- just for information

5.3. POWER FAILURE DURING DRYING PROCESS

If power is lost and then restored, while the drying process is running in automatic mode, MC-3000 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.

6. DRYING REGIMES

6.1. ABBREVIATED TABLE OF PREDEFINED DRYING REGIMES *

						Drying						Conditioning		
	No	TEMP	EMC	Regime type	Heat ramp (°C/h)	Temp	EMC	Temp	EMC	Temp	EMC	Time (h)	Temp (°C)	EMC (%)
						60% MC		30% MC		9% MC				
CONVENTIONAL DRYING SCHEDULES	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	17,0	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	17,0	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	17,0	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	17,0	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	17,0	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	17,0	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	17,0	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	17,0	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

6.2. ABBREVIATED TABLE OF DEDACATED REGIMES *

							Drying						Conditionining		
		No	TEMP	EMC	Regime type	Heat ramp (°C/h)	Temp	EMC	Temp	EMC	Temp	EMC	Time (h)	Temp (°C)	EMC (%)
							60% MC		30% MC		9% MC				
CONVENTIONAL SCHEDULES	conifers	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	17,0	44,0	12,5	62,0	3,8	25	60,0	9,0
		43	06	11	MC	7.0	46,0	16,0	48,0	11,0	64,0	3,5	20	62,0	9,0
	breech	44	12	12	MC	7.0	38,0	18,0	38,0	14,0	57,0	4,0	30	55,0	9,0
		45	12	04	MC	4.0	38,0	17,5	38,0	13,5	57,0	4,0	30	55,0	9,0
		46	04	05	MC	5.0	38,0	17,0	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	25,0	18,0	32,0	14,0	46,0	4,0	30	44,0	9,0
DEHUMIDIFYING SCHEDULES	plank very slow	51	15	02	MC	3.0	36,0	20,0	40,0	15,5	56,0	4,5	35	50,0	9,0
	plank slow	52	15	03	MC	3.5	36,0	19,0	40,0	14,5	56,0	4,5	30	50,0	9,0
	plank average	53	15	04	MC	4.0	36,0	17,5	40,0	13,5	56,0	4,0	30	50,0	9,0
	plank fast	54	15	05	MC	5.0	36,0	17,0	40,0	12,5	56,0	3,8	25	50,0	9,0
	plank 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	13	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.**

⚠ 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 user's wood species.

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.

Table 6.3. **Table of standard drying regimes pre-defined by "NIGOS - elektronik" for certain wood species**

WOOD SPECIES	Group (measure)	FACTORY REGIMES		
		Slow	Average	Fast
conifers	**3**	21, 22, **23**, 24, 25	26, 27, **28**, 29,	31, 32, **33**, 34, 35
beech, steamed	**2**	11, 12, **13**,14,15	16, 17, **18**, 19,	21, 22, **23**, 24, 25
beech, natural	**2**	6, 7, **8**, 9, 10	11, 12, **13**,14,15	/
beech, white	**2**	/	3, **4**, 5	/
oak, slavonian	**3**	1, 2, **3**, 4, 5	6, 7, **8**, 9, 10	11, 12, **13**,14,15
oak, sessile	**3**	/	1, 2, **3**, 4, 5	6, 7, **8**, 9, 10
ash	**3**	3, **4**, 5	6, 7, **8**, 9, 10	11, 12, **13**,14,15
poplar, linder	**2**	16, 17, **18**, 19, 20	21, 22, **23**, 24,	26, 27, **28**, 29, 30
birch	**3**	16, **17**, 18, 19, 20	21, **22**, 23, 24,	26, **27**, 28, 29, 30
cherry, accacia	**3**	6, 7, **8**, 9, 10	11, 12, **13**,14,15	16, 17, **18**, 19, 20
walnut	**3**	6, 7, **8**, 9, 10	11, **12**, 13,14,15	16, **17**, 18
mahagony	**3**	11, 12, **13**,14,15	16, 17, **18**, 19,	21, 22, **23**, 24, 25
samba	**2**	21, 22, **23**, 24, 25	26, 27, **28**, 29,	31, 32, **33,** 34, 35
douglass	**2**	11, 12, **13**, 14, 15	21, 22, **23**, 24,	26, 27, **28**, 29, 30

NOTE: Regimes from 1 to 35 are classified in groups of 5 with the same temperature curves and different EMCs. Within the group, the first regime is the slowest and the last one is the fastest.
Abbreviated table of predefined drying regimes (at the beginning of this chapter) shows characteristic points from beginning to end of drying process.

