14. CONTROL SYSTEM

SMART electric boilers have an intuitive interface and a touch color display for simple and comfortable setting. The control system (CS) has a wide set of functions, some of which contribute to the additional safety of the user and the boiler units, some functions are provided exclusively for the purpose of extending the service life of the units, some provide the convenience of boiler settings and monitoring, and the rest of the functions, with their correct use ensure a rational consumption of electrical energy, thereby increasing the efficiency of heating.

The main logic of the control system is aimed at maintaining the ambient air temperature at a preset level. The heating is turned on if the ambient air temperature is lower than the set one (set by the user). When the **current air temperature** (air sensor temperature) becomes higher than or equal to the **set** temperature, the heating is turned off until it reaches the user-set **temperature change range**. In the same way, heating is controlled according to the temperature of the heat carrier, for which the user also sets the maximum temperature value in the **supply** and **return** pipelines and their range of change, while even if the air temperature has not reached the set value, the heating is turned off when the maximum temperature of one of the coolant sensors is reached and is turned on again after cooling to the set **temperature change range**. Thus, the set air temperature is reached due to heating intervals, when the temperature of the heat carrier is in the specified range.

The boiler interface, as shown in Figure 14.1, has three areas: the status panel, the sub-menu selection area, and the operating area. The following information is constantly displayed on the status panel (Fig. 14.1):

① current pressure,

② selected timer type,

③ WiFi signal level,

④ current time,

⑤ '**Antifreeze**' function status.

In the submenu selection area, you can choose the interface of a submenu, which will be displayed in the operating area.

Figure 14.1 — Main areas of the boiler interface

14.1 Boiler setting and monitoring using its Menu

The boiler menu is navigated in the submenu selection area, which, as shown in Figure 14.1, contains 4 submenus:

6 '**Home Page**',

7 '**Settings**',

8 '**Report**',

9 '**Timer**'.

To switch to the desired submenu, click the corresponding icon in the submenu selection area, after which the interface of the selected submenu will be displayed in the operating area. After starting the boiler, the home page is displayed in the operating area of the screen. When switching to another submenu, its interface is displayed as long as the user performs some actions in the operating area. If the screen is not touched for 60 *seconds*, the home page will be displayed automatically.

14.1.1 'Settings' submenu

This sub-menu allows flexible adjustment of boiler operation. For better use, the submenu is divided into sections. To select the desired section, scroll through the submenu by moving your finger up or down in the operating area of the screen.

> **NOTE:** The minimum set of actions to be performed to start the boiler and its correct operation (after its installation and connection to the power grid and heating system) is as follows:
> - **set the pressure in the system not lower than 0.9 bar (the recommended value is 1.5 — 2 bar);**
> - **connect the wired air sensor, which is included in the basic equipment, to the connector on the bottom face of the boiler (near the power button);**
> - **set the desired power by choosing the number of tubular heating elements (THE) for heating;**
> - **set the required air and coolant temperature;**
> - **choose one of the four main modes of operation.**

14.1.1.1 'AIR' section

In this section, as shown in Figure 14.2, the desired air temperature is set and the operating mode is selected.
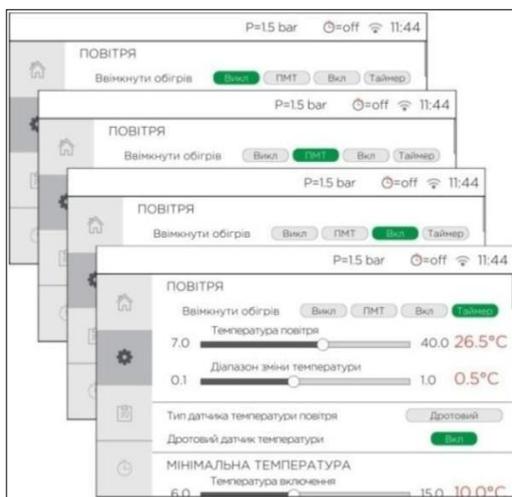
Figure 14.2 — Selecting the operating mode in the '**AIR**' section

This section also includes the '**Type of air temperature sensor**' and '**Wired temperature sensor**' fields. The last field allows you to turn off (block) the wired air temperature sensor if necessary, while the boiler will continue operating regardless of its data. To block, switch the '**Wired temperature sensor**' field to the '**Off**' position.

> **NOTE:** if the boiler needs to be used only to control the temperature of the coolant, or if the wired air sensor has failed, it

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may be blocked, but as a result, the automatic power selection ('**AUTO**' function - p. 14.1.1.3) and **delays** (p. 14.1.1.4) will not work, so the pump will be switched on constantly. Also, when the wired air sensor is blocked, the '**MTM**' mode (p. 14.1.1.1.3) will not work, and in the '**Timer**' mode (p. 14.1.1.1.4) the heating can be turned on and off only according to the schedule, without changing the set air temperature.

In the '**Type of air temperature sensor**' field, you can choose '**Wired**' or '**Wireless**' as the air temperature sensor. It is also possible to activate the '**External**' function (see p. 14.2.2) by selecting a **normally open** or **normally closed** contact for connecting an external thermostat, for which it is necessary to set '**Thermostat NO**' or '**Thermostat NC**' in the '**Type of air temperature sensor**' field respectively. Clicking on the current value of the field changes to the next value in a circle, which is shown in Figure 14.3.
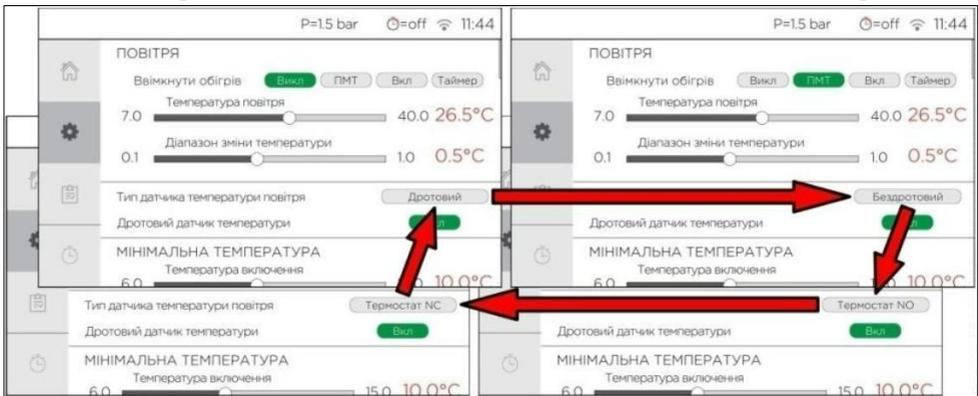
Figure 14.3 — '**Settings**' submenu, '**AIR**' section

