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LB-762 MUSHROOM FARM CONTROLLER INSTALLATION MANUAL

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Rozdział 1

System description

Regulator LB-762 is used to control a single mushroom cultivation hall. It provides all necessary measurements and control over appropriate executive devices to ensure optimum climatic conditions for fungi cultivation.

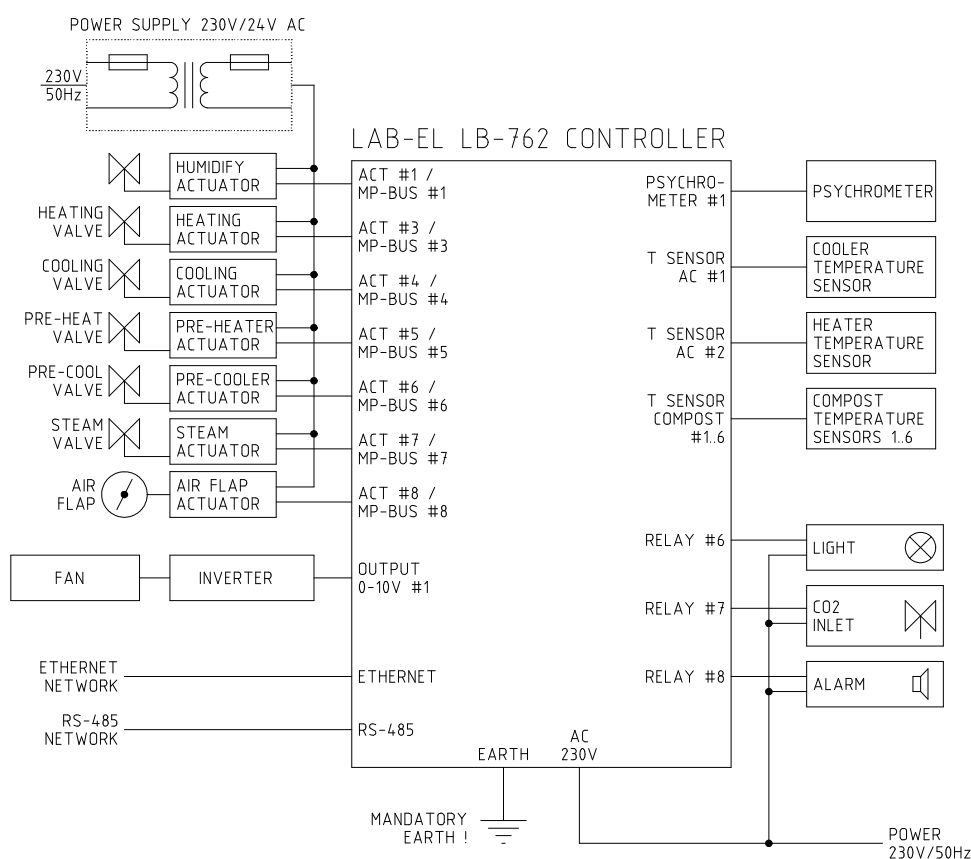
For a greater facility, consisting of more cultivation halls, each hall must be equipped with a separate regulator. In this case it is possible to connect all the regulators into a common measurement-regulation system. In such system each regulator operates autonomously, but it is possible to control together all the regulators from one PC computer and appropriate software. Additionally, it is possible to perform some functions common for the entire system, such as measurement of external air parameters or CO₂ concentration measurement.

Regulator LB-764 is LB-762 model with special modifications prepared for "Baltic Champignons", installation instructions also applies to this regulator.

1.1 External connections of a single LB-762 regulator

Figure 1.1 presents a scheme of typical external connections of a single LB-762 regulator. To the regulator one should attach a set of suitable measurement probes and executive equipment so that it could perform its functions.

Rysunek 1.1: External connections diagram of LB-762 regulator



1.2 Measurement probes

- Psychrometers – are used for measurement of temperature and relative air humidity. The regulator may co-operate with or one two psychrometers (at least one is required for proper operation of the regulator). Attaching one psychrometer provides one-point air temperature and humidity measurement in the cultivation hall. The second psychrometer may be optionally used for temperature and humidity measurement elsewhere in the cultivation hall, for better averaging of the conditions prevailing in the room. Another function of the second psychrometer may be measurement of air parameters in air intake channel for regulation of humidity and temperature of air flowing into the hall.

- Cooler temperature – single thermometer advising the regulator of cooler work.
- Heater temperature – single thermometer advising the regulator of heater work.
- Air supply temperature – optional single thermometer advising the regulator of temperature of air supplied to the air-conditioning tunnel (before the cooler). Application of this thermometer is optional.
- Base temperature – 6 thermometers used for measurement of temperature of base in different places of the hall. It is not required to attach all 6 thermometers – the regulator correctly cooperates with any number of attached thermometers – from 1 to 6, depending on the requirements of the given installation.
- CO2 concentration – for CO2 measurement, it is necessary to attach a separate dedicated CO2 concentration meter. It is possible to connect for each regulator a dedicated CO2 meter (separate meter for each hall), or use one CO2 meter for more than one hall (what permits reduction in the cost of the installation). Detailed description further the manual.
- External hytherograph – to ensure better operation of mechanisms controlling climate in the cultivation hall, the regulator may use information about external air parameters flowing into the air-conditioning tunnel. This allows for using directly the properties of this air (enthalpy and humidity mass) to control climate in the hall, without use of executive devices of air-conditioning tunnel, what may reduce energy consumption. It is possible to connect to each regulator a separate hytherograph, or apply one hytherograph for the whole system (what permits reduction in the cost of the installation, as parameters of external air are normally common for all three halls and individual measurement for each hall is not reasonable). Application of this meter is optional.

1.3 Executive equipment

- Heating, cooling, moistening, initial heater valves, initial cooler, steam valves – are controlled by servomotors (some outputs are optional and may not occur in the given installation).
- Ventilation – the fan is used to provide air circulation, its motor is controlled by an appropriate frequency converter (inverter). The frequency inverter is an external device, which is appropriately controlled by the regulator.
- Hall lighting – the regulator has the possibility to control lighting in the hall, what is used e.g. at gasing operation.
- Alarm signaling device – the regulator has the possibility to signal alarm situations (e.g. inappropriate parameters of climate in the hall, different breakdowns, etc.). The regulator has a suitable relay output for alarm signaling, which may control e.g. sound signaling device. It is possible to connect alert signalling to each regulator separately, or by a joint connection of alert outputs of all regulators in the given installation and common control with one signaling device. The application of alert signaling device is optional. It is also possible to signal an alert via control software on a PC computer.

1.4 Data transmission network

In an installation where there is a greater number of regulators, it is possible to connect them into a data transmission network. This network ensures cooperation with a PC computer and relevant control software. By means of a data transmission network, the system can also perform additional functions:

- pomiar parametrów zewnętrznego powietrza (przy wykorzystaniu pojedynczego termohigrometru),
- wspólny pomiar stężenia CO2 (gdy jeden miernik CO2 obsługuje większą liczbę hal uprawowych).

The regulator is equipped with two data transmission network interfaces: Ethernet and RS-485. The application of a relevant network is dependent upon conditions and requirements in the given installation:

- Ethernet – this network provides very high data transmission speed (10 or 100 MBit/s). Owing to great popularity of this type of networks in any other applications, it is easy to integrate it with already existing data communication systems. Limitation of the Ethernet network is distance – one cable section (between two network devices, e.g. between the regulator and switch) cannot be longer than 100 meters. This does not mean that the whole network may not have greater range – with application of proper network devices (switches, repeaters or even routers) the network can be expanded over any area. The number of devices in an Ethernet network is relatively unrestricted – the only practical limits result from the type of network devices used (switches) and the adopted IP network addressing class.
- RS-485 – this network provides relatively slow data transmission as compared to the Ethernet network (19.2 kbit/s), however, its advantage is simplicity of cabling and greater scope without use of additional network devices (up to 1200 meters). As a result, cabling of networks is easier and a bit cheaper. One single RS-485 network has a limit of the number of attached devices – from 1 to 32. network extension to a greater number of devices requires application of proper network devices (repeaters).

