MIKROEL®
PRODUCENT URZĄDZEŃ MIKROELEKTRONICZNYCH

MS-887VFD

User manual

Contents

List of Tables

List of Figures

1. Introduction

1.1. Description

MS-887VFD is a compressor controller dedicated to air compressors with various operating power. It controls motors in star – triangle configuration.

Controller features include:

- Automatic switching of star and triangle motor configurations
- Supervision of pressure, oil temperature and motor current draw
- Selection of configurable outputs
- 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
- Auxiliary pressure sensor – 4-20mA current loop sensor
- Oil temperature sensor - PT100
- Air temperature sensor - PT100
- Motor temperature sensor - KTY84
- 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-887VFD 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 should read 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

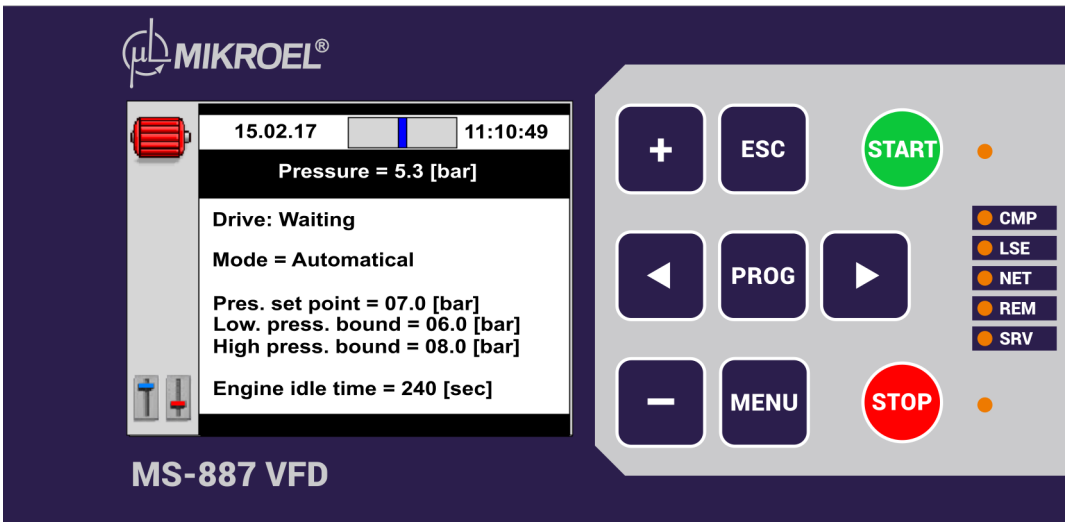


Figure 1: Front panel view

3.1. Button descriptions

Table 1: Button operation descriptions

Button	Description	Usage
MENU	Menu button	Enter user parameter list (single press) and service parameter list (double press)
PROG	Program button	Enter programming mode
ESC	Escape button	Return to previous menu, return from active parameter edition screen
> <	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

3.2. 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
NET	Network operation diode	**Constant** - network operation enabled but not initialized **Blinking** - network operation initialized
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

3.3. Display

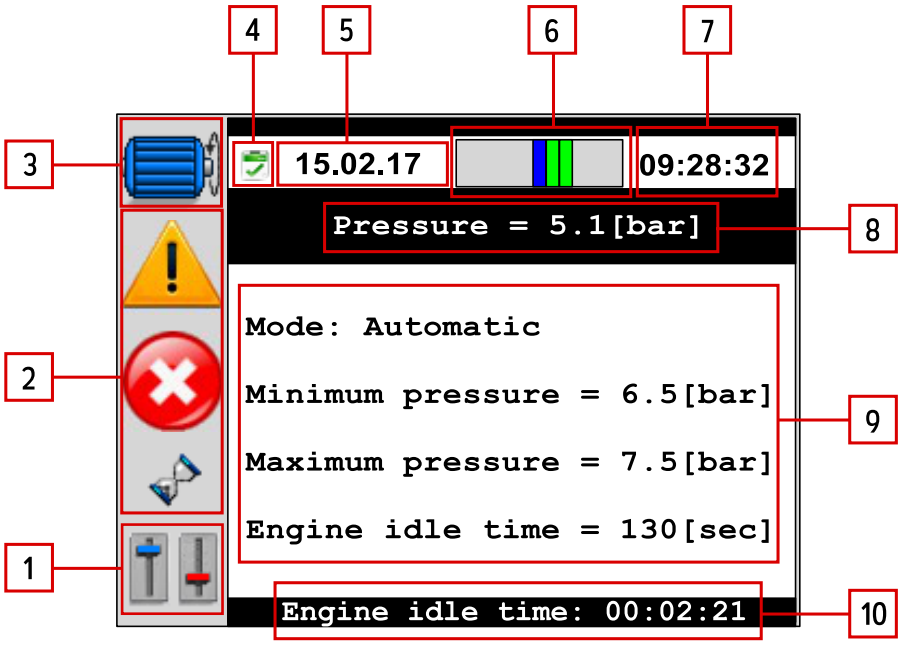


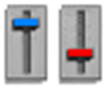
Figure 2: Main display screen

Table 3: Display sections description

Section	Description	Sample value
1	Active menu symbol	Service parameter menu
2	Animation area	Error animation
3	Engine icon	Engine stopped
4	Schedule icon	Scheduled operation is performed
5	Current date	13.07.2017
6	Pressure change bar	
7	Current time	12:32
8	Current pressure in the network	6.2 [bar]
9	Text field	Mode: Automatic
10	Information bar	Time of neutral operation: 00:02:12

3.3.1. Active menu symbols

Last events menu



Operating parameters menu

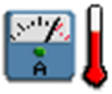
Counters menu

Network operation menu

Service parameter menu

User parameter menu

Password input menu



Sensors menu

3.3.2. Animation area

Fatal error animation

Non-critical error animation

Wait animation

Compressor start/stop animation

3.3.3. Engine state indicators

 Engine stopped

 Idle operation

 Waiting in auto mode

 Compressing

3.3.4. Pressure trend bar

Pressure trend bar informs the user about the tempo of pressure change in the network. It can inform the user of the uncontrolled air leak in the system.

The pressure trend is displayed on top of the display. The more bars displayed, the faster pressure change. Green bars indicate pressure increase, red bars indicate pressure decrease.

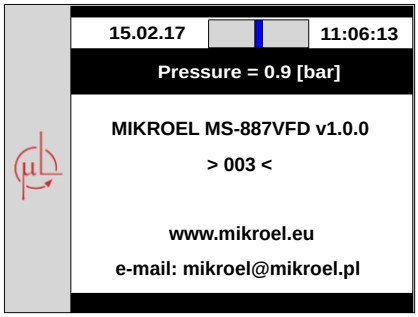
Sensitivity of the trend bar is controlled by service parameter 140. The value in parameter indicates the pressure that is represented by a single bar. For example, if the set value of 0.1 bar/s, three green bars mean that the pressure rises by 0.3-0.4 bars per second.

Possible sensitivity range is <0.02 - 0.3> bar/s.

3.4. Main menu operation

After startup the controller displays title page and information about the controller.

Table 7: Startup pages description

Menu page	Title
	Title page
	Controller information

Then enters main menu.

Menu pages are described in table 8. To switch between pages the user presses (<;>) buttons.