To set the required air temperature, two values are set: the maximum air heating temperature, in the '**Air temperature**' field, within 7.0 — 40.0°C with a step of 0.1°C, and the temperature drop value, which is the point the heating is resumed at, in the '**Temperature change range**' field, within 0.1 — 1.0°C with a step of 0.1°C.

The required operating mode is set in the '**Enable heating**' field. As shown in Figure 14.2, one of four main operating modes can be set: '**Off**', '**MTM**', '**On**', and '**Timer**'.

14.1.1.1.1 'Off' mode

In this mode, the heating is off, regardless of how all other options are set. In this mode, only the indication and background '**Antifreeze**' and '**RCD**' functions work (p. 14.2.3 and 14.2.5).

14.1.1.1.2 'On' mode
In this mode, the heating is turned on to maintain the manually set air temperature, following the main control logic described earlier.

14.1.1.1.3 'MTM' mode
The '**MTM**' (Minimum Temperature Maintenance) mode is similar to the '**On**' mode but the On and Off heating range is set in advance as a preset with minimum values that are much further apart. This preset is used if it is sometimes necessary to switch the boiler not to maintaining a temperature comfortable for a person, but only to minimal heating of the room and the heating system. As Figure 14.4 shows, the values are preset in the '**MINIMUM TEMPERATURE**' section of the '**Settings**' submenu.
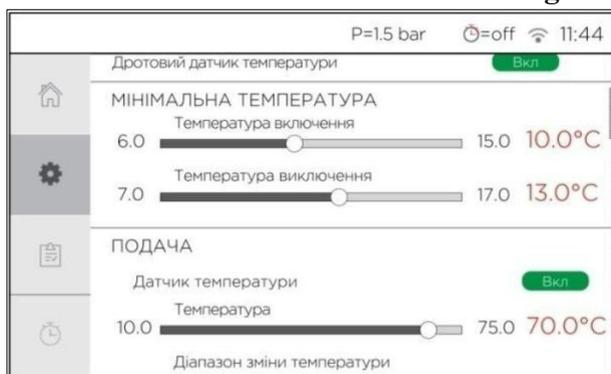
Figure 14.4 — '**Settings**' submenu, '**MINIMUM TEMPERATURE**' section

The mode can be activated by the user if the heated room remains without people for a long time and it is possible to heat it to a much lower temperature than the comfortable one, while saving electricity. When people return to the room, this mode should be turned off to restore the previously set (manually or by timer) comfortable air temperature.

14.1.1.1.4 'Timer' mode
The "Timer" mode allows the boiler to automatically change the maintained air temperature during the day or the whole week to pre-programmed values. This is feasible when using a multi-tariff electricity

meter, because the boiler can automatically set a higher maintained air temperature at night, when electricity is cheaper, and a lower temperature or complete shutdown of heating during the day, when electricity is expensive. A separate sub-menu is provided for selecting the type of timer and presetting its values, which is described in p. 14.1.3.

14.1.1.2 'SUPPLY' and 'RETURN' sections

These sections provide setting of the coolant temperature. As Figure 14.5 shows, for each parameter, similarly to the '**AIR**' section, a maximum heating temperature is set, within 10 — 75°C with a step of 0.1°C, and a temperature change range within 1 — 9°C with a step of 0.1°C.
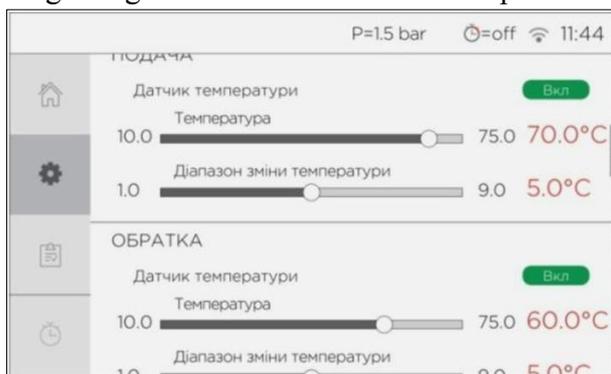
Figure 14.5 — '**Settings**' submenu, '**SUPPLY**' and '**RETURN**' sections

When setting the heating limits of the coolant, please note that if the air sensor is active and the boiler seeks to maintain the air temperature in the room at a given level, the value of the temperature to which the coolant is heated has almost no effect on the boiler's consumption of electricity, because, based on the law energy conservation, the total operating time of heating elements is inversely proportional to the given temperature of the coolant. Considering the above, setting the temperature of the coolant should be guided by the search for a balance between the room heating speed and the fact that the set temperature will be safe for all system units and users.

By setting the supply and return temperatures, the difference between their values is selected in such a way that the heating is turned off only when the current supply temperature reaches the set value.

Similar to the '**AIR**' section, these sections have buttons that allow you to block the sensor if necessary (for example, in the event of a malfunction), while the boiler will continue to operate regardless of its data. Blocking the

coolant sensors should be a temporary measure, and if both sensors are blocked, the control system will not allow the heating to be turned on, because it will lead to overheating of the THE units.

