**Dear user!**

In this device, the sensor circuits are supplied with alternating current, which significantly reduces electro corrosion of electrode sensors and prevents the deposition of salt deposits on them. The common wire of the level sensors (terminal COM) is connected to the neutral line (terminal “N”) through a protective current limiting resistor.

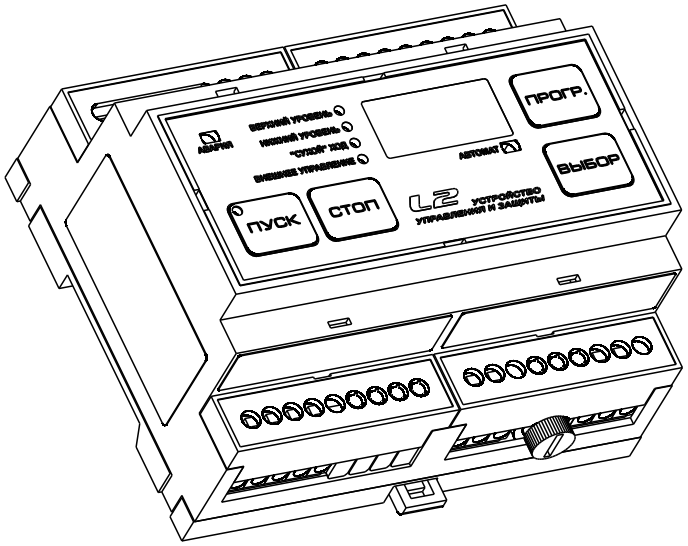
If you are using electrode level sensors galvanically connected to ground (e.g., a dry-running sensor located in a water well), check the **neutral wire connection to the “N”** terminal before plugging in the device!

L2 is supplied from the mains with voltage ~220 V (terminals “F_A” and “ N”) and in case of absence or bad contact of neutral on the terminal “N”, the device will be supplied from the phase wire F_A and from the grounded sensor through its measuring circuit, **which will lead to its failure!!!**


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HMS LIVGIDROMASH




# L2

## *CONTROL AND PROTECTION DEVICE*

***PROGRAMMING MANUAL 012.45.00.00.00 РП***

***Version 1.5***


Livny, 2025.

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# 1 DESCRIPTION AND OPERATION OF THE PRODUCT

## 1.1 Product designation

**1.1.1** Microprocessor control and protection device L2 (hereinafter L2) is designed for control and protection of any three-phase asynchronous AC electric motors with squirrel-cage rotor by operator commands and/or sensor signals.
**1.1.2** L2 corresponds to climatic execution of У category 2 according to ГОСТ 15150-69 (operation in unheated premises or under a canopy at ambient air temperature from minus 40 to plus 40°C).
**1.1.3** Degree of protection of L2 elbows and dust - IP21 according to ГОСТ 14254-96.
**1.1.4** In terms of protection against electric shock, the device corresponds to class II according to ГОСТ 12.2.007.0-75 (products with double or reinforced insulation and without grounding elements).
**1.1.5** L2 does not belong to measuring instruments, but has accuracy characteristics and does not require mandatory certification.
**1.1.6** L2 is not intended for operation in explosive, fire hazardous and aggressive environments.

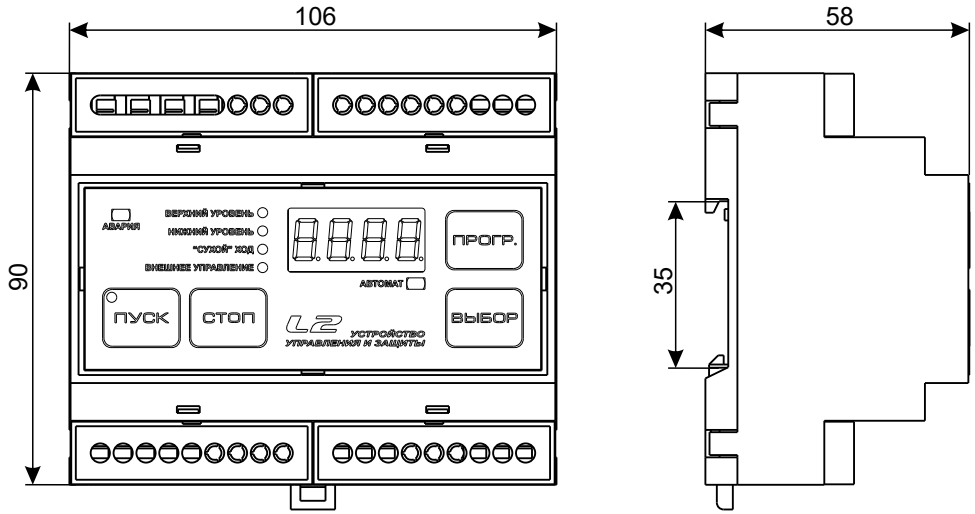
## 1.2 Specifications

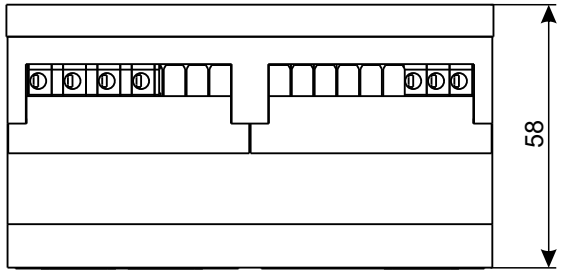
Table 1

| | |
|---|---|
| Number of sensors to be connected | 4 |
| Number of power channels | 1 |
| Rated voltage of the power circuit, V | ~380 |
| Number of phases | 3 |
| Frequency of supply voltage current, Hz | 50 ±2 |
| Supply voltage, V | ~160...270 |
| Rated voltage of level sensor power supply circuits, V | ~15 |
| Permissible deviations of supply voltage from nominal value, % | +10<br>-15 |
| Maximum measurable current, A:<br>- T03-90A type current sensors (T2000:1)<br>- sensors with unified current output 5A | <br>100.0(125.0)<br>600.0 |
| Maximum measurable phase voltage, V | 300.0 |
| Absolute error of measurement of voltages and currents, %: | ±1,0 |
| Power consumption, VA, not more | 5 |
| Cross-section of connected wires, $mm^2$ | 0,2...1,5 |
| Enclosure protection degree | IP21 |
| Overall dimensions, mm, not more | 120x90x60 |
| Weight, kg, not more | 0,5 |
| Mounting method | mounting on DIN rail 35 mm |

## 1.3 Overall and mounting dimensions

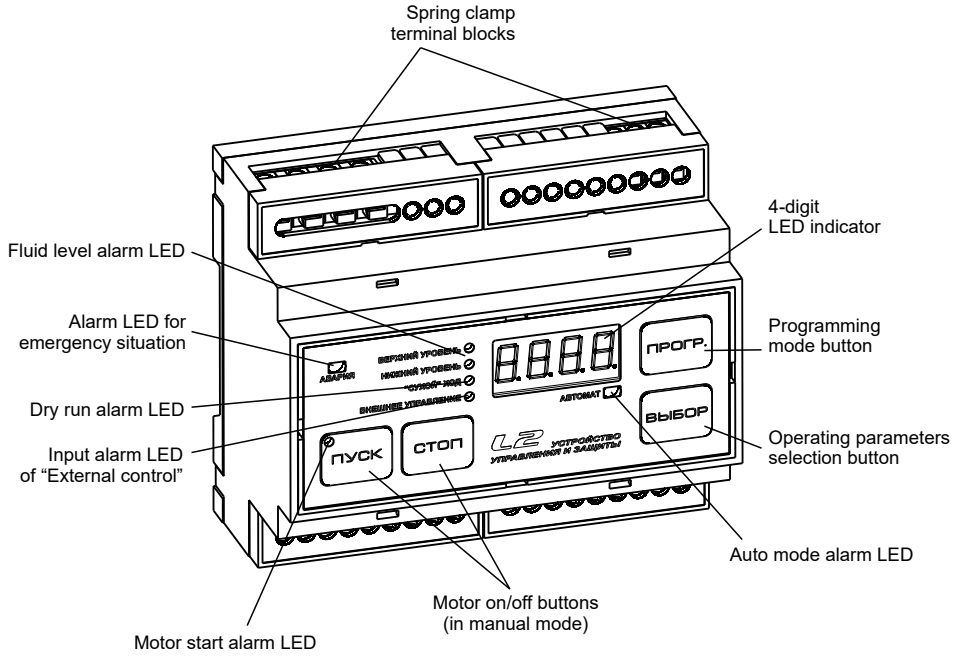
### 1.3.1 Overall dimensions

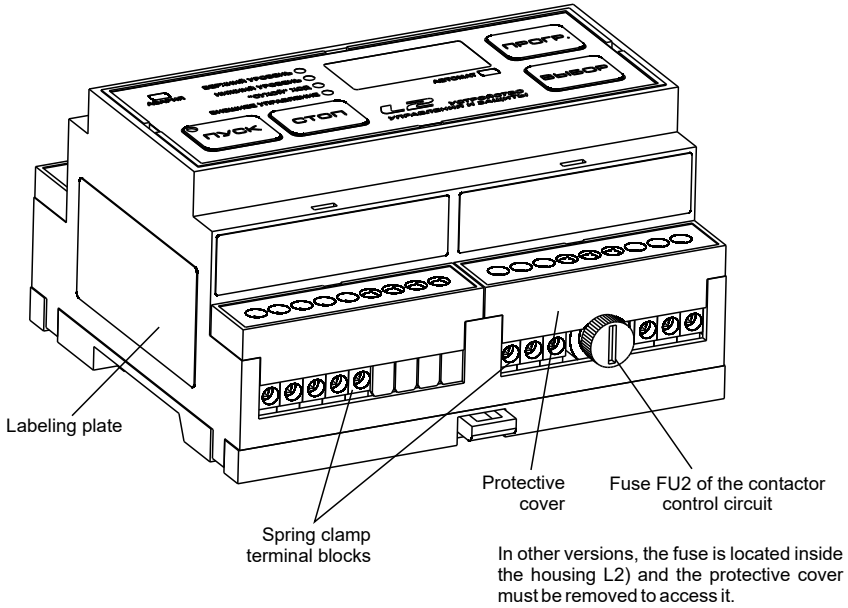





## 1.4 Controls



**1.5 Labelling**

**1.5.1** The plate attached to the L2 enclosure is labeled with the following information:

- name or designation of the device;
- trademark or name of the manufacturer;
- country of manufacture;
- serial number of the product;
- month and year of manufacture.

**1.5.2** The transport container is marked with cargo marking according to ГОСТ 14192-96 and design documentation of the manufacturing company.

**1.6 Packaging, storage and transportation**

**1.6.1** L2 shall be packed in the packaging of the manufacturing enterprise.

**1.6.2** L2 shall be stored in the manufacturer's package in rooms with natural ventilation at ambient air temperature from minus 50°C to plus 50°C and relative humidity 98% at 25°C at a distance from heating devices not less than 0.5 m and in the absence of aggressive impurities in the air.

**1.6.3** During loading and transportation of packaged products, the requirements of the warning inscriptions on the crates shall be strictly observed and shocks and impacts that may affect the external appearance and performance of the device shall not be allowed.

**1.6.4** Transportation of L2 can be performed by all types of transport, in covered vehicles, during transportation by air transport in heated sealed compartments. It is allowed to be transported as a part of products.

**2 USAGE**

**2.1** Safety precautions in preparation for operation

**2.1.1** L2 operators and maintenance and repair technicians must receive safety training and study this “Programming Manual”.

**2.1.2** Before being allowed to work with L2, the operating personnel must be trained, instructed and certified in accordance with the requirements of the “Rules for Technical Operation of Consumers' Electrical Installations” and “Safety Rules for Operation of Consumers' Electrical Installations”.

**2.1.3** When performing repair and adjustment works, the system in which L2 is installed must be disconnected from the supply network, and measures must be taken to exclude the possibility of its switching on until the end of the work.

**2.1.4** The system where L2 is installed must be reliably earthed in accordance with the Electrical Installation Regulations.

**2.1.5** In case of accident or malfunction of L2 it is necessary to stop work and switch off the circuit breaker of this installation in the power cabinet.



**2.2 Preparing the product for operation**

**2.2.1** Unpacking should be done from the “TOP” side in the following order:
- open the packaging,
- check for completeness.

In case of any defects or incompleteness of the delivery, draw up a report and send it to the manufacturer.

**2.2.2** During installation, operation, maintenance and repair of L2, the requirements of “Safety Requirements and Safety Requirements for Electrical Installations of Consumers” must be complied with.

**2.2.3** Persons having at least III license according to “Safety Requirements and Safety Requirements for Electrical Installations of Consumers” for installations up to 1000 V and familiarized with this manual are allowed to work with L2.

**2.2.4** Before connecting L2, make sure that the plant is completely disconnected from the mains power supply.

**2.2.5** Wiring should be performed according to the wiring diagrams (Section 3).

**2.2.6** L2 is considered operable if the instrument name and software version number are displayed on the screen after it is plugged into the network.