Table 6.4. **Table of dedicated drying regimes pre-defined by "NIGOS - elektronik" for certain wood species**

	DEDICATED REGIMES		
CONVENTIONAL DRYER	**Slow**	**Average**	**Fast**
conifers	**41**	**42**	**43**
beech, steamed	**44**	**45**	**46**
oak, sessile	**47**	**48**	**49**
lamella < 10 mm	/	**50**	/
DEHUMIDIFYING DRYER	**Slow**		**Fast**
conifers	**51, 52, 53, 54, 55**		
soft hardwood	**51, 52, 53, 54, 55**		
hard hardwood	**51, 52, 53, 54, 55**		
lamella < 10 mm	**Slow 56**		**Fast 57**
lamella by EMC (without MC probes)	**58**		

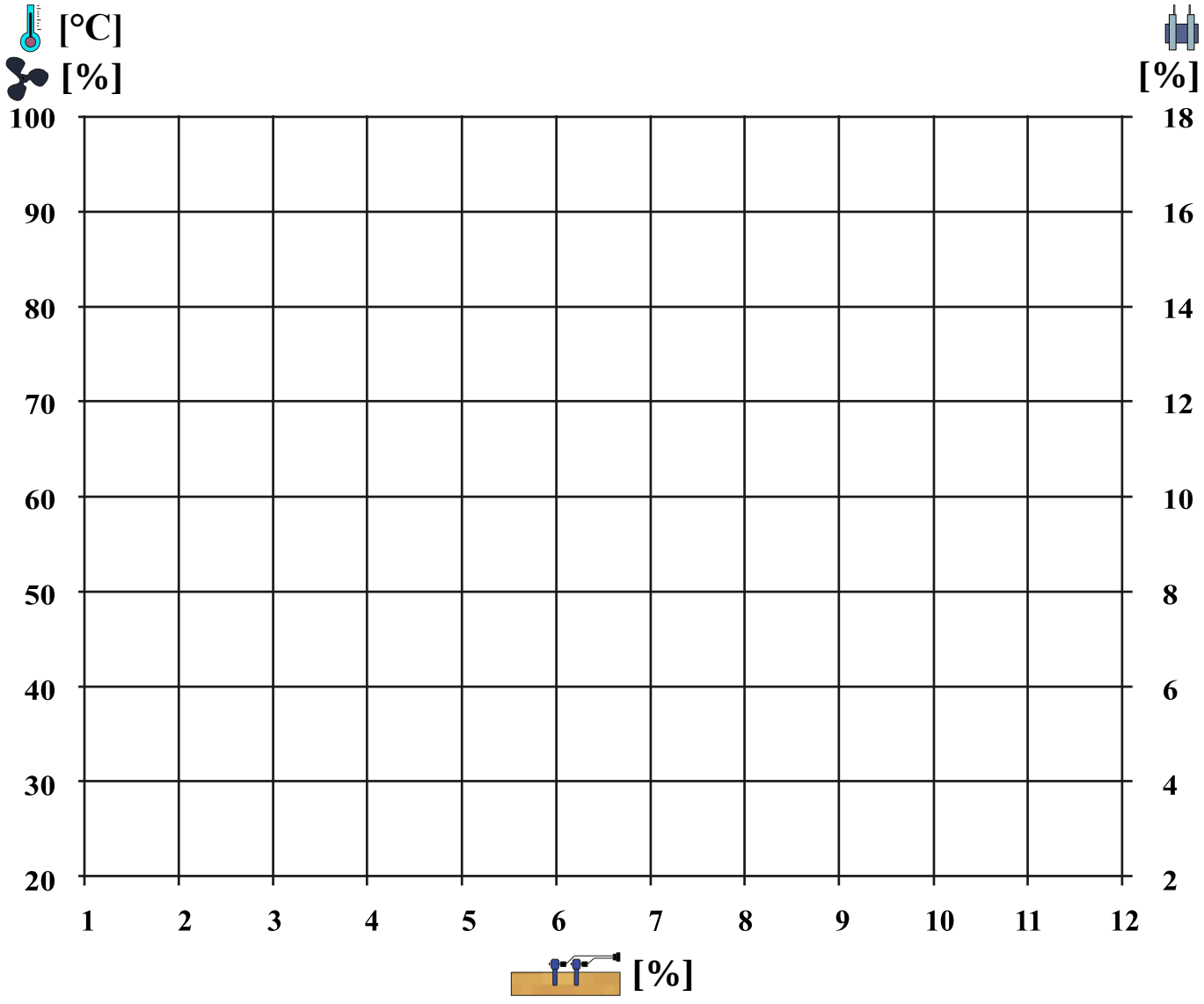
NOTE: Dehumidifying drying regimes from 11 to 20 can also be used, but the maximum drying temperature will not exceed the limit in dehumidifying dryers (factory default is 55 °C)