Selection of the network type depends on the given installation – if it is possible to use Ethernet network, it is suggested to use this type of network. It provides greater comfort of use (greater transmission speed of data means smaller delay in system response, faster reading

of data from regulators, etc.). If, however, the facility is very extensive and the application of Ethernet network would require use of a number of additional network devices, boosting the cost over the benefits, one can use RS-485 network.

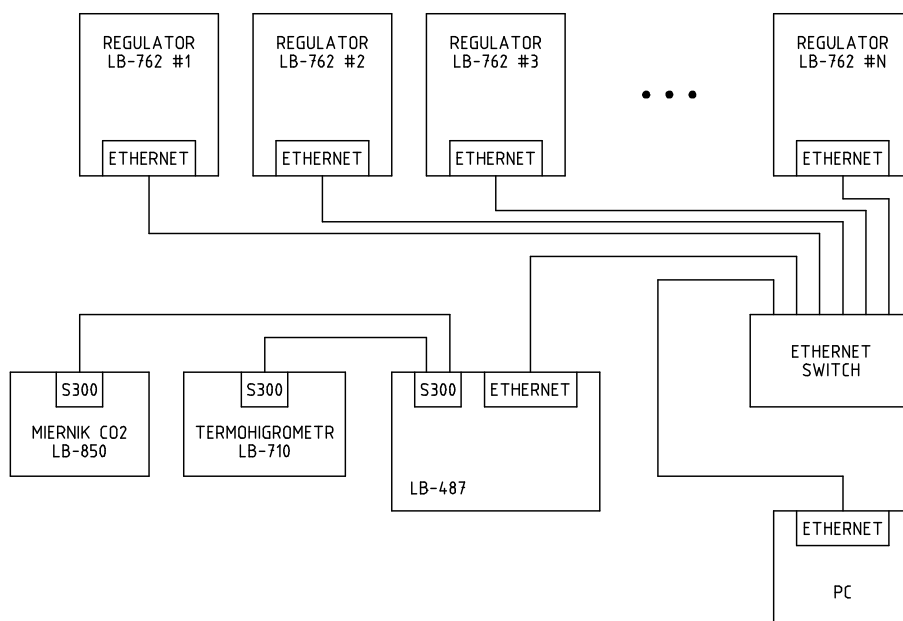
To ensure greater reliability, it is also possible to operate both networks. In such case, the system can use the Ethernet network as the basic one, and in case of network failure (what is more likely than in RS-485 network owing to the need to apply additional network devices) it would be possible to switch to RS-485 network.

1.4.1 Ethernet network

Figure 1.2 presents a scheme of installation in which N LB-762 type regulators are combined by means of an Ethernet network. The number of regulators that can be connected in an Ethernet network is practically unrestricted. The length of a single cable section between two network devices (in a typical case, between the regulator or computer and network switch) cannot be longer than 100 meters, but the network can be prolonged by means of relevant network devices, cascade joined switches or routers.

Comments with regard to the method of cabling Ethernet network can be found in Section 3.10.

Rysunek 1.2: Scheme of a system with several LB-762 regulators and Ethernet network



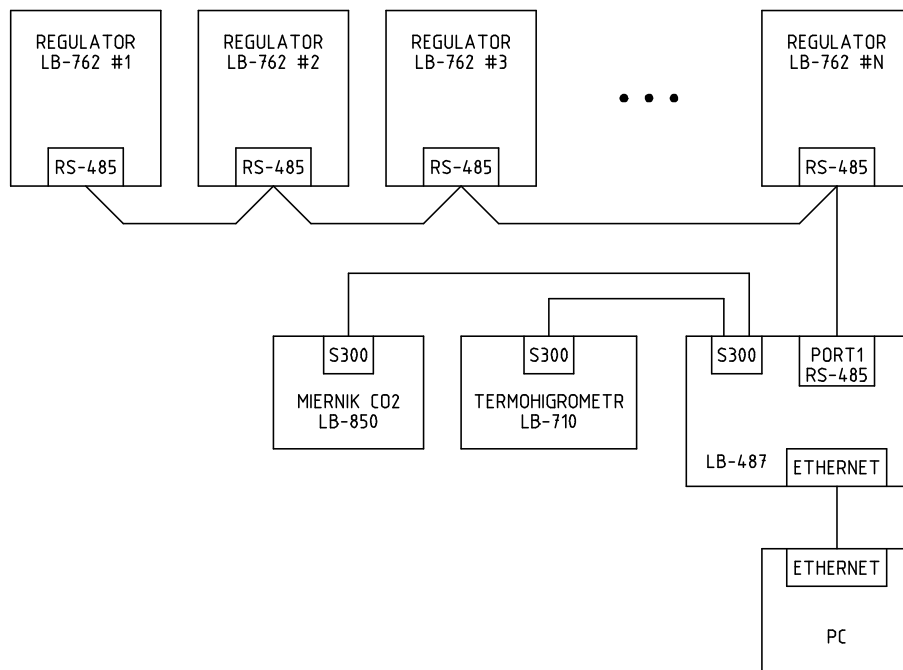
1.4.2 RS-485 network

Figure 1.3 presents a scheme of installation in which N LB-762 type regulators are combined by means of a RS-485 network. The number of regulators that can be connected in one RS-485 network segment is from 1 to 32 (see description of RS-485 network connections), maximum total length of cable is 1200 meters.

RS-485 network requires the application of LB-487 module that works as converter of communication interfaces. Connection between a PC computer and LB-487 module is by means of Ethernet network. LB-487 module communicates with the regulators by means of RS-485 network. Additionally, to LB-487 unit common system equipment may be attached – such as an external hytherograph and CO2 concentration meter.

Comments with regard to the method of cabling RS-485 network can be found in Section 3.11.

Rysunek 1.3: Scheme of a system with several LB-762 regulators and RS-485 network



