PFP-MM-CP-R/2.2.2-0206-V
01117_131_002_02AR0P0

ÖKIMO®
Drive Systems

Product Manual

FrigoPack®

FrigoSoft®-Software Version 2.2

for *MotorMaster*® **MM1.5...MM90FEP**
as from Software Version 4.3

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1 Product Overview

1.1 Important Information

These Operating Instructions are a supplement to the product description for the *MotorMaster*® FEP series for applications with the *FrigoSoft* ® application software. The application, warning and safety information, specified in the Product Manual, must be carefully observed.

These Operating Instructions are sub-divided into the following parts:

Installation Instructions and information for electrical technicians to correctly install, wire, and connect-up ***MotorMaster***® Frequency Inverters. The installation itself is determined by the operating mode required, which is defined by the refrigeration specialist responsible for the engineering.

Commissioning Instructions and information for refrigeration specialists to correctly parameterize and adapt the ***MotorMaster***® AC drive inverter to the refrigeration system.

1.2 Introduction

The ***FrigoSoft*** ® software for KIMO ***MotorMaster***® Frequency Inverters was developed in close cooperation with specialist refrigeration companies and allows refrigeration systems to be optimally operated in all areas of refrigeration technology. ***MotorMaster***® Frequency Inverters with ***FrigoSoft*** ® make refrigeration systems very cost-effective as a result of the increased efficiency and energy saving using continuous closed-loop controlled operation. In addition to the higher cooling quality, the energy-saving potential is a decisive criterion, as the extra costs for the AC drive inverter and ***FrigoSoft*** ® can be paid-back in the shortest time.

1.3 Advantages

Up to 40 % less energy over conventional systems comprising compressor banks

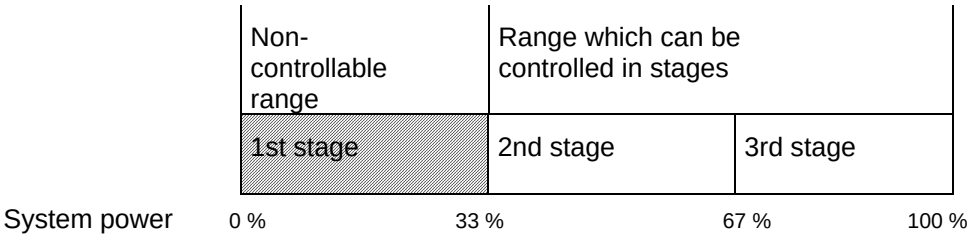
0. The compressors are powered-up and powered-down less frequently.
1. The starting current and power peaks are eliminated (max. 200 % rated current on the line supply side).
2. It is possible to increase the volatilization temperature by up to 2-3 K (this depends on the particular system).
3. The compressor operating point (c.o.p.) can be increased in the lower speed range.

Improved cooling quality

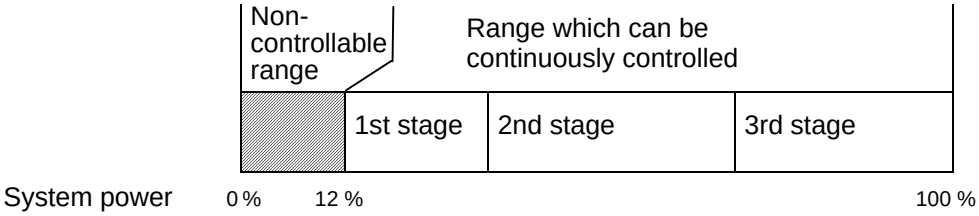
4. Constant suction pressure during all load fluctuations of the refrigeration control system (factory setting ± 2 K, it is possible optimize for the particular refrigeration control system)
5. Cooling medium deposits can be prevented from building-up in the external condenser in winter.

Extended control range

6. Conventional 3-stage compressor system



7. Comparable system with 3 identical large compressors and ***FrigoSoft*** ®



1.4 Features

8. Pressure setpoint input for closed-loop suction pressure control
   using a) up to two programmed fixed values
   or b) an analog setpoint when using higher-level control systems
9. Freely-selectable minimum compressor frequency
10. Up to three inhibit frequencies can be suppressed (refer to 3.1.3.3)
11. In local operating mode, the system can be tested and operated in filling mode without an external encoder
12. The oil pressure switch, the oil sump heating, the reduced load start and the condenser fan are controlled via the drive inverter run signal
13. Up to three additional compressor stages or capacity regulation can be directly controlled.
14. Internal safety functions:
    - Overload
    - Phase failure detection
    - Undervoltage
    - High pressure monitoring
    - Wire breakage monitoring for the pressure transducer
15. External safety functions which can be simply incorporated
    - HP/LP pressure switches
    - Cooling medium monitoring
    - Anti-freeze monitoring
    - Motor temperature monitoring
16. Increased system security:
    Delayed restart after the fault signal has been withdrawn (e.g. HP/LP pressure switches)
17. By reducing the compressor speed when the high pressure monitoring responds, prevents the system from being tripped by the HP pressure switch. Furthermore, the system can automatically adapt itself to changing ambient conditions (e.g. day-night changeovers, failure of liquefier fans).

1.5 Compressors

FrigoSoft ® was especially developed for operating ***MotorMaster***® Frequency Inverters with cooling compressors.

Generally, there are no problems using compressors, as long as manufacturers have released their units for operation with Frequency Inverters. The limiting parameters, preset in the ***FrigoSoft*** ® software should, where required, be adapted to the compressors. When problems and questions arise, our Application Service department should be contacted.

1.6 Accessories required

Depending on the selected ***FrigoSoft*** ® mode, different accessories are required in order to ensure that the AC drive inverter functions correctly.

FrigoSoft ® requires the precise measured values of the suction pressure at the compressor or the pressure on the high pressure side (optional) in order to control the cooling temperature and to monitor the high pressure. We recommend that two-wire pressure transducers are used with an output signal of 4...20 mA (e.g. *Huba Control 506.A23101* with a pressure range of -0.5...7.0 bar for the suction pressure). The pressure transducer should be is supplied by the control voltage of the **MM FEP** Frequency Inverter. The connecting cables must be screened to provide adequate noise immunity.

Sensors and transducers with other output signals (e.g. 0...10 V) can also be used, however, they require an adapted ***FrigoSoft*** ® version (on request at a surcharge).

In order to control a three-stage compressor pack, it is necessary to connect a special relay to one of the analog outputs of the **MM FEP** Frequency Inverter. Only special relays **A RELAY-DC12V** supplied by KIMO are suitable for this purpose (contacts: AC 230 C, 2 A, mounting: 35 mm DIN rails).

In order to control a four-stage compressor pack, it is necessary to connect two of the special relays described previously to the analog outputs of the **MM FEP** Frequency Inverter.

Relay contacts on the **MM FEP** Frequency Inverter are available for the other switching outputs.

1.7 EMC regulations

The EMC regulations must be maintained when operating the AC drive inverter from the public line supply. The EMC line filters which are required (radio interference suppression level B in compliance with EN50081-1) are provided with the ***FrigoPack*** **FEP** kit.

Important information regarding EMC-correct installation (e.g. earthing, screened motor cables) are described in the **MM FEP** Product Manual.

