MIKROEL®
PRODUCENT URZĄDZEŃ MIKROELEKTRONICZNYCH

MS-485

User manual for owner’s use

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1. Introduction

1.1. Description

MS-485 is a compressor controller dedicated to air compressors with operating power up to 22kW. It controls motors in star – delta configuration.

Controller features include:

- Automatic switching of star and delta motor configurations
- Supervision of pressure, oil temperature and motor current draw
- Support for external power line asymmetry modules
- Password protection of control parameters
- Number of counters for service time supervision
- Support for heaters, driers and condensation drain
- Networked operation mode (EIA-485)
- Remote control mode
- Multiple language versions

1.2. List of supported sensors

- Pressure sensor – 4-20mA current loop sensor
- Oil temperature sensor – PT100
- Power line asymmetry detector
- Motor current transformer
- Vacuum sensor
- Pressure switch
- Thermal switch
- Air filter, oil filter and separator sensors

1.3. Selection of language version

In the MS-485 controller, you can set one of the four available languages:

- polish
- english
- russian
- german

We are doing this at parameter **003u**.

1.4. References

In the following part of the instructions, two types of parameters will be used:

- **s** - service parameter - for example **014s**
- **u** - user parameter - for example **003u**

2. Safety

The person installing the controller must familiarize himself with the following manual and warranty information. Improper installation and handling of the controller voids the warranty.

Any connection and mounting work can be performed only when the supply voltage is disconnected.

The controller should be installed only by an authorized service or authorized personnel.

To comply with safety standards, the PE terminal of the controller should be connected to a protective conductor or dedicated grounding.

Using the controller without the encloure is forbidden as it might result in an electric shock.

The device should not be exposed to water or excessive humidity which may cause damage.

Before switching on check the electrical connections according to the connection diagram in the operating manual.

Before starting the controller, make sure that the power supply meets the requirements in the operating manual.

Any repairs can be done only by the manufacturer's service. A repair done by an unauthorized person voids the warranty.

3. User interface

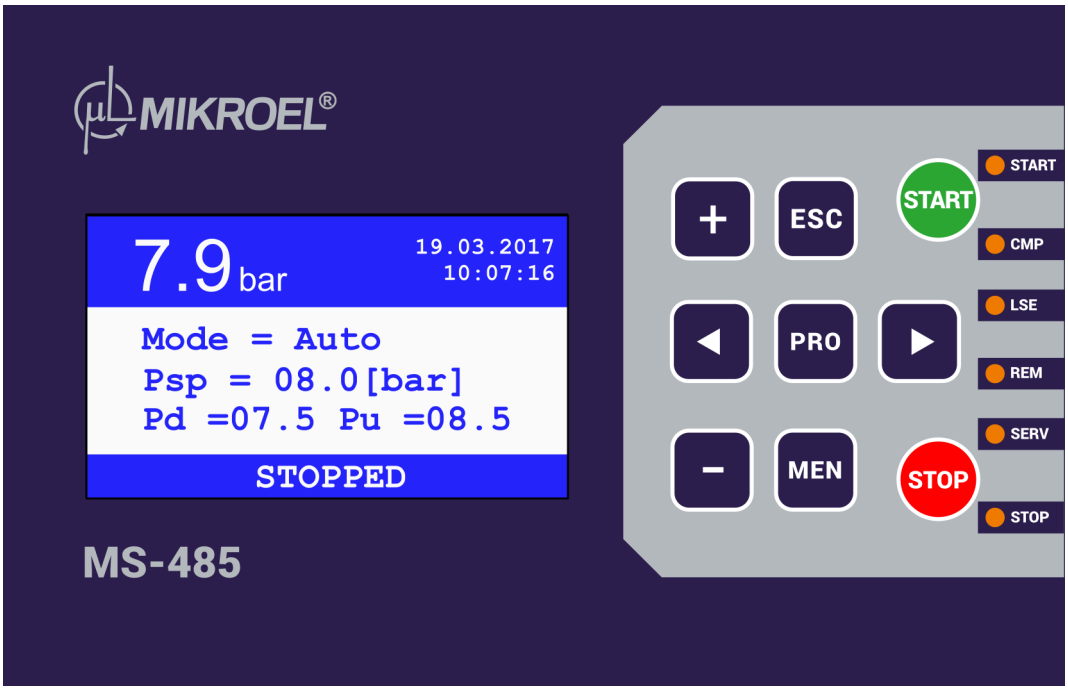


Figure 1: Front panel view

3.1. Button descriptions

3.2. Opis przycisków

Table 1: Opis działania przycisków

Przycisk	Opis	Zachowanie
MEN	Menu button	Enter user parameter list (single press) and service parameter list (double press)
PRO	Program button	Entering programming mode or confirming changes
ESC	scape button	Exit programming mode, return to the previous menu, and activate the screensaver
> <	Left and Right buttons	Transition between main menus, parameter set windows, each digit of the element, and switching between the multiplier and the offset of the sensor calibration
+	Plus button	Increase current setpoint or password character
-	Minus button	Decrease current setpoint or password character
START	Start button	Compressor start
STOP	Stop button	Compressor stop

3.3. Diode description

Table 2: Diode function description

Diode	Description	Diode behaviour
START	Start diode	**Constant** - air compressing or running idle **Blinking** - the engine is starting
CMP	Compression diode	**Constant** - air compressing
LSE	Engine operation in neutral	**Constant** - the engine is in neutral operation mode
REM	Network operation and remote operation diode	**Constant** - controller is in remote operation mode **Blinking** - controller is in active network operation mode
SERV	Service diode	**Constant** - the user or service menu is active or one of the main menu parameters is being programmed **Blinking** an error has occurred
STOP	Stop diode	**Constant** - the compressor is stopped **Blinking** - the compressor is stopped or in standby

3.4. Display

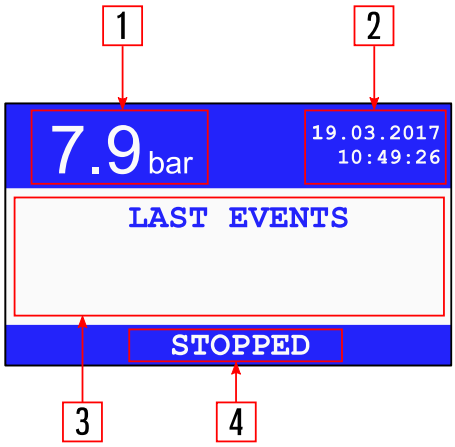


Figure 2: Main display screen

Table 3: Display area descriptions

Field	Description	Example content
1	Current pressure	7.9bar
2	Current date and time	19.03.2017 10:28:36

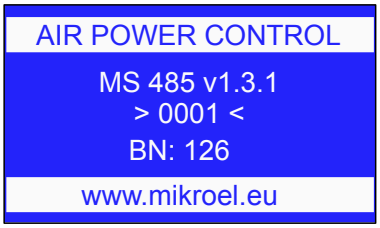
Table 3: Display area descriptions

Field	Description	Example content
3	Text field; contents depend on active menu	LAST EVENTS SERVICE PARAMETERS USER PARAMETERS
4	Information bar	controller state Time remaining until the start, end, or duration of the activity

3.5. Main menu

When the controller is started, two screens are displayed: title screen and basic controller information screen.

Table 4: Description of main menu title screens

Menu screen	Title
	Title screen
	Controller name and serial number

Then the controller displays title screen.

Main menu screens are described in Table 5 The user switches between screens using **<** and **>** buttons.

Table 5: Descriptions of main menu screens

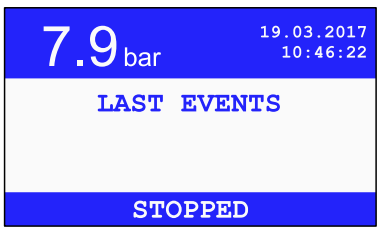
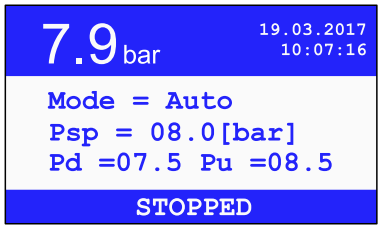
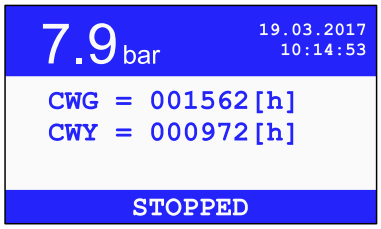
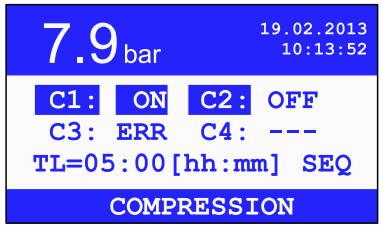
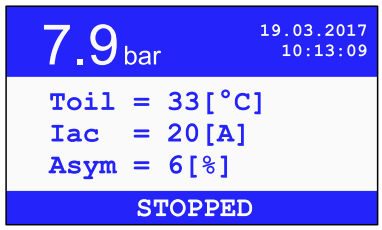
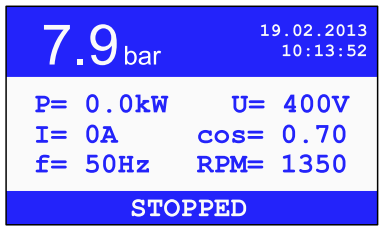
Menu screen	Title	Function
	**Recent messages menu**	Preview of the last message

Table 5: Descriptions of main menu screens

Menu screen	Title	Function
	**Operation parameters menu**	Operation parameter setup menu - operation mode, pressure limits
	**Counters menu**	Preview of current counter values
	**Network operation menu**	Network operation settings menu **disabled by default** (see section 9.3.)
	**Sensors menu**	Preview of current sensor values
	**Engine information**	Preview of engine parameters

3.6. First start

During the first controller start, the service parameters containing engine information (service parameter 006) must be set up in order to allow for the proper compressor operation.