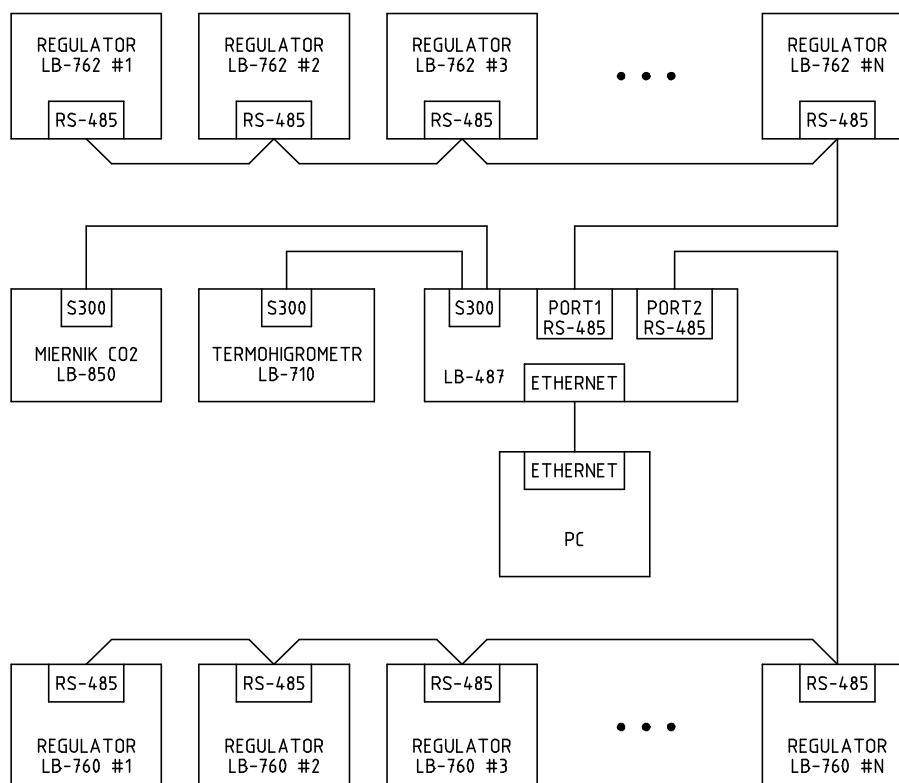
1.5 Cooperation with LB-760 regulators

LB-762 regulators can be used in systems where LB-760 regulators have been used so far. It is possible to build one common system in which both types of regulators operate to provide performance of respective system functions regardless of the type of regulator (such as common measurement of external air parameters and collective CO₂ concentration measurement system).

Unfortunately owing to software incompatibility between the regulators and inconsistency of communication protocols it is impossible to use a common RS-485 network for both types of regulators. LB-760 type regulators must have its own RS-485 network, while LB-762 regulators must have their own, separate network. If LB-762 regulators use Ethernet, this will necessarily be a separate network. If LB-762 regulators are connected by means of RS-485, one should route a separate RS-485 network cable for LB-762 regulators.

Figure 1.4 presents a scheme of a sample common installation with LB-762 and LB-760 type regulators, using RS-485 network for LB-762. The scheme with Ethernet network is analogous - LB-760 regulators remain connected by RS-485 network, while for LB-762 RS-485 network should be replaced with Ethernet network.

Rysunek 1.4: Scheme of a system with LB-762 and LB-760 regulators



1.6 Collective measurement of external air parameters

In the measuring system consisting of more regulators (both LB-762 and LB-760), it is possible to use a single hytherograph to measure external air parameters. It is also possible to connect individual hytherographs to different regulators, but with regard to the fact that they normally measure parameters of the same air, this is not reasonable. Use of a single meter permits reduction of installation costs.

Connection of external hytherograph is independent from the type of applied data transmission network (Ethernet/RS-485). On Figure 1.2 i Figure 1.3 external hytherograph is described as LB-710 HYTHEROGRAPH.

Hytherograph can be attached to any device in the network that has an S300 input. This may be LB-487 module (having 8 S300 inputs), as well as each of LB-762 regulators, having 2 S300 inputs (despite connection to individual regulator, the whole system can be configured to use this hytherograph as a source of data for all other regulators). However, for reasons of reliability of the system, it is advised to connect hytherograph to LB-487 unit – this module is common for the entire system and operates independently of all regulators. In the case of connecting the hytherograph to LB-762 regulator when the regulator is disabled or fails for some reason, the whole system of collective measurement of external air parameters will cease to operate.



Important

for operation of collective measurement of external air parameters it is necessary to ensure ongoing operation of the control software on a PC computer.

1.7 Collective CO2 concentration measurement

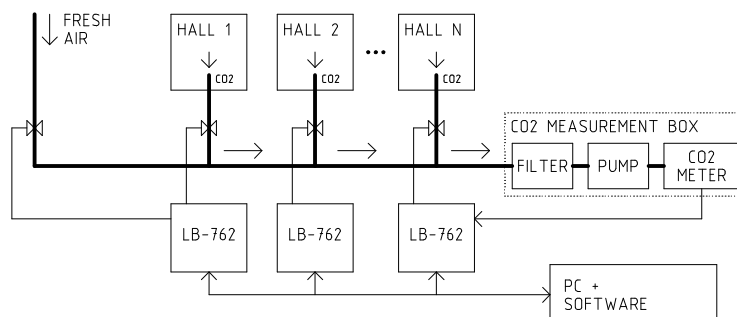
In the measuring system consisting of more regulators (both LB-762 and LB-760), it is possible to ensure CO2 concentration measurement in two ways:

- local measurement – each regulator has its own individual CO2 meter,
- collective measurement – one CO2 meter covers more cultivation halls.

Connecting individual CO2 meters is relatively costly, the application of collective measurement permits reduction in installation costs. Figure 1.5 presents the scheme of a typical installation of collective CO2 measurement. The system consists of the following elements:

- CO2 meter – used for CO2 concentration measurement in the air supplied from different halls,
- pump – provides air suction from different halls,
- valves – provide opening of air supply from different halls.

Rysunek 1.5: Scheme of a collective system of CO2 concentration measurement



The whole operates as follows: the system opens valves in cycles for different halls, accepting at a given moment air only from one hall. The pump sucks in air for a given time and delivers it to the meter of CO2 concentration (the suction time is dependent on the length of pipes supplying air). After the specified time has elapsed, one may consider that air which has arrived to the meter corresponds to that in the hall and the CO2 meter makes the final measurement whose result is sent to the regulator controlling the relevant hall. Then, the air supply valve for the particular hall is shut down, and opened is the valve for the next hall. The whole continues in cycles.

Additionally, it is possible to incorporate to the system CO2 concentration measurement for external air. This has two functions: periodic "blowing" of the CO2 meter with fresh air with low CO2 concentration and verification of correct measurement by means of fresh air. As CO2 concentration in cultivation halls is usually much higher than outdoors, the meter working all the time in the conditions of high concentrations of CO2 shows a tendency to overestimate the results, what can be prevented by periodic delivery of fresh air. This also permits verification of correct measurement – CO2 concentration value in external air is usually a predictable value of a few hundred ppm. A radically different result means incorrect operation of the meter or of the entire system of collective CO2 measurement.

The limitation in the quantity of halls taking part in the collective CO2 measurement is duration of the measuring cycle. For instance: at the time of air suction from the hall of 5 minutes and 5 cultivation halls plus external air measurement, we have cycle time = 5 minutes * (5 + 1) = 30 minutes. This means updating of CO2 result in each hall every 30 minutes. Increasing the number of halls prolongs this time in two ways: once, that each additional hall should be considered in the cycle, two, that the length increases of pipes supplying air to the meter and, at the same time, it may be necessary to prolong the measurement time from one hall. Too rare updates of CO2 concentration measurement result does not let LB-762 regulator effectively regulate fresh air supply to the hall and, at the same time, does not permit effective CO2 level regulation.

In a greater system where the number of halls and regulators would cause too long CO2 measurement cycle time, it is possible to divide the collective CO2 measurement system into smaller parts. In such case in the system a greater number is installed of CO2 meters, each of which covers some selected group of halls. One should create several such groups, depending on size of the system. In such case each collective CO2 measurement group operates on its own and independently of the others. For each group it is advised to attach CO2 concentration measurement in external air, for reasons previously discussed. Separate groups of collective CO2 measurement operate independently, but within one network of data transmission – it is not required here to split the entire system into separate data transmission networks, in accordance with breakdown of CO2 measurement. The data transmission network is common, CO2 measurement groups are independent of this.



Important

For operation of collective CO2 concentration measurement, it is necessary to ensure ongoing operation of the control software on a PC computer.

Rozdział 2

Elements of regulator

2.1 Connections

**Warning**

For the purpose of preserving user safety, all operations on connections should be conducted with regulator power supply switched off!