Table 8: Main menu page descriptions

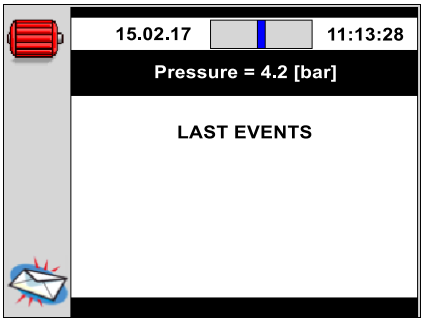
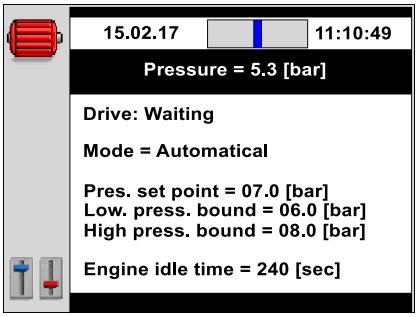
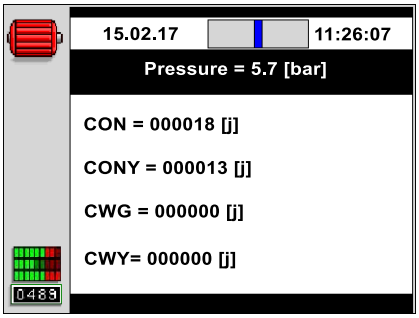
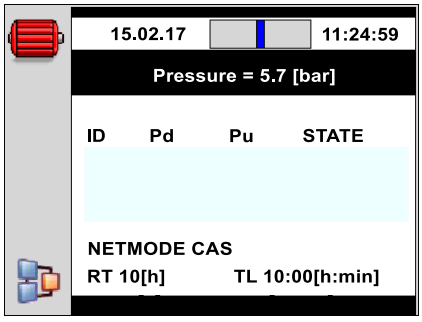
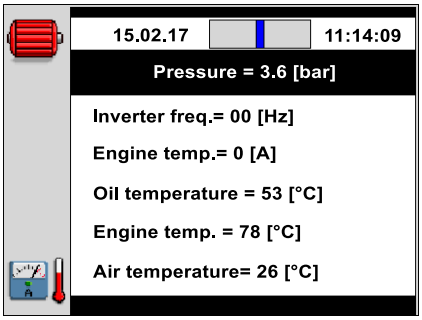
Menu page	Title	Function
	**Last events menu**	Display of last message
	**Operation parameters menu**	Compressor parameter settings - operation mode, pressure limits
	**Counters menu**	Preview of current counter values
	**Network operation menu**	Network operation settings menu **Disabled by default** (see chapter 9.)

Table 8: Main menu page descriptions

Menu page	Title	Function
	**Sensors menu**	Preview of current sensor values

3.5. User menu

The user menu is accessed by pressing the **MENU** button once. Then the user should enter the user password (if active) using buttons: **<**, **>**, **+**, **-** and accept the entered password with a **PROG** button.

Selecting the appropriate parameter code (buttons **+**, **-**, **PROG**) allows the user to display and change the desired parameter.

To change the value of the parameter, press the **PROG** button once and then using the buttons **+** and **-** make modifications. Accept parameters by pressing the button **PROG**, and cancel 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, annotated in the documentation as *parameter-sublevel*. When in parameter edit mode (entered by pressing **PROG**), select the corresponding sub-level with the buttons **<**, **>** and accept the selection with the button **PROG**.

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.

3.6. User parameter list

Table 9: User parameter list

No	Description	Parameter	Unit	Range	Default
001u	Schedule			0-20 events	
002-1u	Reset oil counter value				
002-2u	Reset oil filter counter value	h/data			
002-3u	Reset air filter counter value				
002-4u	Reset separator counter value				
002-5u	Reset belt tension counter value				

Table 9: User parameter list

No	Description	Parameter	Unit	Range	Default
002-6u	Reset general overhaul counter value				
002-7u	Reset counter 7 value				
002-8u	Reset counter 8 value				
003u	Language selection				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
008-3u	Network operation Modbus stop bits			8N1; 8N2	8N2
011u	Time setup				
012u	Date setup				
018u	Show event list				
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
029-1u	REM Master upper pressure limit	Pd	bar	05.0; 10.0	05.5
029-2u	REM Master lower pressure limit	Pd	bar	05.0; 10.0	07.5
030-1u	Drying duration before compressor start	tdrst	min	0; 120	1

Table 9: User parameter list

No	Description	Parameter	Unit	Range	Default
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	10
040-2u	Condensate drain time	drtim	s	1;10	3
051u	Screen brightness	%		20; 40	85
052u	Screensaver			On; Off	On
060u	Time of reaction for REM line change	trem	s	2; 30	5
061u	Automatic regulation of idle operation time change	Autotlse		On; Off	Off.
090u	Automatic restart			On; Off	Off
111u	Restore saved user parameter values				
423-1u	Change user password			000; 999	000
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-887VFD 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 10: List of supported analog sensors

Measured value	Unit	Type	Description
Pressure 1	bar	4-20mA	External pressure sensor
Pressure 2	bar	4-20mA	External pressure sensor
Oil temperature	°C	PT100	Resistive temperature sensor
Air temperature	°C	PT100	Resistive temperature sensor
Engine temperature	°C	KTY84	Semiconductor temperature sensor

4.1.2. Digital sensors

Table 11: List of supported digital sensors

Measured value	Unit	Description
Power asymmetry	NO	Digital asymmetry detection module
Air filter	NO	
Oil filter	NO	
Separator	NC	
Vacuum sensor	NO	

*__NO__ - state of contactor is normally open

*__NC__ - state of contactor is normally closed

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-887VFD has 8 counters, 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 12: 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

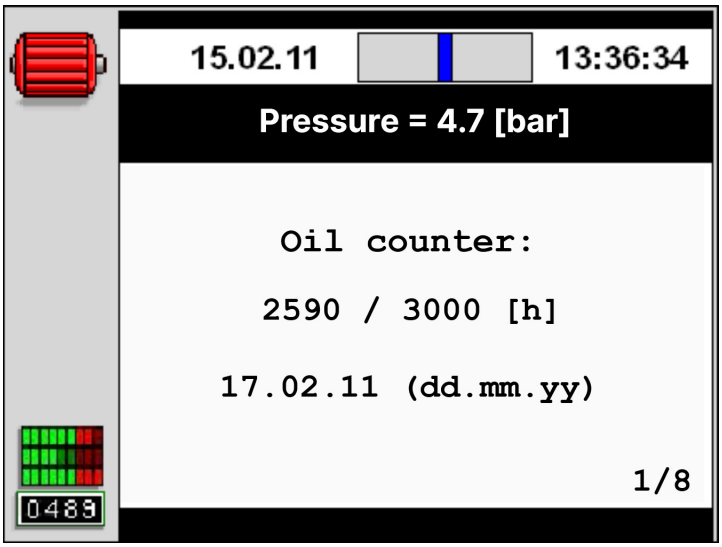


Figure 3: View of the oil counter MS-887VFD

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 002. 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 002 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 002 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 13: Operating time counters list

Number	Description	Parameter	Default value
CON	Total startup counter - counts total number of compressor starts.	586s	0
CONY	Y valve operation counter - counts total number of opening the Y valve.	597s	0
CWG	Warranty counter - counts total time of compressor operation. Utilized by *warranty lockdown function*.	542s	0
CWYh	Operation under load counter - counts total time of compressor operation with Y valve open.	553s	0

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 **PROG**. Errors are stored in the error list, available from the user parameter list (parameter 007). Deleting the error list is available only to the service.

