PPH MAKOT
ul. Ochota 15F | 32-020 Wieliczka | Poland
Support: dt@makot.pl
Sales: biuro@makot.pl
mob. + 48 537 872 522

SMT-05 & SMT-05 PRO CONTROLLERS
USER MANUAL

Table of contents

1. DESCRIPTION OF THE CONTROLLER.

Temperature regulator SMT-05 is a microprocessor-based, programmable temperature controller, intended for use in comprehensive servicing of milk coolers, beer wort tanks, all types of dryers, chambers and sterilizing and pasteurizing devices, devices for producing juices, heating of swimming pools, or for foil tunnels.

The device casing is hermetic (IP65 protection class) and therefore resistant to humidity, dirt and low temperature. It can operate at temperatures down to -10^{O}C. The casing is adapted for wall mounting.

The controller comes with a temperature sensor in TPE cover and ended with a stainless-steel sleeve (protection class IP68). The device signals the failure of the temperature sensor.

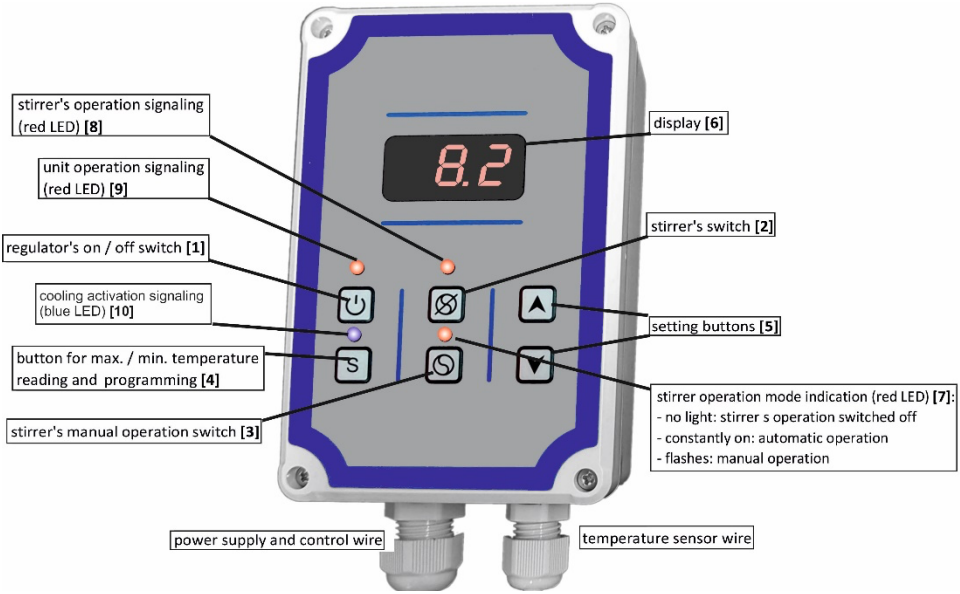
Several functions that the controller is equipped with, as well as the ability for the user to create his own operation program, makes it a universal controller to manage the operation of the refrigeration unit and the stirrer, or e.g. the heater and fan.

2. TECHNICAL DATA.

temperature measuring range	from -40,0^{O}C to +120,0^{O}C
control temperature range	from -40,0^{O}C to +120,0^{O}C (decreased by a set hysteresis)
resolution of the temperature measurer (resolution of control temperature settings)	• under -10^{O}C → every 1^{O}C • from -10^{O}C to +100^{O}C → every 0,2^{O}C • over +100^{O}C → every 1^{O}C
control hysteresis	• under -10^{O}C → from 1^{O}C to 10^{O}C • from -10^{O}C to +100^{O}C → from 0,2^{O}C to 10^{O}C • over +100^{O}C → from 1^{O}C to 10^{O}C
stirrer operation time	from 1 min. to 60 min.
stirrer standstill time	from 1 min. to 60 min.
stirrer temporary operation time	from 1 min. to 60 min.
delay time for switching on the chiller/ stirrer after the controller is turned on or the power outage	from 1 s. to 999 s.
length of temperature sensor	4/5 m
type of temperature sensor	thermistor NTC 10 kΩ +/- 1%
type of temperature meter	digital LED
load capacity of the relay contacts controlling the chiller/heating system	30A 250V AC
load capacity of the relay contacts controlling the stirrer/heating system	10A 250V AC