To obtain access to connections it is necessary to open the regulator casing. For this purpose:

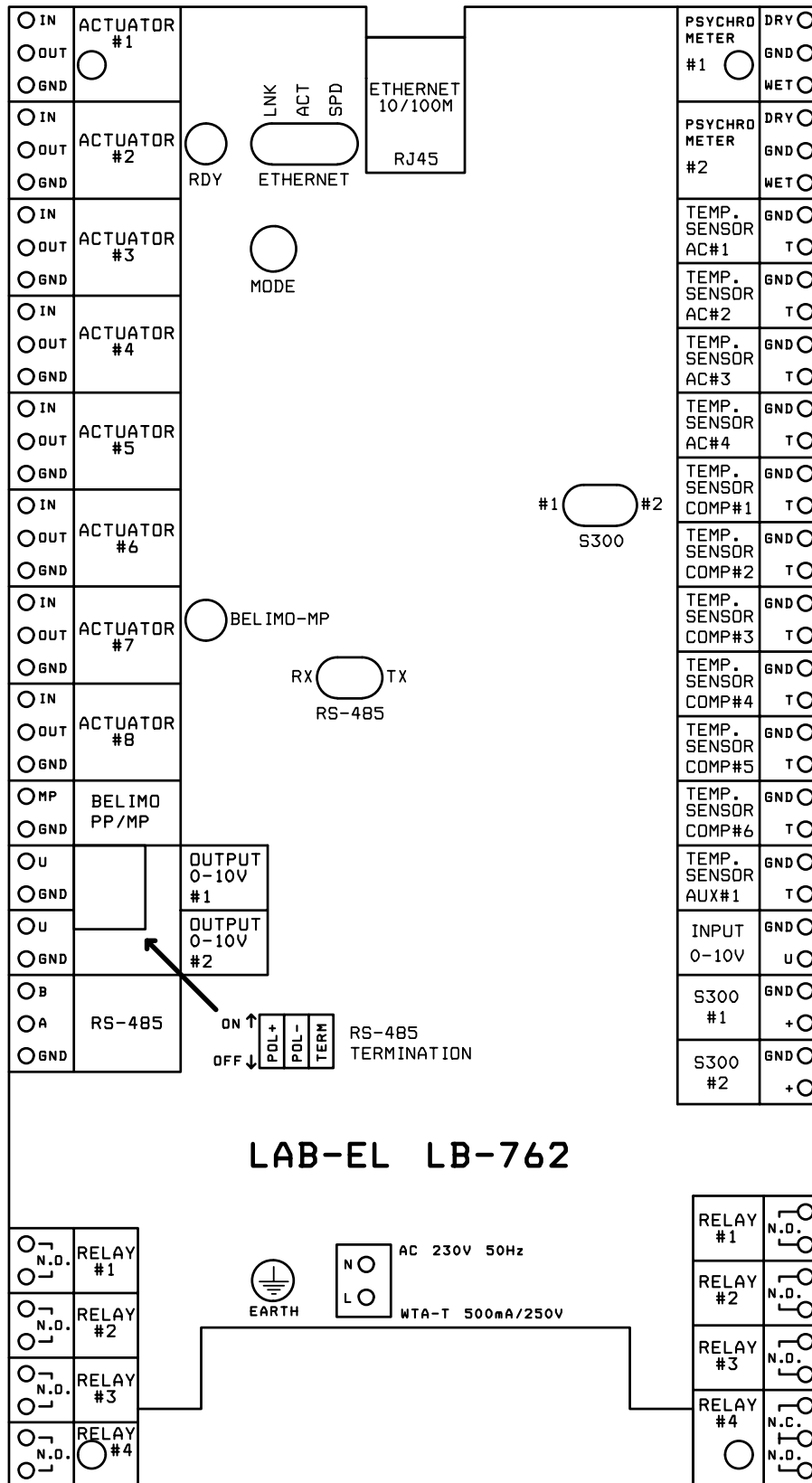
- unscrew four plastic screws on the front panel,
- open the Casing lifting up the front panel on hinges.

Connections are placed in the rear part of the casing, mostly along side edges. The exception are: Ethernet link placed on the top and power supply and earthing link placed on the bottom.

All connections use plugs to which wires are fixed by means of screw clamps or spring clamps.

The distribution of connectors is presented on Figure 2.1. Description of functions of different connectors is included below in the manual.

Rysunek 2.1: Connectors of regulator LB-762



2.2 Signaling LEDs

On main plate of the regulator (in the rear part of the casing) there are several light diodes, which are supposed to signal regulator status. The function of these diodes is above all to provide a diagnostic tool – they are important mostly at the time of installation and start-up, later while normal operation access to them is not required. All signaling elements important during daily operation are located on the

front panel of the regulator casing.

The following LEDs are available:

RDY

regulator readiness to work

ETHERNET LNK

Ethernet connection (LED out - no connection, LED on - connection active)

ETHERNET ACT

data transmission through Ethernet interface (each LED flash is associated with data receipt or transfer)

ETHERNET SPD

data transmission speed through Ethernet interface (LED out – 10 MBit/s, LED on - 100 MBit/s)

BELIMO MP

data transmission through interface of servomotors BELIMO MP (each LED flash is associated with data receipt or transfer)

RS-485 RX

receipt of data through RS-485 interface

RS-485 TX

sending of data through RS-485 interface

S300 #1

data transmission through interface S300 no. 1 (each LED flash is associated with data receipt)

S300 #2

data transmission through interface S300 no. 2 (each LED flash is associated with data receipt)

2.2.1 Errors in operation

Errors in operation of the regulator are signalled both on the display on the the front panel as well as by means of signaling diodes on the main plate of the regulator (possible is e.g. regulator failure condition which does not permit display of the relevant announcement on the displays, in such case the only possible signaling is by means of diodes on the plate).

Errors are announced as follows:

2.2.1.1 Front panel

On the main display located on the front panel the message is displayed SOS XXXX, where XXXX may have different numeric values, denoting the error code.

ALARM diode and buzzer (sound signaling) broadcast SOS message in the Morse alphabet.

2.2.1.2 Signaling LEDs on the main plate

The following LEDs are used to signal failure: RDY, ETHERNET LNK, ETHERNET ACT and ETHERNET SPD. LEDs flash in cycles broadcasting SOS message in the Morse code, similarly to the signalling on the front panel. The error code is characterized by a combination of diodes which flash and which remain off.

Rozdział 3

Connectors description

3.1 Mains supply

Mains supply connector is described as AC 230V and is in the middle of the lower edge of the regulator's main plate. The regulator IS NOT equipped with its own power supply switch, what means that an external mechanism must be provided for mains power supply shutdown.

Connection contacts are described as N and L, what means Neutral (zero wire, blue color) and Live (phase wire, brown color). Maintaining appropriate sequence of connecting wires N and L is not vital for correct operation of the machine, however, it is highly recommended owing to preservation of the convention and elegance of the installation.

3.2 Earthing

Connector of earth is described as EARTH and is located on the right side of the mains supply connector.

Earthing should be running in a separate, dedicated cable in color green-yellow (in accordance with appropriate standards), with eye tip phi 4mm, screwed down in the regulator to the screw clamp EARTH and connected outside to the respective earth.



Caution

To ensure safety of use, proper operation of the regulator and immunity to interference, it is necessary to ensure appropriate connection of the earth clamp!

IT IS NOT allowed to connect the earth clamp to contact N of the power supply connector ! Separate earthing is required.

3.3 Measurement probes

LB-762 regulator is equipped with a number of inputs, ensuring attachment of the following probes:

- 2 psychrometers,
- 4 temperature probes of air-conditioning tunnel,
- 6 base temperature probes,
- 1 extra universal temperature probe.