3.7. User menu

The user menu is accessed by pressing the button **MEN**. Then enter the user password (if activated, default value *0000*) with the buttons **<**, **>**, **+**, **-** and accept the entered password with a button **PRO**. Entering an incorrect password will block the controller for 15 seconds.

Entering the appropriate parameter code (using the **+**, **-** buttons) and confirming the selection by pressing the **PRO** button allows for the display and modification of the desired parameter.

To change the value of the parameter, press once the button **PRO**, then using the buttons **+** i **-** make modifications. Accepting parameters by pressing the button **PRO**, and cancelling the change by pressing the button **ESC**. After the modification is completed, another press of the button **ESC** exits the menu.

Some parameters have sub-levels, marked in the documentation *parameter-sublevel*. When you enter the parameter edit with the button **PRO** select the corresponding sublevel with the buttons **<**, **>** and accept the selection with the button **PRO**.

For safety and stability reasons, some parameters can only be modified if the compressor is off. Similarly, when programming certain parameters, the compressor's start-up is blocked.

Parameter values can be previewed in any operating state.

3.8. User parameter list

Table 6: User parameter list

No	Description	Parameter	Unit	Range	Default
001u	Schedule			0-5 events	
002-1u	Reset oil counter value				
002-2u	Reset oil filter counter value		h/data		
002-3u	Reset air filter counter value		h/data		
002-4u	Reset separator counter value		h/data		
002-5u	Reset belt tension counter value		h/data		
002-6u	Reset general overhaul counter value		h/data		
002-7u	Reset general purpose counter value		h/data		
002-8u	Reset general purpose counter value		h/data		
003u	Language selection			PL, EN, RU, DE	Polish
004u	Network operation enabled			On; Off	Off
005u	Pressure limits rotation time in sequence algorithm of network operation	trot	h	1; 99	10
006u	Show controller information (controller model, software version, serial number)	Information			
007u	Show list of last 30 errors				
008-1u	Network operation controller ID			1; 15	8
008-2u	Network operation Modbus baudrate		bps	2400; 115200	9600

Table 6: User parameter list

No	Description	Parameter	Unit	Range	Default
008-3u	Network operation Modbus stop bits			8N1; 8N2	8N2
008-4u	Network operation Modbus parity			none, odd, even	none
011u	Time setup				
012u	Date setup				
015u	Idle-running time after exceeding the maximum pressure setting, after which the compressor enters idle operation mode	tlse	s	tlsemin; 999	180
018u	Show list of the last 30 events				
026u	Network operation algorithm (sequential, cascade)			SEQ; CAS	SEQ
027-1u	Network operation - pressure limit of compressor with ID=1		bar	Pmin; Pmax	8.0-6.0
027-2u	Network operation - pressure limit of compressor with ID=2		bar	Pmin; Pmax	8.0-6.0
027-3u	Network operation - pressure limit of compressor with ID=3		bar	Pmin; Pmax	8.0-6.0
027-4u	Network operation - pressure limit of compressor with ID=4		bar	Pmin; Pmax	8.0-6.0
028-1u	Delay between start of compressors in network operation mode		s	1; 20	8
028-2u	Network operation - master controller transfer enabled/disabled **Active only for slave controllers**			On; Off	Off
028-3u	Network operation - rotation algorithm automatic pressure limits change in event of controller number change enabled/disabled			On; Off	On
030-1u	Drying duration before compressor start	tdrst	min	0; 120	1
030-2u	Drying duration after compressor stop	tdrsp	min	1; 120	1
030-3u	Dryer auto-wait time	tdri	s	0; 99	30
040-1u	Time between condensate drains	drper	min	1;60	30
040-2u	Condensate drain time	drtim	s	1;10	5
051-1u	Screen brightness			20; 40	25
051-2u	Invert screen colors			On; Off	On
052-1u	Screensaver			On; Off	On
052-2u	Value displayed on screensaver		P, Toil		P

Table 6: User parameter list

No	Description	Parameter	Unit	Range	Default
060u	Time of reaction for REM line change	trem	s	2; 30	5
090u	The activity of the compressor restart function after an error occurs			On; Off	Off
111u	Restore user settings saved by the service				
423-1u	Change user password			000; 999	000
423-2u	Controller operation menu password protection			On; Off	Off
500u	Safety valve test				

4. Sensors

From the moment the controller is connected to the power supply, information is continuously gathered about the states of the machine's sensors and the devices working with it. These are analog sensors as well as binary (two-state) sensors, with the possibility of setting the input logic (parametr **271s**). The data collected by the sensors is then processed and analyzed by the controller based on the parameters set by the service and the user. Based on them, the MS-485 controls the operation of the machine and informs about any potential errors or events. The current values of the analog sensors are visible in the sensors menu. If question marks ("**????**") are displayed in the value field, it means there is no connection to the given sensor. On the other hand, the asterisks ("****") inform the user about exceeding the permissible value on this sensor.

4.1. List of supported sensors

4.1.1. Analog sensors

Table 7: Analog sensors list

Measured value	Unit	Type	Description
Pressure	bar	4-20mA	External pressure sensor
Oil temperature	°C	PT100	Resistive temperature sensor
Motor current	A		Current transformer
Power asymmetry detection	%	ASKF3B	Analog power supply sensor (interchangeable with the digital power supply asymmetry detection module)

4.1.2. Digital sensors

Table 8: Digital sensors list

Measured value	Default state*	Description
Power asymmetry		Digital power supply asymmetry detection module (interchangeable with the analog module)
Air filter	NO	Interchangeable with oil filter and separator sensor
Oil filter	NO	Interchangeable with air filter and separator sensor
Separator	NO	Interchangeable with oil filter and air filter sensor
Vacuum sensor	NO	
Thermal switch	NC	
Pressure switch	NO	

*__NO__ - normally open,

*__NC__ - normally close.

4.2. Sensor calibration

The analog inputs are calibrated by the manufacturer during production. If sensors need to be calibrated again, contact the manufacturer's service department.

5. Counters

Counters are used to control the compressor running time and to control the wear of mechanical components.

5.1. Service counters

Service counters count the time of the compressor's operation and are used to control the time remaining to replacement of some the mechanical components. The counters are supposed to inform the service about the need for such replacement after reaching the maximum value set by the service.

The MS-485 has 8 counters recording working time, 6 of which are defined, and the other 2 counters are general purpose counters (default inactive) that the user / service can assign to any function. The user can reset counter values, the service can change their maximum values in the range 0-9999.

List of service counters:

Table 9: Service counters list

No	Description	Parameter	Default max
1	Oil counter	002-1u	3000
2	Oil filter counter	002-2u	3000
3	Air filter counter	002-3u	3000
4	Separator counter	002-4u	6000
5	Belt tension counter	002-5u	0
6	General overhaul counter	002-6u	0
7	General purpose counter	002-7u	0
8	General purpose counter	002-8u	0

The time remaining to replace a given compressor component can be determined by:

1. Working time in hours
2. Replacement date

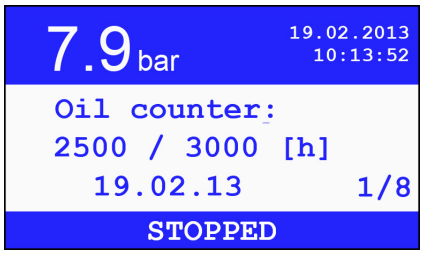


Figure 3: View of the oil counter screen.

Both times are treated independently, ie. only one of them can be active or both are simultaneously active.

In case of an hour counter, the controller counts only the compressor's active time (compressing and idle-running). The count value is not increased when the compressor is off or in standby mode. Achieving the maximum value of the hour counter or replacement date is treated as a non-critical error, and a message is displayed informing that the service counter value has been exceeded.

5.2. Setting counter values

The maximum hourly working time and the date of replacement are set in service parameter **002s**. To disable the unused counters the maximum value of the counter is set to *0000*, and for dates, the year value is set to *00*.

