CONTROL SYSTEMS
(SWITCHBOXES)

ENEL Ltd. produces a wide variety of control, regulation and supply systems.

1. DRIVE SYSTEMS

1.1 Electric Drives Speed Regulation Systems

The speed regulation of asynchronous motors in the power range up to a few hundred kW and in the voltage range up to 1 kV is based on the principle of frequency alternation of the supply voltages. The executive element is the frequency converter. The IGBT technology (power transistors with an isolated gate) has dominated the construction of frequency converters. Nowadays, nearly all used frequency converters are equipped with a power inverter with a transistorized output power block.

We offer speed regulation systems that are equipped with our production - FNT type frequency converters or converters produced by other renowned manufacturers.

Depending on the need, we equip the converters with an auxiliary supply systems, protection systems, switchgear, input and output filters, as well as with measurement, regulation and control instruments. We provide encloses that ensures proper protection in all operation conditions.

Control system of the set of six 3kW pumps.

Speed regulation system of 90kW / 380V motor.

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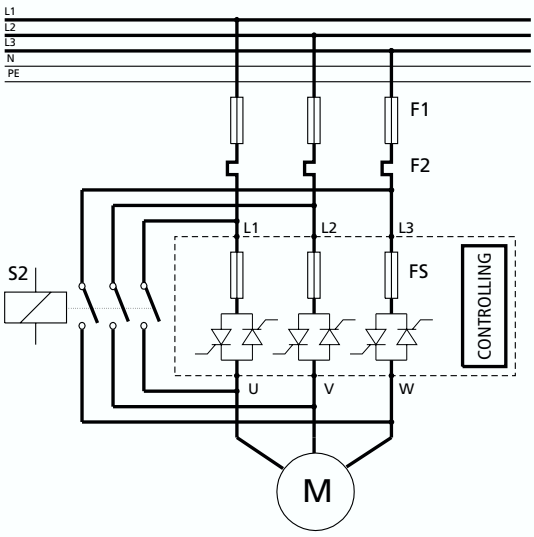
1.2 Electric Drive Soft-Start and Soft-Stop Systems



In terms of structure, a soft-start system is a three-phase regulator of supplying voltages.

In each phase there is a pair of thyristors connected in anti-parallel mode. By the adequate steering of the thyristors the effective value of the voltage is being limited as well as the starting current. The voltage increases gradually, in order to limit the current during the start-up to the value 2÷4 of the nominal motor current, whereas the direct start-up causes over-current up to 7÷8. Limiting of the starting current causes the limiting of the starting torque as well. During the start-up, which is extended in time, the speed increases smoothly from zero to the rated value. The current measurement system controls the starting process and prevents the motor from getting stuck as well as from exceeding the given current value. After the start-up has been completed the starting system can still supply the motor ("on-line" mode) or the contactor connects the motor directly to the mains. ("off-line" mode).

The offered starting systems enables continuous operation ("on-line"). The control circuit of our soft-start systems is based on a motor's thermal model, thus it does not allow the temperature of the motor to rise excessively in consequence of the successive start-up cycles taking place. The system can also work with the temperature sensor of the motor's windings. This temperature protection could be included in to the so called "Technological Interlock" available as the external input to the control system.

We offer starting systems in a wide range of output power and voltages, in all configurations (connection patterns) and all desired degrees of protection.