3.3.1 Psychrometers

LB-762 regulator may cooperate directly with two psychrometers. When connected only to one psychrometer, it is used for measurement of temperature and humidity in the cultivation hall. The second psychrometer may be used also for measurement of temperature and humidity in the hall - in such case the regulator averages results from both measuring points, providing greater independence of measurement from the gradient of temperatures and humidity in the cultivation hall. The second psychrometer may also be used for other purposes, such as e.g. measurement of air parameters on the outlet of air-conditioning tunnel. The basic psychrometer should be connected to input #1.

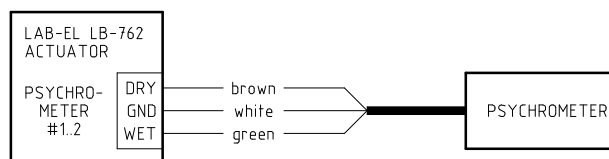
Złącza do podłączenia psychrometrów oznaczone są następująco:

- PSYCHROMETER #1,
- PSYCHROMETER #2.

Each of the psychrometers is attached using three wires:

- DRY - dry thermometer,
- GND - common wire (mass),,
- DRY - wet thermometer.

Rysunek 3.1: Scheme of psychrometer connection



3.3.2 Thermometers

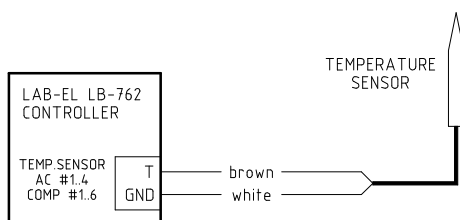
For connecting temperature probes the following connectors are used:

- TEMP . SENSOR AC #1 - the thermometer of air-conditioning tunnel no. 1 (behind the heater),
- TEMP . SENSOR AC #2 - the thermometer of air-conditioning tunnel no. 2 (behind the cooler),
- TEMP . SENSOR AC #3 - the thermometer of air-conditioning tunnel no. 3 (additional),
- TEMP . SENSOR AC #4 - the thermometer of air-conditioning tunnel no. 4 (additional),
- TEMP . SENSOR COMP #1 - base thermometer no. 1,
- TEMP . SENSOR COMP #2 - base thermometer no. 2,
- TEMP . SENSOR COMP #3 - base thermometer no. 3,
- TEMP . SENSOR COMP #4 - base thermometer no. 4,
- TEMP . SENSOR COMP #5 - base thermometer no. 5,
- TEMP . SENSOR COMP #6 - base thermometer no. 6,
- TEMP . SENSOR AUX #1 - additional thermometer.

Each of temperature probes is attached using two wires:

- T - czujnik temperatury,
- GND - mass.

Rysunek 3.2: Scheme of connection of temperature probe



3.4 Analog input 0-10V

Analog input 0-10V is described as INPUT 0-10V. To this input one can attach any source of signal within the measuring range 0-10V, e.g. CO concentration meter ₂.

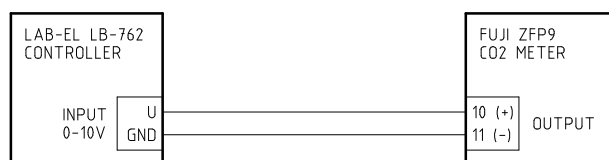
The connection is done using two wires:

- U - signal input,
- GND - mass.

3.4.1 Connection of analog CO₂ concentration meter

Figure 3.3 presents a scheme of connection of CO concentration meter 2 type FUJI ZFP9. Another type of meters are connected in the same manner. After meter connection to the analog input 0-10V one should adequately configure the regulator so that it could read data from the meter. One should indicate the place of connection of the meter and the type of meter – additionally, individual calibration can be made of the particular meter.

Rysunek 3.3: Scheme of connection of FUJI ZFP9 type meter



3.5 Inputs of S300 measurement sensors

LB-762 regulator is equipped with two inputs permitting attachment of any S300 sensors, extending measurement possibilities of the regulator. In typical cases these are concentration meters CO₂ LB-850 or hytherographs LB-710.

For connecting sensors the following connectors are used:

- S300 #1 - sensor input no. 1,
- S300 #2 - sensor input no. 2.

The connection is done using two wires that they provide power supply to the meter and are used for data transmission:

- "+" - power supply,
- GND - mass.

S300 interface is a current loop which permits any polarization of the attached sensor, thus the manner of connection (sequence of wires) does not have any importance here.

3.5.1 Connection of CO₂ concentration meter type LAB-EL LB-850

Figure 3.4 presents a scheme of connection of concentration meter CO₂ type LAB-EL LB-850. The meter can be attached to any of the two S300 inputs which LB-762 regulator is equipped with. After connection of the meter to S300 input it is necessary to properly configure the regulator, so as to ensure that it could use measurement data from the S300 input.

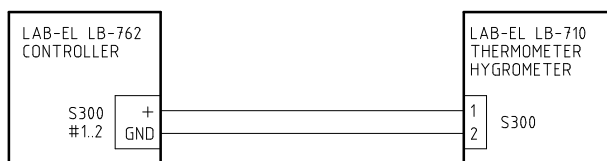
Rysunek 3.4: Scheme of connection of LAB-EL LB-850 type meter



3.5.2 Connection of hytherograph type LAB-EL LB-710

Figure 3.5 presents a scheme of connection of concentration meter CO₂ type LAB-EL LB-850. The meter can be attached to any of the two S300 inputs which LB-762 regulator is equipped with. After connection of the meter to S300 input it is necessary to properly configure the regulator, so as to ensure that it could use measurement data from the S300 input.

Rysunek 3.5: Scheme of connection of LAB-EL LB-710 type meter



3.6 Relay outputs

LB-762 regulator is equipped with 8 relay outputs, used to control any executive devices. For connecting executive devices, the following connectors are used:

- RELAY #1 - relay no. 1 (contact),
- RELAY #2 - relay no. 2 (contact),
- RELAY #3 - relay no. 3 (contact),
- RELAY #4 - relay no. 4 (contact),
- RELAY #5 - relay no. 5 (contact),
- RELAY #6 - relay no. 6 (contact),
- RELAY #7 - relay no. 7 (contact),
- RELAY #8 - relay no. 8 (contact - no contact).

Relays 1-7 are shorted, contacts are marked as N.O. (what means inactive condition "Normally Open" – normally no contact). Switching on the relay causes short circuit of output contacts.

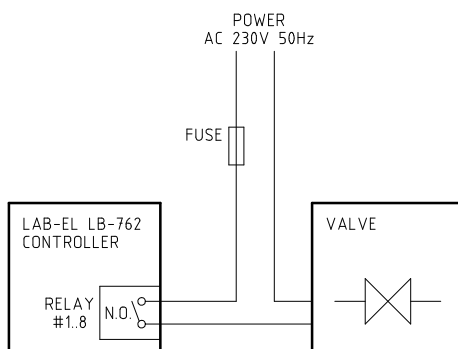
Relay no. 8 is of contact-no contact type, pairs of contacts are marked as N.O. (what means inactive condition "Normally Open" – normally no contact) and N.C. (what means inactive condition "Normally Closed" – normally contact). One contact is common. Switching on the relay causes short circuit of output contacts N.O. and opening of contacts N.C.

Relay outputs are completely insulated galvanically from all other connectors, in particular from the mains supply. This means that these relays can control any circuits, independently of existing voltages. In any case external power supply is required to the executive device – the regulator does not emit voltage on relay outputs.

3.6.1 Connection of OPEN-CLOSE 230V valve

Figure 3.6 presents a scheme of connection of a typical valve to the relay output. External connection is required of power supply voltage (the regulator does not emit power supply on relay outputs), additionally, it is necessary to use an appropriate fuse protecting the circuit against short-circuit.