5.3. Resetting the counters

The service counter should be reset after replacing the compressor component. The counters are reset in user parameter **002u** by selecting the appropriate parameter number and holding down **ESC** for longer that three seconds.

Described procedure results in reset of the current counter value and date. If the working time control by date is to be active, it must be reset to **002s** in the service parameter.

5.4. Operating time counters

Working time counters count the characteristic parameters of compressor operation, so that they can determine the load and the nature of operation. The user can see the counter values in the working time counters' menu. The possibility of changing the value of the counters is available for the service in the service parameters presented in the table **??**.

Table 10: Operating time counters

Number	Description	Parametr	Max. default value
CWG	LWarranty counter - counts total time of compressor operation. Utilized by *warranty lockdown function*.	**542s**	0
CWY	Operation under load counter - counts total time of compressor operation with Y valve open.	**553s**	0
CONh	Compressor ON cycles counter within an hour - used for the maximum number of start-ups per hour (*CONhmax*) when the compressor does not have an engine temperature sensor.	**001s**	25

6. Errors and events

During the compressor operation the controller generates errors and events.

Events are displayed as on-screen messages and are used to inform the operator of the change in operating status of the compressor or co-operating devices. The message is displayed on the screen for a few seconds and then the screen returns to the state before its occurrence.

Errors are indicated by the pulsating service diode **SERV** and by displaying a message on the screen. Additionally, fatal errors are indicated by alternating changes of ACK line with a frequency of 1 Hz (provided that the controller is not set to REM mode) and by ERROR line which changes its state to low. The error remains active until the root cause of the problem has been eliminated and deleted from the list *LAST MESSAGES* with the button **PRO**. Errors are stored in the error list, available from the user parameter list (parameter **007u**). Deleting the error list is available only to the service in parameter **201s**.

Fatal errors report the failure and malfunction of the compressor, which could cause damage to the compressor or create a hazard for people nearby. When a fatal error is detected, the compressor is switched off. If the cause of the error is eliminated within a short time, then the automatic restart function restarts the compressor.

Restart of the compressor will not be possible until at least one critical error is active.

Non-fatal errors do not stop the compressor, they are only informative.

6.1. Fatal error list

Table 11: Fatal errors list

Number	Message	Error description
E01*	POWER ASYMMETRY	Compressor motor power asymmetry. Restarting the device may take place after the condition of the power network has been checked. When using the ASKF3B module, check its controls.
E02	WRONG PHASE SEQUENCE	Wrong phase connection. Turn off the controller, check the phase connections and the state of the power network. When using the ASKF3B module, the wrong phase sequence may be the cause of the error, but also the absence of one of the phases. Check the external ASKF3B module controls.
E03	ABSOLUTE PRESSURE OVERFLOW	The pressure exceed maximum allowed pressure value.
E04	OIL TEMPERATURE OVERFLOW	Maximum allowed oil temperature exceeded. The error may be caused by too low oil level or too high operating resistance of the device. Check the oil level and allow the oil mixture to cool down before restarting.
E06	Iac OVERFLOW	Exceeding the preset allowable motor current. The cause of the error may be too high operating resistance of the device. Failure can lead to engine damage.
E09	SETTINGS ERROR	Set service parameters or user parameters exceed their allowable values. Verify that the parameters set or transmitted externally (eg. by the master or visualization system) do not exceed the allowable values. Check if the motor parameters were entered correctly (see section 3.6. for details)

Table 11: Fatal errors list

Number	Message	Error description
E10	NO Toil SENSOR	Damage or failure to connect the temperature sensor of the oil mixture. Check if the appropriate sensor is connected and if it is not damaged.
E12	NO PRESSURE SENSOR	Damage or no pressure sensor connection. Check if the appropriate sensor is connected and if it is not damaged.
E15	ASYMM. MODULE ERROR	No ASKF3B external assymetry power supply module. Check if the ASKF3B is connected and is not damaged. To change the module type to binary, set the service parameter **014** to 0.
E16	THERMIC ERROR	Thermal switch error. Check the state of the thermal switch
E19	Iac UNDERFLOW	The value of the motor current during the device operation below the preset minimum value (service parameter **078**).

* - possible attempts to automatically restart the compressor after the error cause has been eliminated

6.2. Non-fatal errors list

A memory error may result in restoring the default configuration parameters. The controller configuration must be restored manually. Operating the compressor without re-configuration can cause the machine malfunction and lead to failure

In case of re-occurrence of errors it is required to contact the compressor service department

Table 12: Non-fatal errors list

Number	Message	Error description
E40	LOW OIL TEMPERATURE	Lower than set (service parameter **063s**) temperature of the oil mixture during compressor start. It may cause the heater to turn on if the function H1 or H2 is set on one of the configurable outputs in parameter **009**. The compressor will start after the oil mixture has reached the minimum oil temperature.
E41	OIL TEMPERATURE OVERFLOW	Higher than set (service parameter Toilh **063s**) temperature of the oil mixture. The machine starts after the oil temperature has dropped below the set value minus the set hysteresis value. The error will be reset automatically after the temperature has fallen below the set value minus 10 °C. In case of re-occurrence of the error it is required to contact the service.
E45	COMMUNICATION ERROR	Communication error on EIA-485 or CAN bus. Error can be caused by physical link damage, the exclusion of one of the cooperating devices or the incompatibility of their communication parameters.

Table 12: Non-fatal errors list

Number	Message	Error description
E47	SERVICE COUNTER(S) EXCEEDED	Exceeding one or more service counters. There is a likelihood that one or more of the compressor's components need to be replaced. **In case of an error it is required to contact the service**.
E59	AFOFSEP SENSOR ERROR	Air, Oil, or Separator Sensor Error. Check the condition of the filters.
E60	MEMORY ERROR	Memory error during driver startup. WARNING! A memory error may result in restoring the default values of the configuration parameters of the driver. After detecting a memory error, the compressor must not be started! It is necessary to reconfigure the driver. Failure to comply with the above recommendation may result in improper machine operation and lead to a breakdown.

6.3. List of events

Table 13: List of events

Message	Event description
DELAYED MACHINE START	Starting procedure as a result of 1. pressing the **START** button 2. REM setting in the remote mode 3. the command from the master controller in the continuous or automatic mode 4. scheduled work 5. restart of the controller.
DELAYED MACHINE STOP	Stopping procedure as a result of 1. pressing the **STOP** button 2. REM switching off in the remote mode 3. the command from the master controller in the continuous or automatic mode 4. planned work 5. a fatal error.

Table 13: List of events

Message	Event description
AUTOMODE WAITING	Memory error during driver startup. WARNING! A memory error may result in restoring the default values of the configuration parameters of the driver. After detecting a memory error, the compressor must not be started! It is necessary to reconfigure the driver. Failure to comply with the above recommendation may result in improper machine operation and lead to a breakdown.
INCORRECT MACHINE SHUTDOWN	Incorrect shutdown of the machine due to the disconnection or loss of power to the controller during compression. If the restart function (parametr **090u**) is enabled, the compressor will be turned on by the controller when the power is restored. **WARNING: The date and time of the event refer in this case to the moment the controller is restarted, not to the moment of power loss.**
RESTARTING PLEASE WAIT	Restarting the compressor after its improper shutdown or as a result of a fatal error that allows automatic restart.
RESTARTING PLANNED WORK PLEASE WAIT	Restarting the compressor in the scheduled (parametr **001u**) operation mode after its improper shutdown (the date and time of the restart is within the timeframe of one of the planned activities).
RESTARTING NETWORK PLEASE WAIT	Restarting the network operation on the master controller after its improper shutdown. Network operation will be initialized, including research of slave drivers.
COOLING PLEASE WAIT	The engine and oil mixture are currently cooling down. The event will occur when, at the machine's start, the oil temperature exceeds the maximum value of Toilmax reduced by the hysteresis.
HEATING PLEASE WAIT	The external heater has been activated. The heater is activated when the oil temperature is lower than the minimum temperature Toilmin at the start of the compressor. The machine will be started when the oil temperature reaches Toilmin + His Toilmin.
DRYING PLEASE WAIT	Waiting for the end of the dryer operation according to the set parameters *tdrst i tdrsp* (parametr **030u**).
EXCEEDING THE NUMBER OF ON CYCLES	The maximum number of start-ups within an hour has been exceeded.
ROTATION PROCEDURE NETWORK MODE	Procedure of rotation of maximum and minimum pressure limits on working compressors in the network. The message appears on the master controller after the set *trot* time has elapsed (user parameter **005**).
VS SENSOR WAITING	No signal from the VS sensor. The controller waits for the VS signal, which will cause the compression to start.