1.8 Application Service

MotorMaster® with ***FrigoSoft*** ® allows many special solutions to be quickly implemented at a favorable cost, as various application solutions are already pre-configured in the software.

2 Installation

2.1 Power Wiring

When installing and connecting-up the drive inverters, it is important that the appropriate Chapters of the Product Manual for **MM FEP** are carefully observed. Important information concerning EMC-correct wiring is also provided in the appropriate Chapters.

It is important to determine the power loss of the Frequency Inverter to determine whether the enclosure has to be cooled.

The power connections of the ***MotorMaster*® FEP** are shown in Fig. 2.1.

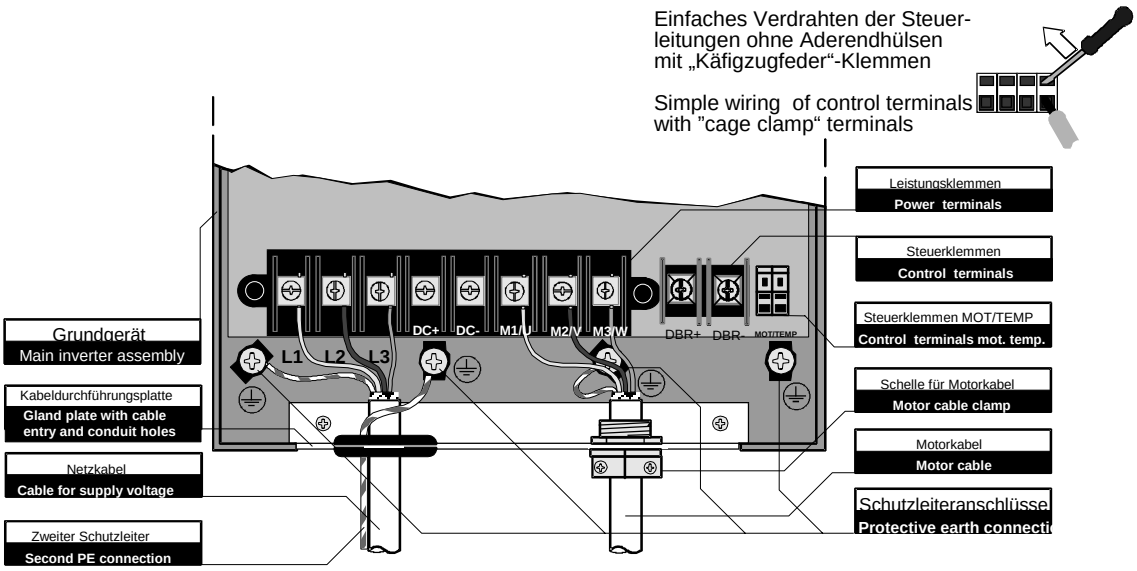


Fig. 2.1: Power connections of MM FEP

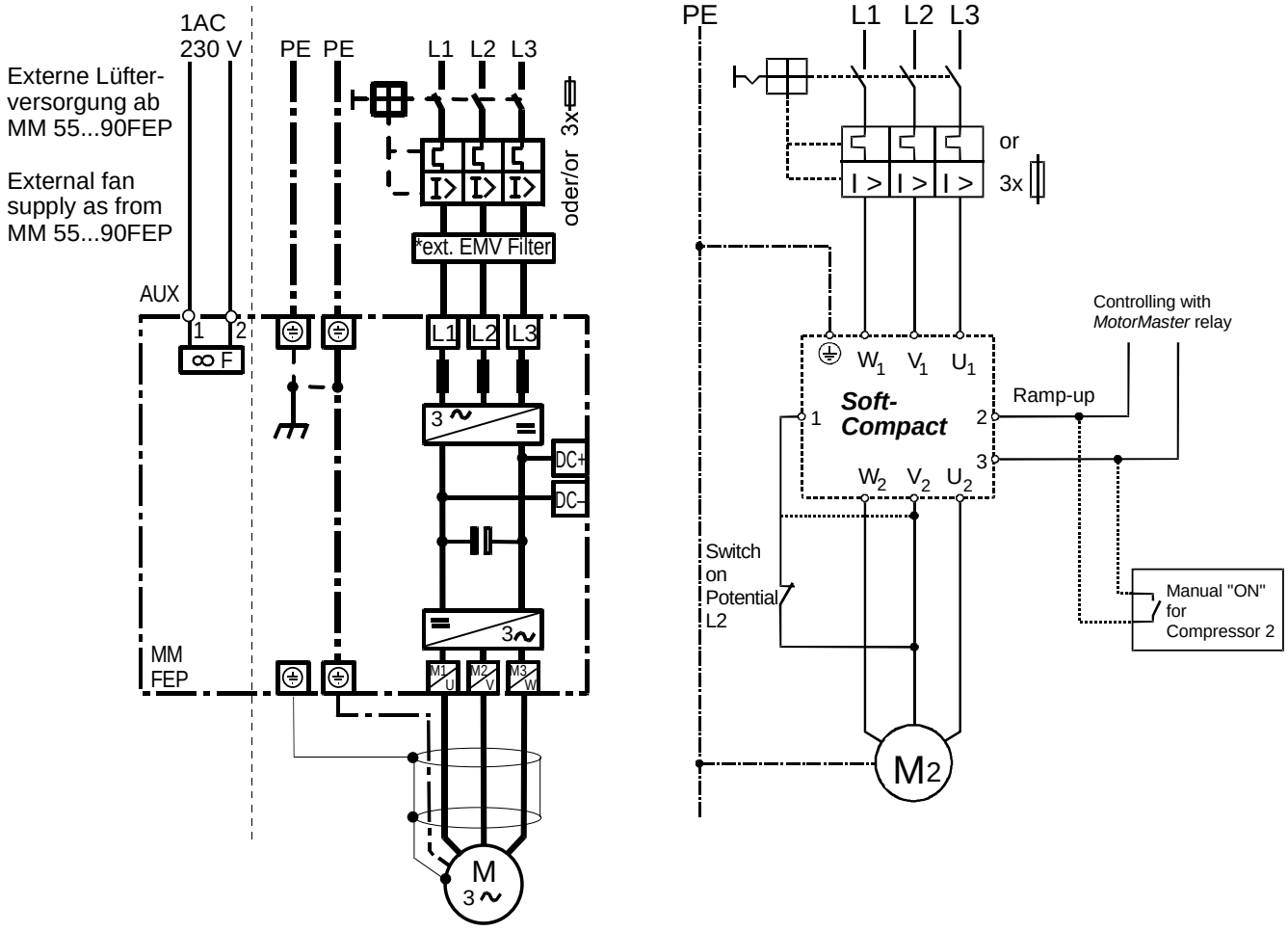
When connecting-up the ***MotorMaster*®** Frequency Inverters, it must be ensured that the correct line supply voltages are maintained. An overview of the permissible line supply voltages is provided in Table 1.

Type	**Supply voltage**	**Motor connection**
***MotorMaster*®** FEP	3 AC / 380...460 V	3 AC / 380...460 V

Table 1: Electrical voltages to *MotorMaster*®

A block circuit diagram of the ***MotorMaster***® with ***FrigoSoft*** ® system and compressor, including the control of a 2nd stage, is illustrated in Fig. 2. If the 2nd stage is not required, the appropriate connections can be eliminated. It must be ensured that the system is carefully connected-up because only then can the system operate disturbance and fault-free.