6.3. USER'S DRYING REGIME TABLE

As already stated in the introduction chapter, automatic controller unit MC-3000 has 60 predefined regimes in memory. The user may change each of these regimes at their own persuasion. Below is an empty table that users can copy and make their own regimes as needed.

Regime number:	
Regime type:	

Segments	**H**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**CN**	**CL**
%															
°C															
%															
%															



7. DESCRIPTION OF ALARMS, INFORMATIONS AND WARNINGS ON MC-3000 UNIT

Relay output **ALARM** can be used to report an alarm situation. Certain irregular situations and occurrences may occur during drying. If the controller manage to identify them, in the right part of the screen status line, it cyclically writes messages about all types of **warnings** that have occurred. At the same time, the symbol ⚠ appears next to output line or next to measure.

Warnings that occur do not stop the drying process, but require user to pay attention to the situation and make any decisions. The description of the warning situation stands on the right side of the status line as long as that warning that triggers it exists. At the same time as the text and warning symbol, the sound signaling of the alarm output is also included, which shuts down after a while. The warning activates the alarm output (sound or light signaling) for a period of time without interruption and then turns it off, and the warning stands on display (visual signalization) until the warning cause is removed. By touch the warning symbol, it will open message window.

Alarm situration causes the drying process to pause, because the situation that has emerged is such that MC-3000 can not continue drying. In this way, the message and symbols as already described, triggering an alarm output that can turn on sound signaling. In this situation, the user must intervene, detect the source of the alarm situation and remove it if possible, or call an authorized servicer or technical person who maintains the dryer and controller. Until the cause of the alarm is resolved, the red sysmbol ❗ will remain present after reading the alarm message. In this case, a specific procedure must be applied to remove the alarm situation given in the right column of table 7.1. After removing the cause of the alarm, controller goes through the measurement phase and continues with the process of drying accordind to measured values. Every time an alarm situation occurs, certain data is recorded in the archive, so that by subsequent examination of the archive it is possible to study the time and occurrence of the alarm situation.

If multiple alarm and/or warning situations occur, they are written one after another on the right in the status line for 2 seconds, as well as in MC-3000's **History** list.

The following tables provide all possible alarms, informations and warnings that may occur, as well as procedures carried out by MC-3000 or to be carried out by the user or an authorized technical person to remove them (aka Troubleshooting).

Table 7.1. **Alarms**

ALARM ❗	DESCRIPTION OF ALARM	TROUBLESHOOTING
alarm !!!	The alarm caused the drying process to stop.	Look for the cause of the alarm that caused the dryer' stop.
MKM error	Communication error between MC-3000 and MKM-xx.	Check the validity of MKM module and possible breaks in communication cable.
RB error	Communication error between MC-3000 and RB-3000..	Check the validity of RB-3000 and possible breaks in communication cable.
- temp probe ?	All the temperature probes have failed and temperature measures are wrong. It pauses the system and shuts down all equipment in all phases except in the heating phase.	Check all temperature probes and cables / signal range. If it's all fine, replace defected MKM with new one.
- EMC probe ?	All the EMC probes have failed and EMC measures are wrong, at all phase except in (core) heating and cooling phase.	Check all EMC probes and cables / signal range. If it's all fine, replace faulty MKM.
- wood probe ?	All the wood MC probes have failed and wood MC measures are wrong, only for the wood MC-driven regimes.	Check all MC probes and attachment cables / signal range.
Obligate service !!!	Controller unit requires intervention by an authorized service.	Call a registered service for this unit.