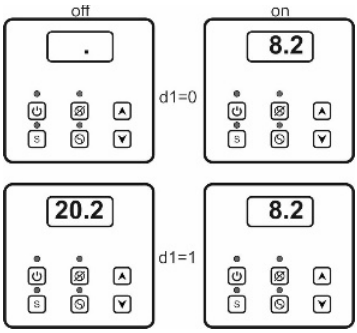
3. CONSTRUCTION OF THE CONTROLLER.

SMT-05 controller is placed in a compact, hermetic casing, intended for wall mounting, including all control and executive elements:



ATTENTION
The blue LED indicates the activation of the cooling/heating mode.
If the LED is off and the controller is connected to the mains, it means the cooling/heating operation of the device is switched off.
However, you can switch on the stirrer's manual operation by pressing the button **[3]**.

If the controller's control operation is switched off, a dot is displayed on the display (factory settings). By changing the parameter **d1** (*see section 6.*) from the value 0 to 1, when the device is switched off, the display will show the current measured temperature.



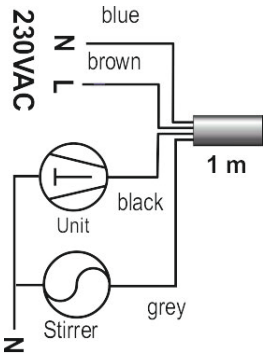
The device is equipped with:

- ✓ button for switching on and off **[1]**,
- ✓ button disabling automatic stirrer/ventilator operation **[2]**,
- ✓ button enabling manual operation of the stirrer/ventilator **[3]**,
- ✓ digital temperature meter allowing for current temperature control, independently from switching on or off **[6]**,
- ✓ LEDs signalling the current operating status of the cooling/heating unit and the stirrer/ventilator **[7] [8] [9] [10]**
- ✓ input for connecting the limit switch,
- ✓ control outputs, that is:
  - chiller (unit)/heating system control output,
  - stirrer/ventilator control output.

4. SCHEME OF CONNECTION.

To connect the controller to the device with which it is to be controlled, the following should be done:

- ✓ mount the controller in its place of operation; the fixing of the regulator is carried out in the following way:
  - unscrew the screws of the casing cover,
  - take the cover off,
  - screw the regulator casing to the prepared structure through the fixing holes,
  - put on the cover,
  - fasten the screws of the casing cover,
- ✓ place the temperature sensor inside the cooling device in the most convenient place for temperature measurement and at the same time shielded from accidental damage,
- ✓ connect the controller according to the following scheme:



5. FUNCTIONS.

The controller is equipped with several functions that, together with the possibility of creating your own program, enable adjusting its operation to the individual needs of the user. Some of the functions listed below are activated after the appropriate programming of the device (*see section 6 and section 9.*).