Rysunek 3.6: Scheme of connection system of a typical valve to relay output



3.7 Outputs of analog servomotors

LB-762 regulator is equipped with 8 connectors used for connection of analog servomotors. The outputs permit control of any servomotors which accept control signal within the range 0-10V or 2-10V. Apart from control of servomotor it is also possible to connect return signal from servomotor, informing about the current position of the servomotor. Scope of voltages of return signal is analogous to the control output: 0-10 or 2-10V. The return signal is used by the regulator to control correct operation of the servomotor (check whether the servomotor is set in accordance with the preset control signal). If the servomotor has no return signal output or is not used in the given installation, one should make the connection according to Figure 3.9.

Connectors of regulator LB-762 intended for cooperation with servomotors are marked as follows:

- ACTUATOR #1 - servomotor no. 1,
- ACTUATOR #2 - servomotor no. 2,
- ACTUATOR #3 - servomotor no. 3,
- ACTUATOR #4 - servomotor no. 4,
- ACTUATOR #5 - servomotor no. 5,
- ACTUATOR #6 - servomotor no. 6,
- ACTUATOR #7 - servomotor no. 7,
-

3.7.1 Servomotor power supply

LB-762 regulator does not supply power to servomotors – servomotors require a separate source of power supply. The manner of power supply depends on the type of servomotors. Popular BELIMO servomotors can be powered with voltage 24V AC or 24V DC, Johnson Control servomotors require only 24V AC power supply.

For 24V AC power supply the so-called safety transformer can be used 230V/24V, one should however ensure proper anti-shorting protection.

The power supply unit can be one common for all servomotors – it must however ensure appropriate current efficiency (one should calculate the sum of input power by all servomotors and depending on this power accordingly select efficient power supply). Configuration is also possible in which each servomotor has its own individual power supply.

If both analog and digital servomotors are used in the system, their common power supply is possible – see description of digital servomotor power supply, found below in the manual.

3.7.2 Connection diagrams

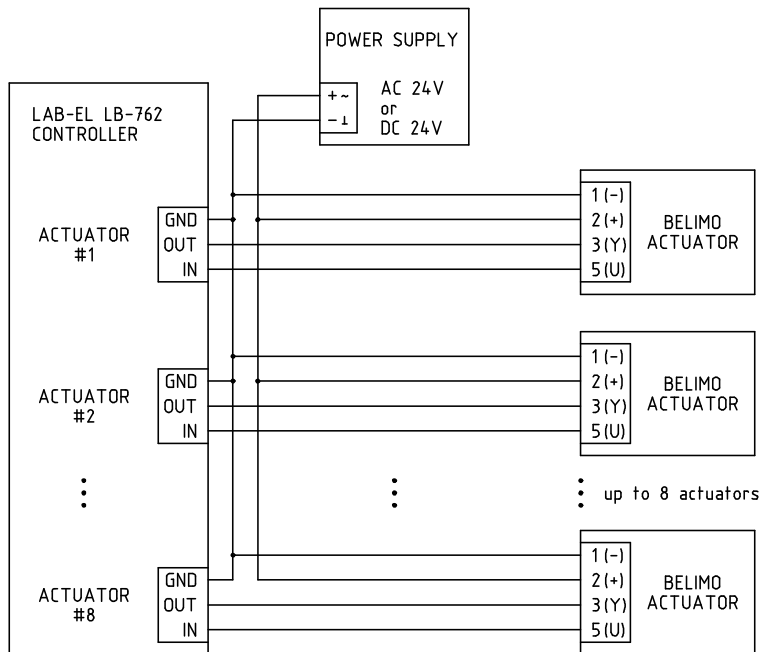
3 contacts are provided for connection of each servomotor:

- IN - return signal input informing about position of the servomotor,
- OUT - control signal output fixing servomotor position,
- GND - mass.

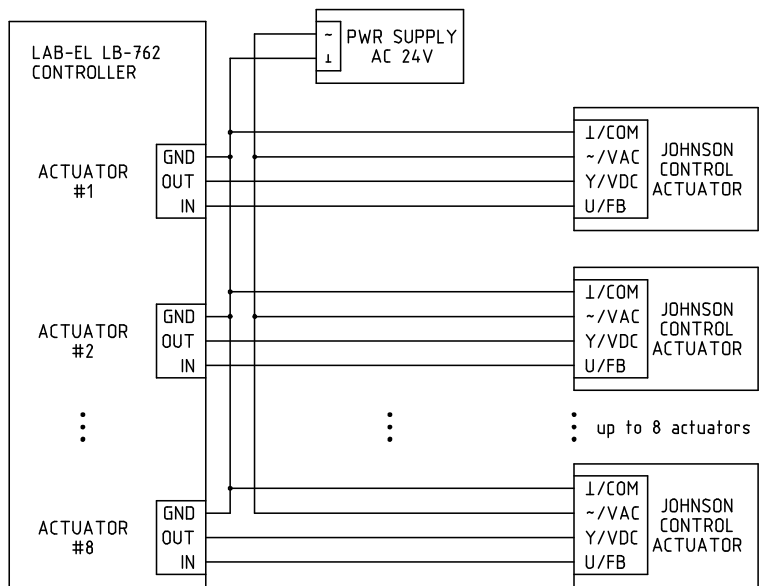
GND contact is present on each of the connectors, but this is a common signal without galvanic insulation between different connectors, what can be use to possibly simplify cabling.

Figure 3.7 and Figure 3.8 present typical connection diagrams for Belimo and Johnson Control servomotors.

Rysunek 3.7: Scheme of connection of analog servomotors Belimo

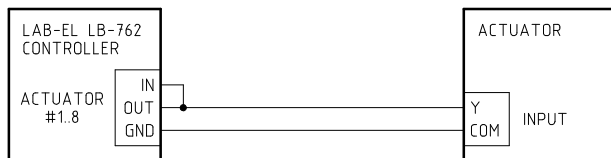


Rysunek 3.8: Scheme of connection of analog servomotors Johnson Control



For servomotor which does not have a return signal, one should short-circuit contacts IN and OUT in the given connector of regulator LB-762 in accordance with figure Figure 3.9. Such connection will ensure "cheating" of the regulator as to compliance of the set and the actual servomotor position and shall prevent alert signalling of servomotor failure.

Rysunek 3.9: Scheme of connection of analog servomotor without return signal



3.8 Bus of digital servomotors BELIMO MP-BUS

LB-762 regulator is equipped with one connector used for connection of a bus of digital servomotors consistent with BELIMO MP-BUS standard. By means of this bus the regulator permits operation of 1 servomotor configured in PP mode or from 1 to 8 servomotors in MP mode. The key advantage of MP-BUS bus as compared with analog controlled servomotors is important simplification and reduction in the quantity of cabling (instead of 3 separate ducts from each servomotor to the regulator only 3 wires are conducted in parallel to each servomotor), better diagnostics (the regulator is able to detect lack of correct communication with the servomotor – e.g. in consequence of damage of servomotor, power supply unit or cabling) and more precise servomotor positioning and reading of its actual position (digital data transmission resistant to interference).

For cooperation with MP-BUS bus suitable servomotors must be used, consistent with this standard. Before connection to the system they require configuration – address setting. Default, factory servomotor setting permits operation in PP mode (permitting communication only with one servomotor), use of a greater number of servomotor requires assignment of an individual address to each one. Servomotor address setup procedure is described further in the manual.

MP-BUS bus is galvanically insulated from all other connectors of LB-762 regulator, in order to ensure greater immunity to interference created by digital data transmission.