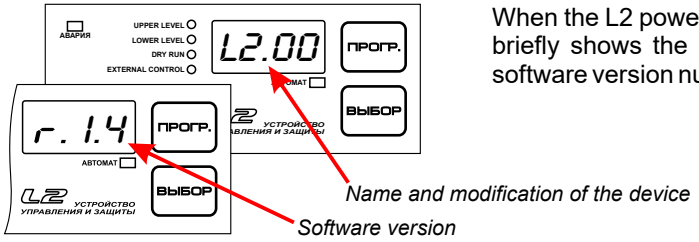
**2.3 Key parameters and characteristics**

- Setting of maximum and minimum protection currents depending on the type of applied electric motor from 0.5 to 600.0 Amperes (changeable by the user in the setup menu);
- Switching off the motor when the set current rises / falls within 1...60 seconds;
- Blocking of starting current measurement (and level sensor signals at start) for 1 to 30 seconds (user can select);
- Blocking of motor starting in case of incorrect phase sequence or phase failure;
- Motor shutdown in the event of phase failure or phase misalignment;
- Motor shutdown when the mains voltage rises or falls;
- Emergency shutdown of the motor when the timer time exceeds 1...240 minutes (can be changed by the user);
- Possibility of blocking the operation in case of frequent accidents;
- Availability of additional on/off timers designed to avoid false triggering of level (pressure) sensors in case of possible water shocks;
- Possibility of cascade switching on of several devices on one main line;
- Automatic re-activation, not earlier than in 1...60 minutes after the protection is triggered;
- LED display of operating current, phase voltages, motor run time, etc.;
- LED display of the codes of the last three alarms that occurred in automatic mode;
- LED indication of sensor status;
- Audible and LED indication of operating modes and alarms;
- Counting of operating time (motor hours) and number of motor's starts;
- Monitoring of various types of discrete level (pressure) sensors;

• Sensor circuits are powered by alternating current to significantly reduce electrode (pin) level sensors electro-corrosion and prevents the deposition of salt deposits on them.
• Control of additional inputs: “external” control (operation authorization);
• Remote transmission of binary signals (switching contacts of relay K2) on the event selected by the user;
• Control of short circuit (leakage) to the motor housing.

## 2.4 MODES OF OPERATION

### 2.4.1 Manual operation mode

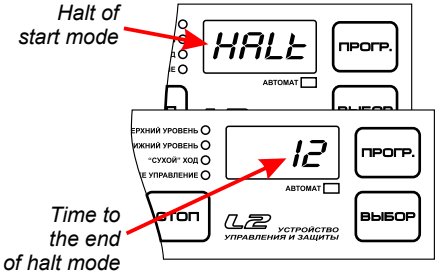



When the L2 power is turned on, the display briefly shows the name of the device and software version number.

Then all necessary data and protection parameters are read from the non-volatile memory. If there is a data failure or any values do not correspond to the permissible values, all data in the memory are overwritten with the factory values and L2 displays the alarm “Er.0”. Resetting of this alarm is described in chapter 2.9 “Alarms and their indication”.

Next, the presence and correct alternation of supply phases is checked. If one of the phases is missing (U<50V) or if their alternation is not correct, the display will show the corresponding flashing inscription with an intermittent sound signal. It is necessary to check the phase voltages and to ensure their correct alternation.

If in the setup menu (Table 3) the value of item 19 “Halt of start after power supply” is different from zero, the start-up of the device will be delayed for this time. The display will show a flashing inscription with the name of the mode “ **HALT**” and the time in seconds until the end of the delay. This power-on mode is intended for situations where multiple consumers are being energized at the same time.




If powerful loads are switched on at the same time, the supply voltage may drop, which may cause emergencies. By setting different delay times, it is possible to smoothly connect all consumers to the mains after, for example, a power failure and subsequent restoration.



If the manual mode was selected in the setup menu, after displaying the device name and software version, the “**OFF**” symbol will appear on the display and L2 will wait for pressing the “START” button to start the electric motor.




If the external control input is activated in the setup menu (the value of item 17 “External control input” is 1), the motor will be switched on/off when this input is connected or disconnected. If the input is not closed, the display will show the blinking inscription “**-no-**”. The “START” and “STOP” buttons are locked in this case.

After the operator presses the “START” button or closes the “External control” input E.Run, which is activated in the setup menu, the insulation resistance of the motor is checked, the value of which must not be lower than 18 kOhm. After that, the parameters “Mains voltage increase”, “Mains voltage decrease” are checked for 0.5...1 second.

The status of the dry running sensor is checked depending on the value set in item 28 of the setup menu. It may not be checked; it may always be checked and it may only be checked after the engine has been started.

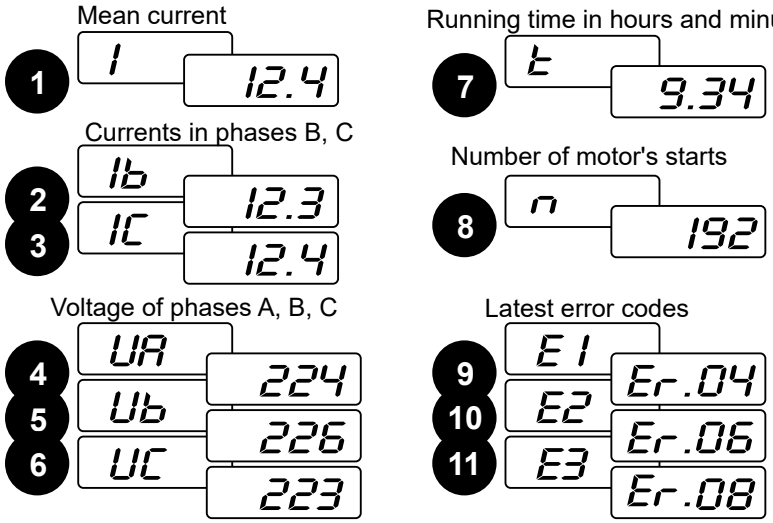
If all parameters are normal, the output relay (contacts K1.1, K1.2) is switched on, switching on the contactor that starts the motor. After switching on the relay for 1...30 seconds (changed by the user in the setup menu) L2 ignores inrush currents and distortions. Before the relay is energized, a brief audible alarm sounds to alert the operator that the motor is starting. The signaling LED on the START button lights up to indicate that the motor is on.

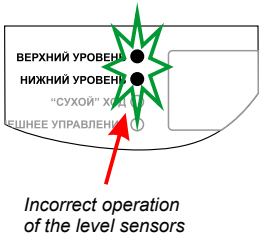
If the voltage on any phase falls below 100V or the average current draw falls below the “Minimum Current” setpoint during the inrush current interlock time, a rapid emergency motor shutdown will occur within 2 or 4 seconds. This is an additional protection in case of phase failure.

After counting down the inrush current interlock time (during the countdown the indicator displays running dashes), L2 continuously calculates the effective (RMS) current values for the two motor phases, which must lie within the minimum and maximum current settings, and displays the average current value for phases B and C on the indicator.




By pressing the “SELECT” button it is possible to view all available operating parameters of the station. Pressing the button once will briefly display the name of the parameter to be displayed and then its value. If you press the “SELECT” button twice, the next parameter will be displayed, and so all other parameters in sequence. If no button has been pressed for 30 seconds with the motor off (60 seconds with the motor on), L2 will automatically switch to the indication of the first parameter - the average current of the two phases B and C.




*Incorrect operation of the level sensors*

In manual mode the status of the level sensors is ignored, but the liquid level is indicated by the LEDs on the front panel L2.

The LEDs show the actual liquid level according to the contacts of the selected sensors in item 3 of the setup menu.

In case of incorrect operation of the level sensor inputs, no error is indicated, but the level LEDs start blinking, signaling a malfunction.

If the installation of dry run sensor is not provided at the object, it is necessary to disable it in the installation menu (in item 28 “Dry run sensor check” set the value “0” - not checked) for the station operation. It is also possible to short the dS and COM terminals on the signal terminal block with a piece of wire (see Section 3), otherwise the Er.8 alarm will always be triggered (see Table 4).

In manual mode, the number of motor's starts per hour is not checked or limited.

In case of overcurrent or undercurrent for 1...60 seconds (user adjustable in the setup menu), the contactor relay is switched off and L2 indicates an alarm. The signal LED on the front panel starts blinking, signaling the alarm, intermittent beep sounds. Other alarms (see Table 4) are fixed and cannot be changed.

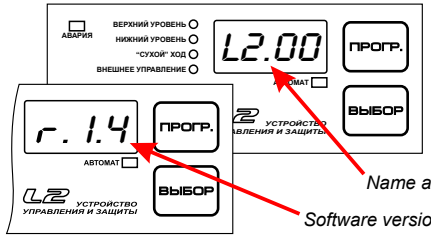
In manual mode the operation interlocking in case of frequent accidents is not used.

After pressing the “STOP” button, the alarm will be reset, the **“OFF”** symbol will be displayed on the indicator and L2 will wait for pressing the “START” button. If the alarm occurred when the “External control” input is closed, then to reset the alarm it is necessary to open this input. The alarm will be reset.

All the alarms that occurred in the manual mode are not saved in the L2 memory.



### 2.4.2 Automatic operation mode

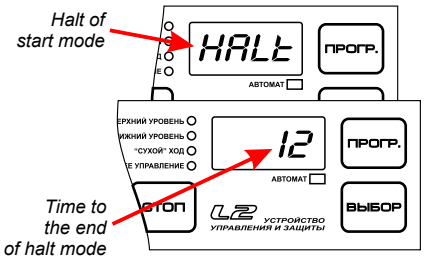



When the L2 power is turned on, the display briefly shows the name of the device and software version number.

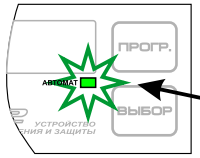
Then all necessary data and protection parameters are read from the non-volatile memory. If there is a data failure or any values do not correspond to the permissible values, all data in the memory are overwritten with the factory values and L2 displays the alarm “Er.0”. Resetting of this alarm is described in chapter 2.9 “Alarms and their indication”.

Next, the presence and correct alternation of the supply phases is checked. If one of the phases is missing or an incorrect phase sequence is detected, the display will show the corresponding flashing inscription with an intermittent audible signal. The phase voltages must be checked and correct phase rotation must be ensured.

If in the setup menu (Table 3) the value of item 19 “Halt of start after power supply” is different from zero, the start-up of the device will be delayed for this time. The display will show a flashing inscription with the name of the mode “HALT” and the time in seconds until the end of the delay. This power-on mode is intended for situations where multiple consumers are being energized at the same time.




If powerful loads are switched on at the same time, the supply voltage may drop, which may cause emergencies. By setting different delay times, it is possible to smoothly connect all consumers to the mains after, for example, a power failure and subsequent restoration.

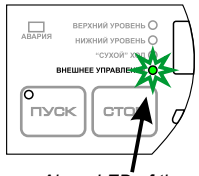



*Alarm LED for automatic operation mode*

The automatic operation mode signal LED on the front panel will light up.




*No “External control” signal”*



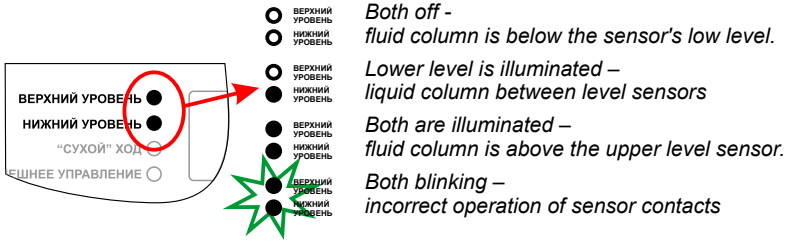

*Alarm LED of the “External control” input*

If the external control input is activated in the setup menu (the value of item 17 “External control input” of the setup menu is 1), the filling/draining processes will take place only when this input is closed.

If the input is not closed, the display will show blinking inscription “**-no-**” and L2 will wait for its closure. When it is closed, the signal LED on the instrument panel will light up.

The function (filling or drainage) is selected in item 2 of the setup menu.

Type of level sensors - item 3 of the setup menu. As level sensors it is possible to use electric contact pressure gauges of any design or single level sensors of different types (float, diaphragm, pin, etc.). On the front panel of L2 there are signal LEDs showing the liquid level according to the state of contacts of level sensors. Possible variants of level display are shown below:




*Both off -*
*fluid column is below the sensor's low level.*

*Lower level is illuminated –*
*liquid column between level sensors*

*Both are illuminated –*
*fluid column is above the upper level sensor.*

*Both blinking –*
*incorrect operation of sensor contacts*

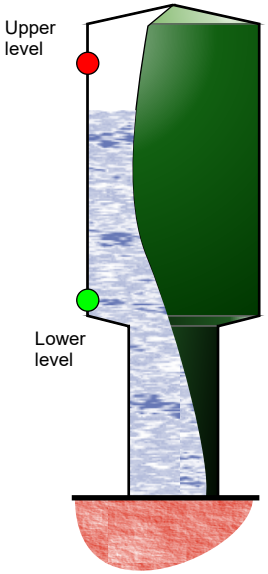
The situation with incorrect operation of the sensor contacts is caused by incorrect selection of the sensor type in the setup menu (e.g. in item 3 of the setup menu the type of ЭКМ-V sensors is selected, but in reality, pin sensors are installed). The following results: when the liquid reaches the upper level of the vessel, the contact of the lower level must be open, the contact of the upper level must be closed (see item 2.5 “Electro-contact gauges”). In reality, both pins are closed, which is physically impossible for the ЭКМ-V. As soon as a situation with incorrect sensor contacts occurs, the level LEDs start flashing and after 4 seconds the protection is triggered. The motor is switched off and error Er.10 is displayed. The error will be reset automatically when the sensor signals are restored. This fault can occur either when the sensors are faulty or when the L2 input(s) are faulty. Refer to APPENDIX Б of this manual for details on troubleshooting.

### Tank filling

If the liquid column in the tank is above the lower level, L2 switches to waiting for the tank to drain. The display will show flashing bottom dashes.




*Waiting for the lower level*




After the tank draining is finished (level LEDs on the front panel L2 are extinguished) before starting the electric motor the motor insulation resistance is checked, the value of which should not be lower than 18kOhm.

After that during 0.5...1 second the parameters “Increase / decrease of mains voltage”, phase imbalance by voltage, number of starts per hour are checked.

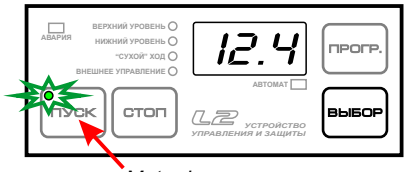


The status of the dry run sensor is checked depending on the value set in item 28 of the setup menu. It may not be checked; it may always be checked and it may only be checked after the motor has been started.

If all parameters are normal, the output relay (contacts K1.1, K1.2) is switched on, switching on the contactor that starts the motor. After switching on the relay for 1...30 seconds (changed by the user in the setup menu) L2 ignores inrush currents and imbalances and the state of level sensors. Before the relay is switched on, a brief audible signal is emitted to warn the operator that the motor is starting. The signaling LED on the START button lights up to indicate that the motor is on.