14.1.1.3 'POWER' section

In this section you can manually choose the number of heating elements (Figure 14.6, *a*), which will be used for heating, or to activate the '**AUTO**' function (Figure 14.6, *b*), which will automatically calculate the number of heating elements required to be turned on, based on the difference between the current and the set air temperature in the room and the speed of its heating.

| *a*) | *b*) |
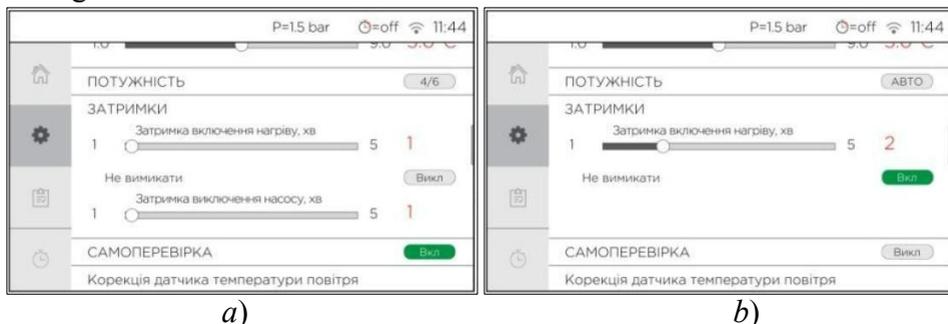
Figure 14.6 — '**POWER**', '**DELAYS**' and '**SELF-TEST**' sections: a) — selection of the number of heating elements and delay time, activation of the self-test function; b) — activation of the '**AUTO**' function, selection of permanent pump operation, deactivation of the self-test function

> **NOTE:** since the '**AUTO**' function is based on the difference between the current and the set air temperature, when the air temperature sensor is blocked, the function will use the maximum number of THE for heating.

By analogy with the coolant temperature setting, the choice of the number of working heating elements has almost no effect on the total electricity consumption of the boiler during the entire operating time, because the number of operating heating elements is inversely proportional to the heating time. This option is provided for the ability to adjust the balance between the rate of room heating and the load on the power network.

14.1.1.4 'DELAYS' section

In order to save electricity and increase the service life of the pump, the latter does not work continuously but is temporarily turned off when heating

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does not occur and circulation of the coolant is not required. Heating and pump switching are separated by time intervals called **on and off delays**. As Figure 14.6,*a* shows, these time intervals are configured in the '**DELAYS**' section of the '**Settings**' submenu, within 1 — 5 minutes.

'**Heating switch-on delay**' is the time interval between the moments of switching on the pump and the start of heating.

'**Heating switch-off delay**' is the time interval between the moments when heating stops and the pump is turned off.

The **switch-on** delay is used to vent the air accumulated in the system through the automatic air exhaust valves before the start of heating, and the **switch-off** delay is used to remove the heat from the heated heating element into the system after the heating is stopped. Based on the purpose, the **switch-on** delay should be selected in such a way that the entire heat carrier has time to make a complete circle around the system and pass through all the air-exhaust valves, and the **switch-off** delay should be selected so that the heat exchanger has time to cool down as much as possible.

The delays work only when the heating is turned off and on by the air sensor, because the switching of the heating by the coolant sensors happens often, and during one pause there may be several such switchings.

In this section, you can also activate the continuous operation of the pump if necessary, for which, as shown in Figure 14.6, *b*, select '**On**' in the '**Do not turn off**' field.

14.1.1.5 'SELF-TEST' section

In order to detect a malfunction of the power channels in a timely manner, the '**Self-test**' function of the power channels is provided and enabled by default (Figure 14.6, *a*) in the boiler, which is started every 10 minutes when the heating is on. At start-up, all heaters are turned off and on in turn, each for 500 ms, 500 ms after the previous one, after which heating is restored, as before the start of the test. As Figure 14.6, **b** shows, the '**SELF-TEST**' section of the '**Settings**' submenu serves to disable this function if necessary (for example, if the power network is weak or overloaded).

14.1.1.6 'Air temperature sensor adjustment' section

The values set in this section, in the range of -3 to 3 with a step of 0.1, are added to the values obtained from wired or wireless air temperature sensors. As Figure 14.7, *a* shows, by default these values are equal to zero but can be changed (Figure 14.7, *b*) when there is a need to adjust the value obtained from the air temperature sensor.

a)   b)
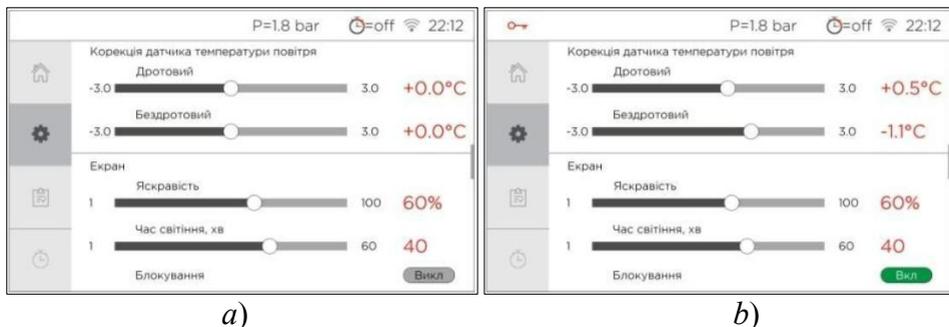
Figure 14.7 — The 'Air temperature sensor adjustment' and 'SCREEN' sections: a) — adjustment of the value of the air sensor, the brightness of the screen and its default glow time; b) — adjustment of wired and wireless air temperature sensors at +0.5 and -1.1, respectively, constant glow of the screen, the screen '**Lock**' function is activated

14.1.1.7 'DISPLAY' section

In this section you can set the brightness of the screen, in the range of 1 - 100%, and its glow time, in the range of 1 - 60 minutes. As Figure 14.7,*a* shows, by default these values are equal to 60% and 40 min. respectively. If you set '**always**' in the '**Glowing time**' field, as in Figure 14.7,*b*, the screen will glow up constantly. The section also has an option to lock the screen, for which you need to select '**On**' in the '**Lock**' field. After activating the menu function, the boiler stops responding to any gestures if the screen is not touched for more than 5 minutes (or after the screen is turned off, if the glow time is less than 5 minutes). The screen lock is indicated with a key symbol on the left side of the status panel, which can be seen in Figure 14.7, *b*. To unlock the screen, touch this symbol for 3 seconds.

