

Booster microprocessor controller



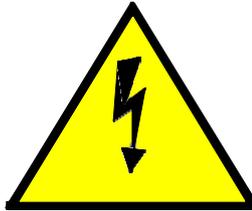
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1. Important information

Please read this manual carefully and watch the equipment before its start-up.

Safety warnings

POWER SUPPLY: 400V/50Hz – danger of electrocution



Electrical equipment may only be operated by fully qualified personnel. This document is not intended for use by unqualified people.

The persons responsible for installation and operation of the equipment should ensure that they have met all the regulations, laws and rules and safety requirements required during installation and operation of electrical equipment.

Before installation, dismantling, connection or maintenance, always disconnect the equipment from power supply. In the case of devices equipped with a frequency changer, one should additionally wait for a certain period of time, the length of which has been described in the power inverter manual.

Use only the appropriate voltage to supply the equipment.

BERG Kompressoren does not take responsibility for any consequences occurring due to the inappropriate usage of the device and changes in the device driver control program and network attacks after connecting to the LAN network.

2. Structure of the control system

The compressor controller is equipped with the PLC central unit and operator panel used to monitor the booster operation and input parameter settings. The panel is equipped with the function keys (playing also the role of alphanumeric keyboard) and system keys (e.g. Enter, Esc and Tab). Arrangement of the keys is presented in figure 1 and the function description is in table 1.

The operation principle of the controller is based on switching between the screens and performing the operations on those screens. After energizing, the panel operating system is initialized and then the main screen is displayed.

Table 1. Functions of the conventional keys.

No	Function
F1	Calling the main screen
F2	Calling the event screen
F3	Calling the counter screen
F4	Calling the service screen
F5	Calling the clock screen
F6	Calling the setting screen
F7	Calling the user management screen
F8	Calling the system screen
F9	Calling the diagram screen
F10	Calling the information screen



Fig.1 Arrangement of the screen elements.

The booster controller performs the following tasks:

- Check of power supply
- Protection against motor overload
- Check of oil pressure
- Supervision of the oil pressure sensor (the control can be switched on and off)
- Check of suction pressure(binary or analog)
- Protection against too high air pressure
- Booster switching on and off
- Control of solenoid valves
- Measurement of air pressure

The controller may work in operation modes:

- **Local neutral gear** – the source of the start signal for the compressor is the knob-operated switch placed on the front of the electric box. Upon reaching the cut-out pressure, the compressor will go into neutral gear. If, during the preset time of the neutral gear, the pressure does not decrease below the cut-in pressure, the compressor will switch off and it will remain on stand-by. After the pressure decreases below the cut-

out pressure, the compressor will switch on and then go into discharge mode.

- **Local interrupted** – the compressor start signal source is the knob- operated switch located on the front of the electric box. Upon reaching the cut-out pressure, the compressor will switch off and when the pressure decreases below the cut-in pressure, the compressor will switch on.
- **Remote neutral gear** - the compressor start and load signal source is the outer pin connected to the appropriate place in the electrical installation, whereas the knob-operated switch on the doors of the electric box must be set in the on position. Upon reaching the cut-out pressure or opening the external contact the compressor will go into neutral gear. If during the neutral gear present time, the pressure does not decrease below the cut-in pressure, and the external contact does not close, the compressor will switch off and it will remain on stand-by. After the pressure decrease below the cut-out pressure, and the external contact closes, the compressor will switch on and then go into discharge mode.
- **Remote interrupted** – the start signal source is the outer pin connected to the appropriate place in the electrical installation, whereas the knob-operated switch on the doors of the electric box must be set in the on position. Upon reaching the cut-out pressure, the compressor will switch off, and when the pressure decreases below the cut-in pressure, the compressor will switch on.

Selection of the suitable operation mode is carried out from the main screen level.

The display backlight of the operator panel changes depending on the booster status. Table 2 presents colours and situations of their occurrence.

Table 2. Screen backlight colours.

Colour	Occurrence situation
White	No booster start signal or booster in ready state
Yellow	Booster during start-up or idle running
Green	Booster discharges air
Red	An event resulting in the booster stop occurred and it is to be acknowledged by a user

Figure 2 presents the main screen, where it is possible to read the most important information and introduce changes in the basic settings.