3.8.1 Servomotor power supply

LB-762 regulator does not supply power to servomotors – servomotors require a separate, own source of power supply 24V DC or 24V AC (BELIMO servomotors can be powered by both direct and alternate current). In the case of AC power supply polarization of power supply does not have any importance here, for DC power supply attention should be paid to correct polarization (see scheme of connections).

The power supply unit can be one common for all servomotors – it must however ensure appropriate current efficiency (for example for digital servomotor LM24A-MP maximum power consumption is 3W, what means 24W with 8 servomotors peak power consumption; depending on the number and type of servomotors used appropriate power supply efficiency should be considered).

For a system using both analog and digital servomotors, it is also possible to provide their common power supply from one power supply unit - in such case one should connect contact GND of connector BELIMO PP/MP with contacts GND of joints of analog servomotors (ACTUATOR #N), as there is no connection between these contacts inside the regulator (galvanic insulation).

24V DC power supply to servomotors has the advantage of permitting longer connecting cables than 24V AC power supply – see the description below. However, it must be quite well filtered out – the amplitude of pulsations cannot be higher than 10 %.

3.8.2 Connecting cable

MP-BUS bus imposes some restrictions as to the length of cabling and section of wires. While the type of cable has no greater importance (it does not have to be screened, simplest 3-conductor cable is sufficient), , depending on the type of power supply (AC/DC), the number of servomotors and the section of the connection cable, different is the maximum acceptable cable length. Detailed information on the method of setting the maximum connection cable length can be found in the documentation of Belimo, below presented are the most typical cases for cable with core section 0.75 mm² and popular types of servomotors.

consumed power	power supply 24V AC	power supply 24V DC
20 W/VA	25 m	40 m
40 W/VA	15 m	20 m
60 W/VA	8 m	10 m

Tabela 3.1: Maximum cable length for section 0.75 mm mm²

One should sum up power collected for all connected servomotors. For example for servomotor LM24A-MP consumed power is 2.5W for 24V DC and 5.0VA for 24V AC. With 8 servomotors we have the sum of powers 20W for 24V DC and 40VA for 24V AC, what permits application of cable with length respectively 40 meters at supply 24V DC and 15 meters at supply 24V AC.

In special cases when larger distances are required, double increase in the cable section up to 1.5 mm² permits twofold growth in these distances.

In the case when each servomotor has its own power supply located in the neighborhood of the servomotor, connection of MP-BUS bus with LB-762 regulator can be made by two cables. In such case cable length is restricted to 800 meters, regardless of its section (it is not however recommended to use cable with section smaller than 0.75 mm²).

3.8.3 Connections diagram

Connector of LB-762 regulator used for connection of MP-BUS bus is described as BELIMO PP/MP and is equipped with 2 contacts:

- MP - signal,

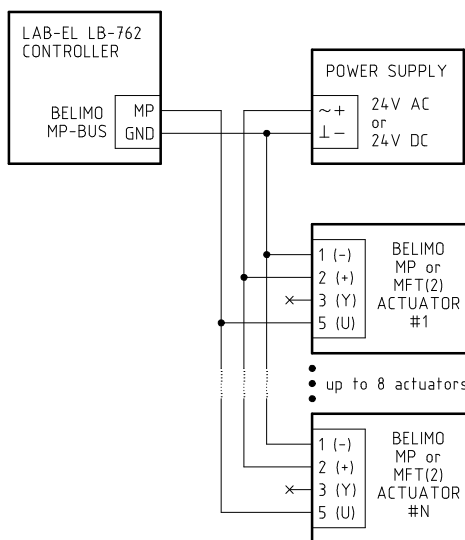
- GND - mass.

Figure 3.10 presents the typical manner of connection of MP-BUS bus, using additional common 24V power supply unit.

The manner of laying the cable between LB-762 regulator, the power supply unit and servomotors has no importance here. It can be running in any convenient way, this may be a layout of bus, star, mixed or any other.

More details concerning MP-BUS bus and its technical parameters can be found in BELIMO documentation.

Rysunek 3.10: Scheme of connection of bus of servomotors BELIMO MP-BUS



3.8.4 Setting of servomotor addresses

Factory standard setting of BELIMO servomotor is operation in PP mode, which allows connection of only one servomotor to MP-BUS bus. Operation in MP mode allows connection of 1 to 8 servomotors, but requires setting of individual addresses for the servomotors, so as to ensure that the regulator could communicate with each servomotor independently of the others. In PP mode one can also connect a servomotor with set MP address, however, the address is then used and the servomotor operates always independently of the set address.

For proper cooperation of LB-762 regulator with digital servomotors BELIMO MP-BUS one should correctly configure both the servomotors and the regulator itself, according to the used operation mode of the servomotors (PP or MP with addresses).

The configuration of servomotor addresses can be done in several ways:

- ordering appropriate configuration settings from the producer – not quite practical method, as the configuration has to be fixed at the order,
- BELIMO configuration tools – such as MFT-H programmer or interfaces ZIP-RS232, ZIP-USB-MP, ZIP-232-MP, ZIP-232-KA plus dedicated Belimo PC-Tool MFT-P configuration software; description the method of conduct is in the respective documentation of Belimo,
- configuration procedure built in LB-762 regulator – this method is described below.

LB-762 regulator software permitting configuration of addresses of attached servomotors. Individual connection of each servomotor is not required - the configuration can be made after completing full installation with all servomotors. The servomotors must have power supply on and must be respectively connected to the regulator.



Important

The necessary condition for correct operation of servomotors is to assign individual addresses to them. Each MP-BUS servomotor attached to the particular regulator must have a unique address!

The procedure below applies to one servomotor, it should be repeated for each installed servomotor:

- enable programming of the regulator (PROGRAMMING button on remote control, specify the respective regulator number),

- go to advanced settings menu (button **PASSWORD**, enter correct password – this is normally 1111),
- choose **MP-BUS** servomotor addressing function (button **B**),
- at any moment use button **BACK** to cancel the procedure of servomotor address setup,
- in response to message **MP-BUS addr** =enter the required servomotor address (1 to 8),
- the regulator will display the blinking hint **SET ACT**, in response to which the address setting should be confirmed in the desired servomotor – the procedure depends on the type of servomotor.

Possible are the following options (more information can be found in the Belimo documentation):

- servomotors...-MP: after switching on the address setup procedure on servomotor the yellow indicator should regularly flash; to confirm the address press this control (it is at the same time a button) and hold until the address is confirmed (control off and address confirmation on the regulator),
 - servomotors LM,NM,AM,GM...-MFT(2): push disengagement button only once, hold it pressed until the address is confirmed on the regulator,
 - servomotors LF,AF...-MFT(2): over less than 5 seconds change twice the position of sense of rotation switch (L/R),
 - servomotors NV,NVF,AV...-MFT(2): after switching on the address setup procedure on servomotor indicator H1 should flash (alternately red and green); to confirm the address press **S2** button only once, hold it pressed until the address is confirmed on the regulator.
- after confirming the address the regulator should display message **SET ACT** without flashing, what means confirmation of correct address setting. If the regulator displays message **ERR**, this means an error in communication with the servomotor – try to repeat the operation. If the error persists, this means a problem in communication with the servomotor – check the connections as well as the possibility of address collision with other servomotors. In such situations immediate disconnection can help of the other servomotors and conduct of the address setting procedure with a single servomotor connected. Continuous flashing of announcement **SET ACT** and no reaction to confirm the address in servomotor means no communication with the servomotor – check the correctness of all connections,
 - after setting the servomotor address, use button **NEXT** to go to address setup for the next servomotor, or use **BACK** button to end the address setup procedure.