The 3rd or 4th compressor stage is controlled, essentially the same as the second stage via the drive inverter output, described in Chapter 2.2.x or 2.3.x.



Compressor 1

Compressor 2
up to 5.5 kW with *SoftCompact*
as from 5.5 kW with *SoftPower*

Fig. 2: Principal diagram of power wiring

If a contactor or a repair switch (e.g. to electrically disconnect the EMERGENCY OFF) is used at the ***Motor-Master***® output, an auxiliary contact of this contactor or switch should be used to disconnect the connection between the 24 V supply and the "Enable" control input (also refer to Chapter 2.2, 2.3 or 2.4). This guarantees, that if a ***MotorMaster***® is possibly active, it cannot be powered-up with the compressor motor at a standstill.

If bypass circuits are provided to operate the compressor without AC drive inverter, all of the power connections at the ***MotorMaster***® output must be disconnected. The ***MotorMaster***® can be destroyed if power is fed-in at the output terminals.

MotorMaster® Frequency Inverters are designed for a 230/400V supply from the public line supply. The appropriate Standards and Regulations must be carefully observed regarding earthing and the use of a residual-current-operated circuit-breakers. Furthermore, it is important to note, that by using the line filter and the shielded motor feeder cables, which are required, that increased leakage currents of ≥ 3.5 mA with respect to PE can be expected. This means that it is necessary to provide increased or double earthing.

The residual-current-operated circuit-breakers used must also trip for DC fault currents (universal current-sensitive residual-current-operated circuit-breaker), and they must able to handle the inrush current when the filter and cable capacitances are charged without erroneously tripping.

2.2 Control wiring for MM FEP

2.2.1 Description of control connections

Preferably 0.2...0.75 mm^2 cables should be used for the control circuit connections. The control connections of the **MM FEP** have cage clamp terminals which allows connections to be quickly made. Fig. 1a shows how these terminals are used.

The screen of cables with analog signals (e.g. pressure transducer cables) should only be connected at one end to earth at the ***MotorMaster***® in order to prevent earth loops.

Cables, which are used to transfer digital signals, must be connected directly to earth or the housing at both ends.

If pressure transducers with a 4...20 mA signal output are used, which are recommended by KIMO, then the connections are listed in Table 2.2.1. It is not absolutely necessary to connect the high-pressure monitoring when using ***FrigoSoft*** ® , but it represents an additional safety feature for the refrigeration control system.

***MotorMaster*® FEP**	**Pressure transducers**
Terminal 20	Supply cables for the pressure transducers (Terminal 1)
Terminal 2	Signal output of *suction pressure* transducer (Terminal 2)
Terminal 3	Signal output of *high pressure* transducer (Terminal 2)

Table 2.2.1: Connection of pressure transducers

The input ranges of analog inputs 1 and 2 are preset to 4...20 mA. Any changes made to the analog input settings must be first clarified with the Application Service department, as changes also have to be made to the *FrigoSoft* ® configuration.

An overview of the digital I/O of the **MM FEP**. is provided in Table 2.2.2. As a result of the ***FrigoSoft*** ® software, the terminals have, in some cases, other functions as specified in the general product description. The ***FrigoSoft*** ® mode which has been selected defines which terminals must be connected (refer to Chapter 2.2.2).

***MotorMaster*® FEP**		**Significance**
Terminal 12	Switching input 1	Enable and start
Terminal 14:	Switching input 3	Changing over between two fixed setpoints
Terminal 15:	Switching input 4	Analog setpoint input
Terminal 16:	Switching input 5	Activating the capacity regulation
Terminal 17:	Switching input 6	Invert relay 2
Terminal 19:	Switching input 8	External fault (safety circuit)
Terminal 6:	Analog output 1	Speed actual value
Terminal 7:	Switching output 2	Controlling the 2nd compressor stage **(*)** (A RELAY-DC12V)
Terminal 8:	Switching output 3	Controlling the 4th compressor stage **(*)** (A RELAY-DC12V)
Terminals 21, 22:	Relay 1	"Ready" signal
Terminals 23, 24:	Relay 2	"Compressor stationary/run" signal" **(**)**
Terminals 25, 26:	Relay 3	Control of the 3rd compressor stage (or the 2nd stage)

(*) Not required for two-stage systems. For 2-stage systems, the second compressor is controlled by relay 3.

(**) This signal can be used to control the condenser fan, the oil-pressure switch, reduced load start, etc.

Table 2.2.2: Assigning the inputs and outputs of the MM FEP

2.2.2 Selecting the FrigoSoft ®mode

The ***FrigoSoft*** ® program was designed to fulfill most of the requirements for refrigeration applications without any additional programming costs. Using this program, there are various ways of entering setpoints.

There are three different modes which can be selected. These will now be explained:

1. Setpoint input via a programmed fixed value
2. Setpoint input via two fixed values which can be changed over (e.g. nighttime setting)
3. Variable setpoint input via analog input

The necessary accessories and the commissioning steps required are now explained for each mode. The signal cables to be connected can be taken from the relevant block diagram. The commissioning and parameter settings are described in Chapter 3. Furthermore, it is possible to activate the special “capacity regulation” function.

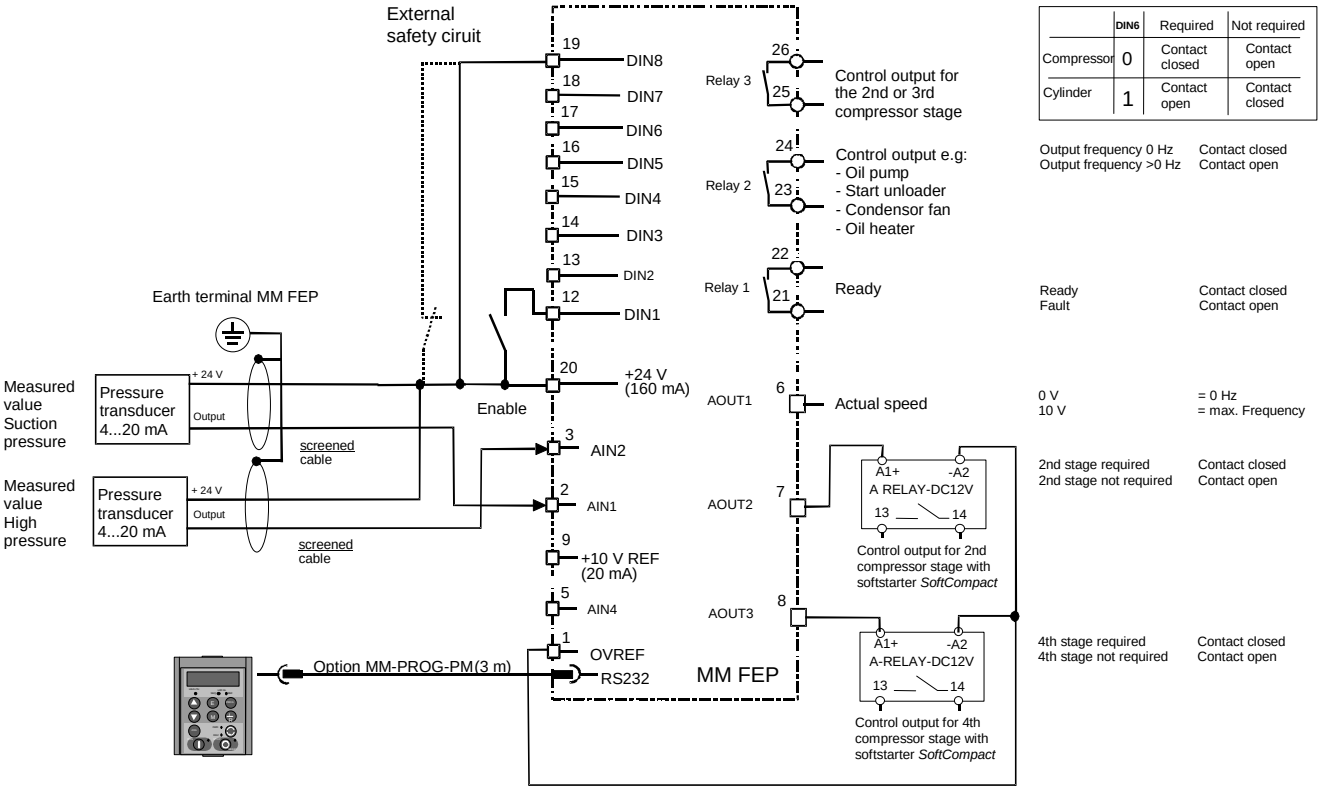
2.2.2.1 Version 1: Setpoint input with a programmed fixed value