14.1.1.8 'WiFi SETTINGS' section

In this section, the '**WiFi Access Point Name**' and its '**Password**' are set for connecting the boiler to the Internet using WiFi. Such a connection makes it possible to remotely change the boiler settings and monitor its condition through a mobile application or WEB interface, as well as to update the software (p. 14.1.1.10).

Here, you can also change the state of the DHCP protocol. By default, this protocol is activated, but you can refuse to use it by selecting '**Off**' in the field with the same name. After deactivation, the fields for manually setting the IP address and other network parameters necessary for connecting the boiler to the Internet will become available.

All available section fields are shown in Figure 14.8. To change the value of any field in which it is set manually, click that value, which will lead to the display of the keyboard shown in Figure 14.9 on the screen. Use the keyboard to enter a new value for the selected field, then press the 'Enter' key to confirm.

Figure 14.8 — '**WiFi SETTINGS**' section

After setting the '**Access Point Name**' and '**Password**' fields, the boiler will automatically connect to the specified access point after a few seconds. The quality of the WiFi connection is displayed in the status panel, as shown in Figure 14.1, in the box under the callout ❸. The figure shows a notation indicating a missing connection. The notation indicating the signal level in the event of a successful connection to the access point can be seen in Figure 14.8.

Figure 14.9 — Keyboard for entering field values

14.1.1.9 'TIME' section

To set the current time in this section, click its value in the '**TIME**' field (Figure 14.10, *a*), which will result in the date and time fields being displayed separately on the screen, as shown in Figure 14.10, *b*. When clicking any field, a keyboard will appear on the screen for changing them, similar to the one shown in Figure 14.9.

Figure 14.10 — 'TIME' section: *a*) — all available fields of the section;
b) — setting the date and time

In addition to setting the current date and time, you can activate the '**Automatic daylight saving**' function, for which the field of the same name must be switched to the '**On**' position.

If the boiler is connected to the Internet, it is possible to activate synchronization with the exact time server, for which it is necessary to switch the '**Automatic time setting**' field to the '**On**' position, as shown in Figure 14.10,*a*. When synchronizing with the exact time server, check and, if necessary, set the '**Time Zone**' number according to your location in the field with the same name. If necessary, change the server address in the '**Precise time server address**' field.

14.1.1.10 'UPDATE' section

In this section you can update the software to the latest version (if the boiler is connected to the Internet). To do this, click '**Check**' (see Figure 14.11, *a*), after which, as shown in Figure 14.11, *b*, the '**Available update**' field will appear in the line below, showing the version of the software available for updating. If the number of the available version is greater than the current version, click '**UPDATE**', after which the update procedure will begin. Wait until the procedure is completed and the boiler automatically restarts. After reloading, check in the '**Report**' submenu that the software version corresponds to the one indicated earlier in the '**Available update**' field. If the version has not changed, repeat the entire procedure.
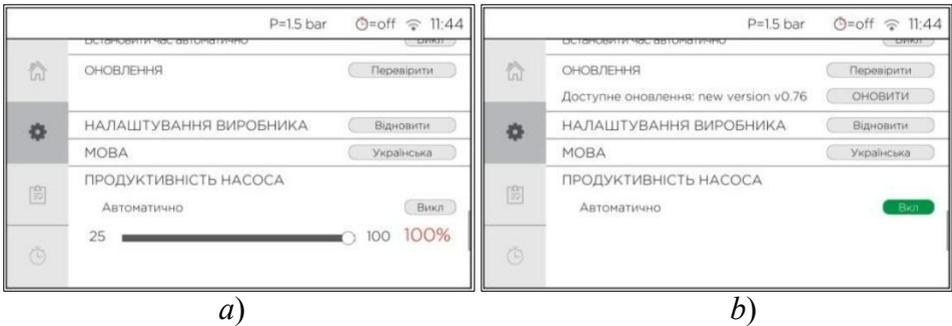
Figure 14.11 — '**UPDATE**', '**DEFAULT SETTINGS**', '**LANGUAGE**',
'**PUMP PERFORMANCE**' sections:
a) — default field values; *b*) — the available version of the software for
updating is displayed, the automatic calculation of pump performance is
enabled

14.1.1.11 'DEFAULT SETTINGS' section

In the section, all settings are reset to the factory defaults, for which press
'**Restore**' and hold for 3 seconds (see Figures 14.11). The settings will be
restored in a few seconds.

14.1.1.12 'LANGUAGE' section

In this section, you can change the menu language by clicking the value
of the current language (see Figures 14.11), and this value will change after
a few seconds. The Ukrainian, Russian, and English languages are available.

14.1.1.13 'PUMP PERFORMANCE' section

In this section, as Figure 14.11,*a* shows, the rotation frequency of the
pump is set in the range of 25 - 100%. It is also possible to activate the
function of automatic performance calculation, for which, as shown in
Figure 14.11,*b*, switch the '**Automatic**' field to the '**On**' position. The
function, changing the performance of the pump, strives to maintain the
coolant at the heat exchanger outlet at 5°C during heating.

14.1.2 'Report' submenu

This submenu contains information about the main elements and
functions of the boiler, information about the product, electricity
consumption statistics, as well as a list of malfunctions as they appear.