7. Operation theory

7.1. Motor control diagram

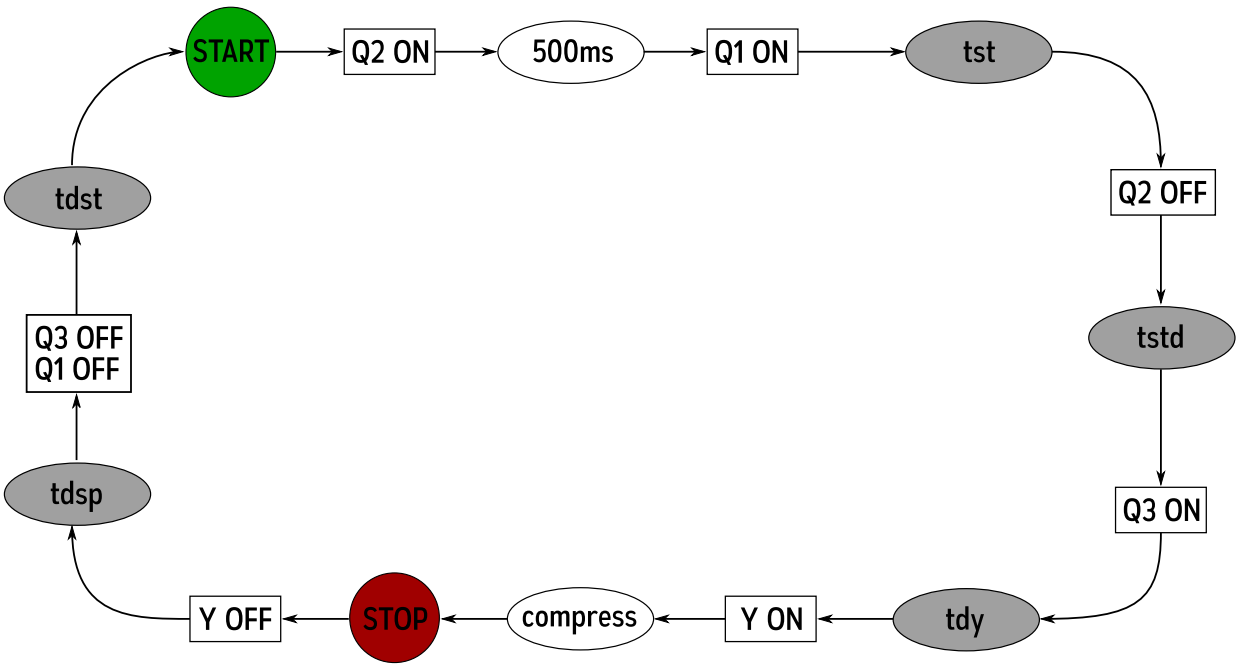


Figure 4: Motor control diagram

Basic compressor operation

- Start the operation (eg. pressing the button **START**)
- Switch on the contactor Q2 (starting the engine in a star configuration)
- Switch on the contactor Q1 (main contactor)
- Star-delta delay *tst*
- Switch off the contactor Q2
- Delay *tstd*
- Switch on the contactor Q3 (triangle configuration), engine in normal operation mode
- Delay *tdy*
- Switch on the Y valve - Start compression
- Compression. Switching off the Y solenoid valve causes the compressor to become unloaded and the engine to run idle. The Y valve is activated/deactivated by the operating algorithm according to the required maximum pressure settings*Pu* and minimum pressure *Pd*.
- Stop the operation (eg. pressing the button **STOP**)
- Switch off the Y valve, switch to idle running

- Stop delay time *tdsp*
- Switch off the contactors Q1 and Q3
- Delayed restart *tdst*, the motor start-up may take place after this time. If the compressor operation is resumed before it expires, the engine will start running at an appropriate delay.

7.1.1. Decompression control method

Decompression control can be carried out using a few strategies, using decompression sensor (Vs), decompression timer (tdst) or the combination of both. The selection of decompression control method is done by selecting the appriopriate option in service parameter **047**.

7.2. Motor operation parameters

The parameters that control the motor operation together with the corresponding service parameters are shown in the table 14.

Table 14: List of parameteres controlling the motor operation

Name	Parameter	Unit	Description	Default value
tst	078-1s	s	Star-delta switching time	7
tstd	010s	ms	Star-delta switching time delay	40
tdy	036-4s	s	Compression waiting time	2
tdsp	036-3s	s	Compressor stop delay time	5
tdst	036-1s	s	Compressor start delay time	30
tlse	015u	s	Idle run work time after exceeding the upper limit of pressure	180
tlsemin	036-2s	s	Minimum value *tlse*	180
Imin	078-3s	A	Minimum motor current value	0
Imax	078-2s	A	Maximum motor current value	34
Iac		A	Motor current	
CONhmax	001s		Maximum number of start-ups within an hour	25

7.3. Pressure control parameters

We make changes to the pressure parameters in the main menu of the controller's operating parameters settings. They are presented in Table 15.

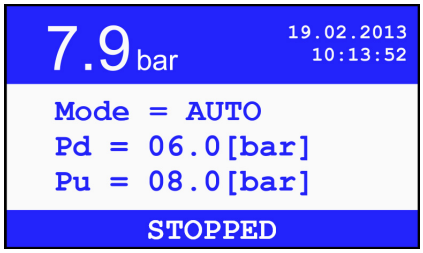


Figure 5: Settings menu for work parameters MS-485

Table 15: List of pressure control parameters

Name	Parameter	Unit	Description	Default value
Mode	Main Menu		Compressor Operating Mode (AUTO, CONST, REM)	AUTO
Pd	Main menu	bar	Lower pressure limit at which the machine starts to compress air	6.0
Pu	Main menu	bar	Upper pressure limit after which the machine stops to compress air	8.0

7.3.1. Pressure limit parameters

The change of the pressure limit parameters (tabele 16) should be carried out by the service in order to correctly adjust them to the type of compressor and the characteristics of the installation.

Table 16: List of pressure limit parameters

Name	Parameter	Unit	Description	Default value
Pabs	045-3s	bar	Absolute pressure. Specifies the pressure level at which the fatal error message will appear and the machine will stop	11
Pdelta	045-4s	bar	Minimum difference between maximum and minimum pressure.	0.2
Pmax	045-2s	bar	Maximum pressure setting possible	10
Pmin	045-1s	bar	Minimum pressure setting possible	5

8. Operation modes

Available operation modes:

1. AUTO - automatic mode
2. CONST - constant operation mode
3. REM - remote control mode
4. LOCAL - local operation mode

8.1. Automatic mode (AUTO)

In automatic mode the controller automatically starts and stops the compressor when the desired pressure limits are met.

When the pressure reaches the upper limit *Pu* the compressor enters the neutral motor operation state, where the motor is run with the Y valve closed for time *tlse*. When the measured pressure value reaches value below the lower pressure limit *Pd* the unit resumes compressing.If the pressure value is higher than the lower limit *Pd* the motor is stopped and enters the auto-wait mode. The motor will be restarted after the pressure value has fallen under the lower limit *Pd*.

Automatic operation mode is recommended when the pressure demand is intermittent.

8.2. Constant operation mode (CONST)

In constant operation mode the compressor's motor is continuously running.

When the pressure reaches the upper pressure limit *Pu* the compressor enters the neutral motor operation state, where the motor is run with the Y valve closed until the pressure value reaches the lower limit *Pd*, after which the Y valve is open and compression continues.

Constant operation mode is recommended when the pressure demand is periodic without long intermissions.

8.3. Remote control mode (REM)

Remote operation mode enables remote management of the compressor's operation using **REM** input or Modbus RTU protocol. It allows the user to set up several compressors to participate in regulation managed by a master controller (e.g. MS4CMPXv2 or the MS-Connect2 visualization system) or a simple on-off control using remote device such as a button on the control panel.

In the remote operation mode the lower and upper pressure limits become inactive by default (the unit does not manage pressure in the system)

For a controller to react to remote commands it must be in ready mode (pulsing red STOP diode and pulsing orange engine diode). To enter ready modes the user presses the START button.

8.3.1. REM input operation

REM input is active low. Control of a unit's operation, using **REM** input is based on the principle of remotely enabling and disabling the active compressing of a single unit, while the unit does not manage the pressure in the system. By default, the reaction to the **REM** signal is as follows:

- **REM** active - load, master controller enables the unit's compression
- **REM** inactive - unload, controller disables the unit's compression

Manual stop in the remote control mode (by pressing the **STOP** button) results in manual disabling of remote control mode (notification: *REMOTE CONTROL DISABLED*). Up until the next press of the **START** button, the controller will not start the operation.

After an improper shutdown during the controller operation while the automatic restart mode is active (section 11.6.), the controller will enter ready mode. If REM input is low, the machine will be switched on. The minimum time that the REM input operation must be maintained to start the compressor is set to *trem* (user parameter **060**).

8.3.2. Enabling the pressure limits in the remote control mode

In order to use the **REM** input as a remote **START** signal (to use it with a remote switch on the control panel, for example) the pressure limits must be manually enabled in service parameter **263**. After the limits are activated the reaction to the **REM** signal is as follows:

- **REM** active - enable operation, the controller regulates the pressure to be within specified limits in automatic mode
- **REM** inactive - disable operation, the controller does not regulate the pressure

8.3.3. ACK output

ACK output informs the master controller that the compression has been started. It can also be used to construct a user interface on the devices control panel by controlling light indicators. Stopping the compressor causes the ACK signal to be removed.