This version of the ***FrigoSoft*** ® software controls the suction pressure at the compressor according to a fixed setpoint programmed in the drive inverter.

Accessories: 2 pressure transducers for high pressure and suction pressure

Commissioning: Enter setpoint parameter **PRESET 2 INPUT 0**

The ***MotorMaster***® is pre-programmed with a pressure (51% ⇔ -10°C for R404a), which can be changed as required. This setting is described in **Chapter 3.1.2**. A control circuit example is shown in Fig. 2.2.1.



Important: – Bridge 20 -19 if external safety circuit is not connected

Fig. 2.2.1: Principal diagram for version 1

2.2.2.2 Version 2: Setpoint input with two fixed values which can be changed over

The ***FrigoSoft*** ® software allows users to change over between two different, permanently-programmed pressure setpoints (e.g. for nighttime settings).

Accessories:	2 pressure transducers for high pressure and suction pressure, switch with closing contact
Commissioning:	Enter setpoint parameter **PRESET 2 INPUT 0** (main preset) und **PRESET 2 INPUT 1** (additional preset) eingeben
Activation:	24 V at switching input 3 (Terminal 14) activates the supplementary setpoint

MotorMaster® is pre-programmed with two pressure values (51% ⇔ -10°C, 55% ⇔ -8°C for R404a), which can be changed as required. This setting is described in **Chapter 3.1.2**. A control circuit example is shown in Fig. 2.2.2.

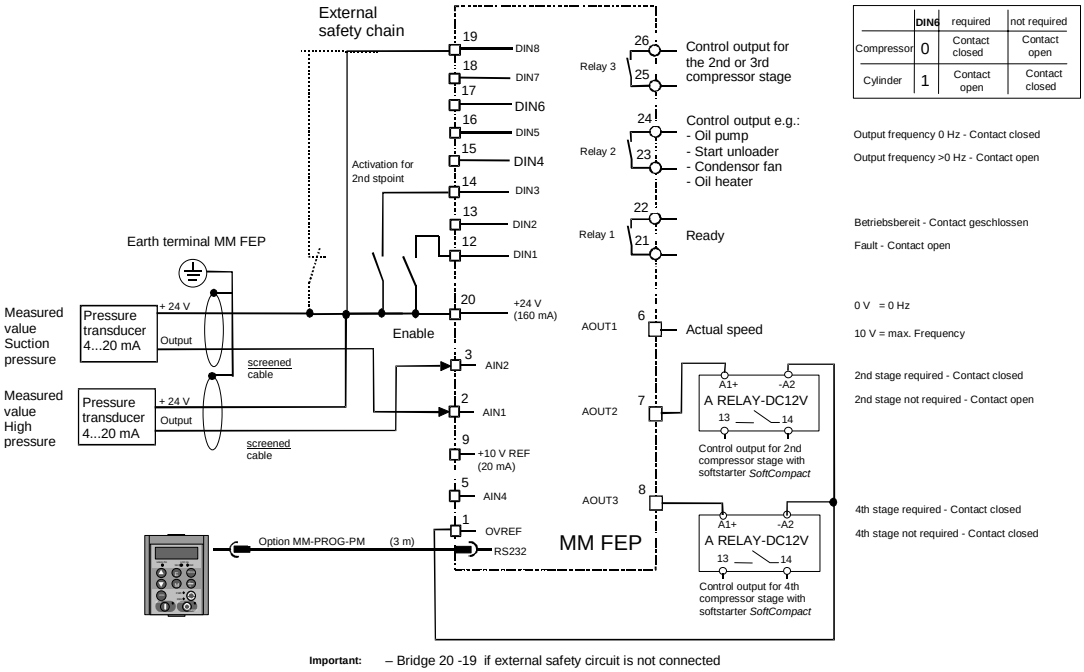


Fig. 2.2.2: Principal diagram for version 2

2.2.2.3 Version 3: Variable setpoint input via analog input

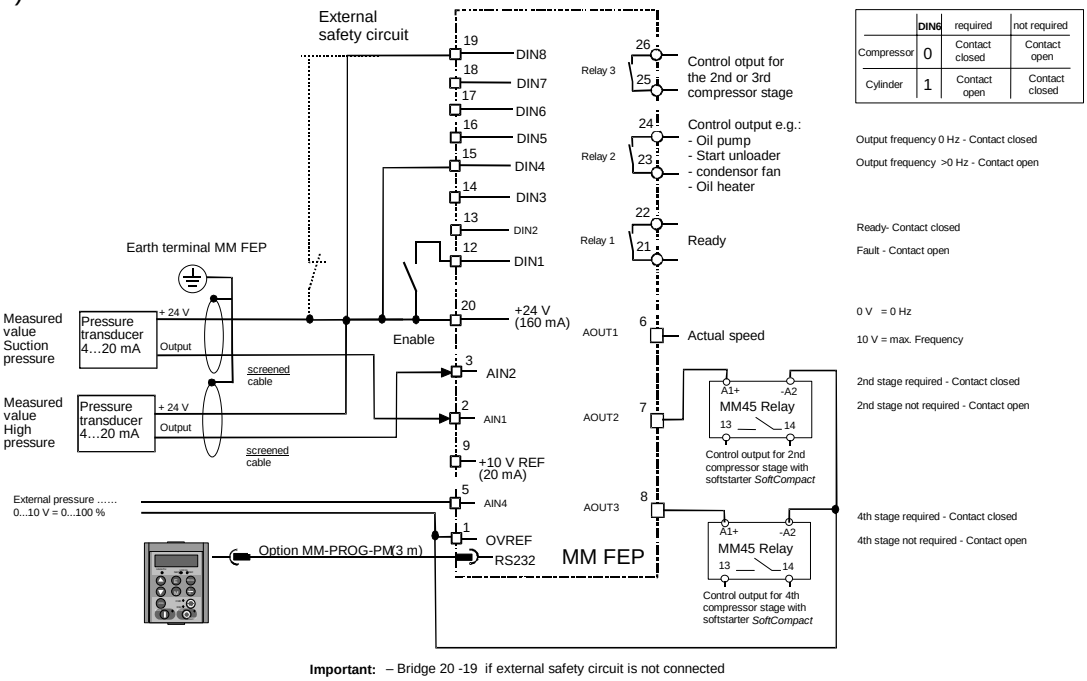
If a variable pressure setpoint is required, e.g. for operation with an external open-loop control (remote setpoint), then this can be realized via the fourth analog input of the ***MotorMaster***®. The ***FrigoSoft*** ® closed-loop control operates without any restrictions - fixed setpoints 1 and 2 no longer have any significance.