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.

In case of an error of the internal inverter, its number is visible. To identify it, the manufacturer's documentation for the inverter should be used. For each of the inverters, a list of 16 errors is defined, whose codes are interpreted and their full names are displayed. The list of errors is included in 6.4.

Pressing the **prog** button while displaying an error message will confirm the error and clear it if its cause has been resolved.

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 14: Fatal errors list

Number	Message	Error description
E01*	FREQUENCY INVERTER ERROR	VFD has reported an error. Error code is displayed in operation parameters menu.
E02	WRONG PHASE SEQUENCE	Asymmetry detection module reported an error or thermal switch error has occurred.
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.
E05	ENGINE TEMPERATURE OVERFLOW	Maximum allowed engine temperature *Tengmax* exceeded. The cause of the error can be high operating resistance of the machine or too frequent starting the machine. Too high engine temperature may lead to engine failure.

Table 14: Fatal errors list

Number	Message	Error description
E07	The error of TOL growth	Lack of increase in oil temperature value during compressor operation. It is necessary to check if the appropriate sensor is connected and whether it is not damaged. Additionally, it is necessary to check whether the parameter values corresponding to the oil temperature sensor supervision function are set correctly (more information in the function description in section 12.6).
E09	SETTINGS ERROR	One of the values in parameters exceed their maximum allowed values. Verify that the parameters set or transmitted externally (e.g. by the master or visualization system) do not exceed the allowed values.
E10	NO OIL TEMP. SENSOR	Damaged or disconnected oil temperature sensor. Check if the appropriate sensor is connected and if it is not damaged.
E11	NO ENGINE TEMP. SENSOR	Damaged or disconnected engine temperature sensor. Check if the appropriate sensor is connected and if it is not damaged.
E12	NO PRESSURE SENSOR	Damage or no pressure sensor connected. Check if the appropriate sensor is connected and if it is not damaged.
E18	V24 SHORT CIRCUIT ERROR	Short circuit in 24V power supply circuit. When the fault is detected, the 24V circuit is disconnected. Re-activation will take place after the short circuit has been removed and after the error has been reset in the *RECENT MESSAGES* menu of the driver.

* - possible attempts to automatically restart the compressor operation after the cause of the error has disappeared, in the case of the restart function being enabled (**parametr 090u**).

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 15: Non-fatal errors list

Number	Message	Error description
E40	LOW OIL TEMPERATURE	Lower than set (service parameter **063**) temperature of the oil mixture during compressor start. Always starts the heater, even if it is disabled in the user parameter **009**. The compressor will start after the oil mixture has reached the minimum oil temperature.

Table 15: Non-fatal errors list

Number	Message	Error description
E41	OIL TEMPERATURE OVERFLOW	Higher than set (service parameter Toilh **063**) 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.
E42	AIR FILTER ERROR	Air filter sensor error. Check the condition of the filter.
E43	OIL FILTER ERROR	Oil filter sensor error. Check the condition of the filter.
E44	SEPARATOR ERROR	Separator sensor error. Check the condition of the separator.
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.
E46	NO AIR TEMPERATURE SENSOR	No air temperature sensor. Check the connection on the terminal block.
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	Error of the AFOFSEP sensor	Error of the air filter, oil, or separator sensor. The condition of the filters should be checked.
E60	MEMORY ERROR	Memory error during the controller start-up.

6.3. List of events

Table 16: 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.

Table 16: List of events

Message	Event description
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.
AUTOMODE WAITING	Waiting for the pressure to drop below the set value Pd in automatic operation mode after the time countdown tlse has finished. A drop in pressure below Pd causes the compressor to automatically restart. The waiting state will also occur when, at the start of the compressor, the pressure is above the lower limit Pd. Also in this case, a drop in pressure below Pd will trigger the automatic activation of the compressor.
IMPROPER SWITCHING OFF	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 operation mode after its improper shutdown (the date and time of the restart is within the time-frame 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 start of the machine, 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 at the start of the compressor is lower than the minimum temperature Toilmin. The machine will be activated when the oil temperature reaches Toilmin + His Toilmin.
DRYING PLEASE WAIT	Waiting for the end of the dryer operation according to the set parameters.
EXCEEDED NUMBER OF ACTIVATIONS	The allowable number of compressor starts has been exceeded in the last hour.
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**).

Table 16: List of events

Message	Event description
WAITING FOR DECOMPRESSION	No signal from the VS sensor or other decompression detection method. The controller will start the operation after decompression has been detected.

6.4. List of defined frequency inverter errors

The error codes listed below are the manufacturer's codes. Refer to the error identification section of the installed inverter's manual for identification purposes.

Table 17: List of defined inverter errors

Yaskawa		LG		Danfoss	
Code	**Identifier**	**Code**	**Identifier**	**Bit**	**Identifier**
0x02	Uv1	0x00	OCT	1	IoT/A29
0x05	SC	0x01	OVT	2	EF/A14
0x06	GF	0x02	EXT-A	5	IoC/A13
0x07	oC	0x03	EST	6	OvT/A12
0x08	ov	0x04	COL	7	OoC/A11
0x09	oH	0x05	GFT	8	MoT/A10
0x0A	oH1	0x06	OHT	9	IoL/A9
0x0B	oL1	0x07	GCT	10	uV/A8
0x0C	oL2	0x08	OLT	11	oV/A7
0x19	dEv	0x09	HW-Diag	12	oV/A7
0x1B	PF	0x0A	EXT-B	14	PF/A4
0x1C	LF	0x0B	EEP	24	MF/A36
0x20	oH4	0x0C	-	—	
0x21	CE	0x0D	PO	—	
0x42	EF1	0x0E	IOLT	—	
0x040F	SCF	0x0F	LVT	—	

7. Operation theory

7.1. Motor control diagram

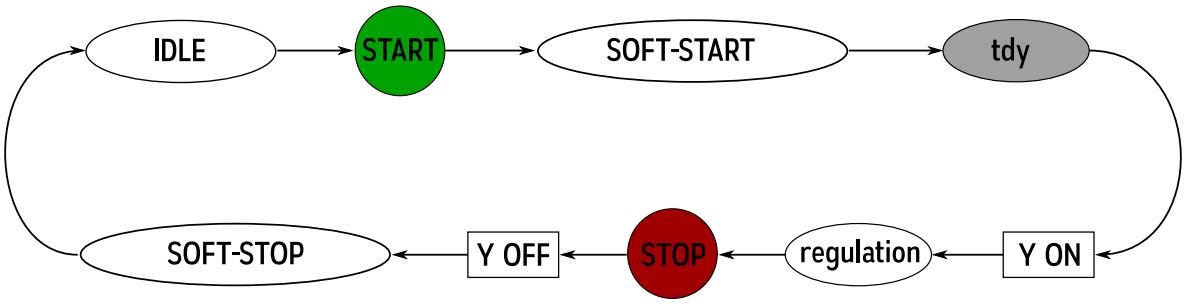


Figure 4: Motor control diagram

Basic compressor operation

- Start of the operation (e.g. pressing the **START** button)
- Soft-start of the motor
- Y valve Switch-on delay (*tdy*)
- Switch on the Y valve - start compressing
- Compressing. During compression, the pressure is controlled by turning on/off the Y valve and controlling the engine speed
- Stop the operation (e.g. pressing the **STOP** button)
- Switch off the Y valve, engine idle operation
- Soft-stop of the motor
- Compressor is in idle state

7.1.1. Decompression control method

Decompression control can be carried out using a few strategies, using decompression sensor (Vs), decompression timer (tdst), secondary pressure sensor (PS2) or the combination of the methods. The selection of decompression control method is done by selecting the appriopriate option in service parameter **047**. Possible control methods:

- tdst
- Vs
- PS2
- tdst + Vs
- tdst + PS2

7.1.2. Motor temperature management method

The management of motor temperature can be carried out using motor temperature, Compressor ON cycles counter within an hour counter or the combination of both. The used control method is selected in service parameter **004**, the setpoint of the counter in service parameter **001**.