Similar to the '**Settings**' submenu, this submenu is divided into sections, as shown in Figures 14.12, *a, b* and 14.13, *a, b*.

a)   *b)*

Figure 14.12 — '**Report**' submenu (part one): *a)* — '**TEMPERATURE**' and '**BOILER INFORMATION**' sections; *b)*, — '**STATUS**' section

c)   *d)*

Figure 14.13 — '**Report**' submenu (part two): *a)* — '**STATISTICS**' section; *b)* — '**FAULTS**' section

The '**TEMPERATURE**' section (Figure 14.12,*a*) has two fields. If the boiler is connected to the Internet, the '**Weather**' field displays the current air temperature, according to the weather server data. The '**Air temperature**' field displays the current air temperature in the room, according to data from wired or wireless temperature sensors. If the lead sensor is blocked, '**Off**' is displayed instead of its data.

The second section, '**BOILER INFORMATION**' (Figure 14.12,a), displays the boiler serial number, software version (in the '**Version**' field), the set date and the total power of the heating units (in the '**Power**' field).

The next section, '**STATUS**', shown in Figure 14.12, *b* (the first two fields in Figure 14.12, *a*), reports information about all the most important elements and functions of the boiler. The fields from '**THE1**' to '**THE6**' reflect the current state of each of the heating elements. The '**Supply temperature**' and '**Return temperature**' fields display the current

temperature in the supply and return pipelines, respectively. It then shows the current pump status, current system pressure, '**MTM**' and '**Antifreeze**' status, and radio sensor battery charge level if used.

The '**STATISTICS**' section (Figure 14.13,*a*) shows approximate information about the boiler's electricity consumption for the last day, week, and month, in the fields with the corresponding names. Also, if you click ">" in the '**Graph**' field, the table shown in Figure 14.14 will appear on the screen, which collects the consumption data for the last 12 months, for each month separately.

ГРАФІК СПОЖИВАННЯ			
місяць	kwh	місяць	kwh
04.2021	447.384	10.2020	0.946
03.2021	10.454	09.2020	846.974
02.2021	2453.602	08.2020	0.000
01.2021	0.794	07.2020	0.000
12.2020	1882.323	06.2020	0.000
11.2020	1609.374	05.2020	0.000

P=1.9 bar ⏱=off 🛜 11:03

Figure 14.14 — Last 12 months electricity consumption table

When malfunctions are detected, the '**FAULTS**' section appears at the end of the submenu, which is shown in Figure 14.13, *b*. This section displays a brief description of all detected problems.

14.1.3 'Timer' submenu

The '**Timer**' mode is activated in the '**AIR**' section of the '**Settings**' submenu, which is described in p.**14.1.1.1**. Its purpose is described in p.**14.1.1.1.4**. The '**Timer**' submenu is used to select the type of this mode and set the points, for each of which the value of the air temperature and the time when this value should be applied as active are set. In addition to the air temperature value, the '**On**' or '**Off**' state is selected for the point. If '**On**' is set, when the set time point arrives, the air temperature set at the point is used as the current value, and if '**Off**' is set, then this state is used as the current value, which is a signal to turn off the heating until the next time point arrives.

As Figures 14.15*a* and 14.15*b* show, when this submenu is selected, a table is displayed with the parameters of all preset points, as well as the

'**TIMER**' field, where you can choose one of two types of mode: '**daily**' or '**weekly**'.

'**Daily**' type can set up to 10 points during the day, which will be repeated every day.

'**Weekly**' type can set up to 10 points during the day, separately for each day of the week, that is, up to 70 points per week.

a)   b)

Figure 14.15 — '**Timer**' submenu: *a*) — '**daily**' type;
b) — '**weekly**' type

In addition to the '**TIMER**' field, the selected type is displayed in the status panel, as shown in Figure 14.1, in the field under the callout ❷. The figure shows the symbol notation corresponding to the state when the '**Timer**' mode is not activated. Symbols indicating whether the '**daily**' or '**weekly**' type is activated can be seen in Figures 14.15*a* and 14.15*b*, respectively.

Since with the weekly timer, the points are set for each day of the week separately, under the '**TIMER**' field there is a field for choosing the day of the week (Figure 14.15, b) for viewing and setting the parameters of the points for this particular day, in contrast to the daily timer, in which this field is missing (Figure 14.15,*a*).

If you click on the parameters of any point in the table of points, an interface for changing these parameters will be displayed on the screen. As Figure 14.16 shows, the interface has three sections. The top section displays the selected timer type and, if the timer is '**weekly**', the day of the week the current point belongs to. The next section, '**TIME**', has only one field which shows the point application time in the range of 0 - 23 hours with a step of 1 hour. In the lower '**TEMPERATURE**' section, opposite the name of the section, '**On**' or '**Off**' is selected. In the middle of the lower section, the exact value of the air temperature of the current point is set, in the range of

7.0 — 40.0°C with a step of 0.1°C. In the lower right corner of the section there are two more buttons: '**Delete**' and '**Back**'.

By clicking '**Delete**' you return to the point table, while deleting the current point from this table.

The '**Back**' button also returns the display of the point table, but if the parameters of the current point have been changed, these changes remain saved.
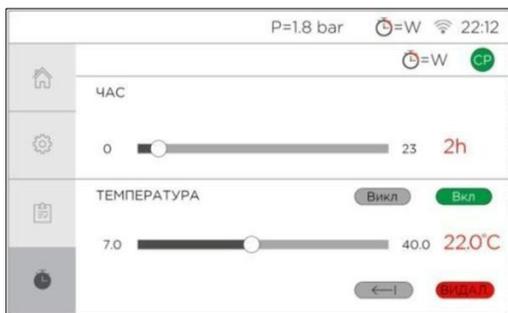
Figure 14.16 — Point parameters adjustment interface

Instead of deleted points, empty fields are displayed in the table, one of which (closest to the last set point) shows a "+" sign (Figure 14.15,*b*), when you click on it, a new point is added and the interface for adjusting its parameters, described above, is displayed.