Accessories: 2 pressure transducers for high pressure and suction pressure, pressure setpoint transmitter with 0...10 V output signal

Commissioning: *(no parameters have to be changed)*

Activation: 24 V at switching input 4 (Terminal 15)

Analog input 4 of the ***MotorMaster***® is pre-set to an input range 0...10 V. If another input range (e.g. 0...20 mA) is required, then the Application Service department must change the pre-setting. With the recommended pressure transducer, 0 V corresponds to the minimum value of -0.5 bar and 10 V, the maximum value of 7.0 bar (refer to Chapter 3.2.2).



Important: – Bridge 20 -19 if external safety circuit is not connected

Fig. 2.2.3: Connection example for version 3

2.2.2.4 Version 4: Local operation

The ***FrigoSoft*** ® program can be disabled to commission or function test the drive inverter. The drive inverter is then only controlled from the operator panel.

Activation: De-activating the “enable signal” at terminal 20. Key **L/R** on the programming unit.

As soon as the function has been activated, the “**SETPOINT LOCAL**“ message is displayed. The setpoint can be adjusted using the arrow keys. The drive inverter is started by pressing the **I** key (RUN) and stopped with **0** (STOP).

In addition to this function, there is also the **JOG** mode. The drive inverter feeds the compressor motor with 30 Hz as long as the jog key is pressed.

CAUTION:	**The automatic restart function is inactive in the local mode! The compressor can be damaged by frequently powering-it up for a short period of time !** **In the local mode, it is neither permissible that the minimum frequency is fallen below, nor the maximum frequency exceeded.**

2.2.2.5 Activating the cylinder head off -loading

Three-stage compressor systems can either be realized using three separate compressors, or with two compressors and an additional capacity regulation. The output signals to control the components are different. This is the reason that the system configuration must be taken into consideration when selecting the software version.

The “3 compressors“ version can also be used to control a system with two compressors without any capacity regulation (refer to Table 2.2.2).

Activation: 0 V at switching input 5 (Terminal 16): **3 Compressors**
24 V at switching input 5 (Terminal 16): **Capacity regulation**

The difference between the two versions is how relay 3 is controlled and this is shown using the signal characteristics in Fig. 2.2.4: A system with 4 compressors is shown at the left and with 3 compressors and capacity regulation at the right.

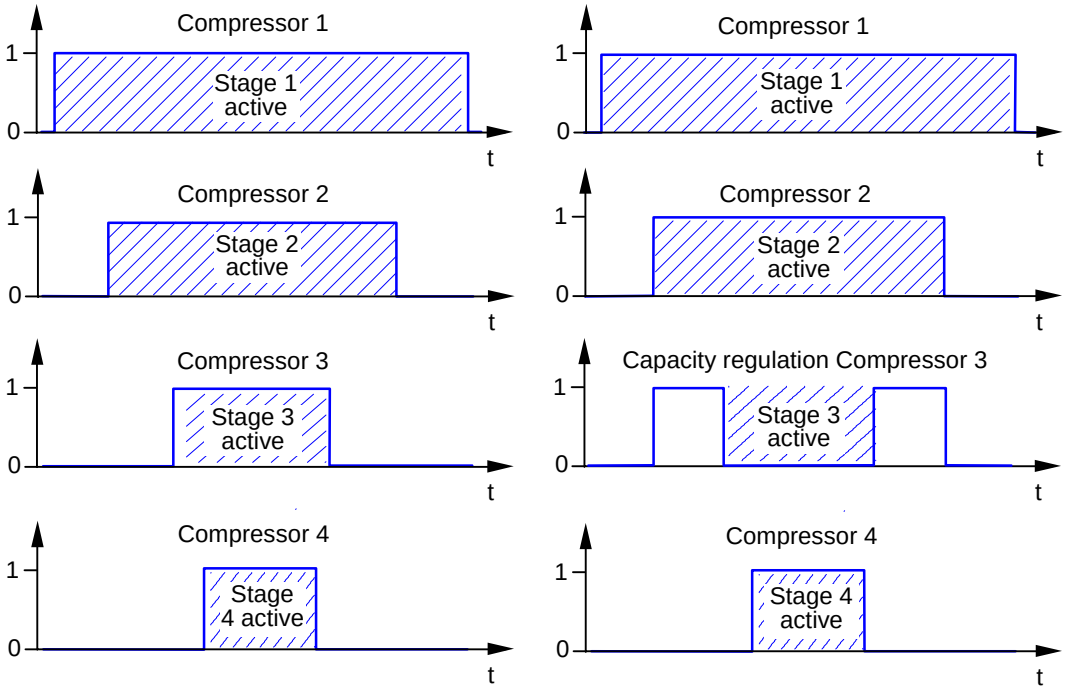


Fig. 2.2.4: Signal characteristics for multi-stage systems

3 Commissioning

WARNING

The *FrigoSoft* ® - Software is completely pre-installed in the supplied ***MotorMaster***®.
That is the reason that the command **RESTORE DEFAULTS** should

N E V E R

be activated.

This could erase the *FrigoSoft* ® software!
Please contact the Application Service department if problems are encountered

3.1 Entering the operating parameters

The necessary operating parameters, such as pressure setpoint, minimum and maximum frequency etc. are set in the “operator menu”. This menu is automatically displayed after power-on. Navigation through the operator menu is shown in Table 3.

3.1.1 Operator menu

The keys on the programming pad


UP key


DOWN key


ESCAPE key


MENU key

The curser can be moved to start position for entering by the MENU key.