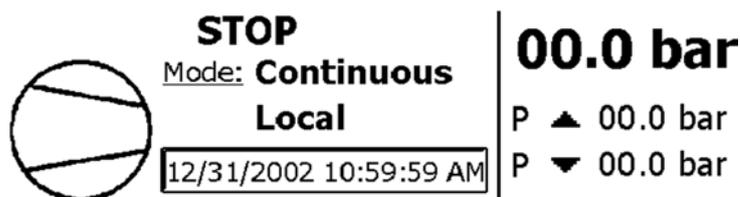


Fig. 2 View of the main screen.

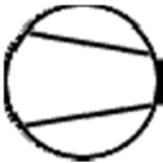
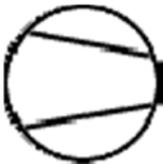
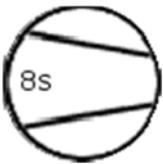
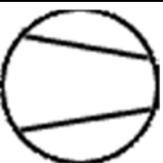
The main elements of the main screen are:

- Status text,
- Status symbol,
- Present operation mode (editable)
- System date and time
- current pressure
- the current suction pressure (displayed when the driver is configured for working with an analog sensor)
- Booster switch on and off pressure (editable)

The dynamically changing elements are the status texts and symbols that are listed in table 3.

After 60 seconds of idleness, a screensaver containing the current pressure will be displayed on the main screen. In order to switch it off, press any function key.

Table 3. Status symbols and texts

Status symbol	Status text	Description
	STOP	No signal to start the booster.
	STOP AUTO	The booster is in ready state and awaits for pressure drop below the switch on pressure.
	UNLOADING	The booster is unloaded before start-up.
	START-UP	The booster start-up.
	OPERATION	The booster discharges air.
	IDLE RUN	The compressor works on idle run due to reaching the cut-out pressure.
	NO SUCTION	The compressor works on idle run due to too low pressure on suction.
	NO SUCTION STOP	The compressor is stopped and in standby condition due to too low suction pressure.
	FAILURE	An event resulting in the booster stop occurred and it is to be acknowledged by a user.
	???	No information on the booster status. The reason may be no communication between PLC unit and HMI panel.

2.1 Levels of access

Access to editing some parameters may require logging in at a specific level of access. You can log in by choosing the manage users screen or by the pop up dialog box at the moment when editing a chosen element. The following are needed to log in:

- user name – related to the permission range
- password – necessary for the authorization of the login process

The user names and passwords are provided to the authorized persons as necessary.

2.2 Introduction of the changes in settings

To introduce changes in the settings, carry out the following procedure:

- Select the value to be edited by using the navigation arrows or TAB key
- Press the ENTER key (to enter into edition of the particular value)
- Change a value with the numeric keyboard (numeric values) or with the navigation arrows (text values from the predefined list)
- Acknowledge the selection with the ENTER key or cancel the edition with the ESC key

An example view of the menu screen is presented in figure 3. In the left top corner there is a number of the particular screen. This numbering is related to the function key that calls that screen. If that number contains a slash, it means that there are more than one screens assigned to one function key. To call a further screen, use the down navigation arrow (if there are active elements on the screen, press the up navigation arrow repeatedly). Calling the closer screen is possible by using the up navigation arrow.

F6/1	Settings
Idle run time:	00000 s
Suction sensor delay:	00000 s
Oil sensor delay:	00000 s
Start delay:	00000 s

Fig. 3 View of the setting screen.

To be able to edit some parameters, it is required to log in with the appropriate authorization level. It is possible to do that from the user management screen level or directly from the context menu that appears when any edition of a value protected with the password is attempted.

If there is more than one screen on a given menu level, its number is displayed in the upper left corner. Further screens can be entered by scrolling with the arrows or by pressing the given function key again.

The controller is equipped with the real-time clock that is backed up with the high capacity capacitor in case of supply failure. After a few days of power supply failure, check clock readings and correct them if required.

2.3 The suction pressure control

The compressor controller controls the suction pressure based on one of the following functions:

- Binary - the source of the binary signal is the pressure switch, and the switching threshold results from its characteristics.
- Threshold - the source of the analog signal is a pressure transmitter, and the threshold of operation is configurable from the operator panel level.
- Continuous - the source of the analog signal is a pressure transmitter, and the algorithm is based on the continuous measurement of suction pressure and discharge pressure. On their basis, the current compression ratio is calculated, which is the quotient of the absolute discharge pressure and the absolute suction pressure. The value of the permissible pressure is configurable from the operator panel level.