If the voltage on any phase falls below 100V or the mean current consumption falls below the “Minimum Current” setpoint during the inrush current lockout time, a rapid emergency motor shutdown will occur within 2 or 4 seconds. This is an additional protection in case of phase failure.

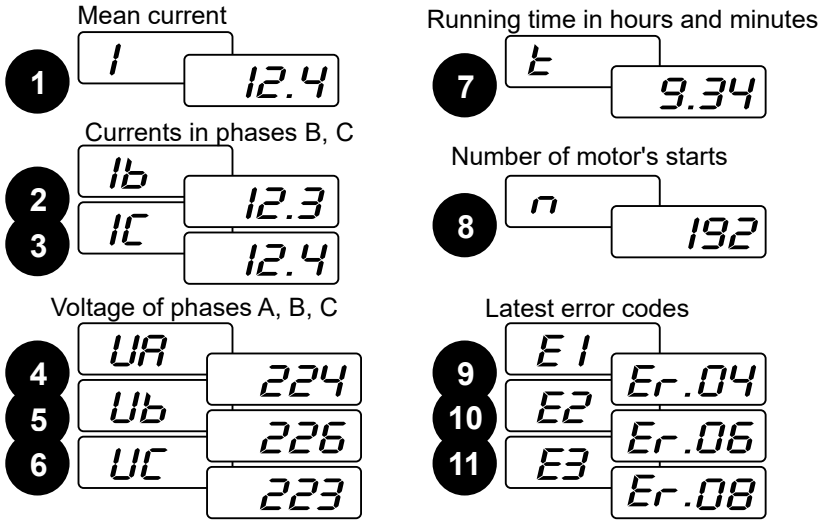
After counting down the inrush current interlock time (during the countdown the indicator displays running dashes), L2 continuously calculates the effective (RMS) current values for the two motor phases, which must lie within the minimum and maximum current settings, and displays the average current value for phases B and C on the indicator.




*Motor is on*

By pressing the “SELECT” button it is possible to view all available operating parameters of the station. Pressing the button once will briefly display the name of the parameter to be displayed and then its value.

If the “SELECT” button is pressed twice, the next parameter will be displayed and so all other parameters will be displayed sequentially. If no button has been pressed for 30 seconds with the motor off (60 seconds with the motor on), L2 will automatically switch to displaying the first parameter - average current of two phases B and C.



During the filling process, currents and voltages are constantly monitored and must be within the setpoint range set in the setup menu. If the values exceed the setting range within the set time, the emergency shutdown of the electric motor will take place. The indicator will display the emergency code and the time until the next start of the motor. Also, during operation, the state of the "External control" input and the state of the dry run sensor (if it is activated in item 28 of the L2 setup menu) are checked).

When the tank is filled to the upper level, the motor will be switched off and L2 will switch to waiting for draining. The display will show flashing lower dashes and the LED on the "START" button will go out. The "START" and "STOP" buttons are automatically interlocked.

For an emergency stop, it should be possible to quickly disconnect the power supply to the device or power equipment.

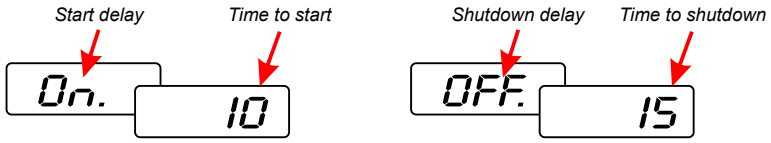
Although false alarms are filtered out (debouncing) when the level sensors are monitored, it is not uncommon for false alarms to occur over a long period of time. This is noticeably evident on "long" lines, when an electrical contact pressure gauge is used as a level sensor. Water shocks occurring after the motor has been switched on and off give false level signals for a long time, which may result in undesirable starting/stopping of the electric motor.

To avoid such situations, a motor start/stop delay function is provided.

If in item 21 "Start halt timer" of setup menu L2 set a non-zero-time value (in seconds), the motor will start after this time, provided that the liquid level state is constant. If during this time the state of the level changes (for example, there was a water shock, the ECM hand changed its position and changed the state of the contact, and then returned to the original position), then the start delay time will be reset to zero and will start counting again after the hand returns to its original state. And so on until the oscillation of the ECM hand ends. As soon as the hand oscillation stops and the timer countdown is over, the motor will be started. The timer time is selected depending on the duration of hydraulic shocks and can reach a value of up to 180 seconds.

The "Shutdown delay timer" (item 22 of the setup menu) works in the same way. When the upper level is reached, the motor will be switched off after the time set in item 22 of the setup menu. If during the countdown of this time there will be fluctuations of the ECM arrow changing the level, the countdown timer will also be reset and restarted.

When the timers are activated, the display shows the alternating inscriptions on the indicator: on/off and motor start/stop time.






It is not uncommon for a tank to overflow due to the failure of one of the level sensors (e.g. the upper level sensors on water towers often freeze and, as a result, overflow occurs).

The runtime timer (item 20 of the setup menu) will help to avoid overflow in such cases. Its task is to switch off the motor after the time set in item 20 (in minutes) has elapsed, if the upper level sensor has not been triggered. The timer is started together with switching on the motor during filling/draining operation.

If the level sensor is triggered earlier than the timer, the timer stops until the next motor's start.

When the timer is triggered, the motor stops and the indicator displays blinking inscriptions with the error code Er.11 and the time of the next switching on. After the expiration of the dwell time L2 switches to the normal operation mode.

During operation it is possible to change any parameter of the L2 setup menu. This is described in detail in p.2.8 of this manual.

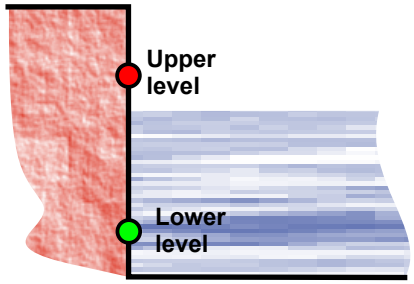
If necessary, it is possible to limit the number of engine's starts per hour. For this purpose, the user sets the maximum permissible value in item 27 of the setup menu. Before starting, L2 checks the current number of starts and, if it is exceeded, blocks operation until the current hour expires (or switching to manual mode). Every hour the current number of starts is reset to zero. The limitation of the number of starts per hour is only valid in automatic operation modes.

It is also possible to block operation in case of frequent accidents. If any consecutive fault occurs more than, for example, 3 times per hour, L2 will shut down the motor and block its further switching on until user intervention. For more details on this see paragraph 2.4.4 "Using and setting protections".

**Tank drainage**

The operation of L2 during drainage is identical to that during filling, except for the reverse order of switching the motor on/off when the liquid level changes.

When the liquid reaches the upper level, the motor will start. Once the level reaches the minimum level, the motor will stop and L2 will wait for the tank to fill to the upper level.



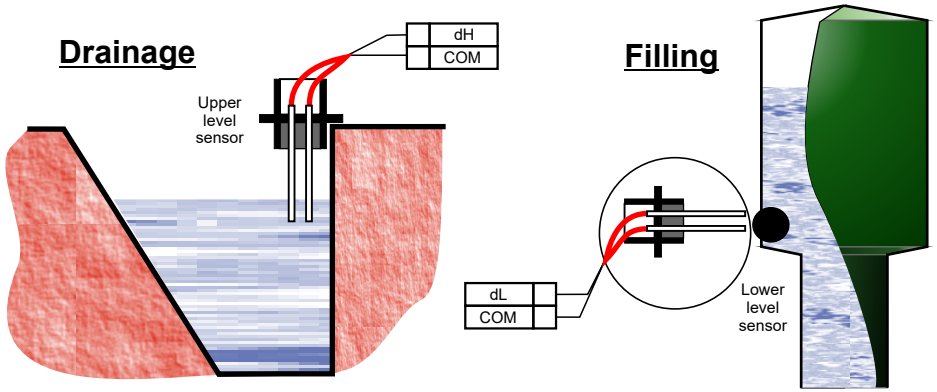

As in the case of filling, start delay, stop delay and runtime limitation functions are also possible.

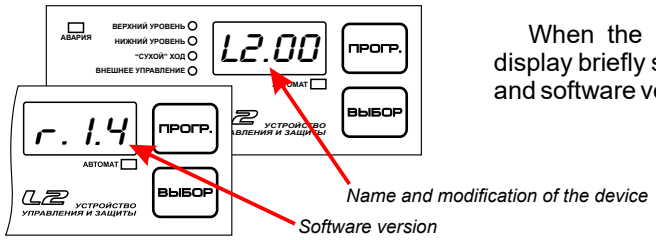
Delayed start and stop functions are similar with the fill, the run time timer is activated with the motor and resets when the lower level is reached.

Also, a limit on the number of starts per hour and the possibility of interlocking the motor operation in case of frequent accidents are available.

### 2.4.3 Timer operation mode (and low- or high-level sensor)

This mode is intended for such conditions, where installation of the upper level sensor is not possible (for example, on water towers at severe frosts it freezes and, accordingly, fails), and the use of electric contact pressure gauge is difficult for some reasons. In this case, only one lower level sensor is installed, which triggers the filling/draining of the tank for the time required for filling or draining. The second level sensor is not used in this mode. The filling or draining function is selected by setting the desired value in item 2 of the L2 setup menu.
When filling, the lower level sensor input is used, when draining, the upper level sensor input is used.



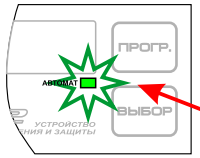

When the L2 power is turned on, the display briefly shows the name of the device and software version number.

Then all necessary data and protection parameters are read from the non-volatile memory. If there is a data failure or any values do not correspond to the permissible values, all data in the memory are overwritten with the factory values and L2 displays the alarm “Er.0”. Resetting of this alarm is described in chapter 2.9 “Alarms and their indication”.

Next, the presence and correct alternation of the supply phases is checked. If one of the phases is missing or an incorrect phase sequence is detected, the display will show the corresponding flashing inscription with an intermittent audible signal. The phase voltages must be checked and correct phase rotation must be ensured.

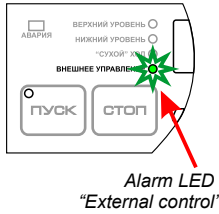
If the value of item 19 “Startup delay after power supply” in the setup menu is different from zero, the device will be delayed to turn on for this time. The display will show a blinking inscription with the name of the mode and the time in seconds until the delay is over.






The automatic operation mode signal LED on the front panel will light up.



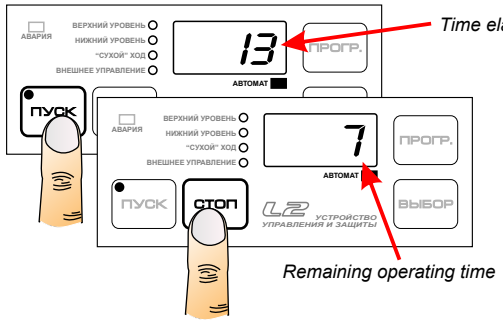




If the external control input is activated in the setup menu (the value of item 17 “External control input” of the setup menu is 1), the filling/draining processes will take place only when this input is closed. If the input is not closed, the display will show blinking inscription “**-no-**” and L2 will wait for its closure. When it is closed, the signal LED on the instrument panel will light up.

The function (filling or draining) is selected in item 2 of the setup menu.

The status of the upper (for drainage) or lower (for filling) level sensor is then checked.
**A) When filling.** If the sensor is disconnected, which means that there is no liquid in the vessel, the pump motor is switched on for a time from 1 to 180 minutes (user adjustable in the setup menu). The filling time of a specific tank is selected manually by test. After the end of the filling time L2 will wait for the lower level sensor to open and then repeat the filling cycles again. After the end of the filling time, the display will show flashing bottom dashes.
**B) When draining.** If the sensor is connected, which means that the tank is full, the motor is switched on for 1 to 180 minutes.
The draining time of a particular vessel is selected by test in manual mode. After the end of the draining time, L2 will wait for the upper level sensor to close and then repeat the draining cycles again.

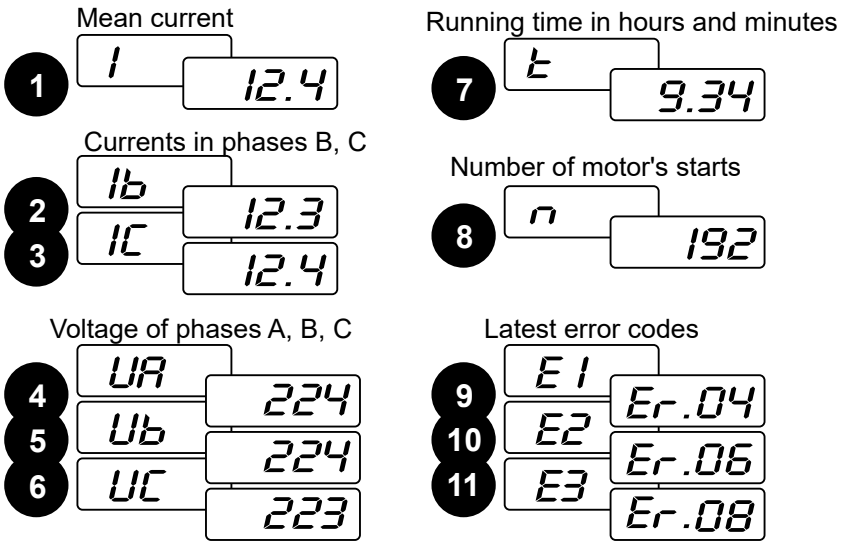
Before starting the electric motor, the motor insulation resistance, “Increase / decrease of mains voltage”, phase voltage imbalance, number of starts per hour are checked. After starting L2 continuously calculates the effective (RMS) values of currents on two motor phases, which must lie within the limits of the minimum and maximum current settings, and displays the average value of current on phases B and C.