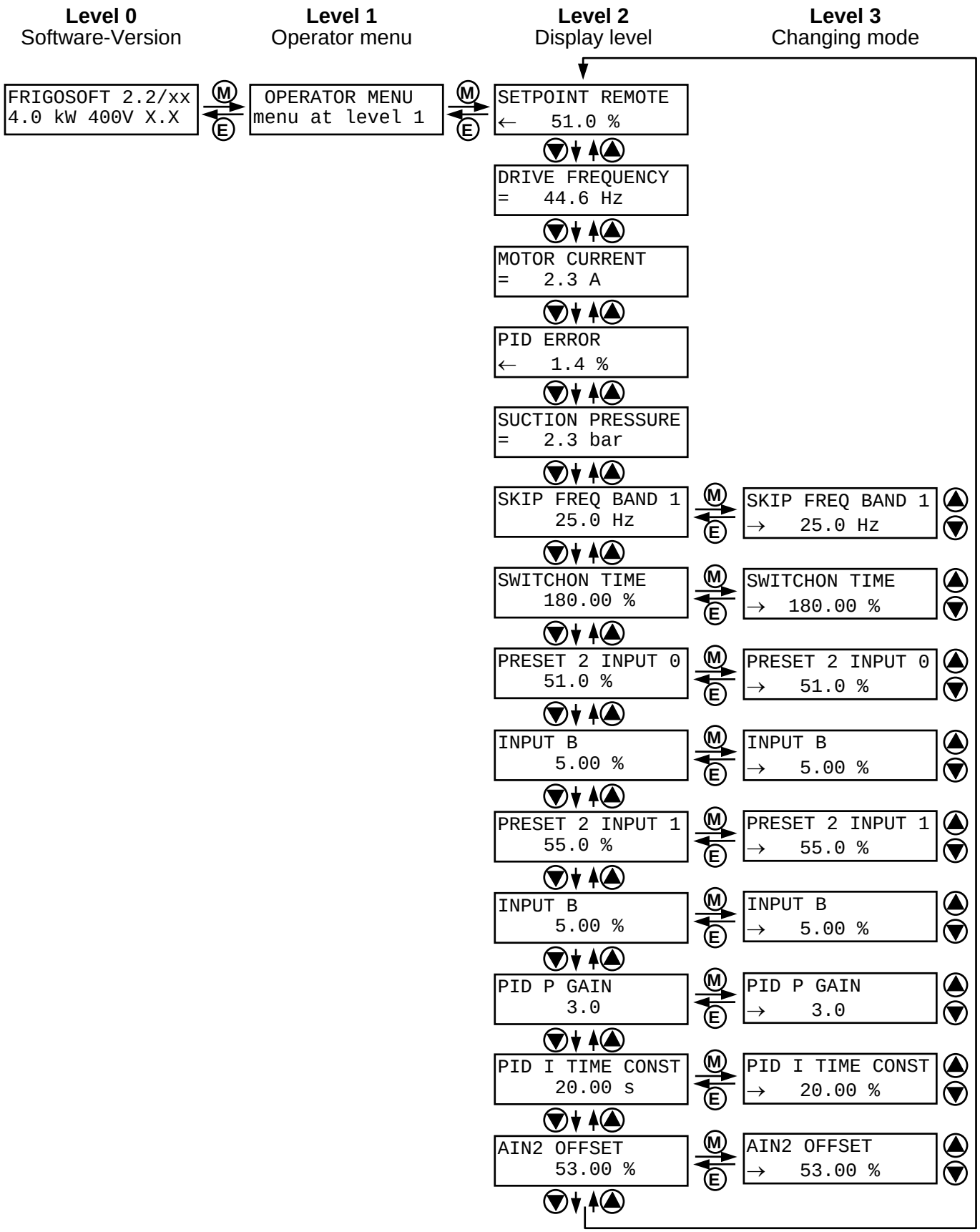


Table 3: Arrangement of *MotorMaster*® parameters

	Type of parameter	Explanation	Notes
1	only display	Shows the actual set setpoint in %	Enable deactivated: SETPOINT REMOTE Enable activated: SUM-SOLLW FERN
2	only display	Displays the output frequency of the ***MotorMaster***® in Hz	
3	only display	Displays the motor current in A	
4	only display	Displays the PID error from the set value in %	Difference between setpoint and feedback
5	only display	Displays the suction / low pressure in bar	Feedback display
6	adjustable	Minimum frequency in Hz	Preset has to be checked with the first starting
7	adjustable	Time for the switch-on delay for the inverter controlled compressor	Setting see Chapter 3.1.4
8	adjustable	Preset pressure value 1 in % as in Table 5 (main preset value)	
9	adjustable	Time for the switch-on delay for the 2nd, 3rd and 4th stage	Setting and explanation see Chapter 3.1.5
10	adjustable	Preset pressure value 2 in % as in Table 5 (additional preset value)	Only available with Version 2
11	adjustable	Time for switch-off delay for the 2nd and 3rd stage	Setting and explanation see Chapter 3.1.5
12	adjustable	P gain of the PID controller to control the suction pressure (without unit)	Setting and explanation see Chapter 3.1.7
13	adjustable	I time constant of the PID controller to control the suction pressure in s	Setting and explanation see Chapter 3.1.7
14	adjustable	Threshold value of high pressure in % depending on the high pressure transducer	If the threshold value is reached the Inverter reduces the output frequency

Table 4: Parameters explanations

3.1.2 Pressure setpoints

3.1.2.1 Selecting pressure setpoints

The pressure setpoints for the suction pressure are entered via the operator menu. A differentiation is made between the main setpoint, which is entered under **PRESET 2 INPUT 0** and the supplementary setpoint, under **PRESET 2 INPUT 1**.

Depending on the cooling medium used, a specific pressure setpoint is obtained for a specific temperature at the suction side of the compressor, which is controlled by the ***FrigoSoft*** ® software. The ***MotorMaster*** ® receives the pressure actual value in the form of an electrical signal. In order to achieve precise closed-loop control without any fluctuations, it is important that this signal is generated as accurately as possible and is transferred noise-free.

The pressure transducer 506.930A23101W, which KIMO recommends for the suction pressure, has a measuring range of between -0.5...+7.0 bar. For cooling mediums which are generally used, an assignment of the temperature values to the setpoint to be entered is shown in Table 5.

Current/Pressure - characteristic for the recommended pressure transducer						
Control setpoint	Current/Pressure-ratio		Cooling medium			
%	Signal [mA]	Over pressure [bar]	R22 [°C]	R407c [°C]	R404A [°C]	R134A [°C]
0,0	4,0	-0,50	-54,5	-50,0	-60,0	-40,0
3,1	4,5	-0,27	-47,0	-43,0	-53,2	-32,5
6,3	5,0	-0,03	-41,0	-37,0	-47,0	-26,0
9,4	5,5	0,20	-37,0	-33,0	-42,8	-22,0
12,5	6,0	0,44	-32,8	-29,0	-38,4	-18,0
15,6	6,5	0,67	-29,5	-26,0	-35,3	-14,5
18,8	7,0	0,91	-26,0	-23,0	-32,1	-11,0
21,9	7,5	1,14	-23,2	-20,0	-29,2	-8,2
25,0	8,0	1,38	-20,5	-18,0	-26,8	-5,5
28,1	8,5	1,61	-18,0	-15,0	-24,1	-3,0
31,3	9,0	1,84	-16,0	-13,0	-22,0	-0,8
34,4	9,5	2,08	-13,9	-11,0	-20,0	1,2
37,5	10,0	2,31	-11,8	-9,0	-18,0	3,6
40,6	10,5	2,55	-10,0	-7,0	-16,0	5,5
43,8	11,0	2,78	-8,1	-5,5	-14,0	7,2
46,9	11,5	3,02	-6,2	-4,0	-12,5	9,0
50,0	12,0	3,25	-4,8	-2,5	-10,9	10,9
53,1	12,5	3,48	-3,1	-1,0	-9,6	12,1
56,3	13,0	3,72	-1,3	0,9	-7,8	14,1
59,4	13,5	3,95	0,0	2,0	-6,5	15,5
62,5	14,0	4,19	1,2	3,5	-5,1	17,0
65,6	14,5	4,42	3,0	5,0	-3,7	18,3
68,8	15,0	4,66	4,0	6,5	-2,5	19,8
71,9	15,5	4,89	5,6	7,2	-1,0	-
75,0	16,0	5,13	6,5	8,5	0,0	-
78,1	16,5	5,36	7,8	9,5	1,2	-
81,3	17,0	5,59	8,9	11,0	2,5	-
84,4	17,5	5,83	10,2	12,0	3,8	-
87,5	18,0	6,06	11,2	13,0	4,9	-
90,6	18,5	6,30	12,5	14,0	5,8	-
93,8	19,0	6,53	13,3	15,0	6,8	-
96,9	19,5	6,77	14,5	16,0	7,8	-
100,0	20,0	7,00	15,5	17,0	8,9	-