Table 7.2 **Informations**

INFORMATION 🅘	DESCRIPTION OF INFORMATION	TROUBLESHOOTING
- running -	Drying process has been started.	Notification that drying is in progress.
! paused !	Drying has been started, but due to an alarm situation, it has been paused. This warning occurs whenever any warning occurs that causes the drying process to pause.	Notification that the user has paused the drying or the cause of the problem needs to be fixed..
- end drying	Drying process is over.	Notification that process has finished.
defrosting	It occurs if the temperature in the dryer has dropped below freezing temperature and that pre-heating is activated.	Notification about freezing protection.

Table 7.3. **Warnings**

WARNING ⚠	DESCRIPTION OF WARNING	TROUBLESHOOTING
temperature 1; 2; 3; 4 ?	It signals an error on one of the air temperature probes..	Check certain temperature probe.
temp1-temp2 differ ?	It signals that there's too much difference between measurements of active temperature probes.	Check validity and position of probes.
temp. holdback HI	The temperature in the chamber is higher than necessary. All outputs are normally active, but regime is not tracked further until this warning is removed.	Check the measured value and actual temperature in dryer.
temp. holdback LO	The temperature in the chamber is lower than necessary. All outputs are normally active, but regime is not tracked further until this warning is removed.	Check temperature probes and the operation of heating valves and flaps.
- overheat	The temperature in the chamber is too high. The fans are turned off! Drying is forbidden!	Check temperature probes and the operation of heating system.
EMC 1; 2; 3; 4 ?	One of the EMC probes measures incorrect value.	Check certain EMC probe.
EMC1–EMC2 differ ?	If both EMC probes are active, it indicates that there is too much difference between measures of EMC probes.	Check validity and position of EMC probes and possible cause of high moisture difference.
humidity holdback HI	The air moisture in the chamber is greater than necessary. It doesn't affect the further drying.	Check drying systems and sprayers.
humidity holdback LO	The air moisture in the chamber is lesser than necessary. It doesn't affect the further drying.	Check drying systems and sprayers.
- too low EMC	The air moisture in the chamber is below the approved limit. The fans are turned off!!	Check drying systems and sprayers.
wood probe 1;2;3;4;5;6;7;8;9;10 ?	One of the temperature probes measures incorrect value.	If other probes work well, put the defective probe in passive state and finish drying with the valid ones.
control temp. 1; 2 ?	An error occurred while measuring on one of the control probes.	Check certain control probe.
fan failure ?	There's a problem with some of the circulation fans, i.e. At least one fan isn't working.	Check the fan and frequency regulator operations. Stop the drying process and replace the defective fan.
circul.pump failure ?	The circulation pump is not working.	Remove defects.
compresor failure ?	The compressor is not working.	Remove defects.
recuperator fail ?	The recuperator is not working.	Remove defects.
fan flap failure ?	It signals that there is a problem with some of the fan in flaps, i.e. a particular fan is not working.	Check the fan operation. Stop the drying process and replace the fan.
compres.fan fail ?	The fan on the thermal/heat pump is not working.	Check the fan and frequency regulator operations. Stop the drying process and replace the defective fan.
temp.out for compress	The compressor work temperature is out of range.	Check temperature in drying chamber.
temp.low for spraying	The temperature has dropped below the minimum temperature at which sprayers are allowed to operate.	Check temperature in drying chamber.
PC error	Communication error between panel and PC	Check PC connection and cables.
boot error	Memory error inside automatic controller	Call repair service!
code error	Memory error inside automatic controller	Call repair service!
lang error	Memory error inside automatic controller	Call repair service!
resource error	Memory error inside automatic controller	Call repair service!
eeprom error	Memory error inside automatic controller	Call repair service!
flash error	Memory error inside automatic controller	Call repair service!
nand error	Memory error inside automatic controller	Call repair service!
LCD error	Memory error inside automatic controller	Call repair service!
touch error	Memory error inside automatic controller	Call repair service!
battery voltage low	The battery in panel is at its end. It should be replaced.	Replace battery as in Chapter 2.
Alarm user's ?	Alarm created by user.	Depends of purpose.