The time elapsed from the beginning of the filling/draining cycle can be viewed by pressing the “START” button, the time until the end of filling/draining can be viewed by pressing the “STOP” button.

By pressing the “SELECT” button it is possible to view all available operating parameters of the station. When pressing the button once, the name of the parameter to be displayed is briefly indicated, followed by its value.

If the “SELECT” button is pressed twice, the next parameter will be displayed, and so all other parameters will be displayed sequentially. If no button has been pressed for 30 seconds with the motor switched off (60 seconds with the motor switched on), L2 will automatically switch to the display of the first parameter - mean current per phase B and C.




This mode has additional functions such as a delay timer (item 21 of the setup menu).

If necessary, it is possible to limit the number of engine's starts per hour. For this purpose, the user sets the maximum permissible value in item 27 of the setup menu. Before starting, L2 checks the current number of starts and, if it is exceeded, blocks operation until the current hour expires (or switching to manual mode). Every hour the current number of starts is reset to zero. The limitation of the number of starts per hour is only valid in automatic operation modes.

It is possible to interlock the motor operation in case of frequent accidents. In case of any accident more than 3 times per hour, for example, L2 will switch off the motor and interlock its further switching on until the user's intervention. For more details on this see paragraph 2.4.4 “Using and setting the protections”.



### 2.4.4 Using and setting protections

Up to 15 different types of protections are used in the L2, some of which are set in the setup menu. The following is a brief description of the main protections and their setting.

**a) Protections by voltage**

The purpose of this group of protections is to stop the operation of the actuator in case of unsatisfactory quality of the supply network. It includes: phase sequence control, phase failure control of one or more phases and phase voltage values exceeding the limits set by the user.

**Incorrect alternation or interruption of one (or more) phases.**

To be checked after the power supply has been applied. In case of incorrect phase sequence or undervoltage on one or more phases (<50 V), motor operation is blocked. It is permanently active and does not require adjustment.

**Voltage rise or fall below the set voltage, voltage phase imbalance.**

This is checked before the motor is switched on and during operation. If the voltage values are out of the user-defined range or if the value of imbalance in volts is exceeded, the motor is switched off in emergency mode. The setpoint values are set in item 8, item 9, item 26 of the setup menu (see Table 3).

When setting the values of maximum and minimum voltages it is recommended not to exceed the limits +10...-15% of the nominal value of 220 V. If zero value is set in the item “Voltage phase misalignment”, the phase imbalance protection will be disabled.

**b) Current protections**

The purpose of this group of protections is to stop the operation of the actuator in case of a critical change in the load current or a significant imbalance of the phase currents. It includes: monitoring of current consumption, current imbalance. Emergency load disconnection occurs when the current values exceed the limits set by the user.

**Current rise or fall below the set current, phase current imbalance.**

It is checked after the motor has been started and has reached the operating mode after a user- set time. During this time (inrush current interlocking time) the overcurrent and phase imbalance protections are disabled due to high inrush currents that can lead to false triggering of the protection. After the motor has finished accelerating, these protections start functioning.

If the current values are out of the user- set range or if the imbalance value in percent is exceeded, the motor will be switched off in an emergency. The current and imbalance setting values are set in item 6, item 7, item 10 of the L2 setup menu (see Table 3). If a zero value is set in the item “Current phase misalignment”, the misalignment protection will be switched off.

In the setup menu it is recommended to set the minimum current value 10...15% lower than the operating current, the maximum current value is 10...15% higher than the operating current.

The inrush current blocking time (motor run-up time) is set individually for each device. For some motors this interval is 1...2 seconds, for others, e.g. exhaust fans, it can be up to 30 seconds or longer.

The motor current consumption monitoring is one of the main protection parameters, it is set as follows:

- in the manual mode by pressing the “START” button turn on the motor and wait for the end of its acceleration time (running dashes are displayed on the indicator during acceleration). After acceleration, the motor mean current consumption in amperes will be displayed on the indicator;
- check the direction of rotation of the pump (motor) shaft, in case of reverse rotation turn off the station power supply and change the sequence of connection of motor wires to the contactor;
- adjust the operating parameters of the pump for normal operation with the gate valve and **memorize the mean current value displayed by L2**;
- turn off the motor by pressing the “STOP” button;
- enter the programming mode and set the value of the parameter “Maximum current” 10... 15% higher than the average value you have memorized, and the value of the parameter “Minimum current” 10... 15% lower. These will be the limits of overload or underload protection of the motor. Using the “Minimum current” (underload) protection, it is possible to monitor the dry running of the pump, when the pump operating current drops to the idle current of the motor. This is particularly relevant in cases where a dry run sensor cannot be activated.

Since the factory set currents of the L2 protections may not match the actual current of the motor used, it is possible that the current protection may be triggered 5...60 seconds after acceleration. If there is not enough time before triggering of the protection to bring the pump to the operating mode, it is necessary to enter the setting menu and set the values “Minimum current” - zero and “Maximum current” - obviously higher than the mean current, which was displayed on the indicator during manual start-up.

**c) Interlocking of operation in case of frequently occurring accidents**

In some cases, it is necessary to stop the device in an emergency and prevent it from starting again in case of, for example, a successive overload accident.

In item 18 of the setup menu ***“Number of alarms per hour for interlocking”*** set the number of occurring emergencies per hour, e.g. 3. Now, if the motor operating current rises above the “Maximum current” setpoint three times within an hour, L2 will switch off the motor in an emergency and interlock its further switching on until the user intervenes. Pressing the “STOP” button for a long time will reset this alarm.

This protection is also necessary when operating **without a dry run** sensor. If, for example, the well runs out of water, L2 will detect this by triggering the minimum current protection (motor underload) or the dry run sensor. After the dry run dwell time has elapsed, L2 will continually attempt to start the motor. If there is no water for a long period of time, the pump will be started “dry” and after 20...25 seconds it will be switched off in an emergency, which will lead to rapid pump failure.

When pumps are not running for long periods of time, there are cases when they are airlocked, e.g. due to leaking seals or temporary loss of water in the supply line. If the pump is not self-priming, it must be interlocked in these situations.



The interlocking parameters set in L2 will prevent the pump from failing. In the event of an air locking, the minimum current protection will be triggered and, if it occurs more than e.g. 3 times per hour, the pump will be interlocked until the user intervenes.

Interlocking is performed for alarms:

- voltage increase/decrease, phase imbalance to voltage;
- current increase/decrease, current phase imbalance;
- dry run sensor operation.

**d) Monitoring of discrete level sensors**

Due to the fact that it is difficult to check the correctness of circuits of discrete level sensors, the logic check of the state of the upper and lower level sensors is introduced in L2.

In the process of filling or draining the change of liquid level in the tank leads to successive triggering of sensors of lower and upper levels. The type of sensor contacts is determined by the user in item 3 “Type of level sensors” of the setup menu for each sensor individually.

For example, for ЭКМ version V (lower - NC., upper - NO), the triggering sequence is as follows:

- when there is no pressure: contact lower level is connected, contact upper level is disconnected;

- pressure above the lower setpoint: - contact lower level is disconnected, contact upper level is disconnected;

- pressure above the upper setpoint: - the lower level contact is disconnected; the upper level contact is connected. Any other contact state (e.g. both of these contacts are connected) is physically impossible for the ЭКМ -V and L2 will prevent the motor from running until this fault is corrected.

There may be several reasons for this failure: incorrect selection of the sensor type in the setup menu, malfunction of the sensor(s) itself, or physical damage to the sensor circuit (external connections from the sensor to L2 or internal L2 circuits).

**e) Protection against dry running**

There are a number of dry run protections: by line pressure, by pump motor current consumption, by water sensor, by flow sensor.

***1. Pressure presence.*** It is mainly determined by means of a pressure controller. It serves to cut off the power supply to the pump if the water, e.g. in a well, runs out. In such a case, the pressure drops sharply, the dry run switch switches off and gives a signal to the control unit or directly switches off the pump. The status of the pressure controller is checked after the motor has been started. The relay can be installed both in the pressure line and in the suction line.

***2. Direct contact with water.*** Float, electrode, capacitive and other sensors are used in this method. If the water level drops below the permissible level, the sensor contact will trigger the L2 signal for an emergency stop. When the water level is restored to normal, the pump will automatically resume operation.

***3. Consumption current.*** When there is no water, the pump motor operating current drops from the rated current to the no-load current. L2 monitors the current drop and switches the motor off in an emergency. The parameter “Minimum current” must be set correctly in the L2 setup menu.

***4. Flow sensor.*** With this sensor, the moving water presses on a special vane and the vane changes the positions of its output contacts by an angular force. This principle is based on the detection of water flow in the pipeline. If there is no flow, the contact disconnects and gives the L2 signal for emergency stop of the pump. The status of the flow sensor is checked after the motor has been started.

For more information on the use of discrete sensors see section 2.5.

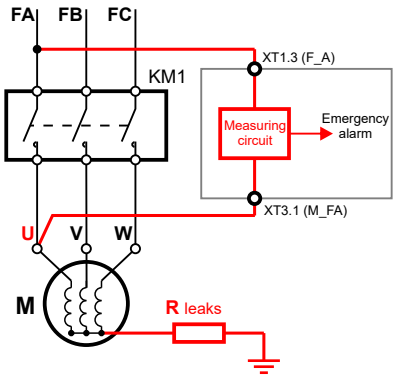
### f) Protection against frequent switching on

For some equipment, e.g. powerful submersible pumps, there is a limit on the number of starts. A maximum number of starts per hour is usually specified. Exceeding the start-up frequency leads to premature failure of the equipment.

In L2 it is possible to set the limitation of the number of starts per hour in item 27 of the setup menu “Number of allowed starts per hour”. If a non-zero value is set in this item, L2 will limit the number of starts to this value. If the number of starts for the current hour is exceeded, the motor start-up is blocked until the current hour expires.

If the value of item 27 is zero and in manual mode of operation, the protection against frequent starts does not work.

### g) Motor winding short-circuit (leakage) monitoring




Control principle: The rectified mains voltage of phase A (F_A) is fed to the output terminal U of the contactor via a current limiting and measuring circuit. When the contactor is switched off, this circuit is connected to all motor windings. If a large leakage occurs (circuit resistance < 20 kΩ), the motor start is blocked.

It is checked before the motor is turned on. After the motor is switched on, its readings are ignored.

Connecting the circuit to another terminal of the contactor is **not allowed** - the circuit will be damaged by high voltage when the contactor is switched on!

Activating/deactivating of this protection - item 16 of the setup menu “Checking of body short-circuit”.

When connected to the soft starter output terminals, the soft starter “Damage to power keys” alarm may be triggered falsely. In this case, do not connect the leakage monitoring wire or use a contactor after the soft starter.



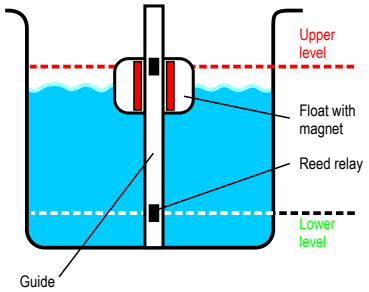
## 2.5 Use of different types of level sensors

Level sensors are devices that allow to monitor the quantity of liquid or bulk material by the level of its surface in some container. Level sensors can give a discrete (when a certain level is reached) or continuous signal (absolute height of the current level). In addition, level sensors can be contact and non-contact. According to the principle of operation level sensors can be: conductometric, capacitive, float, radar type, ultrasonic, hydrostatic and others.

Pressure switches configured for specific actuation values can also be used as level sensors.

The most commonly used sensor applications are as follows.

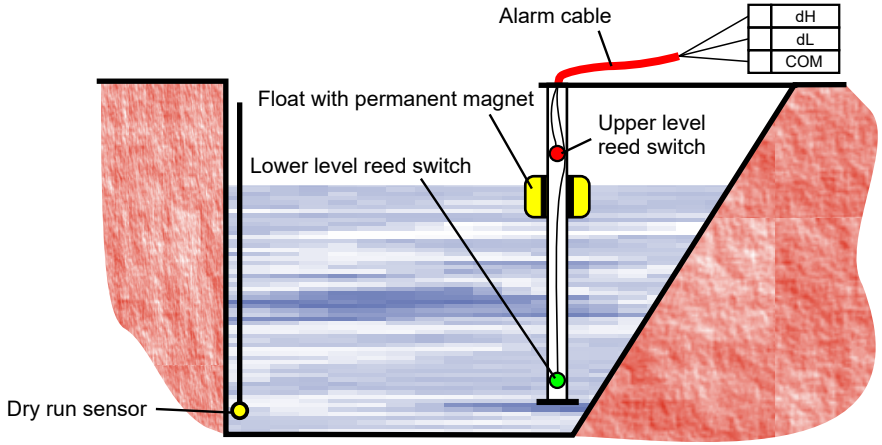
### Discrete float level sensors




A discrete-signal sensor design typically utilizes a set of floats located at different levels of the tank. When the liquid reaches the level at which a float is located, it is pushed upwards. This drives a mechanical system or electromechanical system and the output signal appears, for example, when the electrical contacts of a reed relay are connected.

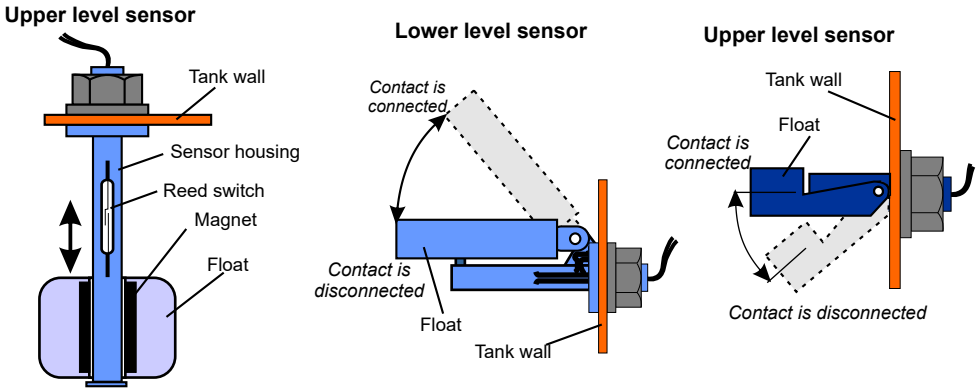
In an alternative configuration, there is a guide containing a set of relays. A float containing a permanent magnet moves along the guide following the liquid level. When the float approaches the relay, the relay is triggered.