Table 5: Assignment table, volatilization temperature-setpoint

3.1.2.2 Entering the setpoints

Main setpoint:	Parameter designation:	**PRESET2 INPUT 0** (line 8 in the operator menu) Pre-setting: 51.0 %
Supplementary setpoint:	Parameter designation:	**PRESET2 INPUT 1** (line 10 in the operator menu) Pre-setting: 55.0 %
Method of changing:	1. Select **PRESET 2 INPUT 0** (or **PRESET 2 INPUT 1**) in the display level with UP or DOWN key. 2. Press the MENU key to select the changing mode. 3. Enter the new value using the UP or DOWN key. 4. Store the new value using the ESCAPE key and select the displaying mode.	

3.1.3 Compressor operating frequencies

Before changing the pre-set operating frequencies, the minimum and maximum frequencies, permissible for the compressor, must be determined. If a compressor is operated with an inadmissible frequency, this can result in death, severe bodily injury and/or significant material damage.

3.1.3.1 Minimum frequency

Parameter designation:	**SKIP FREQ BAND 1** (line 6 in the operator menu)
Pre-setting:	25.0 Hz
Method of changing:	1. Select **SKIP FREQ BAND 1** in the display level with UP or DOWN key. 2. Press the MENU key to select the changing mode. 3. Enter the new value using the UP or DOWN key. 4. Store the new value using the ESCAPE key and select the displaying mode.

3.1.3.2 Maximum frequency

Pre-setting:	60.0 Hz
Method of changing:	The parameter was removed from the operator menu - contrary to ***FrigoSoft*** ® version 1.0, as in most cases it does not have to be changed. However, if a change is required, then the Application Service department can help.

3.1.3.3 Skip frequencies

Method of changing:	The parameter was removed from the operator menu - contrary to ***FrigoSoft*** ® version 1.0, as in most cases it does not have to be changed. However, if a change is required, then the Application Service department can help.

Under no circumstances may the minimum and maximum frequencies be suppressed as otherwise the additional compressor stages will not be able to be switched-in and switched-out.

3.1.4 Restart inhibit

In order that the compressor is adequately lubricated, it is not permissible that the compressor is cyclically operated. This is the reason that a variable timer has been incorporated in the ***FrigoSoft*** ® program. This delays the compressor from being powered-up again in a range which can be set between 0...300 s. The optimum time should be determined when commissioning the system and depends on the lowest cooling requirement. If the power-on inhibit is selected to be too long, then there is a danger that the pressure actual value will deviate too significantly from the setpoint and more significant temperature fluctuations will occur in the cooling circuit.

Parameter designation:	**INPUT B** (line 7 in the operator menu)
Pre-setting:	180.00 % corresponds to 180.0 s, (1.00 % corresponds to a time of 10.0 s)
Method of changing:	1. Select **INPUT B** with the UP or DOWN key. **(Caution: not to be confused !!!)** 2. Press the MENU key to select the changing mode. 3. Enter the new value using the UP or DOWN key. 4. Store the new value using the ESCAPE key and select the displaying mode.

Note: The designations of the restart inhibit, the power-on and power-off delays in the operator menu are, for program-related reasons, unfortunately the same. This is the reason that the specified line in the operator menu in Table 3 and in the following text must be observed.

3.1.5 Refrigeration system using four compressors

When the first compressor reaches its maximum speed, the second compressor stage is switched-in after the programmed delay time has expired. If the total compressor power is now sufficient, or too high, ***MotorMaster***® reduces the speed of the first compressor. If this is not the case, then the third compressor stage is switched-in, but as before, only after the programmed power-on delay has expired.

If all four compressor stages are active, and if the speed of the first compressor drops to the minimum frequency, the fourth compressor stage is immediately shutdown. If the speed of the first compressor again reaches the minimum frequency or remains there, because the total compressor performance is still to high, then the third resp. the second stage is also switched-out after the power-off delay time has expired.

Switch-off delay	Parameter designation:	**INPUT B** (line 11 in the operator menu)
of the 2nd and 3rd stage:	Pre-setting:	5.00 % (1.00 % corresponds to a time of 1.0 s)
Power-on delay of the	Parameter designation:	**INPUT B** (line 9 in the operator menu)
2nd, 3rd and 4th stage:	Pre-setting:	5.00 % (1.00 % corresponds to a time of 1.0 s)

Method of changing:	1. Select **INPUT B** with the UP or DOWN key. **(Caution: not to be confused !!!)** 2. Press the MENU key to select the changing mode. 3. Enter the new value using the UP or DOWN key. 4. Store the new value using the ESCAPE key and select the displaying mode.

3.1.6 Refrigeration system with two compressors and capacity regulation

When the first compressor reaches its maximum speed, then initially, the second compressor stage is switched-in after a programmed delay time has expired. At the instant that the second compressor is switched-in, the solenoid valve to shutdown the bank or banks of cylinders, is activated, i.e. these cylinders are not active. If the overall compressor power is now sufficient or too high, ***MotorMaster***® reduces the speed of the first compressor. If this is not the case, the cylinder, which was previously shutdown, is activated, however, only after the programmed switch-in delay has expired. If all of the three compressor stages are active and the speed of the first compressor drops to the minimum frequency, initially, the cylinders, which are shutdown are bypassed.

If the speed of the first compressor again reaches the minimum frequency or remains there, because the overall compressor power is still high, then the second compressor is also powered-down after the power-on delay time has expired.

The delay times can be set according to the technique described in Chapter 3.1.5.

3.1.7 Changing the controller parameters

The controller coefficients of the P and I components can be changed to optimize the dynamic control behavior of ***FrigoSoft*** ® .

WARNING:	**Only trained specialist personnel may change the controller parameters. This personnel must have sufficient experience in optimizing PI controllers. Incorrect changes can damage the refrigeration system, especially the compressor motors. This is the reason that only small changes should be made and the effect carefully observe!**

Proportional gain of the PID -controller:	Parameter designation:	**PID P GAIN** (line 12 in the operator menu)
	Default:	3.00 %

Integral action time of the PID -controller:	Parameter designation:	**PID I TIME CONST** (line 13 in the operator menu)
	Default:	20.00 s

Änderungsverfahren:	1. Select **PID P GAIN** , (or **PID I TIME CONST**) using the UP or DOWN key 2. Press the MENU key to select the changing mode. 3. Enter the new value with the UP or DOWN key. 4. Store the new value using the ESCAPE key and select the displaying mode.

3.1.8 Changing other parameters

Several operating steps, which are described in detail in the following, must be made when changing parameters which are not available through the operator menu. After changing the controller coefficients, the original access authorization levels must be re-established. This is the only effective way in order to prevent unauthorized personnel from making changes.