14.1.4 'Home Page' submenu

This sub-menu clearly displays information about the main settings and the state of the most important parts of the boiler, thanks to which it is possible to evaluate the heating speed and the accuracy of the settings.

The submenu is divided into 12 fields. Each field has its own number, which is shown as footnotes in Figure 14.17.
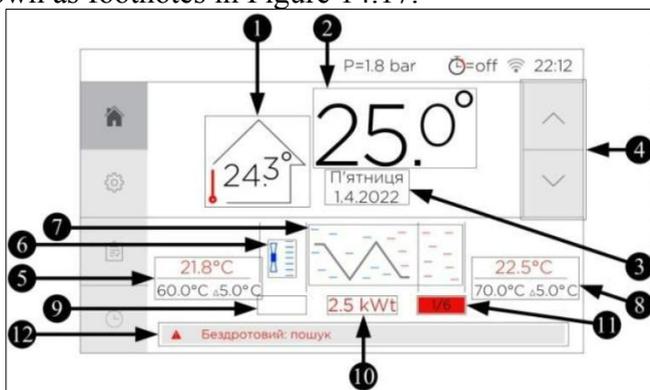
Figure 14.17 — '**Home page**' submenu

The field ❶ displays the current air temperature obtained using a wired or wireless sensor. If a wireless sensor is selected and its signal is received, the field icon changes accordingly, which can be seen in Figures 14.19*a* and 14.19*b*.

The field ❷ displays the set air temperature of the active mode ('**On**', '**MTM**' or '**Timer**' modes). When the '**Timer**' mode is active, the field displays the set temperature of the operating point. If '**Off**' is displayed instead of temperature in this field (Figures 14.19*a* and 14.19*b*), this indicates the active '**Off**' mode or the '**Off**' state of the operating point. When the '**On**' or '**Timer**' modes are activated, the value of the field can be changed without leaving this submenu using the buttons in the field ❹, but if for the '**On**' mode, these buttons change the value set in the '**Air temperature**' field of the '**AIR**' section of the '**Settings**' submenu, then when the '**Timer**' mode is active, when using these buttons, a temporary value is created, which is valid only until the activation of the next point.

If the '**External**' function is activated (see point 14.2.2), instead of the set air temperature, the field ❷ displays one of the four conventional designations shown in Figures 14.18*a* — 14.18*d*.

a)

b)

c)

d)

Figure 14.18 — Display of the selected '**External**' function type and '**EXT_IN**' terminal status in the '**Home page**' submenu field: *a*) — '**Thermostat NO**' type, the terminal is open; *b*) — '**Thermostat NO**' type, the terminal is closed; *c*) — '**Thermostat NC**' type, the terminal is open; *d*) — '**Thermostat NC**' type, the terminal is closed

The field ❸ displays the current date and day of the week.

The location of the fields ❺, ❻, ❼, ❽ symbolizes the path of the coolant through the boiler: the cooled coolant after the heating system enters the return pipeline (**return**, field ❺), where the pump (field ❻) pumps it to the heat exchanger (field ❼), in which the coolant is heated and leaves the direct pipeline (**supply**, field ❽). The field ❼ never changes and is provided only for visual demonstration of the path of the coolant. The field ❻ notifies about the state of the pump by changing its color: if the pump is turned on, the symbol of the pump turns blue; if it is turned off, the field turns gray. The fields ❺ and ❽ are organized according to the same principle and consist of two parts separated by a border. The upper part of these fields displays the current temperature of the return or supply coolant, respectively. The lower part of the fields displays the set value of the coolant temperature, which determines the upper threshold up to which the coolant can be heated (when it is reached, the heating is turned off). Also, the lower part reflects the delta by which the temperature of the heat carrier must decrease to resume heating. The logic of setting the values displayed in the lower part of the fields is described in p.**14.1.1.2**.

The field ❾ informs about the activated **on** or **off** delay and its duration. Conventional designations notifying about the effect of a certain delay are shown in Figures 14.19*a* and 14.19*b*. Marks in the field are displayed only during delays, and the rest of the time the field is empty.

| *a*) | *b*) |

Figure 14.19 — Display of the type and duration of the delay in the field **⑨**, '**Home page**' submenu ('**AUTO**' function is activated, the signal of the wireless air temperature sensor is received):

a) — '**Heating switch-on delay**', action time 1 min; *b*) — '**Pump switch-off delay**', action time 15 min (the '**Off**' mode is activated)

The field **⑩** displays the approximate current power used to heat the coolant. The power value is displayed only during heating.

The field **⑪** displays the number of heating elements selected by the user for heating the coolant and the total number of heating elements that the boiler has. If the '**AUTO**' function is activated, the field displays only the inscription of the same name, which can be seen in Figures 14.19*a* and 14.19*b*. Also, the field notifies with color about the state of heating: during heating, the field turns red, and the rest of the time, the field is gray.

The field **⑫** informs about existing malfunctions in case of their occurrence, for example, as shown in Figure 14.17. When several malfunctions are detected, they are displayed one by one. If no faults are detected, this field remains empty.

As Figure 14.20 shows, all the fields displaying the current temperature received from the sensors, instead of the temperature value, can display '**Off**' in the case of blocking the sensor, or a dash in the case of a malfunction or absence of the sensor.

Figure 14.20 — Display of blocked and missing sensors

14.2 Auxiliary functions

For the convenience and additional safety, the boiler provides a number of functions, described below.