Regardless of the selected function, after the insufficient suction pressure has been detected, the compressor will go into the idle run and then switch off. The condition to resume pressing or switching on is to achieve and maintain the correct parameters for a given time. The correct parameters are limit values adjusted by hysteresis.

2.4 Menu language

On the F8 system settings screen, one can change the menu language by pressing the change button, which is shown in 0.

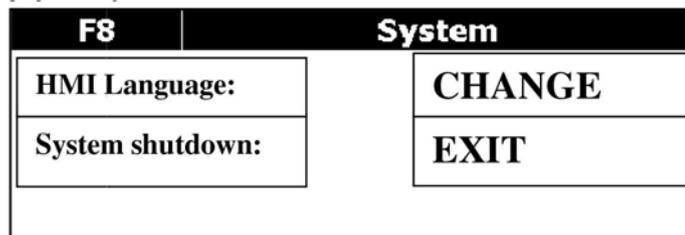


Fig. 4. The view of the system screen.

2.5 Alarm events

The controller supervises the booster parameters and records the system events in the operator panel memory. The possible events to occur are presented in table 4.

Table 4. List of alarm messages.

Code	Description
1	E Bad sequence, power supply failure or asymmetry
2	E Motor overload
3	E Oil pressure sensor error.
4	E Too low oil pressure
5	E Too high air pressure
6	E No connection between HMI panel and PLC controller.
7	E The retentive memory was lost. Restored to the default parameters. Check and set all the driver parameters.
17	A Low oil pressure.
18	A The compressor needs servicing.
19	A Web server error.
20	A The real-time clock settings have been lost.
33	S Last switching off of PLC: time and date. Current switching on of PLC: time



The table 5 presents the alarm message structure that consists of the following:

- Date and time of an event occurrence
- Class (E – event causing the stopping of the device, A - warning events, S - informational system event)
- The status defining the present event state (I – active event; IO – historic event)
- Code unambiguously defining an event
- The content explaining a given message (pressing the right arrow shows its full content which can be then hidden by pressing the Esc key)

Table 5. Alarm message structure.

Date	Time	Class	Status	Code	Content
2012-06-01	12:00:00	E	IO	2	Motor overload

Figure 5 presents an example event screen. Events can be confirmed by the key located under the event list or by using the knob-operated switch located on the electric box doors. To confirm, turn the knob from the switched-on to the switched-off position. In order to show the history event list, one should press the F2 key again.

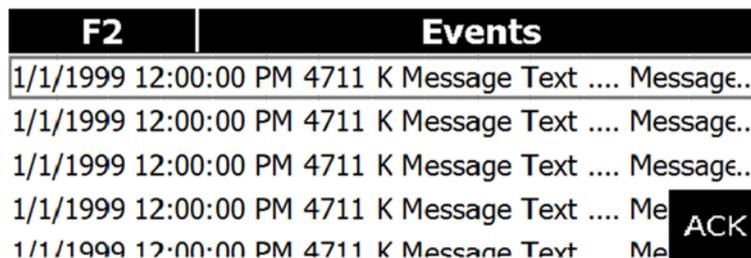


Fig. 5 View of the list of events screen

2.6 Servicing activities

The driver informs the user about the necessity of proceeding with servicing activities. After completing an inspection, one should enter the amount of working hours and the date when the next servicing should take place. In order to record these changes, the below procedure should be applied:

- log in with the appropriate permissions,
- go to the servicing activities settings screen,
- click on the field with the working time counter and enter the counter value at which the next inspection has to be carried out,
- click on the date field and enter the date until which the next inspection has to be carried out,
- check the correctness of the entered settings on the servicing counters screen,
- log out,

Tab.6 presents exemplary servicing counter settings.

Current run and time	Inter-inspection intervals	Settings on the servicing activities screen	Values on the servicing counter screen
2996 h	3000 h	5996 h	3000 h
14-05-2016	1 year	14-05-2017	365 days

2.7 Changing the network settings

Notice

Most activities in the procedures presented in the further part of this document are handled via and with the assistance of the operator panel firmware, which has been created by its manufacturer. Due to this, the progress or availability of each of these procedures may change depending on the firmware version. Handling any of the presented procedures or changing other firmware settings requires specialist knowledge from the scope of IT and automation. Therefore, the compressor manufacturer does not recommend interfering with the firmware settings and does not take responsibility for the results of changes done to the firmware settings or by using its tools.

All of the below procedures should be handled with the compressor switched off.