1. Changing the view level

1. Press the PROG key shortly: **VIEW LEVEL**│**OPERATOR** is displayed.
2. Press the M key: **ENTER PASSWORD** is displayed.
3. Enter the Password with the ▼ and ▲ key and confirm with the E key.
4. **VIEW LEVEL**│**OPERATOR** is displayed.
5. Press the ▼ and ▲ key to select the menu **VIEW LEVEL**│**ADVANCED**.
6. Press the E key 2 x: **QUICK SETUP** is displayed.

2. Displaying and changing parameters

Select the parameter required to display or to change with the keys E, M, ▲ and ▼ as described in the **Parameter List** delivered with the **Product Manual for the *MotorMaster*® Frequency Inverter**

1. Press the M key
2. Change the set value with the keys ▲ and ▼
3. Press the E key to complete
4. Press the E key , the display will show „SETUP PARAMETERS|menu level 1“

3. Limiting the setting possibilities

1. Press the ▼ key until the display will show „ QUICK SETUP|menu level 1“
2. Press the M key, the display will show „CONTROL MODE“
3. Press the ▲ key, the display will show "OPERATOR│ADVANCED"
4. Press the M key to change setting
5. Press the ▼ key until the display will show „OPERATOR“
6. Press the E key to complete
7. Press the E key, until the display will show „ QUICK SETUP|menu level 1“

Storing changed values, see 3.2.1 on page 18.

3.2 Saving values which have been set

With the **MM FEP** range all changes made in the operating menu are automatically stored.Changes made to other menus must be stored as a separate action.

3.2.1 Storing changes

1. Press PROG key for approx. 3 s until **SAVE CONFIG** is displayed.
2. Press the M key: **SAVE CONFIG** | **APPLICATION** is displayed.
3. Press the M key: **'UP' TO CONFIRM** is displayed.
4. Press the ▲ key to confirm: **READY** is displayed shortly.
5. Press the E key to revent to original position in programming menu.

3.2.2 Making a back-up copy of the settings

MotorMaster*® FEP** and ***FrigoSoft ® refrigeration software are able to make an intend back-up copy of the settings. This back-up copy is already stored in the MM Frequency Inverter as the Macro **FRIGOSOFT22**.
If the main program is lost or if there are any other unexplained difficulties then this software can be reloaded.

When saving the reloaded program always store under **APPLICATION** as the MM Frequency Inverter always operates with the **APPLICATION** settings.

Never store as FRIGOSOFT22! Otherwise the back-up settings will be lost.

3.2.3 Loading the back-up settings

1. Select menu **SYSTEM**
2. Press the M key: **SAVE CONFIG** is displayed
3. Press the ▼ key: **RESTORE CONFIG** is displayed
4. Press the M key: **RESTORE CONFIG** | **APPLICATION** is displayed
5. Press the ▼ key: **RESTORE CONFIG** | **FRIGOSOFT22** is displayed
6. Press the M key: **'UP' TO CONFIRM** is displayed
7. Press the ▲ key to confirm: **RESTORE CONFIG** is displayed shortly
8. Press the E key to revent to original position in programming menu.

Finally save the configuration by storing under **APPLICATION**.

3.3 Automatic restart

If a fault, e.g. power failure occurs, then ***MotorMaster*®** automatically restarts after the line supply voltage has returned. However, an enable signal must be present. For internal or external faults (safety circuit), an attempt is made to again power-up the drive inverter after a delay time has expired (10 minutes are set as default value).

8. If the fault is no longer present, the compressor starts and operation continues normally.
9. If the fault is still present, ***MotorMaster*®** attempts to start a total of 10 times before it finally goes into a fault condition. In this case, the complete system must be checked.

3.4 Outputs

The ***MotorMaster***® signal outputs have the following functions:

Analog output 1: (refer to Chapter 3.1.9)	Provides the actual output frequency value as 0...10 V signal. The following assignment applies: 0 V = 0 Hz and 10 V = max. Frequency (**MAX SPEED**)
Relay 1 (NO):	After the ***MotorMaster***® has been initialized (READY is displayed in the programming unit) and there is no fault, the output switches to TRUE (contact closed). If a fault is present, the output switches back to FALSE (contact open).
Relay 2 (NO): (Operation)	Signals when the compressor is at a standstill (contact closed), i.e. the output frequency of the ***MotorMaster***® is 0. For example, the condenser fan, the oil pressure switch, the oil sump heating and start load reduction can be controlled from this output. The relay output is opened if the compressor is operational. The function of relay 2 can be inverted using the switching input 6 !
Switching output 2: (2nd stage)	Activates the second stage (= additional compressor) (closed). This occurs if the first compressor reaches the maximum frequency. If the first compressor again reaches the minimum frequency, the second stage is shutdown after a selectable delay has expired (open)
Relay 3 (NO): (3rd stage)	This activates the third stage (in this case: additional compressor) (closed). If the first compressor again reaches the maximum frequency, the relay pulls-in after a selectable delay has expired. When the first compressor reaches the minimum frequency, the third stage is again shutdown (open). The signals are inverted for the cylinder head off - loading (open ⇔ 3rd stage active).
Switching output 3: (4th stage)	Activates the 4th stage (= additional compressor), if the first compressor reaches the maximum frequency. If the first compressor again reaches the minimum frequency, the second stage is shutdown after a selectable delay has expired (open).

3.5 Configuration overview

In order to have a better overview for future service work carried-out in the refrigeration system, or especially at the ***MotorMaster***®, all of the system-specific data, the selected ***FrigoSoft*** ® operating mode and the set parameters should be documented during the commissioning phase. The time involved is minimum and can play a significant role in reducing service costs.

Project designation:	
MotorMaster®**-Type:**	
Type Machine:	
Date of commissioning:	
Monting firm:	
Cooling medium:	

Selected *FrigoSoft* ® mode of operation:

Version 1: Setting presets with programmable preset values.....
Version 2: Setting presets with two adjustable preset values.....
Version 3: Variable presets with analog input.....
Switching input 5 (Cylinder head off-loading) activated.....

Adjusted operating parameters:

Parameter designation	Default	**Actual setting**	
SKIP FREQ BAND 1	25.0 Hz		**Hz**
INPUT B	180.00 %		**%**
PRESET 2 INPUT 0	51.0 %		**%**
INPUT B	5.00 %		**%**
PRESET 1 INPUT 1	55.0 %		**%**
INPUT B	5.00 %		**%**
PID P GAIN	3.00		
PID I TIME CONST	20.00 s		**s**
AIN1 OFFSET	53.00 %		**%**

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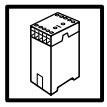

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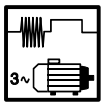
- **N** Drehzahlregelung

Electronic soft starters up to2000 kW
fully controlled
STANDARD-OPTIONS
- **I** Optimised start for pumps, power monitoring, current and cos φ control
- **N** Speed control



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0,37...315 kW, 3AC 400 V
Elektronische Frequenzumrichter
0,37...1,5 kW, 1AC 230 V
2,2...15 kW, 3AC 400 V

Digital frequency inverters
0.37...1.5 kW, 1AC 230 V
0.37...315 kW, 3AC 400 V
Electronic frequency inverters
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