7.2. Motor speed control

7.2.1. Regulator settings

The correct operation of PID regulator requires the values in service parameter 039 to be set properly.

Table 18: List of parameteres controlling the PID regulator

Name	Parameter	Unit	Description	Default value
Kp	039-1	%	PID proportional term coefficient. Affects the response rate of the control signal to network pressure changes. Too high a Kp value can cause over regulation of the algorithm and unstable operation	30
Ti	039-2	%	PID derivative term coefficient	6
Acu	039-3	%	PID derivative accumulator term coefficient. Determines the influence of sampling history on the control signal - the greater the value of Acu, the greater the impact of history (greater delay response to input changes).	30
Rc	039-4	%	Engine speed change limiter. Specifies the maximum allowed step of the control signal, preventing its abrupt changes. Value reduction causes faster reaction to changes.	40

7.3. Control algorithm timing parameters

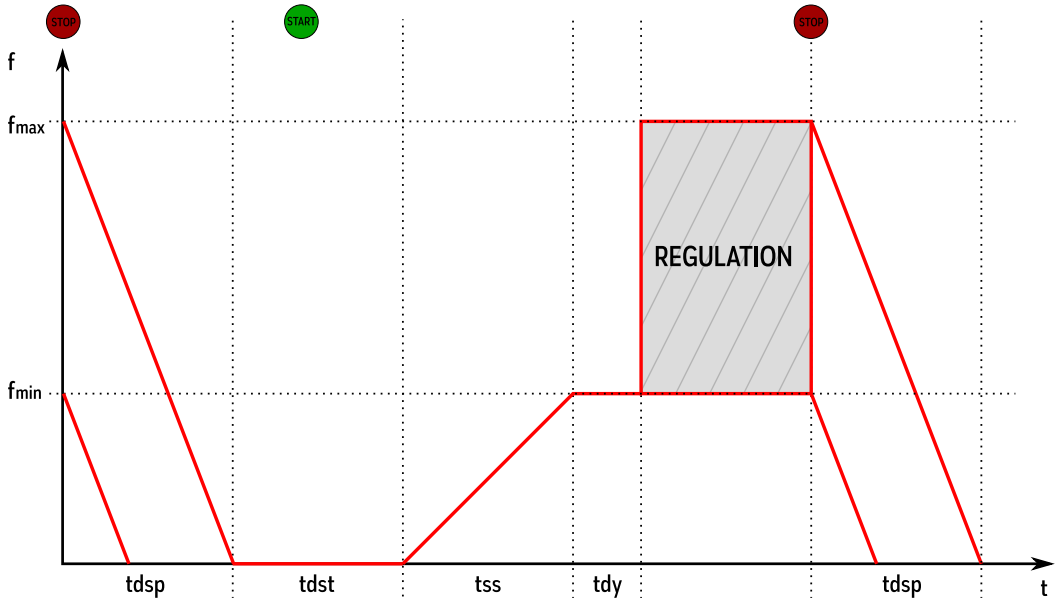


Figure 5: Time variables of speed motor control

The parameters that control the motor operation together with the corresponding service parameters are shown in the table 19.

Table 19: List of timing parameters

Name	Parameter	Unit	Description	Default value
tdst	036-1	s	Minimum time between compressor stop and next start	60
tss	036-2	s	Engine soft-start time. Time required to reach engine minimum speed	10
tdy	036-3	s	Y valve open delay	2
tlse		s	Idle motor operation time after the pressure limit has been reached	300
tlsemin	036-4	s	Minimum time of idle engine operation	240
tdsp	036-5	s	Engine soft-stop time	5
fmin	038-1	Hz	Minimum engine operating frequency	15
fmax	038-2	Hz	Maximum engine operating frequency	50

Minimum and maximum frequency setpoints of the inverter should be within the range of values permitted by the inverter manufacturer

Once started (for example, by pressing the **START** button) the motor is accelerated with time *tss* to its minimum frequency of operation *fmin*.

Switching on Y valve delay timing starts (*tdy*), during which the motor runs idle at minimum speed.

After this time, the compressor runs normally - the speed of the motor is controlled by the speed control algorithm and the compression is continuous according to the demand in the network.

Stopping the compressor (for example, by pressing the **STOP** button) causes the motor to stop during time proportional to the motor's stopping time *tdsp* depending on the speed at which it was running at the time of stop.

Restarting the motor will be possible only after the time *tdst*.

7.4. Pressure control parameters

The diagram 7.4. shows an example of the time waveform of the inverter voltage frequency change based on current network pressure, set pressure and pressure deviation.

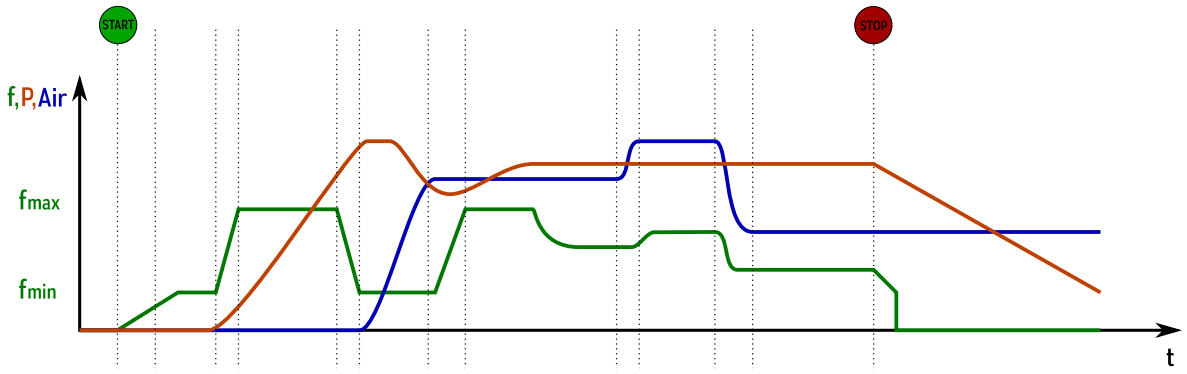


Figure 6: Example of the inverter control sequence

The pressure control parameters presented in the table 20 manage the operation of the pressure control algorithm and directly control the behavior of the controller in case of pressure changes.

Values of the parameters are changed from the main menu of pressure parameters.