- In order to change the PLC driver network settings, one should proceed with the following procedure: Change the network parameters (A – address, M – subnet mask, G – default gateway address) on the F8/2 screen, and which are presented in 0.
- Confirm the entered settings by using the Change button in the parameters on the F8/2 screen.

F8/2	System
Adres sterownika PLC	
A: 192 . 168 . 0 . 11	ZMIENÍ
M: 255 . 255 . 255 . 0	
G: 192 . 168 . 0 . 1	

Fig. 6 The view of the PLC driver address settings screen.

In order to change the connection between the HMI operator panel and the PLC driver, one should proceed with the following procedure:

- Use the Change button on the F8/3 screen, which is presented in 0.
- Change the address in the open window at the Name label to that entered previously on the F8/2 screen in the address box.
- Repeat the previous steps for all languages available for the operation of the operator panel.

F8/3	System
Adres IP połączenia HMI z P.C	
192.168.0.11	ZMIENÍ

Fig. 7 The view of the settings of the connection between the HMI operator panel with the PLC driver.



In order to change the HMI operator panel network settings, one should proceed with the following procedure:

- Shut down the operating system with the Exit button on the F8/1 screen and proceed with the further procedures.
- Use the Info / Settings button in the Loader group.
- Use the Logon / Settings button in the Info/Settings group.
- Use the Transfer / Network button in the Settings group.
- Use the IP Address / Station Name button in the Transfer / Network group.
- Use the IP Address button and change the IP address.
- Use the Subnet Mask button and change the subnet mask.
- Use the Def. Gateway button and change the default gateway.
- Go to the higher menu level by pressing the Esc button several times.
- Start the application by pressing the Start button.
-

2.8 Communication with the Modbus TCP protocol

The PLC driver makes accessible the logs presented in Tab 7. through the Modbus TCP protocol as the Modbus server. Information contained within the logs may be used for visualizing the compressor condition in the master steering systems. When using this form of communication, one should notice the following:

- communication is handled via the Ethernet network,
- the 40001-40030 logs are intended only for Ou,
- each log has the form of a 16 bit fixed-point number with the (int16) sign,
- it is possible to read all the logs within viewing,
- the accessible logs are of the holding type and in order to read them, one should use the 03 Modbus function.
- the default PLC driver address is 192.168.0.11,
- the default communication port is 502,

Tab. 7 PLC driver log description.

Log no.	Description
40001	Compressor status: <ul style="list-style-type: none"> • 0 – stop • 1 – automatic stop • 2 – unload • 3 – start-up • 4 – neutral gear • 5 – compression • 6 –failure • 7 – no suction • 8 – stop
40002	Compressor work mode: <ul style="list-style-type: none"> • 0 – local idle run • 1 – local interrupted • 2 – remote idle run • 3 – remote interrupted
40003	System event condition signaling. If a given bit is set, the corresponding event is active. Bit number 0 corresponds to event 1 and bit number 15 - to event 16.
40004	System event condition signaling. If a given bit is set, the corresponding event is active. Bit number 0 corresponds to event 17 and bit number 15 - to event 32.
40005	System event condition signaling. If a given bit is set, the corresponding event is active. Bit number 0 corresponds to event 33 and bit number 15 - to event 48.



40006	Current air pressure in kPa.
40007	Current suction pressure in kPa.
40008	PLC driver entry condition. If a given bit is set, the corresponding entry has a high status. Bit number 0 corresponds to entry 0 and bit number 15 - to entry 15.
40009	PLC driver exit condition. If a given bit is set, the corresponding exit has a high status. Bit number 0 corresponds to exit 0 and bit number 15 - to exit 15.
40010	The current maximum compressor pressure setting in kPa.
40011	The current compressor cut-in pressure setting in kPa.
40012	The current compressor cut-out pressure setting in kPa.
40013	The current idle run time setting in s.
40014	The number of hours in operation.
40015	The number of working hours counter rewinding. The total result of logs 40014 + 32767 * value of log 40015.
40016	The number of hours in operation under load.
40017	The number of working hours counter rewinding for hours worked with burden. The total result of logs 40016 + 32767 * value of log 40017.
40018	Number of working hours left until next servicing.
40019	Number of days left until next servicing.
40020	Driver type: <ul style="list-style-type: none">• 0 – without manufacturer data• 1 – with manufacturer data
40021	Equipment compatibility program version number.
40022	Program function version number.
40023	Revision number for a given program function version.