8.3.4. Connecting the driver in REM mode

Connecting the controller in REM mode. Before connecting the slave controller, one of its universal outputs (e.g. *OUT 2*) must be set as the ACK confirmation line output. The configuration of universal outputs is described in section **??**. The REM line input on the slave controller should be connected to the control output of the master controller, while the configured ACK line should be connected to the feedback signal input on the supervising controller. Below is a diagram showing the connection of four slave controllers operating in REM mode to the master controller MS4CMPXv2.

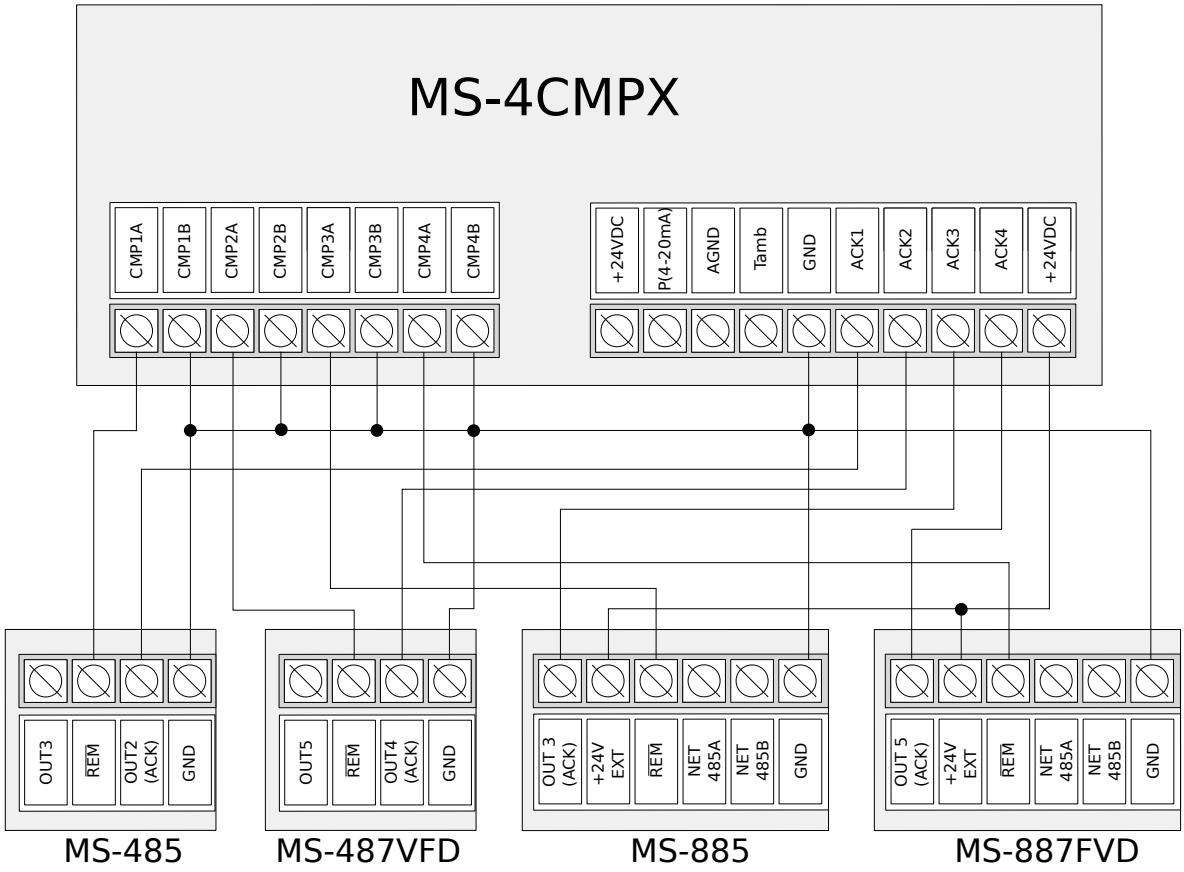


Figure 6: Schemat podłączenia sterownika

8.3.5. Modbus RTU

The MS-485 controller has been equipped with RS485 communication interfaces. Data exchange is carried out based on the Modbus RTU protocol. Sending the appropriate command via the Modbus protocol results in the controller performing a specific action. Control of work through commands is carried out, just like in the case of the REM line, based on remote pressure control (relief/load):

- Command that causes the compressor to enter a loaded state – based on the pressure dropping below the lower pressure limit Pd
- Command that causes the compressor to switch to a unloaded state – based on the increase in pressure above the upper pressure limit Pu

The description of the functions and control capabilities of the compressor using the Modbus RTU protocol is included in the chapter on *Network Operation*.

8.4. Local operation mode (LOCAL)

In local mode the controller uses only local settings. Parameters set using communication protocols and scheduled tasks are ignored.

9. Network operation

The MS-485 controller can manage a group of up to 4 compressors (including itself) using one of two algorithms: sequential or cascade.

All controllers in the network must be connected to each other via a single, established network link: RS485. The data transmission between controllers used the Modbus RTU protocol, which is why the MS-485 can manage all controllers from the *MS* family equipped with this protocol and the appropriate port. (RS485). The transmission speeds on all controllers in the network should be set to the same. When there are large distances between controllers, it is recommended to set lower speeds. At short distances, transmission speeds can be higher. In the network, only one *master* controller can operate. The others work as *slave* controllers. The *master* function is automatically assigned to the controller on which it will be launched, and then the network operation will be initialized. To enable network operation on the given controller, the parameter **004u** should be set to 'Enabled'. This will cause the network menu to appear as one of the main driver menus. The operation of the compressor controlled by a *master*-type controller is independent of the network operation control! The controller on which the network operation is running may or may not operate within the network. If its ID is greater than 4, it will manage the network, but the compressor controlled by it will operate independently (it will not be taken into account in the network operation algorithm). To start the network operation, at least one active compressor is required, whose controller has a Modbus identifier in the range of <1,4>.

Network operating parameters in each of the connected controllers must be configured properly before starting network operation

9.1. Enable/disable network operation

Network operation start is ordered by the *master* controller. To get started, go to the network menu on the controller and press **START**. Active compressors on the network will be started (with start delay as set in user parameter **028-1u**). Network mode is stopped by pressing the **STOP** button in the network operation menu.

Pressing the **START**/**STOP** button from a different position than the network menu only affects the operation of the compressor connected locally to the controller. This makes it possible to stop the compressor connected to the master controller without having to stop the network operation. Network activity is signalled by the blinking network diode *REM*.

Manually stopping the compressor other than the master results in its elimination from the network operation. The compressor is restored to the network operation after manual start with the **START** button. When there is no active compressor in the network , the network mode stops.

9.2. Search for controllers in the network

After the network operation has been initialized on the master controller, search for controllers connected to the network follows.

For a controller to be able to work in network operation mode, it's identifier (Modbus ID, User 008) must be set to a value of 1-4 (identifiers within a network can not be repeated). The order of compressor IDs in the network does not matter. Nevertheless, it is advised to set the IDs in logical manner for easy identification, e.g. according to the physical location of machines in the compressor room. Controller search in the network happens every time the user presses **START** button on the master controller, while the network menu is open. The search for controllers connected to the network occurs also during operation, allowing the user to add new devices to the network without stopping the network mode.

For the master controller, it is possible to set it's identifier to a value outside range of 1-4. Then it will not be used in network operation.

9.3. Network operation menu

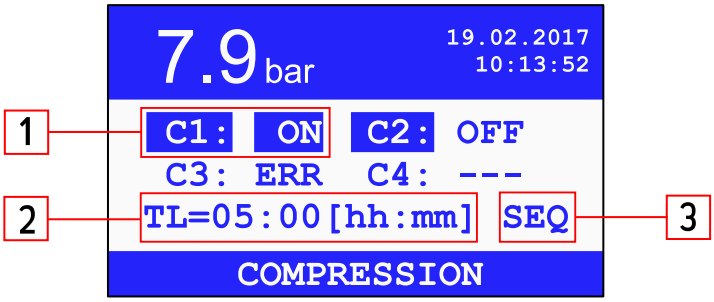


Figure 7: View of network operation menu

Network menu description:

1. The operation status of the compressor, where Cx represents the compressor with identifier x (Modbus ID):
   - **ON** - compressor is running
   - **OFF** - compressor is stopped
   - **ERR** - fatal error
   - **- - - -** didn't detect a controller with this ID
2. Time left until next rotation (active only in SEQ mode)
3. Network operation algorithm: SEQ (sequential) or CAS (cascade)

9.4. Errors and events in network operation

A fatal error of a controller causes it to be removed from the network algorithm. The controller will return to network operation after the error has been removed and the compressor has been manually activated by pressing the **START** button.