1. **Continuous temperature measurement**, regardless of whether the device is on (although it must be connected to the power supply) – parameter **d1** is set to 1.
2. **Two different cooling temperatures** [only in SMT-05 PRO], depending on the time elapsed since cooling was started – parameter **FC**; if FC is set >0 then there is an option to set the following parameters:
   - **t1** (pre-cooling temperature); default setting is 15^{O}C and
   - **t2** (target cooling temperature); default setting is 5^{O}C.
3. **Delay of cooling activation** [only in SMT-05 PRO] – parameter **0d**.
4. **Control function of the refrigeration system (chiller)**, depending on the measured temperature – parameter **C9** is set to the value 0.
5. **Light signalling for switching on the cooling/heating operation** – blue LED diode is on.
6. **Control function of the heating system**, depending on the measured temperature – parameter **C9** is set to 1.
7. **The stirrer or ventilator control function**, enabling the implementation of the following variants of this control – depending on the **F0** parameter settings:
   a. automatic operation:
      - cyclic operation of the stirrer/ventilator, independent of the operating condition of the chiller (unit)/heating system,
      - stirrer operates continuously during the operation of the chiller (unit), when the chiller is switched off, the stirrer goes into cyclic operation,
      - stirrer/ventilator operates only when the chiller/heating system is switched on,
      - continuous stirrer/ventilator operation while the regulator's operation is on (main application in dryers),
      - switched off stirrer/ventilator operation,
   b. operation triggered manually:
      - switching on continuous stirrer/ventilator operation, regardless of whether the control operation of the regulator is switched on; to end the stirrer operation, press button **[3]**,
      - switching on the stirrer/ventilator operation for a strictly defined time, regardless of whether the control work of the regulator is switched on.
8. **Blocking function of the stirrer and the chiller (unit) when the flap of the milk cooler tank opens** (actuation of the limit switch) – parameter **AF**. In dryers it can be used to turn off the ventilator, e.g. when the door is opened.
9. **Defining the operation of the limit switch as negative or positive** – parameter **UU**.

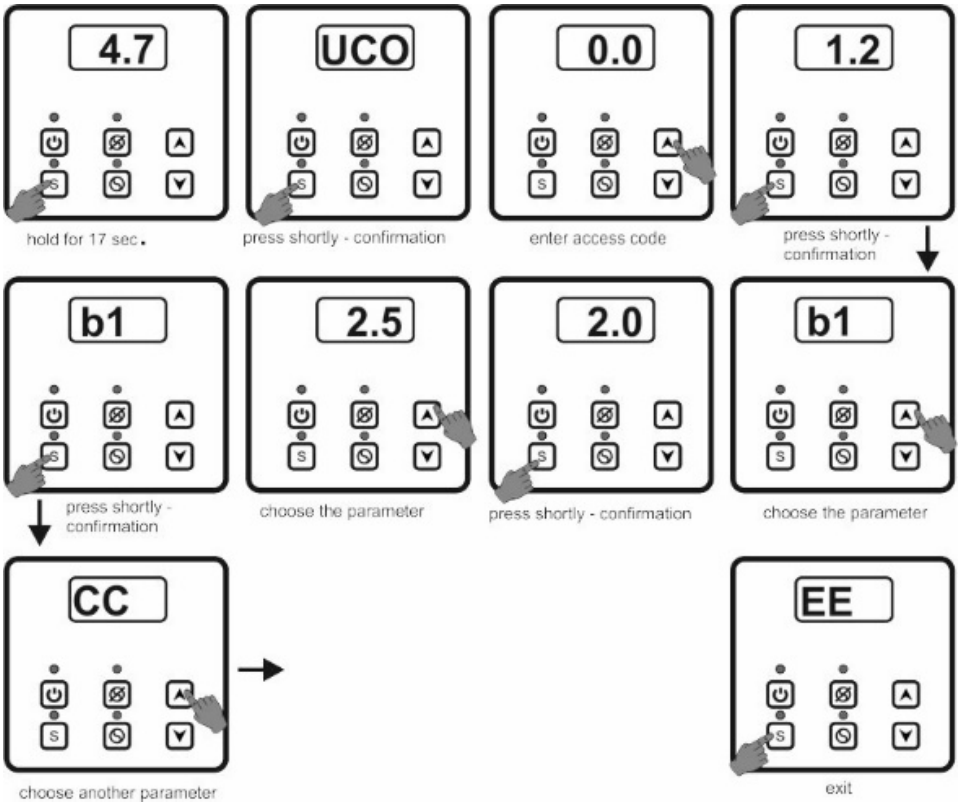
10. **The chiller (unit) operation supervision function**, consisting in the possibility of setting the maximum and minimum operation time of the chiller (unit), as well as its minimum standstill time – parameters **E1** and **E2**.
11. **Registering the maximum and minimum temperature values throughout the controller's operation cycle**. This function relates to the possibility of temporally delaying the recording of temperature data to the device's memory since its activation – parameter **AA**.
12. **Alarm signalling (visual and audible) of exceeding the set temperature range** – parameters **HA** and **HE**. This function relates to the possibility of delaying the time of switching on the alarm system of the controller from the moment of its activation.
13. **Monitoring and signalling function of the damage to the temperature sensor** – in such case the "**ACU**" appears on the display.
14. **Function of adjustable delay time for switching on the chiller (unit) and stirrer** after decay and re-switching on the voltage – parameter **dE**.