Table 20: List of pressure control parameters

Name	Parameter	Unit	Description	Default value
Mode	Main Menu		Compressor Mode (AUTO, CONST, REM)	AUTO
Pd	Main Menu	bar	Lower pressure limit at which the machine starts compression	6.0
Pu	Main Menu	bar	Upper pressure limit at which the compression stops	8.0
Psp	Work parameters screen	bar	PID Regulation point	7.0

7.4.1. Pressure limit parameters

Table 21: List of pressure limit parameters

Name	Parameter	Unit	Description	Default value
Pabs	045-3s	bar	Absolute pressure. Specifies the pressure level after which a fatal error message will appear and the machine will stop	11.0
Pdelta	045-4s	bar	Minimum difference between maximum and minimum pressure	0.2
Pmax	045-2s	bar	Maximum possible pressure setting	10
Pmin	045-2s	bar	Minimum possible pressure setting	5

7.5. Frequency inverter control

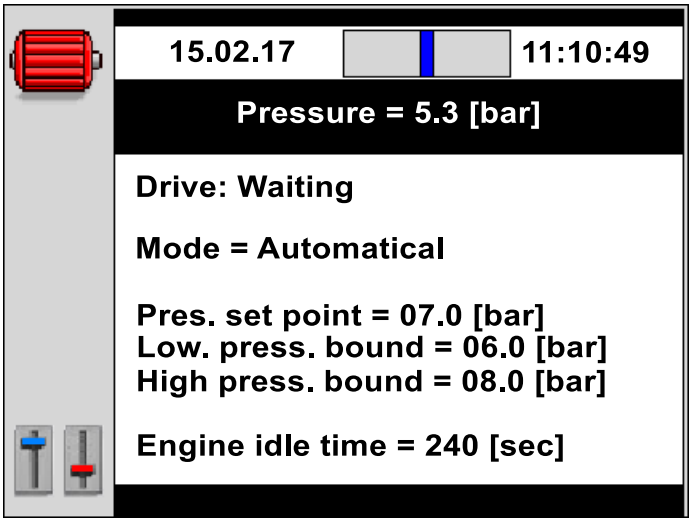


Figure 7: View of the inverter main menu

Information available in the main menu of the inverter:

- Status (*READY*, *ON* or *ERROR*)
- Control mode
- Preset and limit pressure values
- Setting the idle work time

7.5.1. Inverter internal errors

When an internal inverter error occurs, its number is displayed. To identify the meaning of an error use the inverter manufacturer's documentation, first checking the type of inverter that the controller supports (service

parameter 041-1). For each of the presets, a list of 16 errors is defined, whose codes are interpreted and their full names are displayed. A list of errors is provided in the section 6.4. in table 17.

Pressing the **PROG** button while displaying an error message will confirm the error and delete it if the cause of the error has been removed.

7.5.2. Supported inverter models

The lists of supported inverter models presented below include inverter models of each manufacturer whose compatibility has been confirmed.

Supported models of Yaskawa inverters:

1. A1000
2. J1000
3. V1000
4. GA700

Supported models of LG inverters:

1. iE5
2. iS7

Supported inverter models by Danfoss:

1. VLT series

7.5.3. Connection configuration

Establishing communication with the inverter requires configuration of service parameters that control communication.

Table 22: List of connection parameters with the inverter

Name	Parameter	Unit	Description	Default value
Preset	041-1		Preset for communication with the inverter (Yaskawa, Siemens, Danfoss, LG)	Yaskawa
Faddr	041-2		Inverter address	1
Fbaud	041-3	baud	Inverter baud rate	9600
Fparity	041-4		Protocol parity	none
Fcustom	041-5		Custom preset transfer	

After the inverter parameters has been set correctly and the controller has been connected to the bus connection is established automatically. The correctness of the connection is signalled by the status of the inverter in the main menu of the inverter is changed to *Ready*.

If there is no correct connection, a fatal error E01 *INVERTER ERROR* occurs and the compressor stops. Connection status is checked cyclically, thus communication error can occur at any time of operation.

7.5.4. Danfoss VLT FC51 configuration

In order to use the controller with Danfoss VLT inverter FC51, the following Read PCB registers (8-43) must be set:

- PCD0 -> Status Word (value 7)
- PCD1 -> Main Actual Value [%] (value 8)
- PCD2 -> Frequency (value 13)
- PCD3 -> Motor Current (value 14)
- PCD4 -> Alarm Word (value 34)
- PCD5 -> Alarm Word (value 34)

7.5.5. Danfoss VLT FC301/FC302 configuration

In order to use the controller with Danfoss VLT inverter FC301, the following Read PCB registers (8-43) must be set:

- PCD0 -> Status Word (value 1603)
- PCD1 -> Main Actual Value [%] (value 1605)
- PCD2 -> Frequency (value 1613)
- PCD3 -> Motor Current (value 1614)
- PCD4 -> Alarm Word (value 1690)
- PCD5 -> Alarm Word (value 1690)

7.5.6. Custom preset transfer

Selecting the service parameter *041-5* allows the user to install a custom preset for the inverter controller that is not supported by default.

For more information and preparation of the preset, contact the manufacturer of the controller.

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.

8.1.1. AutoTLSE

Optimal setting of engine idle operation time *tlse* is critical to managing compressor operation cost. Too long a time means that the engine operates frequently in idle mode causing excessive power consumption. Too short *tlse* time can cause too frequent engine start and stop, which not only increases power consumption but also causes excessive strain to mechanical components.

AutoTLSE algorithm automatically adjust idle engine operation in Auto mode. Operation history and system pressure is being analysed in real time, monitoring parameters:

- pressure monotonicity
- pressure rate of change
- pressure in relation to upper and lower limits
- times od pressure rise and fall in previous operation cycles
- set *tlse*
- estimated number of hourly on-off cycles

Using the acquired data the algorithm controls *tlse* time, mainly by shortening it (but it is never shorter than 15s). If the demand for pressure is not high and it is slowly being reduced, the algorithm reduces the *tlse* time. If the estimated pressure demand rises, the algorithm allows the engine to operate in idle mode.

AutoTLSE function can be used either with compressors operating separately or in network operation.

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 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 12.5.), 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* (060u).

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

The ACK confirmation line serves as feedback for the master controller regarding the initiation of the compressor start. It can also be used in creating controls on the dashboard. Stopping the compressor causes the ACK signal to be removed.

The ACK line is of the relay type (potential-free), and at the moment of activation, the contacts are shorted to the +24VEXT line. Therefore, for its proper operation, it is necessary to supply +24V to the +24VEXT line. When a critical error occurs on the controller, the ACK line alternates its state at a frequency of 1Hz (provided that remote mode REM is not set). Thanks to this, the line can be used as a signaling line for critical errors.

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.