2. CONTROL SYSTEMS BASED ON THE RP-2001 CONTROLLER

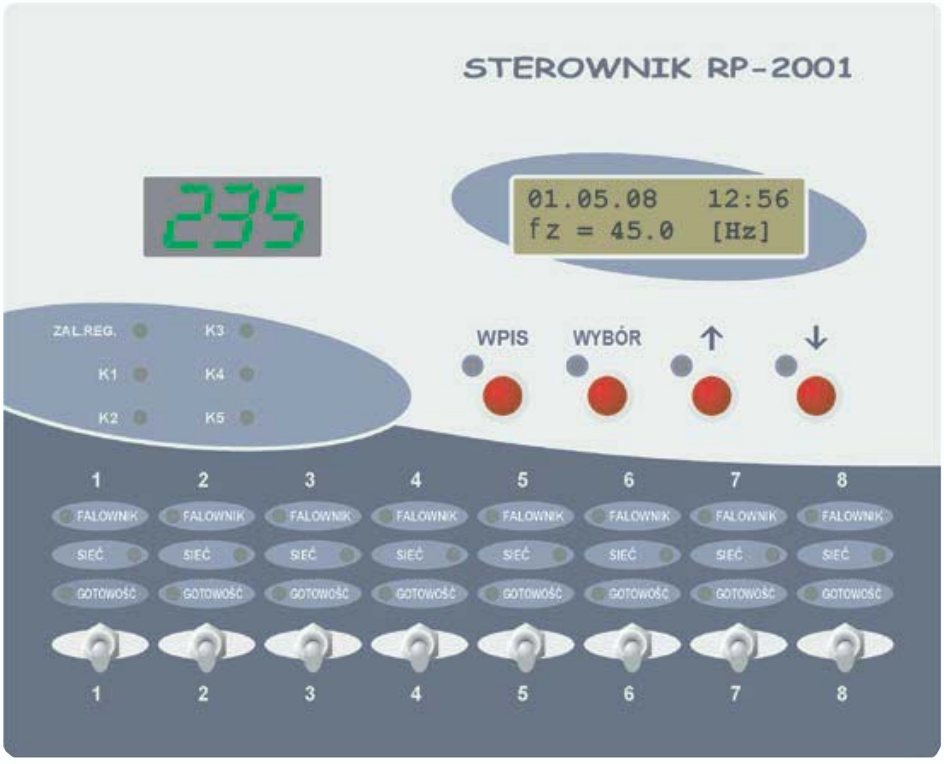
2.1 Pump Control Systems

The RP 2001 controller is a universal microprocessor controller intended mainly to work with frequency converters that supply induction motors.

The main function of the controller is to stabilize a given physical parameter e. g. pressure, liquid level, or flow. Working with a suitable sensor the real value of the controlled parameter is affecting the rotational speed of the motor supplied from a frequency converter.

In the basic version the controller is used to stabilize one physical parameter e.g. pressure or liquid level, through the regulation of rotational speed of one pump.

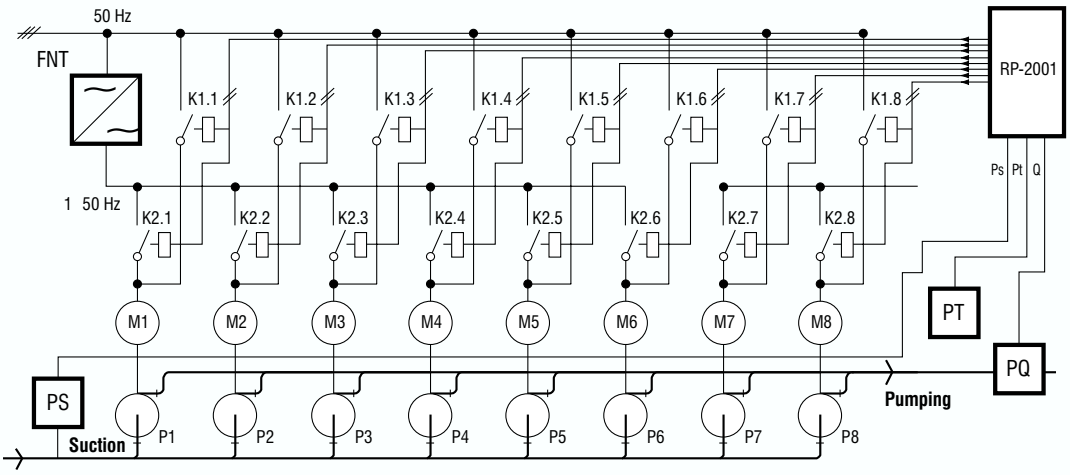
In more advanced versions the controller can control the operation of the set of eight pumps with a common output collector. The frequency converter smoothly regulates the speed of one pump, whereas the other pumps are controlled in a two-mode way (switch on/switch off).