14.2.1 Radio

If the length of the wire of the air temperature sensor from the basic equipment is not enough, the '**Radio**' function helps receive data about the

air temperature in the room from a longer distance. This function is available when purchasing an additional radio transmitter. The function is activated in the 'Air temperature sensor type' field, 'AIR' section, 'Settings' submenu, as described in p.14.1.1.1. After activating the function, the temperature data received by the boiler from the radio transmitter are used instead of the data of the wired air temperature sensor. If, for some reason, data from the transmitter does not arrive for 5 minutes, the boiler switches to work via a wired sensor, until data from the transmitter is received again.

14.2.2 External

This function provides the ability to control the heating of the boiler based on the signal from an external device. After activating the function, the boiler no longer monitors the temperature of the wired or wireless air sensor, the 'MTM' and 'Timer' modes are disabled, and the 'AUTO' function always uses the maximum number of heating elements for heating. The signal to start the pump and heating is the closing or opening of the 'EXT_IN' terminal, depending on the selected function type. The 'EXT_IN' terminal is located on the boiler board, which is shown in Figure 14.21. One of the two function types, 'Thermostat NO' (normally open contact) or 'Thermostat NC' (normally closed contact) is selected in the 'Air temperature sensor type' field, 'AIR' section, 'Settings' submenu, thus this function is activated (see p.14.1.1.1). When selecting 'Thermostat NO' , the pump and heating start when the terminal is closed and stop when it is opened. When selecting 'Thermostat NC', the pump and heating start when the terminal is opened and stop when it is closed.
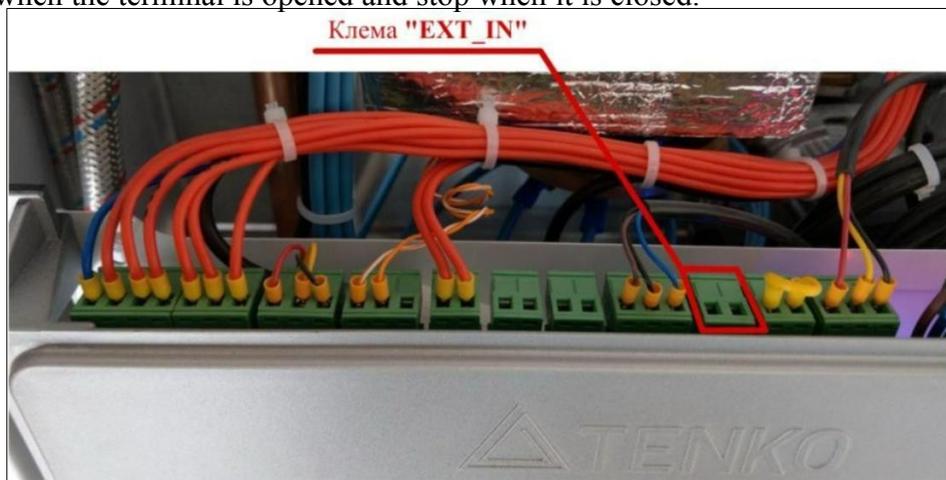
Figure 14.21 — Location of the 'EXT_IN' terminal on the boiler board

As in the case of operation using an air temperature sensor, heating starts only when the temperature of the coolant is in the specified range, even if the terminal is in the corresponding heating state (depending on the selected type), and the switching of the pump and heating are separated in time by **on** and **off** delays.

The external device that switches the '**EXT_IN**' terminal should not supply voltage, but only close or open the terminal.

14.2.3 Antifreeze (AF5)

AF5 (AntiFreeze-5) serves to protect the heating system from freezing. It is the background function that cannot be turned off. The function works when the pump is stopped (a running pump indicates that the coolant temperature is controlled according to the settings of the supply and return temperature ranges). The function monitors temperature of the coolant sensors when the main logic does not provide it. If the temperature of at least one of the sensors becomes less than 5°C, the pump is started, and after a minute pause, heating is started. For heating, the function uses the number of heating elements selected in the '**POWER**' section of the '**Settings**' submenu, while if the '**AUTO**' function is activated, only one heating element is used. When the temperature of both sensors reaches 5.5°C, both the heating and the pump stop. If one of the coolant temperature sensors fails or is blocked, the function focuses on the data of only the operating sensor.

Also, the function starts the pump for 1 minute every 30 minutes, to pass through the return temperature sensors and supply different temperature areas of the coolant from the system.

If the function is active and monitors the temperature of the coolant sensors, the status panel displays **AF5** in gray, which can be seen in Figure 14.1. When the function turns on the pump, this inscription turns red, as shown in Figure 14.22.
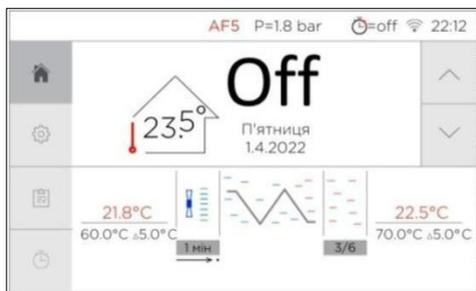
Figure 14.22 — Starting the pump with **AF5**

14.2.4 Selectivity

This is a background function. It helps extend the service life of heaters, which is achieved by changing the group of working heaters, in the case when only part of the power is used for heating. The group of operating heating elements is selected by the function in such a way that the average operating time of all heating elements is approximately the same, and the need to minimize the phase shift of the power lines is also considered.

14.2.5 RCD

The power circuits of the boiler are equipped with a current leakage sensor, which prevents electric shock when contacting the boiler body in the event of a breakdown of heating elements or solid-state relays. If a current leakage of more than 30 mA is detected, the function turns off the safety contactor that feeds the power circuits of the boiler. Power is restored only after the boiler is restarted. This is a background function.

14.2.6 Overheat protection

This function is provided to prevent overheating of heating elements and solid-state relays. The function turns off the safety contactor, regardless of the selected mode and other settings, when the coolant temperature exceeds 78°C. Power supply to the power circuits is restored when the temperature of both sensors decreases to 78°C and below. This is a background function.