Occurrence of non-critical communication error **(E45)** on the master controller informs the user that the communication with slave controllers has been lost. The loss of communication (e.g. due to a connection failure) will not cause the slave controller to change its status. If the slave controller is in active state after successful communication attempt, it is automatically restored to the network operation algorithm. If not, the slave controller operation must be restarted automatically using **START** button.

Restoring power after power failure will restart network operation if network reboot is enabled in user parameter **090u**.

9.5. Master takeover function

Master takeover allows the master controller function to be taken over by one of the slave controllers when the communication with the master controller is lost. Master function is taken by the slave controller with the highest ID. The function is enabled in user parameter **028u**.

9.6. Master controller configuration

Using the controller as a master controller requires configuration of parameters:

1. User parameter **004u** - network operation *ON*
2. User parameter **008u**
    - **008-1u** Modbus identifier, unique in the network
    - **008-2u** baudrate **(same for all compressors in the network)**
    - **008-3u** data formatting **(same for all compressors in the network)**
3. User parameter **026u** - type of network operation algorithm: Cascade *CAS* or Sequential *SEQ*
4. User parameter **027u** - assign pressure limits to individual compressors in the network
5. User parameter **028u** - algorithm control:
    - delay time between starting compressors in the network
    - automatic reconfiguration of the pressure limits when one or more compressors are removed from the network
6. User parameter **005u** - rotation time between rotations of the pressure limits between active compressors in sequential mode
7. User parameter **090u** - restart function on/off
8. Select if the master controller is actively involved in network operation

9.7. Slave controller configuration

Using the controller as a slave controller requires configuration of parameters:

1. Select operation mode:
    - Remote *REM* - remote pressure control with Modbus commands (load/unload) based on the pressure of the master controller, where the upper and lower limit values of Pd are not taken into account.
    - Automatic or Continuous - pressure control (internal measurement) based on upper Pu and lower Pd pressure settings
2. User 008u parameter:
    - **008-1u** Modbus identifier, unique in the network
    - **008-2u** baudrate **(the same for all compressors in the network)**
    - **008-3u** data formatting **(the same for all compressors in the network)**

- **008-4u** parity **(the same for all compressors in the network)**

3. User **028u** parameter - Enable/Disable master takeover function

Master controller manages pressure in the system based on its own pressure measurement. Slave controllers receive commands based on desired pressure limits *Pu - Pd* set in network algorithm configuration parameters. For the slave controllers, it is recommended to configure them in remote operation mode (REM).

The pressures *Pu - Pd* assigned to a slave controller in network operation mode should fall within limiting values *Pmax - Pmin* of that slave controller.

9.7.1. Network mode watchdog

Network mode watchdog allows the compressor to operate if the communication with master controller has been interrupted. If the network mode watchdog function has been enabled (service parameter **016-1**), the slave controller measures the time that has elapsed from the last packet sent by the master controller. If that time exceeds the set limit (service parameter **016-2**), the slave controller switches to automatic operation mode.

9.8. Sequential operation algorithm

The sequential algorithm is designed for the operation in a network of compressors of similar power. The algorithm assumes an even distribution of active operation time between all compressors in the network. This involves cyclical changes in the distribution of the *Pu-Pd* pressure limits of the controllers. Therefore, the sequence of pressure ranges relative to compressor identifiers is not relevant. Rotation of the pressure limits takes place at the interval *trot* (user parameter **005u** on the master controller).

Time left to rotate *TL* is counted down while network operation is active and is visible in the network menu. When stopped, this time is memorized and, after restart, its countdown is continued. This assumption is also satisfied when the controller is off or power failure occurs.

In the rotation phase, no individual compressors are stopped. Stopping/starting the compressor can only occur when current pressure meets the conditions of its newly assigned limits *Pu – Pd*. In the pressure rotation procedure, only the active compressors are involved.

Recommended settings of pressure limits *Pu – Pd* in a sequential algorithm (user parameter **026u**) are exclusive step ranges. With such distribution, the compressor with the highest range of limits is switched off the latest (after reaching the desired pressure in the network) and activated the earliest, because it has the highest lower limit pressure *Pd*.

Before rotation			**After first rotation**			**After second rotation**			cd
ID	*Pd*	*Pu*	*ID*	*Pd*	*Pu*	*ID*	*Pd*	*Pu*	
1	6.0	7.1	1	3.0	4.1	1	4.0	5.1	
2	5.0	6.1	2	6.0	7.1	2	3.0	4.1	...
3	4.0	5.1	3	5.0	6.1	3	6.0	7.1	
4	3.0	4.1	4	4.0	5.1	4	5.0	6.1	

Another example setting of pressure limits *Pu – Pd* in a sequential algorithm is to give the compressors the identical upper limit of Pu and step the lower limits. In this situation, all compressors will be switched off simultaneously and switched on when the pressure drops below the lower limit *Pd*.

1. All active			2. ID=2 compressor inactive			3. Rotation without ID=2 compressor		
ID	*Pd*	*Pu*	*ID*	*Pd*	*Pu*	*ID*	*Pd*	*Pu*
1	6.0	7.1	1	6.0	7.1	1	5.0	6.1
2	5.0	6.1	2	3.0	4.1	2	3.0	4.1
3	4.0	5.1	3	4.0	5.1	3	6.0	7.1
4	3.0	4.1	4	5.0	6.1	4	4.0	5.1

Before rotation			After first rotation			After second rotation			cd
ID	*Pd*	*Pu*	*ID*	*Pd*	*Pu*	*ID*	*Pd*	*Pu*	
1	6.0	7.0	1	3.0	7.0	1	4.0	7.0	
2	5.0	7.0	2	6.0	7.0	2	3.0	7.0	...
3	4.0	7.0	3	5.0	7.0	3	6.0	7.0	
4	3.0	7.0	4	4.0	7.0	4	5.0	7.0	

For compressors that are stopped manually or due to a critical error, the lowest pressure limits are automatically transmitted (with automatic reconfiguration enabled), and their limits are assumed by the active compressors with the lowest limits *Pu – Pd*.

For example, if in scenario 1 the compressor with the ID=2 is manually stopped, the limits will be as in scenario 2. If the compressor with the ID=2 remains inactive, the pressure distribution resolves to scenario 3 after another rotation.

9.9. Cascade operation algorithm

Cascade algorithm is designed for operation in a network of compressors of different powers. The algorithm assumes that the lowest power compressor is switched on and off the most often. The highest-powered compressor will only be started when there is a high demand for network pressure. This assumption is due to the high power consumption of the motor at its start. In addition, this strategy increases the longevity of the motor in the compressor of the highest power.

Recommended setting of limits *Pu – Pd* in the cascade algorithm is to give the compressors same upper limit *Pu* and different lower limit *Pd* (scenario 1). In this situation, all the machines will compress the air to achieve the required network pressure and then shut down simultaneously. At low pressure requirements, the compressor with the lowest power (ID=4) will be switched on. If the pressure drops below the compressor's lower limit of ID=3, this compressor will also be switched on.

1. All active				2. Compressor ID=2 inactive			
ID	*Pd*	*Pu*	Power	*ID*	*Pd*	*Pu*	Power
1	3.0	7.0	120kW	1	4.0	7.0	120kW
2	4.0	7.0	100kW	2	3.0	7.0	100kW
3	5.0	7.0	50kW	3	5.0	7.0	50kW
4	6.0	7.0	20kW	4	6.0	7.0	20kW

In the cascade algorithm the pressure limits *Pu – Pd* are permanently assigned to the particular compressor identifier. There is no rotation procedure (rotation time *trot* is not taken into account).

When setting the pressure limits, the compressor sequence is important relative to ID. When automatic reconfiguration (user parameter **028**) is enabled, compressors stopped manually or due to a fatal error automatically assume the lowest pressure limits *Pu – Pd* in the network. This causes the lower limits to move up one position.

For example, if in scenario 1 a fatal error occurs on the compressor with ID=2, the automatic reconfiguration re-

distributes limits *Pu-Pd* to values in scenario 2. After the compressor with ID=2 has been restored, distribution of limits returns to scenario 1.

9.10. Connection of controllers in network operation

It is recommended to connect cooperating drivers and additionally to run the RS485 bus over shielded cables.

9.11. Integration with the visualization system

The use of the communication interface allows the controller to operate with the visualization system (for example MSConnect2 or MSAirControl). Due to the RS485 structure, the MS-485 controller cannot operate on the network and be connected to visualization simultaneously.

10. Schedule

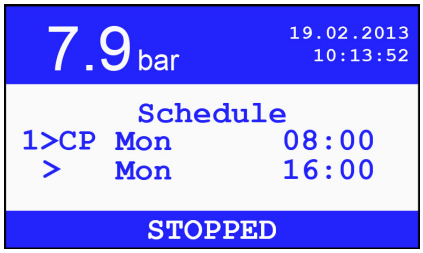


Figure 9: View of the schedule

Schedule allows the user to plan the operation cycles of the compressor, facilitating scheduling the production process and allowing for maintenance-free operation. It is possible to declare up to 5 tasks with the option of a single start-up (one-time start-up on a particular day) or recurring (on specific days of the week) instances of a task. Each task allows you to choose the operating mode of the compressor. Work schedule settings are available in user parameter **001u**.