**Drainage using a float level sensor**




**At this drainage variant in L2 the type of level sensors is set - ECM V.**

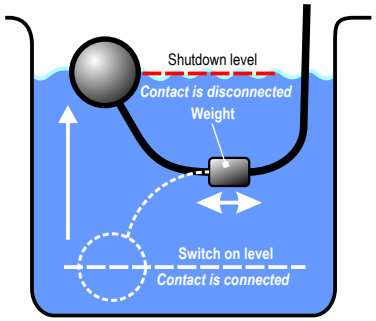
The discrete output signal can be used for “step-by-step” monitoring of the liquid level in the tank - the sensor simply indicates whether the liquid level has reached a specific point or not. Also level sensor with a discrete output signal can serve as an element of autonomous regulator in case, for example, when it is necessary to maintain a constant level of liquid in the tank - to implement this scheme, the output signal can directly control the power relay, opening/closing the inlet/outlet valve of the tank.




## Float switches

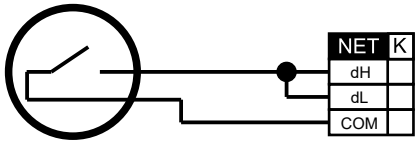
Float switches are used to control the water level when tanks are emptied or filled.

The switch housing is made of plastic, sealed and waterproof. There is air inside the housing, so when it is in water, it tends to float up and takes the highest possible position. When the water level drops, the float drops down to some lower position. The spread between the upper and lower positions of the float is regulated by the length of the wire allotted for its movement. The starting point, relative to which the float moves, is set by means of a weight, which is moved along the switch cable.




The contacts of two electric circuits and a metal ball are inside the switch housing, which rolls from one position to another, closing one of them. In the lower position, the circuit between the common wire and contact 2 is connected; in the upper position, the circuit “common - contact 1” is connected. To ensure that the ball is securely fixed in the end positions and that the contacts close without rattling, there are magnets in the switch housing. The magnets attract the ball to one of the end positions, so that in the intermediate position there is no constant rolling of the ball from one position to another. The strength of the magnets is designed so that the ball moves from one state to another at a gradient of about 70 degrees.



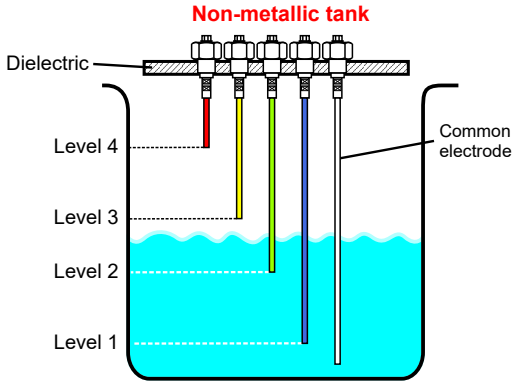



The float switch outputs are connected to terminals dL(XT5.3), dH(XT5.2) and COM(XT5.5). Float switches with **disconnected** contact are used when the tank is empty.

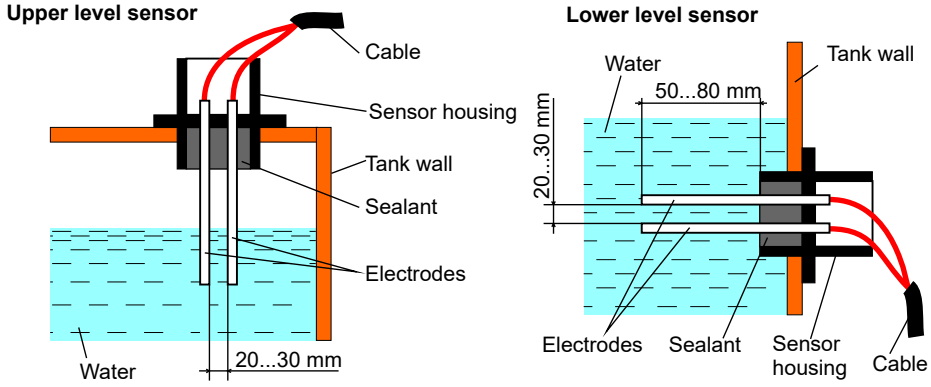
Operating mode - **automatic.**
Function - **filling** or **drainage.**
Type of level sensors - **single** (value of item 3 of the setup menu is 4).
It is recommended to use delay timers for switching on and off (item 21 and item 22 of the setup menu) to avoid rattling of float contact in extreme positions. In most cases, setting the time within 3...5 seconds is sufficient.

## Conductometric level sensors

Conductometric probes are widely used as level sensors, which can be used to monitor the level of electrically conductive liquids such as water and aqueous salt solutions, alkaline and acid solutions, etc.



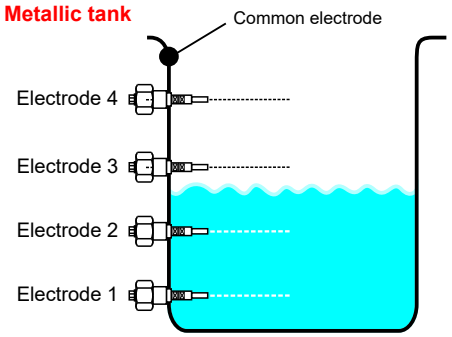

Conductometric probes are isolated from one another metallic electrodes, made of Conductometric probes are isolated from one another metallic electrodes, made of corrosion-resistant materials (e.g. stainless steel). One of the electrodes is common to all level control channels. For level control in a metal vessel, the tank housing can be used as a common electrode. It is not recommended to use a grounded tank housing.




The material of the sealant insulating the electrodes must not be wetted by water, otherwise the sensor will false triggers.

When using the pin electrode as a common electrode, it must be positioned so that its working part is in constant contact with the liquid throughout the entire control range (from the bottom to the top level).

As the tank fills, the electrodes come in contact with the liquid, closing the circuits between the common and the corresponding signal inputs.




The monitoring device detects shorting of the inputs and gives the command to switch on the corresponding level to the output relay.

If pin level sensors are used, electrodes should be selected from stainless steel to avoid corrosion and subsequent destruction of the electrode. If the sensors are used for sewage drainage, the electrodes should be fenced to avoid false shorting of the electrodes by large debris floating in the water.

To significantly reduce electrochemical corrosion of the electrodes and prevent them from fouling by salts dissolved in the liquid, the level sensor circuits L2 are supplied with alternating sinusoidal current.

## Pressure switch

The pressure switch is a small device, which is equipped with a connector for connecting to the water pipe and a terminal group for connecting the electrical cables.



The pressure parameters are registered by means of springs, the force of which is adjusted by threaded regulators. The more the springs are compressed by the regulator, the greater the force they generate, and the higher the pressure required to trigger the relay (large spring), or the greater the pressure difference (small spring). I.e. we increase the values by tightening the springs.

Typically, pressure switches designed for domestic use have factory spring settings that are fully suitable for domestic applications and common pump and accumulator models. For example, minimum pressure-1.5 atm, maximum pressure-3.0 atm.

However, due to some factors, it is sometimes necessary to adjust the pressure. Normally, relays are equipped with two springs with different diameters. The spring with the larger diameter controls the pressure levels. The spring with the small diameter - determines the difference in levels. By compressing the large spring, we increase the minimum and maximum pressure at the same time. By compressing the small spring, we increase the superiority of the maximum pressure over the minimum pressure.

When setting the relay, it is necessary to install a pressure gauge on the pipeline near the relay, according to the readings of which the limits of operation of the relay contacts are checked.



## Electric contact pressure gauges

Manometers, vacuum gauges, manovacuum gauges showing alarm are designed for measuring gauge and vacuum pressure of various media and controlling external electric circuits from a direct-acting signaling device.

Controlled media - non-aggressive non-crystallizing liquids, gases and vapors, including oxygen. Indication range - from (-1.0) to 160 MPa.

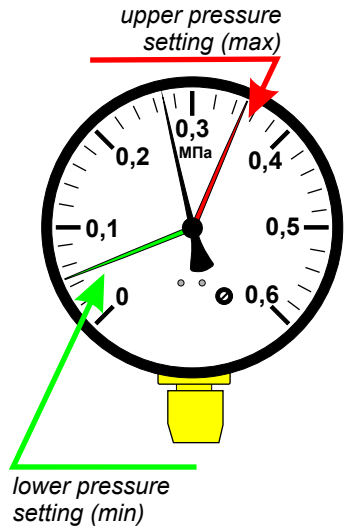
The alarm device by connection of external circuits has version V according to ГОСТ 2405-88, which is the basic one.

Connection to the devices of the electric circuit is made by a four-core cable with cross section of conductors from 0.2 to 2.5 mm2. One core of the cable is used for grounding.

Setting the signal indicators to the required scale marks is carried out by hand by turning the button in the adjustment unit mounted on the glass using a screwdriver.

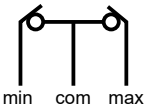
It is recommended to use ЭКМ versions with microswitches as operating contacts.

The alarm device can be manufactured in the following versions:

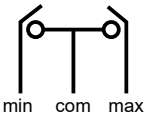



The alarm device can be manufactured in the following versions:

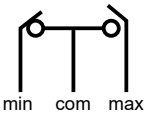
**III** - two disconnecting contacts. Left indicator (min) is blue, right indicator (max) is red.



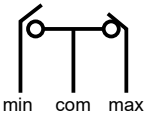

**IV** - two connecting contacts. Left indicator (min) is red, right indicator (max) is blue.




**V** - the left contact is disconnecting (min), the right contact is connecting (max). Both indicators are blue.

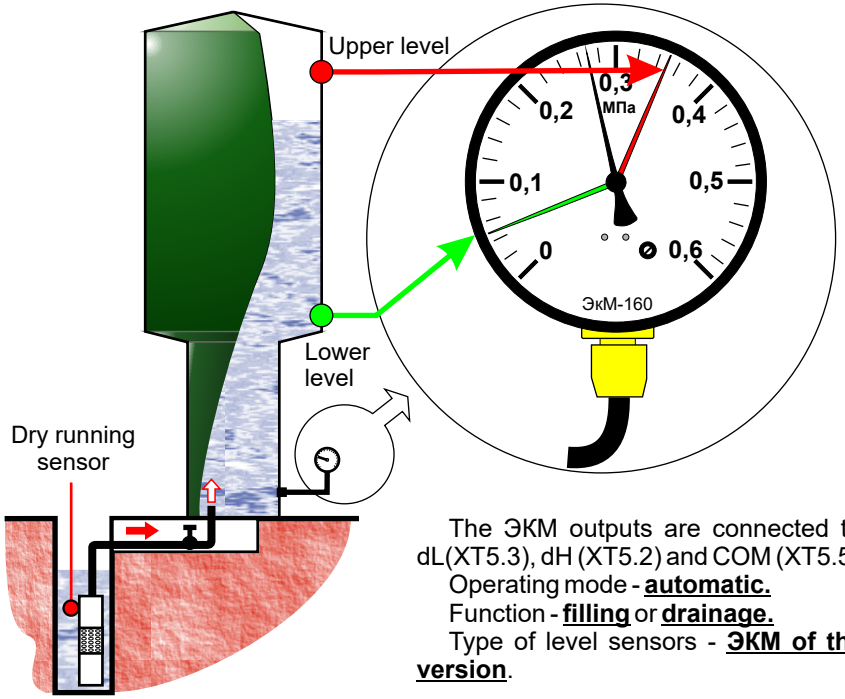



**VI** - the left contact is connecting(min), right contact is disconnecting(max). Both indicators are red.




***Note*** *- when the pressure arrow reaches the set point of the left or right indicator, the contact will be disconnected (connected).*

## Filling using electric contact pressure gauge




The ЭКМ outputs are connected to terminals dL(XT5.3), dH (XT5.2) and COM (XT5.5).

Operating mode - **automatic.**

Function - **filling** or **drainage.**

Type of level sensors - **ЭКМ of the required version**.

It is recommended to use timers of switching on and off delay (item 21 and item 22 of the setup menu) to avoid rattling of the ЭКМ contact in extreme positions. In most cases it is sufficient to set the time within 3...5 seconds.

## Flow switch

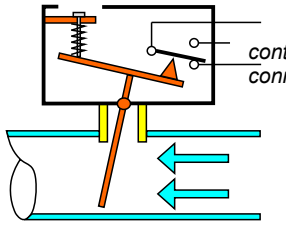
The principle of operation of the water flow sensor is based on the measurement of the water flow through the pump.

The sensor consists of a valve (“petal”) located in the flow section and a reed relay (or mechanical contact). “The petal is spring loaded and has a built-in magnet on one side of the valve.

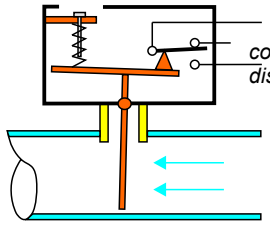


The sensor works as follows: under water pressure, the petal valve moves - the spring starts to compress and the magnet interacts with the reed relay. When the contacts of the reed switch are connected, the pump is activated.