6. PROGRAMMING.

To ensure the correct operation cycle of the controller, it is necessary to program its operating parameters accordingly. By default, the controller is programmed for standard operating conditions for the purpose of controlling the milk cooler.

To change the factory setting, please enter the setting mode. This is done by holding the button **S** for approx. 17 seconds. After entering the setting mode "**UCO**" appears on the display. The next pressing of the **S** button confirms the willingness to make changes. Then press the ▲ key to enter the access code and confirm with the **S** button. After correct entry into the setting mode, the ▲ and ▼ buttons are used to select the desired parameter. The entry to the parameter settings is made by pressing the **S** button. The change of the parameter value is made using the ▲ and ▼ buttons; for the change to be saved, confirm with the button **S**. The exit from the setting mode is made by setting the **EE** parameter and confirmation with the **S** button or automatically after 17 seconds of inactivity.

The following figure illustrates the programming procedure:



7. OPERATION CYCLE.

When the device is connected to the mains and its operation is switched on with the button **[1]**, it goes– after the delay set in parameter **dE** – to the control phase.

The controller controls two control circuits:

a) control circuit for the refrigeration/heating unit;

b) control circuit for the stirrer's moto reducer.

The operation for the control settings of the refrigeration system will be discussed below.

ATTENTION

Parameter **dE** is the delay of switching on the chiller (unit) and the stirrer after switching on the regulator's work or after the supply voltage decay – default value is set to **5 sec**.

7.1. Control of the refrigeration unit.

The temperature control value (within the range specified in parameters **b1** and **b2**) is set by pressing the buttons marked with the symbols ▲ and ▼, while short pressing any of these buttons displays the currently set value, while only the next pressing causes the change of this value. Transition from reading the measured temperature to the reading of the set control temperature is signalled by the digits/numbers flashing.

The chiller (unit) control in the cooling phase takes place depending on the temperature present in the refrigeration chamber. The regulator can control the cooling temperature in the range of -40^{O}C up to +120^{O}C. To limit the scope of the control so as to prevent the user of the cooling device from setting the temperature outside this range, set the proper parameters: **b1** (limitation of the lower control temperature range) and **b2** (limitation of the upper control temperature range).

ATTENTION
*Temperatures specified in parameters **b1** and **b2** do not indicate control points for switching off and switching on the operation of the unit.*
*Setting **b1**=**b2** blocks the possibility of changing the programmed temperature by means of the ▲ and ▼ buttons. It is not allowed to set **b1** > **b2**.*
*The change in the value of **b1** or **b2** can be blocked by the currently set control temperature. In the event of such a situation, change the control temperature settings and then change parameters **b1** and / or **b2**.*

It is also important to set the control hysteresis correctly – parameter **HI**. The control hysteresis is a parameter that determines the temperature difference at which the switching off occurs and then the unit is switched on. For example, if the control temperature is set to + 4^{O}C and hysteresis is 2^{O}C, then the unit will be switched off after reaching 4^{O}C, while its re-activation will occur after the temperature has risen to 4+2=6^{O}C.

The controller allows to set the hysteresis of the control in the range of 0.2^{O}C to 10^{O}C, every 0.2 ^{O}C.

ATTENTION
If the regulator is set in heating mode, the hysteresis operation has the opposite character, i.e. the heating system is switched off after the temperature has dropped below the set value, considering the value of the programmed hysteresis.