Do not perform operations on any component of a compressor when at least one task is active, as the task may execute and compressor may start

10.1. Schedule description

Proper setting of the real-time clock is required for operation of work schedule.

When the scheduled task start is detected the compressor starts in the operation mode specified in task configuration.

If the scheduled task is detected when the compressor is running, the compressor mode will be changed to the mode specified in the task configuration. In addition, if the end of the task occurs the compressor will return to the mode in which it was running before the task started.

If the controller has been properly initialized on the network, detection of the scheduled task causes the compressor to start running without changing the operating mode. The exception of that is when the task's mode of operation is specified as the network mode, which launches the network operation algorithm and does not directly relate to the operation of the compressor. Network operation will be started provided that the network algorithm parameters are enabled and configured. After the task expires, network operation will be stopped.

The scheduled task is automatically restarted in case of a power failure, if a time condition is fulfilled.

A given task can be cancelled in the user parameter **001** by setting its operating frequency to *Off*. If **STOP** is pressed during the scheduled task, the job will be temporarily cancelled and the compressor will stop. Restoring the task will take place after pressing **START**. Scheduled stopping of the machine will take place at a fixed time. Manually stopping the scheduled task (with **STOP**) does not cancel the remaining tasks, but only the current one.

10.2. Schedule settings

When scheduling the work, determine whether the task is to be repeated periodically (weekly plan) or whether it is a one-time start-up and stop of the compressor.

Using the **<** and **>** buttons, select the task (the active task is indicated by ») and press the **PRO** button. Pressing the **PRO** button again enters the edit mode where the **+** and **-** buttons change their value. Validate the parameter value with the **PRO** key. After accepting the given values, pressing the **ESC** button takes the user to the next parameter. If the entered date is incorrect, the user will be informed and the planning of the task will begin again.

When a task has been scheduled in the task list, the following information appears:

- day of week / date and time of compressor start
- day of week / date and time of compressor stop
- operating mode: Continuous (*C*), Automatic (*A*), Remote (*R*) and Network (*N*)
- frequency of operation: weekly cycle *P* - periodic or single - one-time task

11. Other functions

11.1. Heater

Connecting an external relay to a universal output configured as *Heater 1* or *Heater 2* allows for controlling the heating function of the oil mixture.

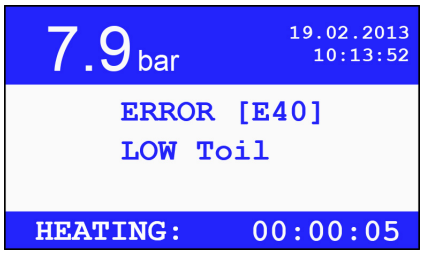


Figure 10: View of the MS-485 screen with the heating function turned on.

11.1.1. Heater 1 (H1)

If the *Heater 1* function is activated at one of the outputs, upon receiving the **START** signal, the temperature of the oil *Toil* is checked. If the *Toil* temperature is lower than the minimum oil temperature *Toilmin* (parameter **063-1s**), the controller activates the heater output 1 and prevents the compressor from starting during the heating period. Upon reaching a temperature higher than the hysteresis *His Toilmin* (parameter **066-1s**) from the minimum oil temperature *Toilmin*, that is, *Toilmin + His Toilmin*, the heater output will be turned off and the compressor start procedure will be initiated. The *Heater 1* only operates when the compressor starts and is used to warm up the oil before startup.

The activity of the heater is indicated by the text *HEATING* on the information bar at the bottom of the screen.

11.1.2. Heater 2 (H2)

If the *Heater 2* function is activated at one of the outputs, then regardless of the compressor's operating state, the oil temperature is continuously monitored *Toil*. If the *Toil* temperature is lower than the minimum oil temperature *Toilmin* (parameter **063-1s**), the heater output is activated until the oil reaches a temperature higher than the minimum oil temperature Toilmin by the hysteresis His Toilmin (parameter **066-1s**), that is, *Toilmin + His Toilmin*. If a start signal occurs during the operation of the Heater 2 function, it will be blocked until the cutoff temperature of the heater is reached. The heater 2 operates continuously as long as the controller is turned on, and it serves to maintain the appropriate temperature of the oil mixture in the compressor

The activity of the heater is indicated by the text *HEATING* on the information bar at the bottom of the screen.

11.2. Dryer

Connecting an external contactor to the universal output configured as dryer allows the controller to control the dryer.

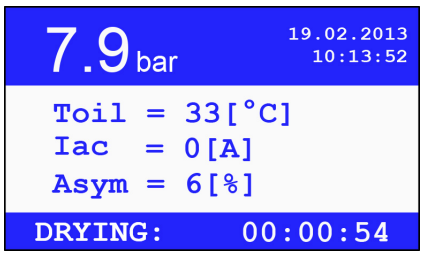


Figure 11: View of the MS-485 screen with the drying function turned on.

Parameters controlling the dryer operation:

Table 17: List of parameters controlling the dryer operation

Name	Parameter	Unit	Description	Default value
tdrst	030-1u	min	Drying time before compressor start	1
tdrsp	030-2u	min	Drying time after compressor stop	1
tdri	030-3u	s	Dryer idle time after stopping.	30

If the compressor is switched on after time shorter than *tdri* the *tdrst* time will not be counted and the compressor will switch on simultaneously with the dryer.

The activity of the dryer is signalled by the word *DRYING* in the info bar at the bottom of the screen.

Additionally, there is the option to activate the dryer when the compressor is in standby mode. Its operation can be regulated by turning the dryer on and off at a specified frequency and with a specified fill level. This allows for the efficient use of the dryer with reduced energy consumption. The parameter **008-1s** is responsible for the period of changes, while the parameter **008-2s** is responsible for the completion.

Additional parameters controlling the operation of the dryer:

Table 18: List of additional parameters controlling the operation of the dryer

Parameter	Unit	Description	Default value
008-1u	min	The work cycle time of the dryer in standby mode	5
008-2u	%	The work cycle time of the dryer in standby mode	100

Sample parameter settings **008s**:

008-1s = 10 min, 008-2s = 30 % This means that the dehumidifier will be turned on for 3 minutes every 10 minutes in a cyclical manner. (3 min - on, 7 min - off)

11.3. Condensate drain

Connecting an external contactor to a universal output configured as a condensate drain output allows the controller to control the condensate drain (parameter **009s**).

Condensate drain function activates the condensate drain valve periodically during compressor operation.

Parameters controlling the condensate drain operation:

Table 19: Condensate drain parameter list

Name	Parameter	Unit	Description	Default value
drper	040-1u	min	Time between operations of condensate drains	30
drtim	040-2u	s	Condensate drain time	5

Condensate drain is inactive only when the compressor is stopped.

11.4. Cooling

Connecting an external contactor to the universal output configured as a fan controller allows the controller to control the oil cooling fan.

Connecting an external contactor to a universal output configured as heater allows the controller The compressor start is possible only when the oil temperature does not exceed the value *Toilmax* (service parameter **063**) and when the engine temperature does not exceed characteristic engine temperature *Tch* (service parameter **078**).

During compressor stop, if the engine temperature is higher than *Tch* the engine will be run in neutral until the engine temperature falls below *Tch - Tch hysteresis* (service parameter **078**).

11.5. Pressure switch

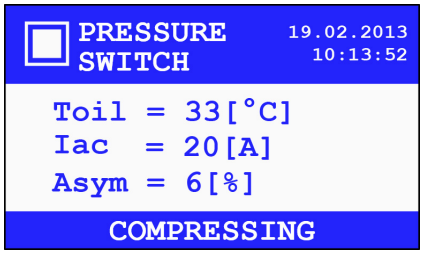


Figure 12: View of the MS-485 screen with the pressure switch function turned on

The MS-485is equipped with a function that allows for the pressure sensor to be turned off and to switch to pressure switch control.

Pressure control using pressure switch is enabled in service parameter **099**. When pressure switch control is enabled, instead of the pressure value the controller displays *PRESOSTAT* string in the top bar of the display along the animated rectangle displaying sensor's logic state.

When the square is filled the driver interprets this as an active state, analogous to the pressure drop below the lower limit Pd. Recharging to the appropriate pressure, changes the state of the pressure line and is interpreted as an increase in pressure above Pu, deactivates the compression, shown by the completion of the animation fill.

By default, pressure switch logic is NO, input logic is selected in service parameter **271s**.

According to the default setting, when the pressure switch outputs a high state (+24VDC) to the input line, the compressor will start and enter the compression state by activating valve Y. When the low state appears on this line, the compressor stops compressing.

If pressure switch is activated, the screensaver displays oil temperature instead of pressure.

11.6. Automatic restart

Performing operations on active components of a controlled compressor is not allowed when the restart function is active because the controlled device may be started.