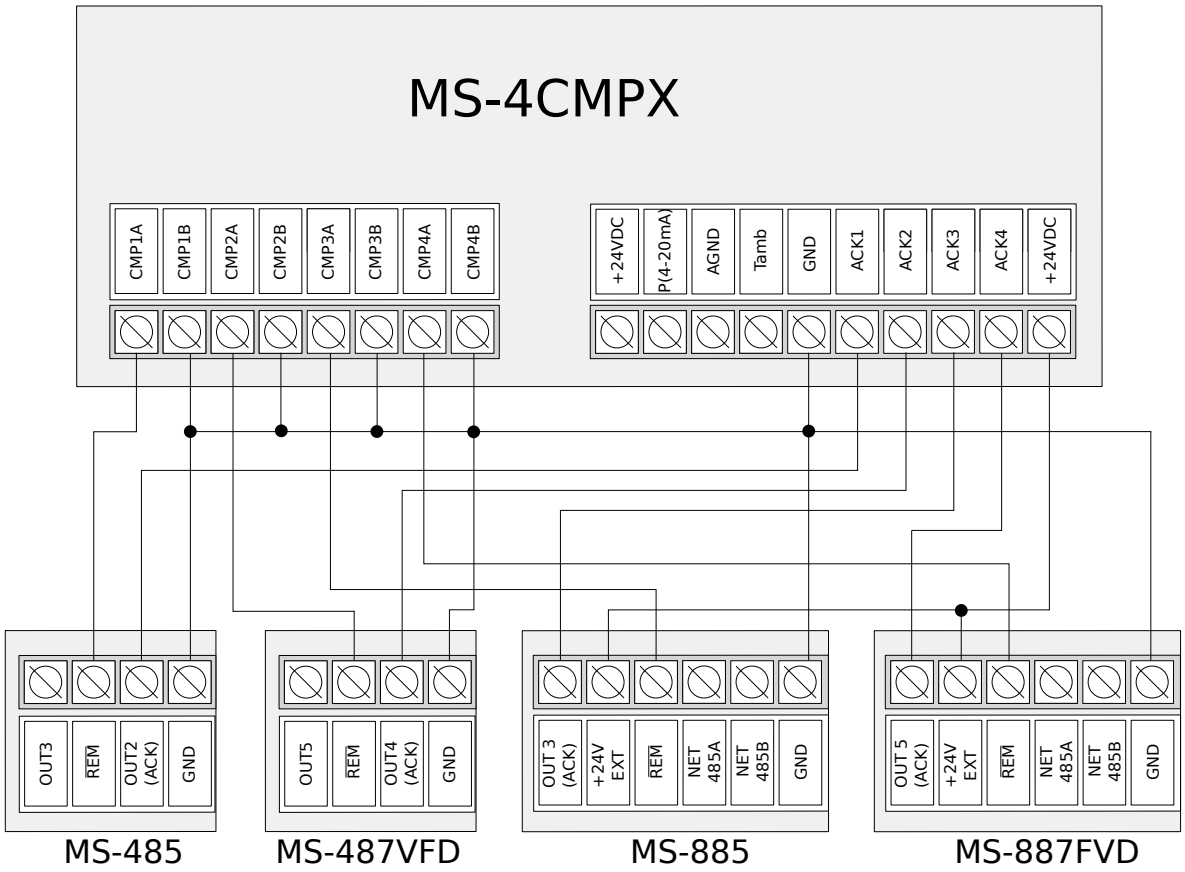


Figure 8: Wiring diagram for the controller

8.3.5. Modbus RTU

The MS-887VFD 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-887VFD 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-887VFD 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 028-1). 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 *NET*.

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

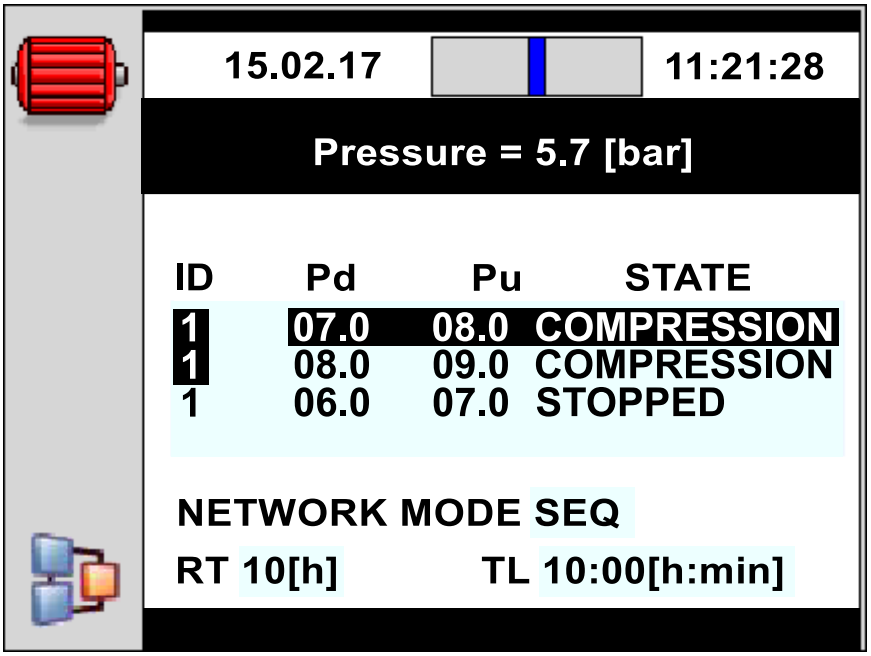


Figure 9: View of network operation menu

Description of network menu abbreviations:

1. **ID** – Modbus identifier
2. **Pd** – lower pressure limit
3. **Pu** – upper pressure limit
4. **STAN** – operation state of the given compressor
5. **RT** – rotation time
6. **TL** – time left to rotate

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 090.

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 028.

9.6. 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 008 parameter:
    - 008-1 Modbus identifier, unique in the network
    - 008-2 baudrate **(the same for all compressors in the network)**
    - 008-3 data formatting **(the same for all compressors in the network)**
    - 008-4 parity **(the same for all compressors in the network)**
3. User 028 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.

9.6.1. 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.

9.7. Master controller configuration

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

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

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 005 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 026) 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*.

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	7.1	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*.

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 the 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 redistributes 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. 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).

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).