7.2. Control of the stirrer's moto reducer.

The operation status of the stirrer is signalled by two red LED (*see section 3*):

- signalling of switching on the stirrer's moto reducer **[8]**,
- indication of the stirrer operation mode **[7]**.

The controller has two modes of stirrer operation, i.e. automatic or manual, which are described in detail below.

7.2.1. Automatic stirrer operation.

In this mode, depending on the settings of parameters **F0**, **E1** and **E2**, the stirrer may be connected to the operation of the unit or completely independent of the operation of the chiller (unit) (*see section 9*).

The stirrer operation setting in the automatic mode is signalled by the continuous lighting of the red LED diode **[7]**.

The stirrer's operation can be switched off at any time by means of the **[2]** button (*see section 3*), except when the **F0** parameter is set to 2 or 3.

Switching off the device by pressing the **[1]** button also turns off the stirrer operation.

7.2.2. Manually triggered stirrer operation.

The manual stirrer operation can be initiated by pressing the button marked by symbol ⦸ **[3]** (*see section 3*); at this point, the automatic operation of the stirrer stops and the manual operation starts. Manual operation of the stirrer is also possible when the regulator is switched off (button **[1]**) or stirrer operation switched off (button **[2]**). The setting of the stirrer operation in manual mode is signalled by a flashing red LED diode **[7]**.

The manual operation of the stirrer is not interrupted when the controller is switched off manually by pressing the **[1]** button.

The stirrer operation in this mode can be interrupted at any time by pressing the button ⦸ again.

The manual stirrer operation can take place in two variants, depending on the **CP** parameter settings:

- setting the value 0 means continuous stirrer operation,
- setting the value >0 means that the stirrer operates for the set number of minutes; after the time set elapses, the manual operation of the stirrer is switched off.

ATTENTION

No light signalling of the stirrer operation **[7] [8]** *when the regulator is switched off means that the automatic stirrer operation has been switched off, at the same time the manual operation has not been switched on.*

8. ADDITIONAL FUNCTIONS.

Below, some specific functions of the controller are described, enabling the device to be used for various applications.

8.1. Limit switch of the flap.

The device allows to connect the external limit switch of the tank flap. The principle of operation of this input consists in immediate switching off the stirrer's operation when shorting or opening of this input (depending on the **UU** parameter setting), made by the connected limit switch of the flap. The return of the stirrer operation (after being interrupted by the limit switch) happens after the disappearance of the flap opening signal with a delay of 5 seconds.

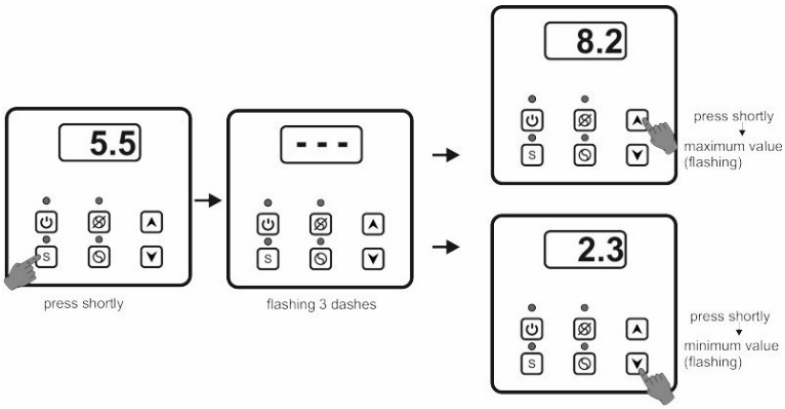
At the same time, depending on the **AF** parameter settings made, it is possible to disable the chiller (unit) operation. The chiller operation is switched off with a set delay in relation to the opening signal of the flap, so that the momentary opening does not immediately stop the operation of the chiller. The chiller restarts operation after the flap opening signal disappears, considering the programmed minimum standstill time of the chiller.