The automatic restart function allows the compressor to start automatically after a power failure during active operation. All interrupted operation parameters will be retained after the compressor is restarted. The restart function applies to:

1. operation of a single machine
2. network operation on the Master controller
3. scheduled work, if time dependencies are met after the power has been restored

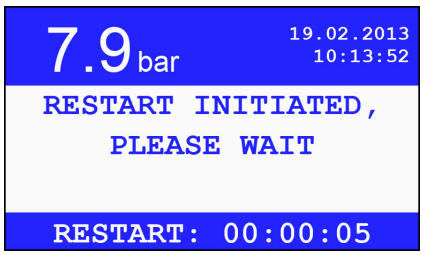


Figure 13: View of the MS-485 with the initiated restart function

In addition, it is possible to automatically restart the controller after few of the critical errors have occurred, such as when the oil temperature falls below the maximum value after an oil temperature error has occurred.

Due to the danger of engine damage, the number of automatic restarts is limited to 2. The counter of the number of restarts is reset when the compressor is stopped by the **STOP** button.

The Restart function is preferred unattended operation of the compressor is required and it is necessary to maintain constant network pressure.

11.7. Power asymmetry control

Control of the power supply asymmetry is done by means of an external module. Detecting asymmetry causes a fatal error. Restoring the compressor is only possible after the cause of the failure has been eliminated.

Supported modules:

1. Analog power supply control modules (eg. ASKF3B) - events such as no module connection, wrong phase sequence and power supply asymmetry exceeding the set level (service parameter **014**) are detected and identified.
2. Digital modules - the controller detects a power failure based on the signal from an external binary module. The error is always signalled with the message *POWER ASYMMETRY*, there is no way to detect the cause of the error.

Asymmetry line sampling time is specified by the service parameter **033** *tasym*. Detected asymmetry for shorter periods of time will not cause an error.

When using an analog module it is crucial to set the allowable level of asymmetry in service parameter **014**. This level determines the degree of deviation of the phase with the lowest voltage relative to the phase with the greatest voltage.

Table 20: Possible to set deviation values

The value of the parameter	Level of asymmetry
0	0%
1	7%
2	13%
3	33%
4	50%
5	70%

When using the digital module, set the power supply level to 0.

11.8. Save/restore parameters

After the controller has been configured the service has the possibility to save current user and service settings (service parameter **112**). Restoring user settings can be done in user parameter **111** and restoring service settings in service parameter **111**.

In case of restoring parameters that were not defined during the recording, the default parameters of the manufacturer will be restored. **The user and service passwords are not subject to saving and restoring**.

11.9. Controller lock

The lock function allows the user to activate a lock that will activate in two cases:

1. when the CWG warranty counter exceeds the maximum value specified in the service parameter **244**
2. when the current date exceeds the date set in the service parameter **245**

Removing the lock is possible in service parameter **243** or by the code provided to the user.

The code is generated for a particular sequence of numbers. Only authorized personnel has the access to the code generator. This method allows the user to unlock the machine without the presence of the service crew. The controller lock function allows the compressor manufacturer to provide the client with a controller demonstration, for a specific compressor operating time, or up to a specific date. **When the lock function is enabled, there is no possibility to modify the date or time.**

11.10. Y valve test

The function allows the service to manually control Y valve. The control is done by pressing the button **PRO**, while in parameter **050** of the service. Each time the button **PRO** is pressed, the Y valve changes to opposite state (open/closed). When the person operating the controller exits the parameter settings, the state of the Y valve in which it was before entering the menu is automatically restored.

This function is particularly useful when a need to lower the pressure in the network during the compressor operation occurs. This prevents the compressor from stopping and the mechanical 'loosening' of the valve.

Y valve test can be performed only by authorised personnel.

11.11. Safety valve test

To perform the safety valve test the user selects the desired target pressure in service parameter **500** and presses the **START** button.

This will start the compressor, which will compress the air until the limit is reached. In order to open the safety valve, the set pressure limit should be higher than the valve activation pressure.

Safety valve testing can be performed only by authorised personnel.

11.12. Screen saver

After five minutes of inactivity, the screen saver showing the current pressure will be activate. The screen saver can also be activated by holding down the **ESC** button while in one of the main menus of the controller. The screen saver is disabled after any of the buttons has been pressed or after a critical error has occurred.

11.13. Access restriction

The access restriction function prevents unwanted parameter changes from the main menu. When enabled, parameters from the user and service parameter lists are protected with a password along with parameters such as operating mode, lower pressure limit or upper pressure limit.

The function is controlled by user parameter **423**. The numeric password is set in the first tab and in the second tab the main menu protection is set. With only a numeric password set, only parameters from the list are protected. If only the access restriction function is enabled, the password will be 000.

12. Technical data

12.1. Electrical characteristics

Table 21: Electrical characteristics

Parameter	Value
Supply voltage	24VAC 50/60Hz, 24VDC
Power consumption	6W max
Relays max switching voltage	250VAC
Relays max switching current, resistive	5A
Relays max switching current, inductive	0,5A
Current loop maximum current	28mA
Maximum current draw from internal reference voltage	250mA
Digital inputs min voltage	-0,5V DC
Digital inputs max voltage	24,7V DC
Analog inputs min voltage	-0,5V DC
Analog input max voltage	24,7V DC

12.2. Mechanical information

Table 22: Mechanical information

Parameter	Value
Enclosure dimensions	130x73x59 mm
Unit weight (without packaging)	0,6kg
Panel mounting style	Mounting tabs

12.3. Operating conditions

Table 23: Operating conditions

Parameter	Value
Operating temperature	-15 ÷ 50 °C
Storage temperature	-20 ÷ 70°C
Relative humidity	10 ÷ 90 %, without condensation

13. Mechanical drawing

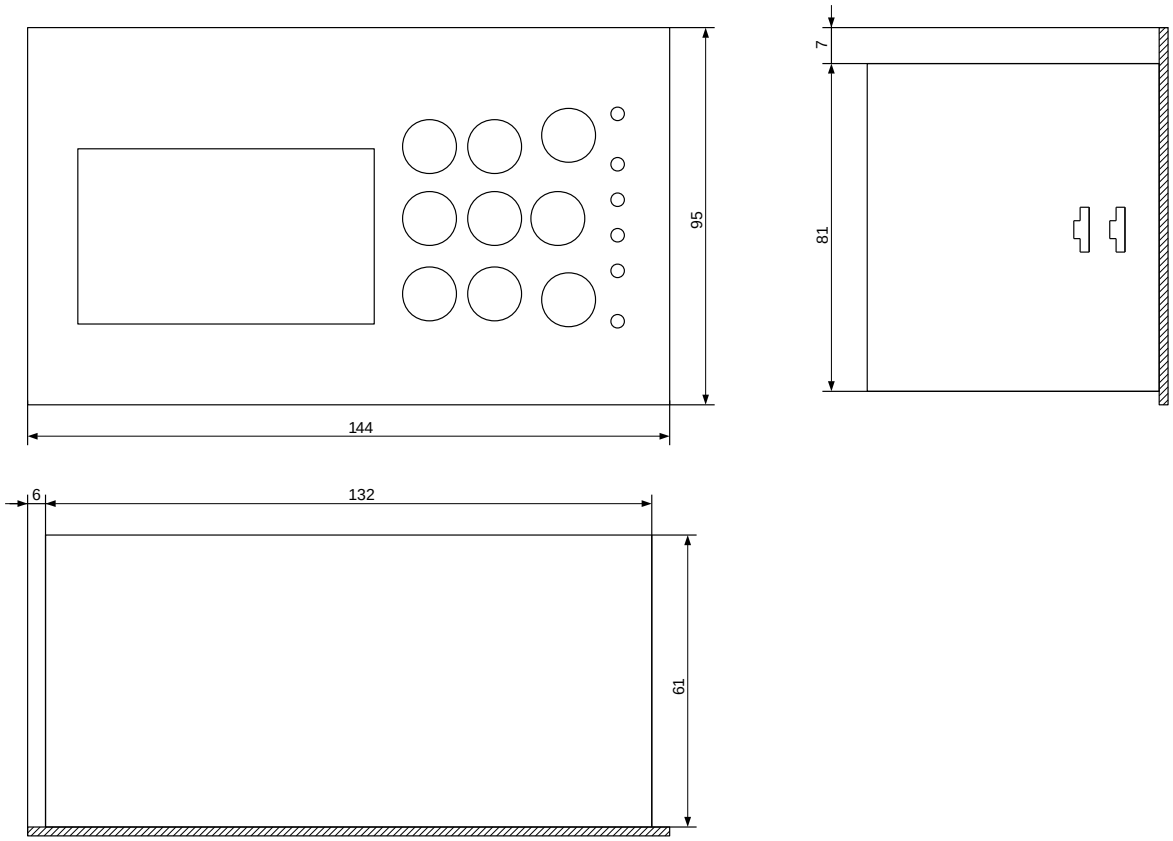


Figure 14: MS-485 mechanical drawing