Flow rate is nominal

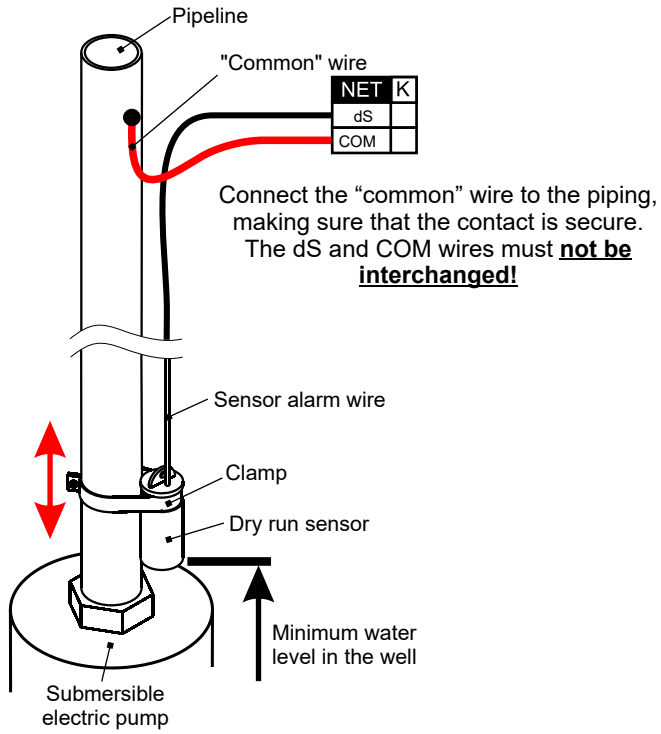



Flow rate is less than minimum

Without liquid flow, the valve spring is released, moving the magnet back to its original position, the reed relay contacts are disconnected and give the command to shut down the pump unit. The relay operation is adjusted by means of an adjusting screw.

A flow sensor is usually integrated in booster pumps with a small capacity and acts as a dry run sensor. If such sensors are used, the setting menu item 28 “Check of dry run sensor” must be set to 2-"to be checked after start-up”.

## Option of using a dry run sensor



## 2.6 Remote transmission of signals

L2 uses electromagnetic relay K2 with change-over contact to remotely transmit signals to the control panel or SCADA.

The relay contacts are connected depending on the selected condition in item 23 of the L2 setup menu. Possible conditions are given in Table 2.

Table 2

| Value of item 23 of the setup menu | Relay function | Discription |
|---|---|---|
| 0 | Operation (power is supplied) | NO contact is connected during normal operation, in case of emergency it is disconnected. |
| 1 | Emergency | NO contact is disconnected during normal operation, in case of emergency it is connected |
| 2 | Motor is On/Off. | NO contact is connected when the motor is switched on, being switched off it is disconnected. |
| 3 | “External control” signal | NO contact is connected when the “External Control” input (E.Run) is triggered. |
| 4<br>5<br>6 | Triggering of dH input<br>Triggering of dL input<br>Triggering of dS input | NO contact is connected when this input is actuated |

**Note** - it is recommended to protect K2 relay outputs with a fuse rated up to 2 A or a single-pole circuit breaker if they are used.

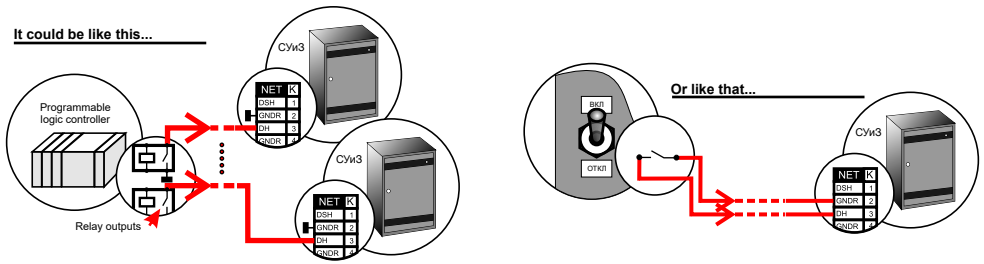
## 2.7 Remote control of the device

The “External control” input (XT5.1) is used for remote control of the device. If L2 is supposed to be remotely switched on, it is necessary to activate the “External control” input in item 17 of the setup menu (the value of item 17 is 1). When the input is closed, L2 will switch to operation depending on the selected operation mode.

In the manual operation mode, when the input is contacted, the motor will start, when it is disconnected, the motor will be switched off.

In automatic modes, connection of the input is a signal to enable operation. The engine will be started by signals from the level sensor(s).

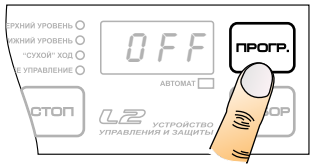
If there is no “External Control” signal in any operating mode, the display will show flashing “**-no-**”.



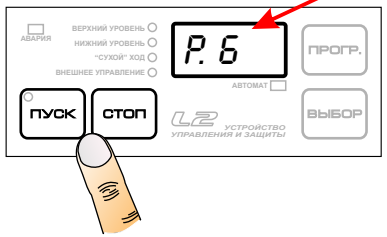



## 2.8 Programming parameters

To enter the programming mode, press and hold the “PROGR.” button in any operating mode, except for the indication of some emergency situations. A short beep will sound and the parameter number will be displayed on the indicator.

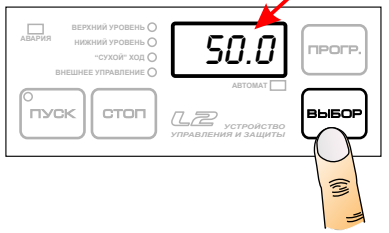



*Parameter number*




Pressing " START " increases the parameter number, pressing " STOP " decreases the number.

*Value of the selected parameter*




Press the “SELECT” button to edit the selected parameter. Pressing the “START” and “STOP” buttons sets the desired values.

Another depression of the “SELECT” button will make you exit from the editing mode. If the edited parameter has been changed, it will be saved in the non-volatile memory L2 and the indicator will display blinking values of the parameter number and its value. If the entered values are erroneous, the flashing inscription *ER.xx* with the number of the erroneous parameter will be displayed*.

If any parameter affecting the L2 operating mode has been changed, the motor will be disabled and its operation will be blocked until the programming mode is exited**.

Exit the programming mode by pressing and holding the “PROGR.” button

If no button has been pressed for a minute in the programming mode, L2 automatically exits this mode. If there was an editing mode, the data of the edited parameter will not be saved.

Description of parameters and their values are given in Table 3.

* The following conditions are checked:
a) the minimum / maximum currents must not be greater than the range of the current transformer;
b) the minimum current must be less than the maximum current;
c) the minimum voltage shall be less than the maximum voltage;

** L2 operation is temporarily interlocked when the following parameters are changed:
a) P.1 - Operating mode;
b) P.2 - Function;
c) P.3 - Type of level sensors;
d) P.17 - External control input.
This is done to prevent unwanted motor starting if one of these parameters is erroneously changed.

Table 3 Setup menu L2 (version 1.5)

| No. | Parameter | Value | Factory values | Notes |
|---|---|---|---|---|
| 1 | Operating mode | 0 - manual,<br>1 - automatic,<br>2 – by timer and dL(dH) | 0 | |
| 2 | Function | 0 - filling, 1 - draining | 0 | |
| 3 | Type of level sensors | 0 - ЭКМ III, 1 - ЭКМ IV,<br>2 - ЭКМ V, 3 - ЭКМ VI,<br>4 - single sensors | 2 | If incorrectly selected, the error “Er.10” may be triggered. It is possible to use any single sensors with different contact statuses, using the ECM contact combinations in Appendix Б |
| 4 | Type of current transformer | 0 - type T03-90A (100A),<br>1 - with unified output 5A<br>2 - type T2000:1 (125A) | 2 | For current transformers type T03-90A(T-7) and T2000:1 the value of current range is fixed (100 and 125A) and is not set in item 5.<br>If the value “1” is selected in item 5, the current range of the TT is set, which is indicated on its marking plate or in its data sheet. When connecting this TT, a 0.39Ω 25W shunt is mandatory.<br>Specify the type of sensor to be used using Appendix A. |
| 5 | Current transformer range with 5A output, A | 5,0...600,0 | 50,0 | It is indicated on the marking plate of the sensor. Incorrect value will result in distorted current readings. |
| 6 | Maximum current, A | 1,0...600,0 | 50,0 | Motor current protection limits. Refer to the average motor current consumption plus/minus 10%. In the absence of a dry run sensor, the absence of liquid can be monitored by a drop in operating current below the “Minimum current” parameter value. |
| 7 | Minimum current, A | 0...599,0 | 30,0 | |
| 8 | Maximum voltage, V | 220...270 | 250 | Voltage limits for motor protection. It is necessary to focus on the nominal value of 220V (+10%, -15%). |
| 9 | Minimum voltage, V | 160...220 | 185 | |
| 10 | Current phase imbalance, % | 0...20 | 15 | The value of the protection “Phase imbalance to flow” is set. The value “0” disables the test. |
| 11 | Inrush current interlocking time, s | 1...30 | 5 | Time period during which inrush currents v level sensor status due to possible hydraulic shocks are ignored. |
| 12 | Time of emergency operation, s | 1...60 | 10 | Only applies to “Overcurrent”, “Undercurrent” faults. |
| 13 | Time of dwell time after failure, min. | 1...60 | 5 | Sets the dwell time after an alarm has occurred (only in automatic mode). |
| 14 | Dry run sensor operation time, s | 1...60 | 2 | Sets the dry run protection triggering time when the sensor contact is disconnected. |
| 15 | Pump timer run time, min. | 1...240 | 10 | Set the running time of the pump motor when filling or draining the tank. This is selected experimentally. |
| 16 | Check for short-circuit to the housing | 0 - off, 1 - on | 1 | Enables or disables the critical insulation resistance test before starting the motor. |
| 17 | External control input | 0 - off, 1 - on | 0 | The input is turned on or off. |
| 18 | Number of alarms per hour to inhibit motor start-up | 0...30 | 0 | After underrun, overrun, current/voltage imbalance or dry run the operation is interlocked. Resetting the interlock is performed by long pressing the “Stop” button. The number of alarms that have occurred within an hour is set. If they are exceeded, the operation is interlocked. 0 - disables protection. |
| 19 | Start-up delay after power supply, s | 0...240 | 0 | Sets the pause time after L2 is energized to prevent multiple devices from starting up simultaneously and thus overloading the supply line. |
| 20 | Run time timer, min. | 0...240 | 0 | Pump motor run time after which the pump motor is forced to shut down. Used to limit run time in the event of possible failure of the level sensor(s). |
| 21 | ON delay timer, s | 0...180 | 0 | They are used to eliminate sensor contact bounce and false triggering in hydraulic shocks in automatic operation modes. As long as there is no stable sensor response during this time, L2 will not start or stop the motor. |
| 22 | Off delay timer, s | | | |
| 23 | Universal relay function | 0 - operation,<br>1 - emergency,<br>2 - motor on/off,<br>3 - external control,<br>4 - dH input actuation,<br>5 - dL input actuation,<br>6 - dS input actuation | 0 | The function of relay K2 operation is set.<br>For more details, refer to paragraph 2.9 “Remote signaling” of this manual. |
| 24 | Resetting counters | 20 - reset of the running time (motor hours),<br>25 - reset the number of motor's starts | 0 | |
| 25 | Factory reset | 50 - reset to factory values | 0 | After resetting, it is necessary to correct all parameters used in operation, especially those related to the level and current sensors used (p.3-p.5 of the setup menu). |
| 26 | Voltage phase misalignment, V | 0...50 | 30 | It sets the value of the “Voltage phase imbalance” protection. The value “0” disables the test. |
| 27 | Number of allowed starts per hour of the electric motor | 0...60 | 0 | The maximum number of starts per hour of the electric motor is set. If the number of starts is exceeded - operation is blocked until the current hour expires. Value “0” disables the check. |
| 28 | Check of the “dry run” sensor | 0 - not checked,<br>1 - always checked,<br>2 - checked after startup | 1 | |
| 29 | Dwell time after dry run emergency (Eg.08), minutes | 1...90 | 5 | It can take quite a long time to fill the well with water before the sensor is triggered. This is selected experimentally. |

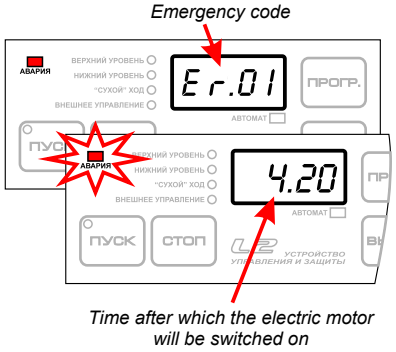
### 2.9 Emergency situations and their indication

In the event of an emergency, L2 will automatically switch off the contactor.

In the manual mode the indicator will alternately display a flashing inscription with the alarm code, in the automatic mode - a flashing inscription with the alarm code and the time in minutes after which the next start of the motor will be allowed.

Intermittent sound and light signaling will also be activated. The sound can be switched off by pressing the “STOP” button.

In manual mode, the alarm is reset by pressing the “STOP” button or by opening the “External Control” input, if it has been engaged in operation. The “EMERGENCY” lamp will go out.




In automatic mode the motor will be started after expiration of the dwell time, which is set in item 13 or item 29 (for dry running) of the setup menu. After expiration of the dwell time, periodically, with an interval of ~30 seconds, the code of the last failure will be briefly displayed on the indicator with a short sound signal. When any button is pressed, the buzzer will sound and this reminder will not be displayed.

• The monitoring of the protection parameters is checked periodically, both before switching on the motor and during its operation.

• If **Er.1 “Incorrect phase sequence or absence of phases”** alarm is triggered when L2 is switched on, its operation will be stopped. It is necessary to turn off L2 and change the order of connection of supply phases. This fault will also occur at power-up if the voltage of any phase is less than 50 volts.

• In case of **Er.8 dry run** alarm and expiration of the dwell time after it (item 29 of the setup menu), L2 will wait for recovery of the signal from the dry run sensor.

• In case of incorrect level sensor operation (Er.10 emergency) in automatic mode, the operation will be stopped until the sensors' normal signals are restored. The upper and lower level LEDs will flash to signal the incorrect tripping. In manual mode, the Er.10 fault code will not be displayed, but the level LEDs will blink.

• When the operation duration timer (**Er.11 emergency**) is triggered, if it is activated in item 20 of the setup menu, the display will show flashing inscriptions with the emergency code and the time after which the next start will take place. After the expiration of the dwell time the L2 operation will continue in normal mode.