8. TECHNICAL CHARACTERISTICS OF DRYING SYSTEM

TECHNICAL CHARACTERISTICS OF RELAY BOARD RB-3000

General characteristics		
	Power supply	24V AC/DC; 20 W (whole control system)
	Relay outputs	10 outputs (common, normal open and closed contacts; 8A / 250 V AC, max 3A)
	Digital outputs	3 outputs (optocouplers, max. 24 V)
	Analog outputs	2 outputs (0 ÷ 10 V DC; 4 kΩ/10 V)
	Digital inputs	5 inputs (voltage-free contacts)
	Analog inputs	2 inputs (Pt-1000; T: - 25 ÷ 160 °C)
	Counter inputs	2 inputs (max. voltage 5 V, max.frequency 5 Hz)
	Communication line	1 line, 3-wired (RS-485, protocol S - NIGOS)
	Work conditions	T: 0 ÷ 50 °C; RH: 5 ÷ 90 %
	Storage	T: - 40 ÷ 85 °C; RH: 5 ÷ 90 %
	Dimensions (LxWxT)	210 x 108 x 64 mm
	Weight	450 g
Output purpose		Equipment in dryer
Relay	Purpose	1 output for electric heating management
		1 output for water heating management
		2 outputs for fan direction management
		2 outputs for moisture regulation management (servo claps or moist ejecting fans)
		1 output for spraying management
		1 output for compressor management
		1 output for circulation pump activation
		1 output for alarm
Digital	Purpose	2 outputs for fan directions activation (coupled with corresponding relay ouputs)
		1 output for compressor activation (coupled with corresponding relay output)
Analog	Purpose	1 output for fan speed control
		1 output for compressor speed control
Input purpose		Equipment in dryer
Digital	Purpose	1 input for fan operation detection
		1 input for compressor operation detection
		1 input for compressor fan operation detection
		1 input for circulation pump operation detection
		1 input for user's purpose
Analog	Purpose	1 input for measuring control temperature on thermal/heat pump vaporizer
		1 input for measuring control temperature on vaporizer or hot water supply
Counter	Purpose	1 input for measuring electricity consumption
		1 input for measuring thermal energy consumption

TECHNICAL CHARACTERISTICS OF HMI PANEL MC-3000

General characteristics		
	Power supply	24V AC/DC; 20 W (whole control system)
	Communication lines	2 lines, 3-wired (RS-485, protocol S - NIGOS)
	Display	HMI colour panel, with touchscreen, resolution 800 x 480 pixels
	Work conditions	T: 0 ÷ 50 °C; RH: 5 ÷ 90 %
	Storage	T: - 40 ÷ 85 °C; RH: 5 ÷ 90 %
	Dimensions (LxWxT)	230 x 135 x 90 mm
	Weight	680 g

TECHNICAL CHARACTERISTICS OF MEASURING MODULE MKM

Inputs	
Power supply	24V AC/DC; 20 W (whole control system)
Temperature	2 inputs (measuring range: -20 ÷ 110 °C)
Equilibrium moisture content	2 inputs (measuring range: 2.0 ÷ 30 % EMC)
Wood moisture content	8 inputs (measuring range: 5 ÷ 160 %)
Communication lines	1 line, 3-wired (RS-485, protocol S - NIGOS)
Work conditions	T: 0 ÷ 50 °C; RH: 5 ÷ 90 %
Storage	T: - 40 ÷ 85 °C; RH: 5 ÷ 90 %
Dimensions (LxWxT)	230 x 135 x 90 mm
Weight	780g (MKM-RF) ÷ 860g (MKM-08)