Front panel of the RP-2001 controller.

A more detailed description of the RP-2001 controller can be found in a separate folder devoted to the applications of the controller.

The structure of the pump control system is depicted in the block diagram below.



It is a follow-up regulation system, in which:
- pressure (liquid level, flow) is the regulated parameter, converted into a standard measurement signal,
- each pump can be supplied from the frequency converter or from mains,
- the frequency converter performs the start-up of each successive pump, which after reaching rated speed it is switched to supply from mains,
- during a period of lower flow, the pump that was switched on as the first one, is switched off,
- there is a possibility of choosing between two different control modes (automatic / manual),
- in the case of the converter's malfunction the controller ensures the cascade control,
- in the manual control mode there is a possibility to manually switch the pumps on,
- the system ensures protection from motor overload and short-circuiting.

2.2 Liquid Level Regulation

The regulated parameter is the level of liquid in the tank that is supplied or emptied by a single pump or by several pump set. The regulation method and the structure of the system are identical as in the case of pressure regulation. The controller receives a standardized measurement signal from the level transducer.

2.3 Stabilization of the Percentage of Oxygen in the Sewage

The system is frequently used in water treatment plants. The measurement signal comes from an oxygen probe. The stabilization of the percentage of oxygen is obtained by controlling a set of blowers that are driven by asynchronous motors. One or two of the blowers is smoothly regulated; the others operate in a two-mode manner. There is a possibility to work with many oxygen probes. The control is based on fuzzy logic methods. In a system containing up to 6 blowers, the RP-2001 controller provides the control of additional drives (shield ventilators and fans of the driving motors).

ENEL Ltd. also offers a specialized microcontroller that provides time-dependent control of shield ventilators and the ventilators of the blower's driving motors. The microcontroller also provides thermal protection using a temperature sensor of the motor's windings.

Microcontroller of a blower.

Interior of a switchbox controlling two 15 kW blowers.

The front of a switchbox.

2.4 Simplified Pressure Regulation Systems

There is a possibility of simplifying the described regulation system. Then, the motor of one drive is supplied directly from the converter whereas the remaining motors can be supplied only from mains. In such a case, the number of contactors and intermediate relays used is lower.
The simplified version of the RP-2001 controller can be employed to:
• regulating the pressure of a single pump with smooth speed regulation, most often in water intakes,
• provide cascade control of a multi-pump set (without a frequency converter).

2.5 Monitoring and Remote Control

Automatic pump regulation systems usually are used in 2nd degree water facilities that supply end-users (municipal or industrial). Cities and big industrial installations mostly have several 2nd degree pumping stations. Proper water distribution requires simultaneous control over the operations of all facilities. Through automation successive facilities are being adapted to operate without service staff. The obvious consequence of the automation of pumping stations is, the need for Supervising Control and Data Acquisition system (SCADA). Such systems are based on two-way wire or wireless communication.

The center of the system is a master computer or controller, which gathers the measurement data from the particular facilities, enables their operation, and allows interfering in the functioning of the control systems (switching on/off, monitoring etc.).

A properly selected and configured visualizing program (SCADA) ensures the communication between the computer and operator. The RP-2001 controller has been designed to find application in remote control systems and in data wire- and wireless transmission. It has a vast capabilities regarding measurements, data collection and transmission. It also ensures communication in most of the used communication standards. We also offer software for PCs working with the RP-2001 controller.

3. CONTROL SYSTEMS BASED ON PLC-TYPE PROGRAMMABLE CONTROLLERS

In case, when the capabilities of the RP-2001 controller are not sufficient, control systems are based on a universal PLC type programmable controller equipped with an operation panel to enable communication with the service staff. The advantage of programmable controllers is the possibility of their further expansion and the fact that they are universal.

ENEL Ltd. designs and produces control systems based on programmable controllers. Among projects involving the use of programmable controllers, ENEL Ltd. has designed and commissioned a few complex control systems for water treatment plants.

System controlling the decalcification process of water from a deep-well intake. The interior of a switchbox. System based on a Mitsubishi PLC controller.