8.2. Registering the minimum and maximum temperatures.

SMT-05 controller has the function of recording the values of maximum and minimum temperatures that occur throughout the device's operating cycle. This allows to check whether the liquid is stored under the correct temperature conditions.

When the device is switched on, after the end of the programmed delay (parameter **AA** – *see section 9*), the temperature values are recorded to its internal memory. The programmable delay time of enabling this function allows pre-cooling of the milk after the start of cooling and thus not considering the maximum temperature when the device is started. This time should be selected by the user for the type of tank and the actual operating conditions of the device.

At any time, the user can read the maximum and minimum temperature values presently available. The following figure illustrates reading:

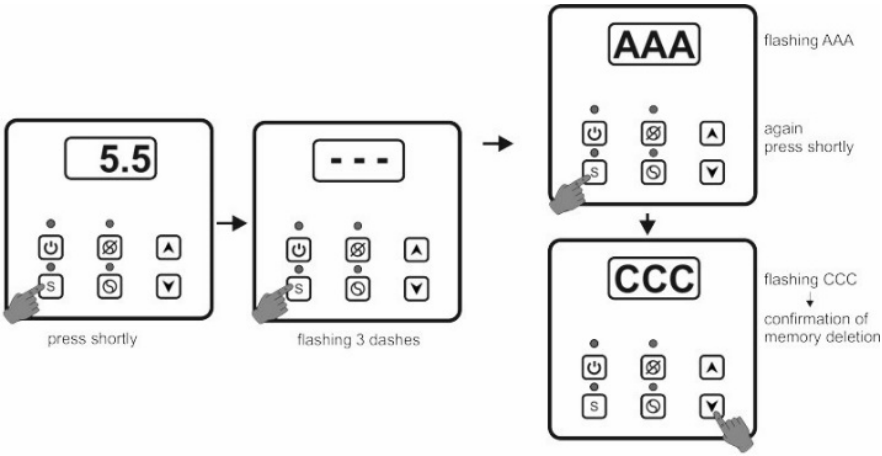


ATTENTION

*In the absence of entries of maximum and minimum temperatures in the regulator's memory, the symbol "**---**" is displayed.*

Power supply loss causes the device's memory to be cleared.

At any time, you can manually delete the current maximum and minimum values. The following figure illustrates manual memory erasing:

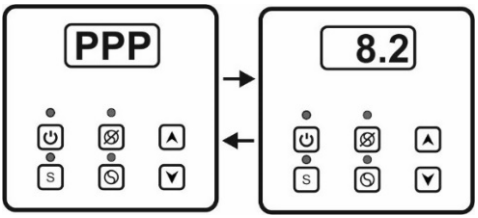


8.3. Alarm signalling of exceeding the correct temperature range.

The controller has the function of signalling the exceeding of the set temperature range. In order for the function to work properly, the appropriate temperature range must first be programmed, this is: parameter **A1** – temperature below which the alarm will be activated and parameter **A2** – temperature above which the alarm will be triggered (*see section 9*).

The third parameter to be defined is the time delay of switching on the alarm function from the moment the device's operation is switched on – parameter **AA**. This delay eliminates triggering of an alarm in the initial cooling phase.

Exceeding the set temperature range is signalled both visually and audibly. In the event of activation of the alarm, the buzzer is triggered cyclically every 1 minute for 5 seconds, and at the same time letters "**PPP**" and the temperature value are displayed alternately.



ATTENTION

*The parameter **AA** is identical to the delay specified in the maximum and minimum temperature recording function.*

*In other words, the delay value set in the parameter **AA** will be the same for recording maximum and minimum temperature and for parameters **A1** and **A2**.*

The audible alarm can be turned off by setting the **HE** parameter to 1 (*see section 9*). In this case, exceeding the set temperature range is signalled only visually, as shown in the figure above. The alarm system (audible and visual) can also be turned off completely by changing the **HA** parameter to 1 (*see section 9*).