14.2.7 HWS

In addition to room heating, the SMART boiler can be used to heat the water of the hot water supply (HWS) system, for which a function with the same name is provided in the boiler control system. The main elements of the hot water supply system, in addition to the SMART boiler, are an indirect heating boiler, a three-way valve and a temperature sensor for the leaving water. The specified elements are always present in such systems, and the need to use auxiliary elements is determined by the specialist who installs the system. The specialist connects the three-way valve and the temperature sensor to the boiler board, thanks to which the boiler control unit can monitor the temperature of the water used for hot water supply (**final water**) and control the state of the valve to redirect the coolant leaving the boiler (supply) to the desired circuit. Also, the specialist must allow the use of the HWS function in the engineering menu of the boiler, after which the '**INDIRECT WATER HEATING**' section will appear in the '**Settings**' submenu, and additional fields will appear in the '**Home page**' submenu that inform about the heating status of the hot water supply system

In the 'INDIRECT WATER HEATING' section, shown in Figure 14.23, you can enable or disable HWS in the 'Indirect heating' field, and set the required value of the final water temperature in the 'HWS temperature' field (7 — 65°C, step 0.1°C) and in 'HWS supply temperature' enter the maximum temperature of the heat carrier (10 — 75°C, step 0.1°C), which will leave the boiler when heating the indirect heating boiler.

Figure 14.23 — 'Settings' submenu, 'INDIRECT WATER HEATING' section

If HWS is enabled and the final water temperature is lower than the temperature set in the 'HWS temperature' field of the 'INDIRECT WATER HEATING' section of the 'Settings' submenu, the three-way valve is switched to the boiler circuit and the coolant from the boiler enters the boiler coil and indirectly gives its heat to the final water. The boiler supplies hot coolant to the coil until the temperature of the final water reaches the set value, after which the three-way valve is switched and the coolant from the boiler enters the heating system. In this position of the valve, the boiler control system decides to heat the coolant, according to the standard logic provided for heating the room by the heating system. In parallel, the monitoring of the temperature of the final water of the boiler continues and when the current value of this temperature becomes less than the set value by delta, the value of which is fixed and equal to 5°C, the three-way valve switches again to the indirect heating boiler circuit, after which the described cycle is repeated.

When heating an indirect heating boiler, the temperature of the coolant leaving the boiler is heated to the value set in the 'HWS supply temperature' of the 'INDIRECT WATER HEATING' section of the 'Settings' submenu, after which heating is suspended until the temperature of the coolant drops to delta set in the 'Temperature change range' field

of the '**SUPPLY**' section of the '**Settings**' submenu. That is, the maximum heating temperature of the coolant, when working either on the heating circuit or on the indirect heating circuit, can be set differently, and the delta to which the temperature of the coolant must decrease to resume heating is the same for both circuits.

After activating **HWS** in the engineering menu, '**Home page**' also acquires some changes, compared to how it looks in Figure 14.7, when the boiler is used only for heating. As shown in Figure 14.24, the fields ❼ and ❽ change to display the function parameters, and a new field ⓭ appears.

The field ❼ displays the conventional designation of the indirect heating boiler, in the middle of which two values separated by a dash are displayed. The current value of the **final water** sensor temperature is displayed above the line. The desired **final water** value is displayed under the line (set in the '**HWS temperature**' field, '**INDIRECT WATER HEATING**' section, '**Settings**' submenu).

The field ❽ now displays three values separated by two dashes. The current value of the supply temperature is displayed in the middle between the two lines. Under the lower line, the set value of the upper threshold of the supply temperature and the delta of heating restoration, which are effective during the operation of the boiler on the heating circuit, are displayed. Above the upper bar the set value ('**HWS temperature**' field, '**INDIRECT WATER HEATING**' section, '**Settings**' submenu) of the upper threshold of the supply temperature and the heating recovery delta are displayed, which are effective when the boiler is operating on the indirect heating circuit.

The field ⓭ informs about the circuit the boiler is currently working on (that is, about the current state of the three-way valve).
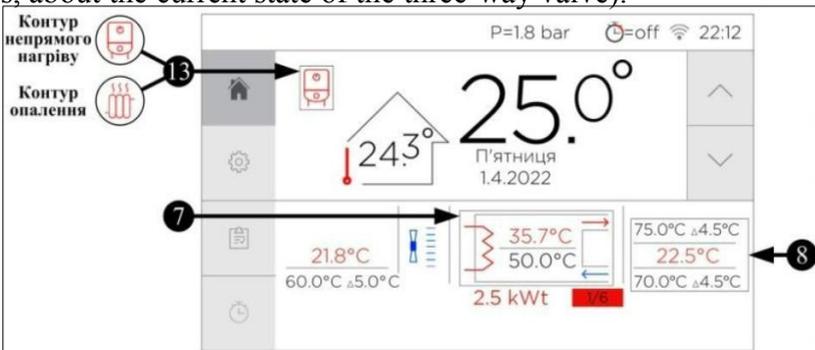
Figure 14.24 — Additional fields indicating the **HWS** status in the '**Home page**' submenu

Please note that the CS supports both electromagnetic and servo drive valves. The electromagnetic valve is connected to the boiler board by only two wires and requires constant power supply to the solenoid to move to one of the positions, and when the voltage is removed from the solenoid, the valve is moved to the opposite position by a spring. The valve, which is moved to the desired position by a servo drive, has three wires, one of which is common, and a short-term (10 seconds) power supply to one of the other two wires determines the position the valve will remain in. The specialist who installs the indirect heating system must choose in the engineering menu of the boiler which valve is used from the two described.

14.2.8 LAN

In addition to connecting the boiler to the Internet via WiFi, an optional UTP (twisted pair) cable connection is possible, for which you need to purchase the LAN module shown in Figure 14.25. Connecting the module to the boiler, as well as its activation in the engineering menu, is performed by a specialist who installs the boiler or a service engineer.

Figure 14.25 — LAN module

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