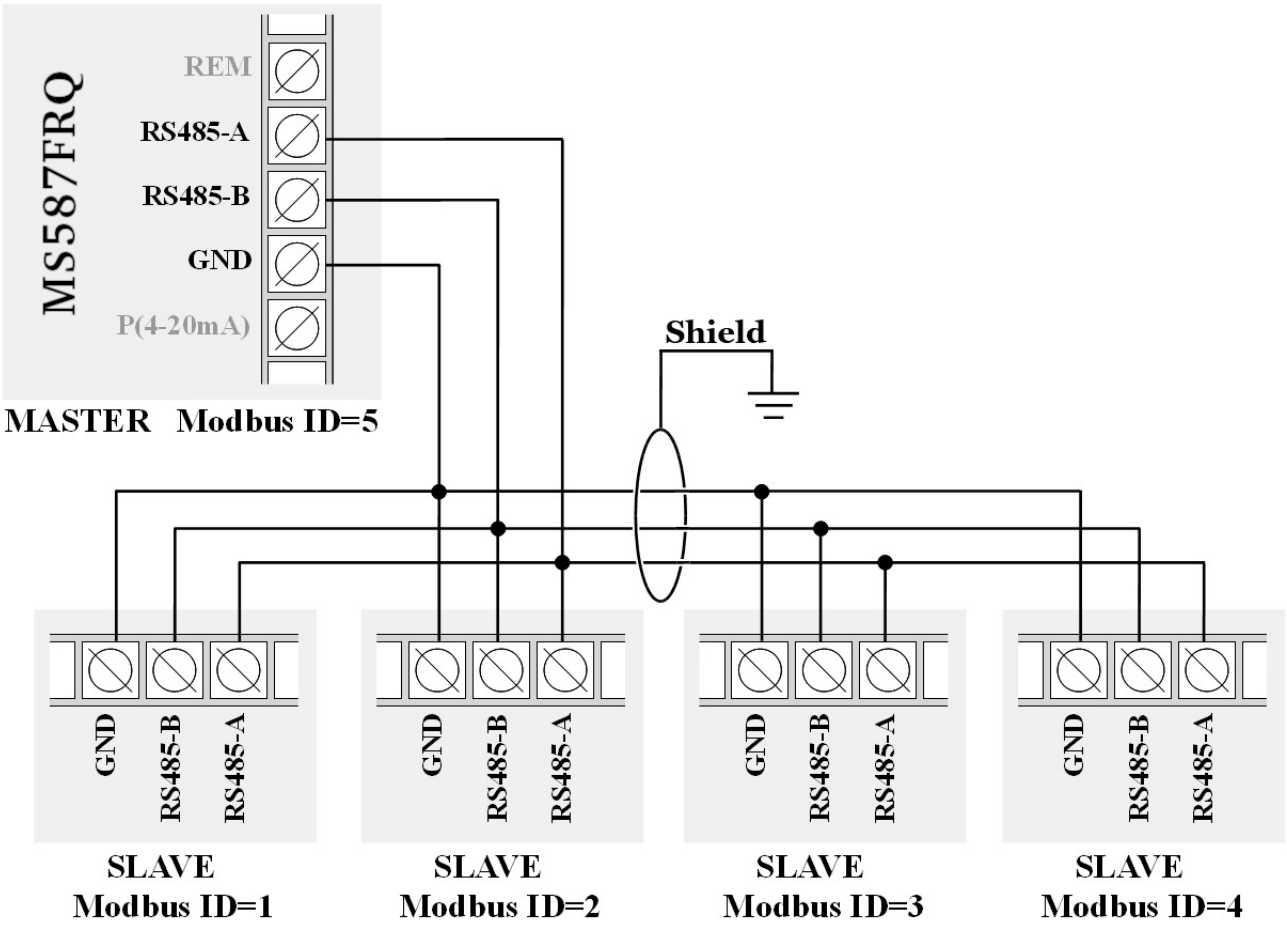


Figure 10: Diagram of connecting controllers via the RS485 interface.

It is recommended to connect the grounds of cooperating controllers both in the case of transmission over RS485 and over CAN. Additionally, it is recommended to run the CAN/RS485 bus over shielded cables.

10. Schedule

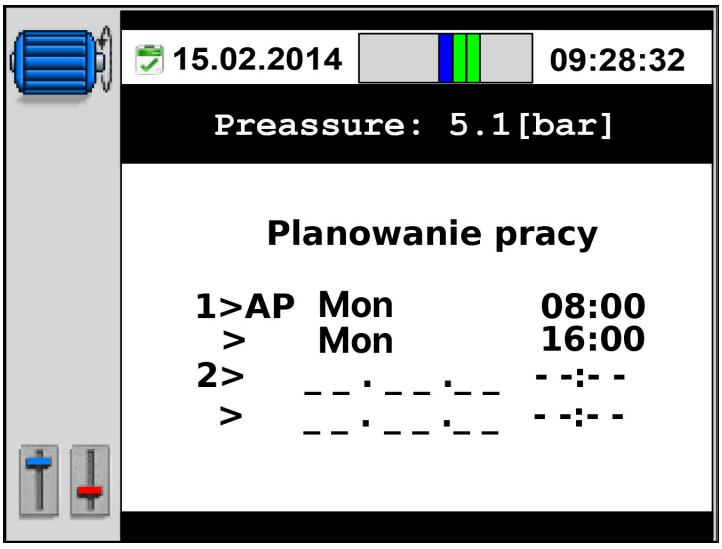


Figure 11: View of the schedule

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 20 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 001.

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. Restor-

ing 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 **PROG** button. Pressing the **PROG** button again enters the edit mode where the **+** and **-** buttons change their value. Validate the parameter value with the **PROG** 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. Miscellaneous functions

12. Other functions

12.1. 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.

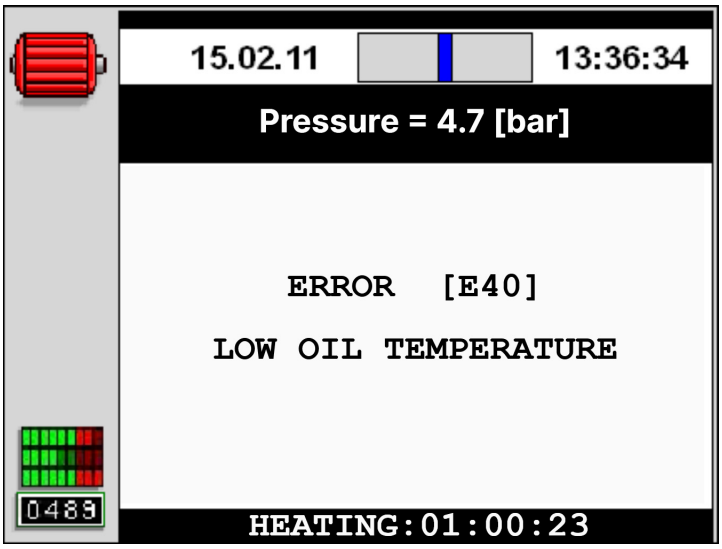


Figure 12: View of the MS-887VFD screen with the heating function turned on.

12.1.1. 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.

12.1.2. 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.

12.2. Dryer

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

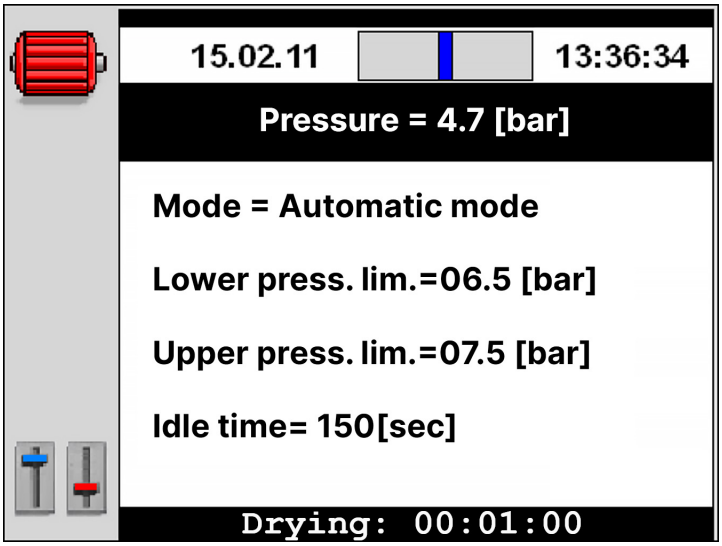


Figure 13: View of the MS-887VFD screen with the heating function turned on.