3.9 Analog outputs 0-10V

LB-762 regulator is equipped with two analog outputs 0-10V, marked as follows:

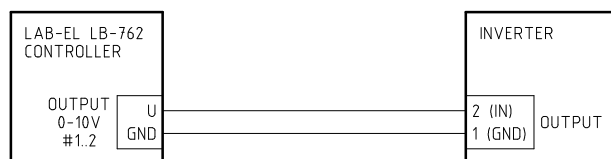
- **OUTPUT 0-10V #1** - output no 1,
- **OUTPUT 0-10V #2** - output no 2.

For connection of device 2 contacts are provided:

- **U** - voltage signal 0-10V,
- **GND** - mass.

Both outputs are insulated galvanically from all other signals, as well as from each other. They are designed for cooperation with devices generating an elevated level of interference as e.g. inverters controlling engine rotations. Of course it is possible to use these outputs for any other purposes – they are universal and can be used for connection of any device that is subject to control by signal 0-10V (or 2-10V).

Rysunek 3.11: Scheme of connection of frequency converter type OBRUSN PC3..., OBRUSN PC4..., SSD Drives 605, SSD Drives 650 and similar



3.10 Ethernet network

RJ45 type connector is used for connection with other network devices by means of cable-spiral, according to standard 10BASE-T and 100BASE-T. In order to obtain as high immunity to interference as possible, for connection use high quality cable Cat 5 or Cat 5e. The maximum acceptable length of a single connection is 100m (from one device to the other, namely e.g. from regulator to switch).

3.10.1 Configuration example

When using Ethernet network for controllers and PC connection, it's necessary to properly configure IP addresses. Below is a sample configuration, assuming usage of private IP address range. It's typical configuration for standalone system, when there's no need for routing between regulators and control software via other networks. Figure 1.2 presents connection diagram for such simple system. 192.168.100.0 network address will be used, preventing conflicts with most popular 192.168.1.0 network, if one is already in use. Static addresses will be assigned to network nodes - autoconfiguration with BOOTP/DHCP protocols is not used.

- regulators #1..99: addresses 192.168.100.1 .. 192.168.100.99
- komputer PC: 192.168.100.100
- optionally additional router (ex. to Internet): 192.168.100.254

Subnet mask: for all network nodes it's the same: 255.255.255.0

Default gateway: if router is present in the network, its address should be used (192.168.100.254), otherwise gateway address doesn't matter - regulators can be set with 0.0.0.0 address, or PC address (192.168.100.100).

Proper settings (IP address, subnet mask, gateway) should be set for every network node (regulators, PC, router) - but every device gets it's own unique IP address. Subnet mask and gateway address are the same for all nodes.

Regulator address settings can be applied using lbnetcfg tool, PC with Windows operating system requires changes to network card settings, under TCP/IP protocol properties.

3.11 RS-485 network

The connector described as RS-485 is used to connect LB-762 regulator to RS-485 network, serving for communication with an appropriate IT system (PC computer and appropriate software).

For connection of RS-485 network 3 contacts are provided:

- A - signal,
- B - signal,
- GND - mass.

RS-485 bus is galvanically insulated from all other signals.

In order to obtain as high immunity to interference as possible, for RS-485 network connection use two-pair screened spiral, with minimal wire section 0.2 mm². One pair of wires should be connected to contacts A and B, the second pair together with the screen connected to contact GND.

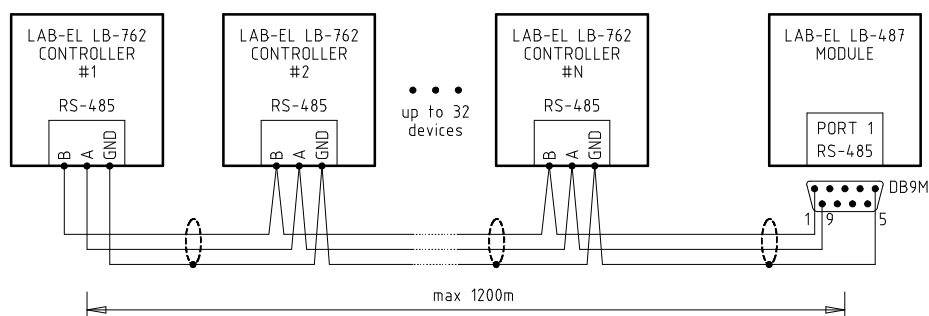
Total length of RS-485 network may be max. 1200 meters.

Figure 3.12 presents the manner of RS-485 network connection. The Connecting cable must be laid from one device to the next one, branching must be directly on connecting clamps – on the diagram points marked with dots.

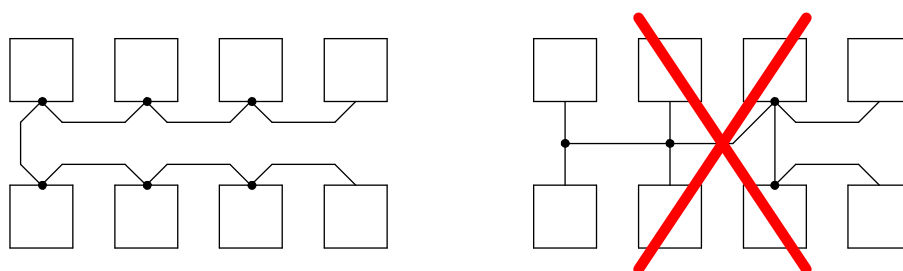
Numbers of contacts described for RS-485 connector of LB-487 module relate to plug type DB9M, which should be used for connecting LB-487 module.

Figure 3.13 presents two examples of RS-485 network topologies. A properly laid network conducts in one cable from one device to the other device. Incorrectly laid network has branching of cable – such placement of network is unacceptable!

Rysunek 3.12: Scheme of RS-485 network connection



Rysunek 3.13: Scheme of correct and incorrect RS-485 network topology



3.11.1 Termination of RS-485 network

RS-485 bus requires relevant termination (impedance match and line polarization). Termination of network should be connected only in two places - on the ends of the network. This means these devices (network nodes) to which cable comes and does not go further to next devices. On Figure 3.12 termination should be enabled in devices described as LB-762 #1 (extreme device on the left side) and LB-487 (extreme device on the right side). In other devices, located in the middle part of the network, termination of the network must be off.

In LB-487 regulator 3 switches are used for network termination, described as RS-485 TERMINATION (Figure 2.1):

- POL+ - polarization (+),
- POL- - polarization (-),
- TERM - impedance match.

Rysunek 3.14: RS-485 network termination switches

Switches in the lower position are off, while in the top position – on.

In practice switching on termination means switching on of all 3 switches, while turning off termination means turning off of all 3 switches. The situation is theoretically possible in which switch TERM or pair POL+ and POL-, but in practice it is not present.

RS-485 interface in converter LB-487 has similar termination mechanisms of RS-485 network. This can be done using 3 contacts which can be found on the interface plate (available after removing the housing), described as LINE TERMINATION. In order to turn on termination of line in converter LB-487 one should set up all 3 contacts:

- JP1 –POL+ - polarization (+),
- JP2 –POL- - polarization (-),
- JP3 –TERM - impedance match.

It is recommended that LB-487 converter be the terminal machine in RS-485 network (thereby that line termination be switched on in it). Of course possible is such network topology in which LB-487 converter is a device placed in the middle part of the network – in such case termination must be in other devices and this is a completely correct configuration. However, positioning LB-487 converter on the end of the network and switching on termination in it ensures correct operation of the network in the case when other equipment (regulators) may be periodically deactivated – in such case the disabled regulator does not ensure line polarization. Since LB-487 converter is a device which by principle of system operation is always on, switching on termination and polarization of line in LB-487 is the most effective way of ensuring proper RS-485 network operation. However, this requires proper network planning so that this device be placed on its end.