• If in item 27 of the setup menu “Number of allowed starts per hour” is set to a **non-zero value**, then at frequent switching on of the motor (the number of starts per hour exceeds the value of item 27), the operation of L2 will be stopped until the expiration of the current hour. The display will show a flashing inscription with the error code **Er.14** and the time until the next switching on.

This emergency can be reset by turning off the power. This function only works in automatic modes.

If in item 18 of the setup menu “Number of emergencies per hour for interlocking” is set to a non-zero value, in case of frequent emergencies Er.2...Er. 8



(number of emergencies per hour exceeds the value of item 18), L2 operation will be interlocked until the operator's intervention. The display will show a flashing inscription with a new alarm code **Er.22...Er.28** (20 will be added to the emergency code) and will beep intermittently. This emergency **will not be reset** when the power is switched off. Press and hold the “STOP” button until a long beep sounds. The emergency will be reset and L2 will continue to operate in normal mode. This function works only in automatic modes.

In case of ROM failure (**Er.0** emergency) L2 operation will be stopped. It is necessary to press and hold the “PROGR.” button until a long audible signal. The factory settings will be automatically set and L2 will enter the programming mode to adjust the parameter values.

Fault indication and dwell time in automatic mode are reset when switching to manual mode. Since L2 does not have a non-volatile real-time clock, the dwell time after a fault is counted down only when the device power supply is switched on.

**The emergency will not be reset when the power is turned off!**

It is necessary to wait until the end of the dwell time of L2 in the on state. Emergency codes and descriptions are given in Table 4.

Table 4

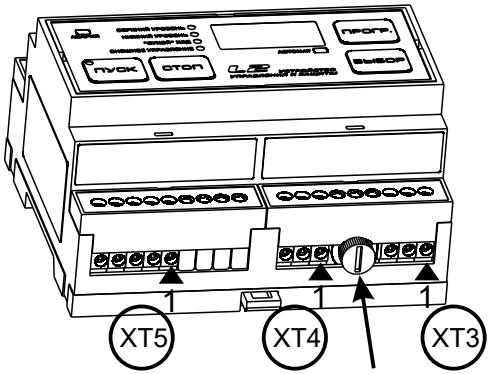
| Emergency code | Description of the emergency | Response time, seconds* | When it's checked |
|---|---|---|---|
| Er.0 | Incorrect data in ROM | | At starting |
| Er.1 | Incorrect alternation or no phases (U<50V) | | |
| Er.2 | Voltage rise | 15 | Before starting and with the motor running |
| Er.3 | Voltage drop | 15 | |
| Er.4 | Voltage phase imbalance | 10 | |
| Er.5 | Current increase | 1...60** | At the motor running |
| Er.6 | Current decrease | 1...60** | |
| Er.7 | Current phase imbalance | 10 | |
| Er.8 | Dry run | 1...60** | It is set in item 28 of the setup menu |
| Er.10 | Incorrect operation of level sensors dL and dH | 4 | All the time |
| Er.11 | Operation time timer triggering | 0...240 min.** | At the motor running |
| Er.12 | Short circuit (leakage) to the housing | | Before starting |
| Er.13 | Internal emergency L2 | 2.5 | All the time |
| Er.14 | Exceeded number of starts per hour | | Before starting |
| Er.22 ... Er.28 | Exceeded number of emergencies per hour | | When an Er.2 ... Er.8 emergency is trigged |

* *Response time should be understood as the period of time during which an emergency is continuously present.*

** *It is changed in the L2 setup menu.*

## 3 CONNECTION RECOMMENDATIONS

### 3.1 Terminals location and labeling




FU2 - contactor circuit fuse, 2.0 A, 250 V

XT1

| K | NET | |
|---|---|---|
| 1 | F_C | } Supply phases Neutral |
| 2 | F_B | |
| 3 | F_A | |
| 4 | N | |

XT2

| K | NET | |
|---|---|---|
| 1 | TA1 | Current sensor 1 |
| 2 | TA2 | Current sensor 2 |
| 3 | GND | Common wire |

XT3

| K | NET | |
|---|---|---|
| 1 | M_FA | Insulation resistance monitoring circuit |
| 2 | K1.2 (NO) | } Contacts of the starter control relay |
| 3 | K1.1 (COM) | |

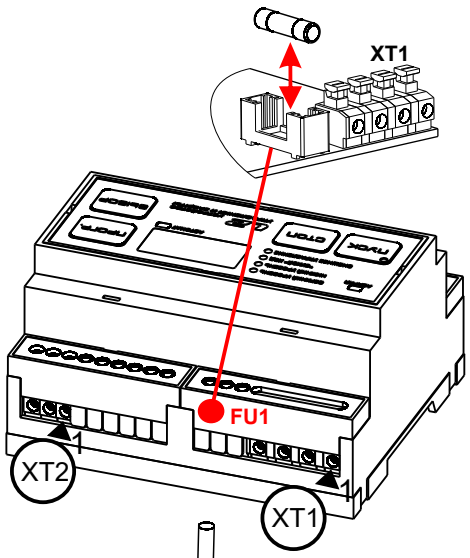
XT4

| K | NET | |
|---|---|---|
| 1 | K2.3 (NO) | } Contacts of the universal relay K2 |
| 2 | K2.2 (NC) | |
| 3 | K2.1 (COM) | |

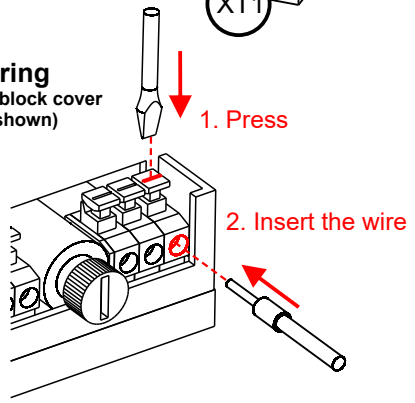
XT5

| K | NET | |
|---|---|---|
| 1 | E.RUN | Input - "External Control" |
| 2 | dH | Input - Top level sensor |
| 3 | dL | Input - Low level sensor |
| 4 | dS | Input - Dry run sensor |
| 5 | COM | Common wire |

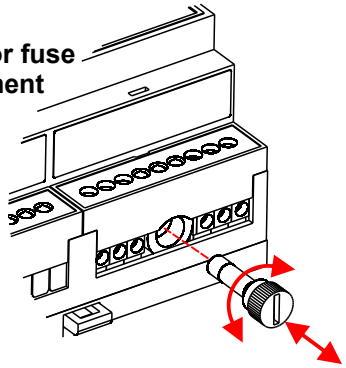
**FU1** - fuse inside the housing L2, 0.25 A, 250 V (the protective cover must be removed to access it)




**Wiring**
**(terminal block cover not shown)**




**Contactor fuse replacement**

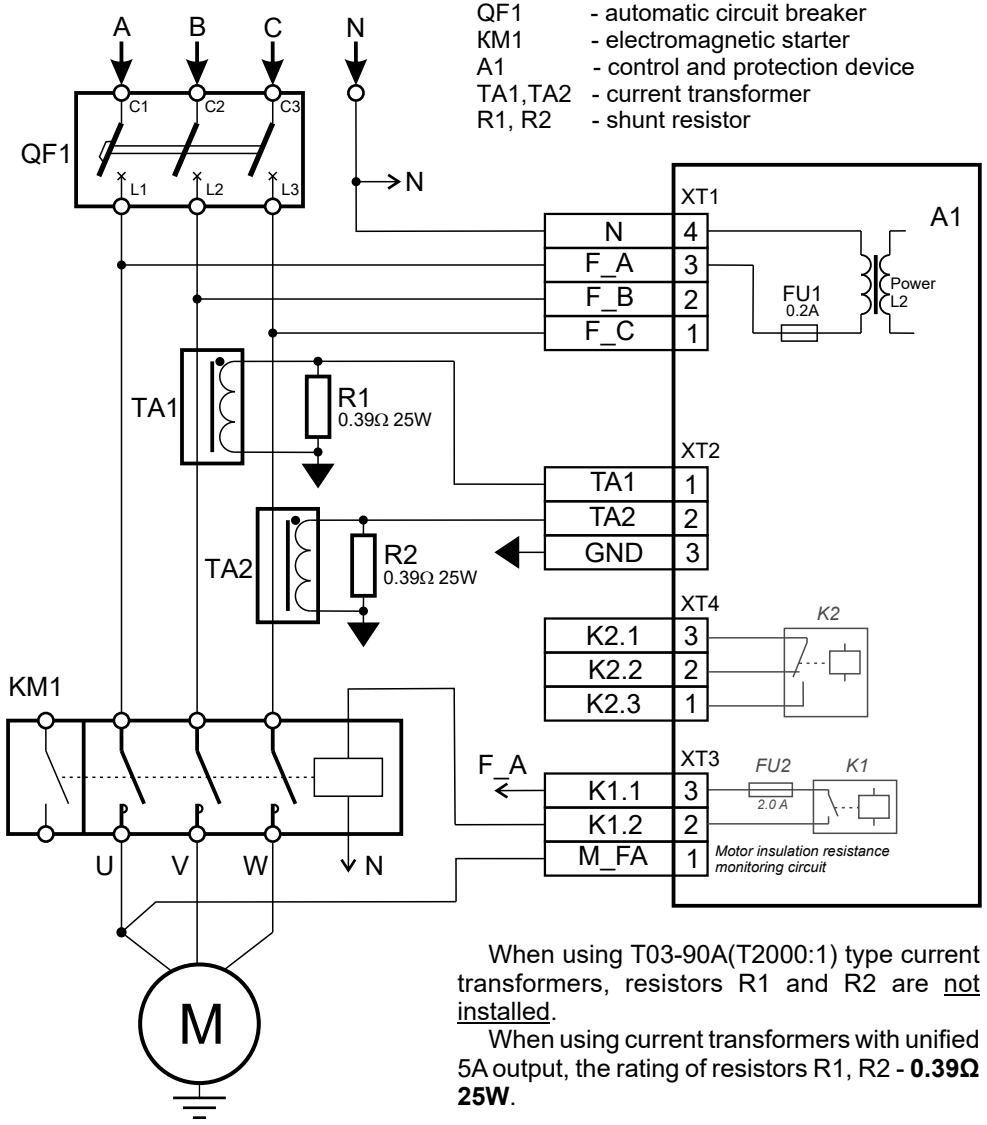


In other versions, the fuse is located inside the L2 housing and the protective cover must be removed to access it.



### 3.2 Wiring diagrams for sensors and actuators

QF1 - automatic circuit breaker
KM1 - electromagnetic starter
A1 - control and protection device
TA1,TA2 - current transformer
R1, R2 - shunt resistor




When using T03-90A(T2000:1) type current transformers, resistors R1 and R2 are not installed.

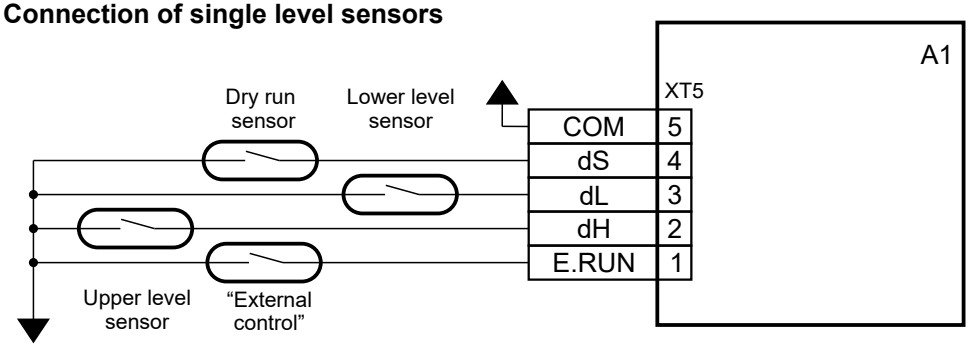
When using current transformers with unified 5A output, the rating of resistors R1, R2 - **0.39Ω 25W**.

Due to the fact that the control and protection device L2 is powered from the mains with voltage ~220V, it is mandatory to connect the neutral conductor (line).

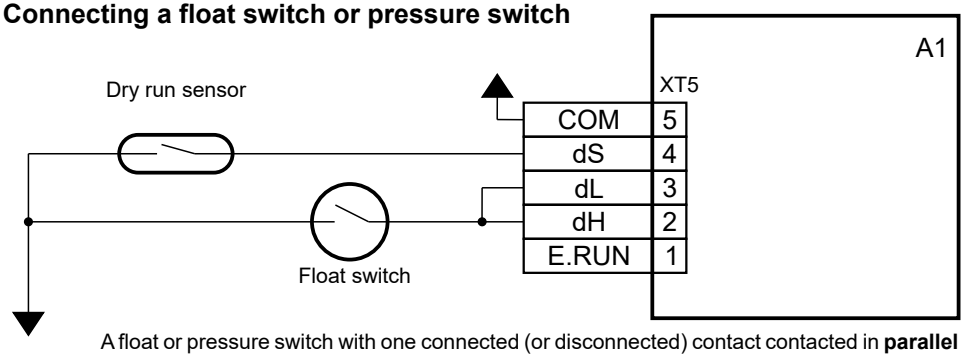
The insulation resistance monitoring wire (XT3.1) **must only be connected to the "U"** line of the motor, otherwise the measurement circuit will fail due to the high voltage!

It is recommended to protect the contacts of the alarm relay K2 with a fuse rated up to 2 A. Instead of the fuse it is possible to use a single-pole circuit breaker type BA47-29.