8.4. Alarm signalling of exceeding the correct temperature range.

If the controller detects damage to the temperature sensor, the letters "**ACU**" appear on the display, and at the same time the audible alarm is activated. The operation of the chiller (unit) and the stirrer is interrupted until the failure is removed.

ATTENTION
Sensor damage indication also occurs if the range of temperatures measured by the regulator is exceeded.

8.5. Pre-cooling and target cooling temperatures (only in SMT-05 PRO).

SMT-05 PRO allows to set two different cooling temperatures, depending on the time elapsed since cooling was started (**FC** parameter). After milking, the milk is pre-cooled to a certain temperature, and then – after the pre-set time has elapsed – the controller automatically switches to control according to the set value of the second temperature, which is the target control temperature.
By default, the FC parameter is set to 0, so there is no pre-cooling (the controller operates as before). If the FC>0 (set cooling time), there is an option to set the following parameters:

- **t1**, that is the pre-cooling temperature; default setting is 15^{O}C,
- **t2** is the target cooling temperature; default setting is 5^{O}C.

FC parameter setting range: 0 (no pre-cooling) to 18 h, every 0.5 h.
During pre-cooling, the cooling LED diode lights up intermittently. After the time set in the FC function, there is a transition to cooling, according to the set temperature in the parameter t2. The LED diode is constantly illuminated, as before during cooling.
If FC=0, then the function t1 does not appear, while if FC> 0 then:

- pressing ▲ button displays the **t1** parameter, and pressing the **S** button causes entering the settings of this parameter and displaying the factory temperature value t1 (15^{O}C); change of this value to another is made with ▲ and ▼ and confirmed with the **S** button,

- pressing ▼ button displays the **t2** parameter, and pressing the **S** button causes entering the settings of this parameter and displaying the factory value of the temperature t2 (5^{O}C); change of this value to another is made with ▲ and ▼ and confirmed with the **S** button.

The controller's temperature memory does not consider the pre-cooling time. Only after the pre-cooling time has elapsed, the delay time for saving the temperature values is considered, as if the controller had just been turned on.

At any time, the user can stop the pre-cooling operation and go to the target cooling by pressing the up and down buttons at the same time.

8.6. Delay of cooling activation (only in SMT-05 PRO).

SMT-05 PRO allows to set a delay in switching on the cooling mode while the milking is being done (for example). Activation of this function is done by entering the setting mode, selecting the function **0d** and changing the value from 0 to another desired value.

By default, **0d** parameter is set to 0, so there is no delay (the controller works as before). If **0d>0** (desired delay value), there is a delay according to the setting made. Setting range of parameter **0d** is from 0 min. up to 999 minutes, every 1 minute.

If the function **0d>0**, then by pressing the cooling start button the display will show the elapsed time remaining until the start of the cooling process. After the set delay time has elapsed (countdown on the display), the current temperature appears and the controller is activated, considering other settings made earlier according to the table of settings.

If the cooling start button is pressed again during the countdown, the delay is interrupted, and the cooling process is started immediately.

The delay time is ignored in the data recording function and all other times are counted as if the regulator was turned on just now.

9. TABLE OF SETTINGS.

description of the parameter	*symbol*	*setting range*	*default setting*
entry in setting mode	UC0	access code	1.2
controller operation mode	C9	**0** – cooling **1** – heating	0
limitation of the lower value for the control temperature range	b1	setting the temperature from -40^{O}C to +120^{O}C, every 1.0^{O}C	2 (^{O}C)
limitation of the upper value for the control temperature range	b2	setting the temperature from -40^{O}C to +120^{O}C, every 1.0^{O}C	10 (^{O}C)
control hysteresis	HI	setting the temperature value: • under -10^{O}C → from 1,0^{O}C to 10^{O}C, every 1,0^{O}C	2 (^{O}C)