Parameters controlling the dryer operation:

Table 23: List of parameters controlling the dryer operation

Name	Parameter	Unit	Description	Default value
tdrst	030-1u	min	Drying time before compressor start	10
tdrsp	030-2u	min	Drying time after compressor stop	10
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 dehumidifier when the compressor is in standby mode. Its operation can be regulated by turning the dehumidifier on and off at a specified frequency and with a specified filling. This allows for the efficient use of the dehumidifier 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 dehumidifier.:

Table 24: List of additional parameters controlling the operation of the dryer

Parameter	Unit	Description	Basic Value
008-1u	min	The work cycle time of the dryer in standby mode.	5

Table 24: List of additional parameters controlling the operation of the dryer

Parameter	Unit	Description	Basic Value
008-2u	%	Filling the dryer cycle in standby mode.	100

Example 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)

12.3. Condensate drain

Connecting an external contactor to a universal output configured as a condensate drain output allows the controller to control the condensate drain.

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

Parameters controlling the condensate drain operation:

Table 25: 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	3

Condensate drain is inactive only when the compressor is stopped.

12.4. Cooling

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

When the oil temperature reaches value defined in parameter *Tfanon* (service parameter 064) the fan will be turned on and when the oil temperature falls below the value in parameter *Tfanoff* (service parameter 064) the fan will be turned off.

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).

12.5. Automatic restart

Performing operations on active components of a controlled compressor is not allowed when the restart function is active because the cootrolled 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 14: View of the MS-887VFD 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 occured.

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.

12.6. Monitoring of the oil temperature sensor

The oil temperature sensor supervision function (parameter **028s**) allows for the detection of issues related to the temperature sensor. In the event of the sensor not being connected or malfunctioning, the compressor will stop and an error will occur.

The control of the oil temperature sensor's operation involves checking whether there has been an increase in temperature by the specified value within the set time (parameter **028-2s**). (parametr **028-3s**). Additionally, there is the option to disable this protection above the set oil temperature value (parameter **028-4s**).

Table 26: List of parameters for oil temperature sensor monitoring.

Nr	Descrip.	Unit	Range	Basic value
028-1s	Toil sensor supervision		On.;Off.	On.
028-2s	Time of Toil Growth	min	1; 999	7
028-3s	Delta Toil	°C	1; 99	25
028-4s	Disabling the Toil protection	s	°C	50

12.7. 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.

The controller works with 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 ASSYMETRY* and it's not possible to detect the error cause.

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

12.8. 24V supply short detection

The active short-circuit control function is in operation throughout the entire working period of the controller. At the moment of a short circuit, the 24V circuit power is immediately cut off, protecting its electronic components from damage. A short circuit in the 24VDC circuit is considered a critical error and causes the compressor to stop working. The circuit can be reactivated after the cause of the short circuit has been removed and the error has been cleared in the CONTROLLER'S LAST MESSAGES menu.

12.9. 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**.

12.10. 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.**

12.11. Y valve test

The function allows the service to manually control Y valve. The control is done by pressing the button **PROG**, while in parameter 050 of the service. Each time the button **PROG** 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.

12.12. 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.

12.13. 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.

12.14. Control of the auxiliary compressor (SLAVE REM)

The MS-887VFDis equipped with a subordinate compressor control function using one of the configurable outputs of the controller.

We enable the function in parameter **009s** by setting the SLAVE REM function on one of the outputs. It is recommended to use one of the non-potential outputs (OUT2 lub OUT3). The assignment of the pressure limits Pu and Pd for the auxiliary compressor is done in parameter **029u**.

In the event that the main compressor is operating at maximum capacity and the pressure in the network drops below the lower pressure limit Pd assigned to the auxiliary compressor, a START signal for the auxiliary machine will be issued through the **SLV** output. Both compressors will operate until the pressure reaches the upper pressure limit Pu set for the auxiliary compressor, which will result in the removal of the START signal (turning off the **SLV** output) and stopping the subordinate compressor.

13. Technical data

13.1. Electrical characteristics

Table 27: Electrical characteristics

Parameter	Value
Supply voltage	24VAC 50/60Hz, 24VDC
Power consumption	10W 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

13.2. Mechanical information

Table 28: Mechanical information

Parameter	Value
Enclosure dimensions	180x80x62 mm
Unit weight (without packaging)	1kg
Panel mounting style	Mounting tabs

13.3. Operating conditions

Table 29: Operating conditions

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

14. Mechanical drawing

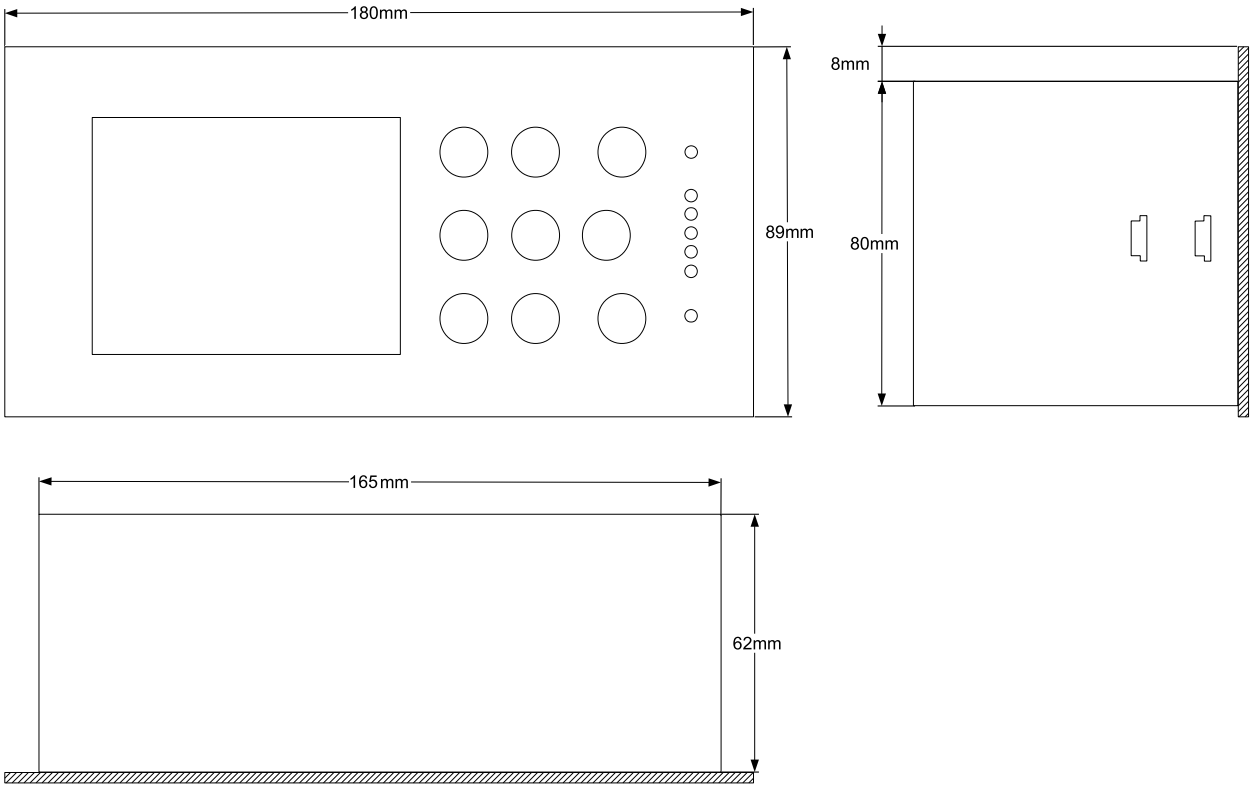


Figure 15: MS-887VFD mechanical drawing