## Connection of single level sensors



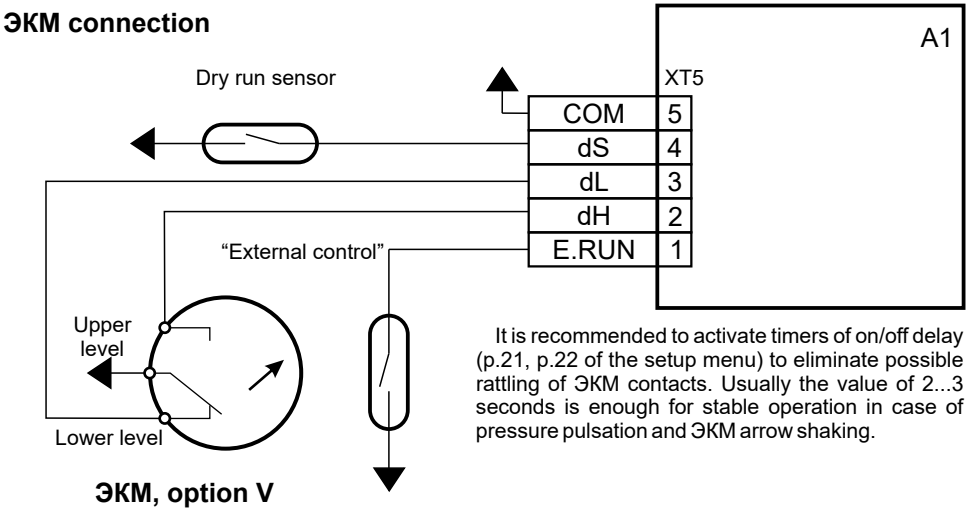

## Connecting a float switch or pressure switch




A float or pressure switch with one connected (or disconnected) contact contacted in **parallel** to inputs dL and dH is used. Type of level sensors in item 3 of the setup menu-single sensors (4).

It is recommended to activate on/off delay timers (p.21, p.22 of the installation menu) to eliminate possible rattling of float contacts. Usually the value of 5...6 seconds is sufficient for stable operation in case of strong water surface agitation.

## ЭКМ connection




**ЭКМ, option V**

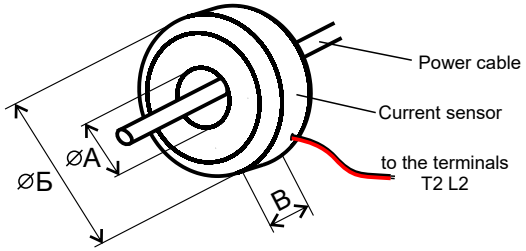
It is recommended to activate timers of on/off delay (p.21, p.22 of the setup menu) to eliminate possible rattling of ЭКМ contacts. Usually the value of 2...3 seconds is enough for stable operation in case of pressure pulsation and ЭКМ arrow shaking.



## APPENDIX A Current sensors

It is possible to use current sensors (transformers) of T03-90A, T2000:1 type and sensors with unified current output 5A (current up to 600A) in L2. When connecting sensors with 5A output, 0.39Ω 25W shunt resistors are mandatory. The current sensor outputs of each phase are connected to the corresponding terminals XT2 (see Section 3).

### Current transformer T03-90A (T2000:1)

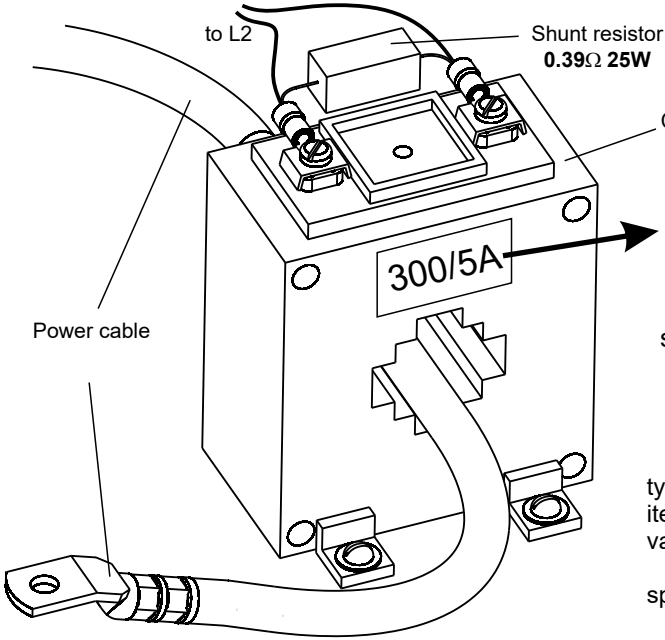



**Brief technical specifications:**

| | T03-90A | T2000:1 |
|---|---|---|
| Max. current, A | 100 | 125 |
| R of winding, Ω | ~ 110 | ~ 90 |
| ØA, mm | 9 | 14 |
| ØБ, mm | 28 | 32 |
| B, m | 18 | 17 |

In item 4 of the L2 setup menu, select the value:
**0** - "T03-90A" or **2** - "T2000:1".

### Transformer with unified current output 5A




Measuring range, A
**5, 10, 30, 50, 100, 150, 200, 300, 400, 500, 600**.

The current range of the sensor is indicated on the marking plate.

It is necessary to select the type of current sensor - 5A in item 4 of the L2 setup menu (the value of item 4 is equal to 1).

In item 5 it is necessary to specify its current range.

When connecting transformers to L2, observe the polarity of the outputs. For example, ТТИ-30 outputs marked as "И1" should be connected to terminals TA1, TA2, and outputs "И2" - to terminal GND of terminal block XT2. This rule also applies to colored wire outputs of T03-90A type transformers (T2000:1).

During operation, the shunt resistors become very warm at more than 75% of the sensor range, so they should be mounted away from plastic components and wires. It is recommended to mount them to the enclosure mounting plate for better heat dissipation.

## APPENDIX Б Troubleshooting and remedies

Table 4

| Indication | Emergency | Cause | Remedy |
|---|---|---|---|
| Nothing is displayed on the indicator, the level and mode LEDs are not lit, and a constant beep may sound. | | No power supply (often bad neutral or broken neutral)<br>FU1 fuse blown<br>Device malfunction | Check the voltage on the supply phases relative to the neutral.<br>Replace the fusible link inside the device.<br>Send back L2 for repair. |
| Er.0 | Incorrect data in ROM | External interference.<br>Device malfunction. | Restore the settings, if frequent occurrence, return L2 for repair. |
| Er.1 | Incorrect alternation or absence of phases | Unsatisfactory quality of the mains supply or wiring error.<br>Voltage of one or more phases is less than 50V.<br>Device malfunction. | Check for voltages on the supply phases with respect to the neutral N wire.<br>Change the phase sequence.<br>Send back L2 for repair. |
| Er.2<br>Er.3<br>Er.4 | Increase in voltage<br>Decrease in voltage<br>Voltage phase imbalance | Unsatisfactory quality of the supply network.<br>Incorrect setting of minimum and maximum voltage values.<br>Malfunction of the measuring circuit. | Check the voltages on the supply phases with respect to neutral before and after starting the motor.<br>Adjust the values of parameters 8,9,26 in setup menu L2.<br>Send back L2 for repair. |
| Er.5 | Current increase | Increased load due to motor (actuator) malfunction.<br>Incorrect setting of the overcurrent values.<br>Faulty current sensor or wiring error.<br>Malfunction of the measuring circuit | Check the current consumption of the motor and the status of the actuator.<br>Correct the value of parameter 6 in the L2 setup menu.<br>Check the connection and replace the defective sensor.<br>Send back L2 for repair. |
| Er.6 | Current decrease | Reduced load due to motor (actuator) malfunction or dry running.<br>Incorrect setting of the minimum current values.<br>Current sensor malfunction or wiring error.<br>Soft starter malfunction or contactor failure (contactor does not turn on).<br>Malfunction of the measuring circuit. | Check the current consumption of the motor and the condition of the actuator. Check the water level in the well.<br>Adjust the value of parameter 7 in the setting menu L2.<br>Check the connection and replace the defective sensor.<br>Check the condition of the contactor and its control circuit. Replace the contactor if it fails. Check fuse FU2.<br>Send back L2 for repair. |



Continuation of Table 5

| Indication | Emergency | Cause | Remedy |
|---|---|---|---|
| Er.7 | Current phase imbalance | Change of load on one of the phases due to a motor fault.<br>One of the current sensors is defective or there is a wiring error.<br>Phase current imbalance set too low in the setup menu.<br>Inaccurate measurement of B and C phase currents.<br>Faulty measuring circuit of one of the current sensors. | Check the current consumption of the motor.<br>Check wiring and replace defective sensor.<br>Correct the phase misalignment value (in %) in step 10 of the setup menu.<br>Calibrate the current channels according to the procedure on the last page of this manual.<br>Send back L2 for repair. |
| Er.8 | Dry run | Insufficient water level in the well.<br>Incorrect connection or sensor failure.<br>Faulty sensor input. | Wait for the required water level in the well.<br>Check the connection and replace the defective sensor.<br>Send back L2 for repair. |
| Er.10 | Incorrect operation of level sensors | Incorrect setting of the level sensor type in the setup menu.<br>Incorrect connection of the level sensors.<br>Faulty circuit of one of the level sensor inputs. | Adjust the value of parameter 3 in the setting menuL2.<br>Check that the connection is correct.<br>Send back L2 for repair. |
| Er.11 | The runtime timer has been triggered | The response time is set low, the upper (lower) level sensor does not respond in time.<br>Level sensor(s) failure or connection error. | Correct the response time value in parameter 20 of the setup menuL2.<br>Check the level sensors for proper function and correct connection. |
| Er.12 | Short circuit (leakage) to the housing | Critical resistance between winding and motor housing (insulation failure).<br>Faulty measuring circuit. | Check the insulation resistance of the motor windings.<br>Send back L2 for repair. |
| Er.13 | Internal error L2 | Internal device malfunction (damage to the measuring module). | Send back L2 for repair. |

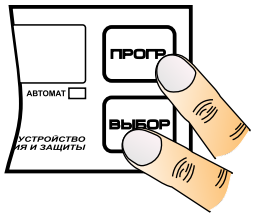
## ATTENTION!

This information MUST BE ACCESSIBLE ONLY TO SERVICE PERSONNEL engaged in the setup and service of the unit.

Due to the variation in the parameters of the radio components used, the measurement of phase voltages and motor currents is not always accurate. To correct these values, the L2 has a hidden calibration function.
If the current or voltage readings on the L2 display differ noticeably from the readings of an accurate external device (L2 measurement accuracy is no more than ±1%), it is necessary to calibrate the channels.

**Note: current measuring clamps, which are not difficult to find, in most cases have a rather high error, and it is not recommended to use them as reference clamps. For accurate adjustment, use the instrumentation complexes.**

It is necessary to check the correct selection of the current sensor and its range in item 4 and item 5 of the L2 setup menu before the calibration process.
So, the calibration process itself (the supply line and motor must be connected to L2):



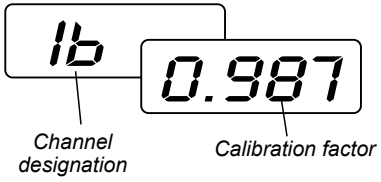

With L2 power off, press the “PROGR.” and “SELECT” buttons on the front panel and, without releasing them, apply power to the instrument.

After displaying the instrument name and software version, “*UST*” will appear on the display. After it flashes, you can release the buttons.

The flashing inscription “*RUN..*” will appear on the display. Press the “RUN” button to start the motor.

**ATTENTION!**

**It is only possible to stop the motor after starting by switching off the power supply!!!! All protections except dry run are deactivated.**



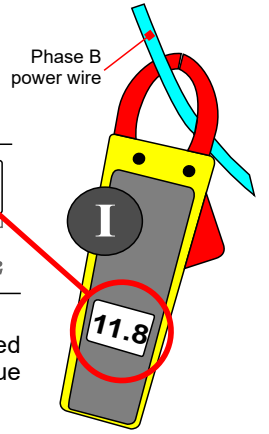

The indicator will alternately display the designation of the corrected channel and the value of the calibration coefficient on it.

There are 5 channels in total: phase B current (designation *IB*), phase C current (designation *IC*), phase A, B and C voltages (designations *UA, UB, UC* ). The correction of the phase B current is displayed first.
Press the “SELECT” button to select the desired channel. After selecting the desired channel, the display will show blinking inscriptions of the channel designation and current or voltage values on this channel.



### Adjustment of IB, IC current channels

Connect a precision measuring instrument (e.g. clamp meter) to the phase to be calibrated. Press the “SELECT” button to select the desired channel.




Press the “START” and “STOP” buttons to achieve the same readings of the clamp and L2.
Press the “PROGR.” button




L2 will calculate, correct this channel and write the desired calibration coefficient into memory and briefly display its flashing value on the indicator. Range of coefficient values - (0.700... 1.200).

If the calibration coefficient is out of the permissible range, its value will not be saved, an audible signal will sound and “**Err.**” inscription will be displayed on the indicator. It is necessary to check the channel values again and perform calibration.

If during calibration the inscription “**Err.**” is constantly displayed with correct entered values and correct current range in p.4, p.5 of the setup menu - the measuring circuit L2 is defective and requires repair at the manufacturer or Service Center.

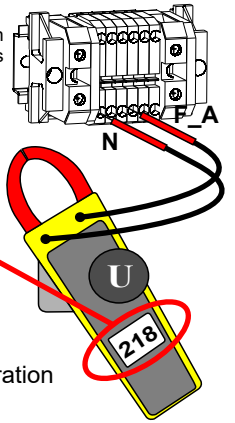
Move the clamp to the next phase wire, move to the next measurement channel with the “SELECT” button and correct the current of the next phase.

It is important that the load on the motor does **NOT CHANGE** during the calibration process!

If the load changes periodically, the adjustment will be inaccurate.

### Adjustment of UA, UB, UC voltage channels

Control station input terminals




Connect the voltmeter probes to the power supply terminals **N** and **F_A** (F_B, F_C) of L2 or to the control station power supply input terminals.
Press the SELECT button to select the desired channel.

Press the “START” and “STOP” buttons to achieve the same reading of the voltmeter and L2.
Press the “PROGR.” button.




L2 will calculate and correct this channel and store the desired calibration factor in memory and briefly display its flashing value on the display.

Move the voltmeter probe to the next phase terminal, select next measurement channel with the SELECT button and correct the voltage, and so on for the voltages of all phases.

After correcting all necessary channels, turn off and turn on L2 again. Having started the electric motor in the manual mode with the “START” button, compare the readings of the external measuring device with the L2 values. If the result is not satisfactory, start the calibration process again.