		• from -10°C to +100°C → from 0,2°C to 10°C, every 0,2°C • over +100°C → from 1,0°C to 10°C, every 1,0°C	
minimum operation time of the chiller (unit)	CA	**0.00** – inactive **>0.00** – active: setting the time from 1 min. to 60 min., every 1 min.	0
maximum operation time of the chiller (unit)	CC	**0.00** – inactive **>0.00** – active: setting the time from 0,5 h to 9,5 h, every 0,5 h	0
minimum standstill time of the chiller (unit)	CF	**0.00** – inactive **>0.00** – active: setting the time from 1 min. to 60 min., every 1 min.	0
delay time after which the chiller is turned off if the flap of the tank is opened	AF	**0.00** – inactive **>0.00** – active: setting the time from 0,1 min. (6 sec.) to 15 min., every 0,1 min. (6 sec.)	0.1 (min.) [=6 sec.]
stirrer operation mode	F0	**0** – operation according to the times set in **E1** and **E2**, regardless of the operation of the chiller (unit) **1** – continuous operation while the chiller is running; when the chiller is on standby, the stirrer operates according to the times set in **E1** and **E2** **2** – as in setting 1, but disabling with the stirrer's operation button causes its operation only during the operation of the chiller **3** – as in setting 1, but the button that disables the stirrer operation is inactive **4** – continuous operation, regardless of the operation of the chiller and times set in **E1** and **E2**	1
standstill time of the stirrer	E1	setting the time from 1 min. to 60 min., every 1 min.	15 (min.)
operation time of the stirrer	E2	setting the time from 1 min. to 60 min., every 1 min.	2 (min.)
manual stirrer operation mode	CP	**0.0** – continuous work **>0.0** – stirrer operation for a specified time in the range of from 1 min. to 60 min., every 1 min.	5 (min.)
delay of registering of the maximum/minimum temperature values and delay of activation of the temperature alarm	AA	setting the time from 0 h to 4 h, every 0,1 h	2 (h)
lower temperature of the alarm	A1	setting the temperature from -40°C to +120°C, every 1.0°C	2 (°C)

upper temperature of the alarm	A2	setting the temperature from -40°C to +120°C, every 1.0°C	12 (°C)
audible alarm	HE	**0** – **active** **1** – inactive	0
alarm system (visual and audible) of exceeding the set temperature range (**A1** and **A2**)	HA	**0** – **active** **1** – inactive	0
scaling the control sensor**	CU	every 0,2 °C	scalable value
setting the operation of the limit switch of opening the tank's flap	UU	**0** – closing the limit switch: raising the flap **1** – opening the limit switch: raising the flap	0
delay of starting the chiller (unit) and the stirrer after pressing on/off button or when power supply decay occurs	dE	setting the time from 1 sec. to 999 sec., every 1 sec.	5 (sec.)
display status when the control is switched off	d1	**0** – the dot is displayed **1** – the currently measured temperature is displayed	0
cooling temperatures (pre-cooling and target) [**only in SMT-05 PRO**]	FC	**0** – inactive; the controller cools down to the target temperature **>0** – active; setting the time after which the controller will start cooling down to the target temperature – in the range from 0.5 h to 18.0 h, every 0.5 h	0
pre-cooling temperature [*accessible if FC>0*]	t1	possibility to set the temperature of pre-cooling in the range from -40 °C to 120 °C (up to 100 °C every 0.2 °C and above 100 °C every 1 °C)	15 (°C)
target cooling temperature [*accessible if FC>0*]	t2	possibility to set the target temperature in the range from -40 °C to 120 °C (up to 100 °C every 0.2 °C and above 100 °C every 1 °C)	5 (°C)
cooling activation delay [**only in SMT-05 PRO**]	0d	**0 –** inactive **>0** – active; cooling will be switched on after the time set in this parameter in the range from 1 min. to 999 min., every 1 min.	0
return to factory settings	FA	**0** – no return to the factory settings **1** – after setting parameter to 1 and turning off the regulator from the power supply, switching it on again restores the factory settings and the parameter value automatically goes back to 0	0
exit from setting mode	EE		

*** set at the manufacturing stage (do not change without obvious need)*