COURSE

Danfoss VLT® HVAC FC 102

Version: 24.06A

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FOREWORD

This course book is provided to those who have completed the Danfoss VLT HVAC FC 102 course at Van der Ende Group. It is also provided with every Danfoss HVAC FC 102.

The course book is also intended as a handy, abridged manual for commissioning the Danfoss VLT HVAC FC 102. A few example applications are also mentioned in this book.
We therefore strongly advise you to always read the original manuals supplied with the controller carefully.

No rights can be derived from the contents of this course book.
Errors and/or typographical errors that may cause incorrect settings and/or damage to the controller or machines connected to it cannot give rise to claims for compensation or warranty and are expressly rejected by us.

The parameters mentioned in this booklet are only examples; no rights can be derived from them.

1 SAFETY

ONLY QUALIFIED PERSONNEL MAY PERFORM WORK ON THE ELECTRICAL INSTALLATION

WARNING	1	The components of the frequency converter's power supply unit are live when the VLT HVAC FC 102 is connected to the mains. Contact with this voltage is life-threatening and can cause serious injury or death. The control unit is potential-free.
	2	The VLT HVAC FC 102 has a leakage current of 3.5 mA AC according to EN61800-5-1.
	3	If the frequency converter is part of a machine, the machine manufacturer is responsible for installing a machine main switch (EN 60204-1).
	4	Only spare parts supplied by Danfoss may be used.
	5	Before performing (insulation) measurements on the motor or motor cables, the motor cables must be disconnected from the frequency converter.
	6	Do not touch the IC circuits on the boards. Static voltage can damage the components.
	7	Check that the EMC value of the frequency converter matches the value required by the environment.
	8	The motor starts automatically if you have set the parameter setting response after fault message to automatic. Read more about this in the application manual.
	9	The VLT HVAC FC 102 frequency converter must be used for permanent installations.
	10	Please note that the frequency converter may start automatically when it receives power. Therefore, disconnect the motor from the frequency converter if an unexpected motor start could pose a hazard.

	1	The motor terminals U, V, W and the DC rail/braking resistor terminals –/+ are live when the VLT HVAC FC 102 is connected to the mains, even if the motor is not running.
	2	The I/O connections for the controls are potentially isolated from the network. However, the relay outputs and other I/O connections may have a dangerous external voltage even if the VLT HVAC FC 102 is disconnected from the power supply network.
	3	Before connecting the frequency converter to the mains, check that the VLT HVAC FC 102 covers and cable connections are covered.
	4	Do not perform any measurements while the frequency converter is connected to the network.
	5	After disconnecting the frequency converter from the network, wait until the fan stops and the control panel switches off (if no panel is installed, check the lights on the cover). **Wait 5 minutes** before performing any work on the VLT HVAC FC 102 terminals. Do not even open the cover before this time has elapsed.
	6	Do not perform insulation measurements on the VLT HVAC FC 102. There is a special procedure for performing such tests. Failure to follow this procedure may result in damage to the product.

Safety instructions

Grounding and ground fault protection

The VLT HVAC FC 102 frequency converter must always be grounded at the grounding terminal ⏚

2 CABLING AND DISPLAY

2.1 Cable diameter and fuses

For more information about cable diameters and fuses, refer to chapter 7 of the design guide.

2.2 Shielded cables

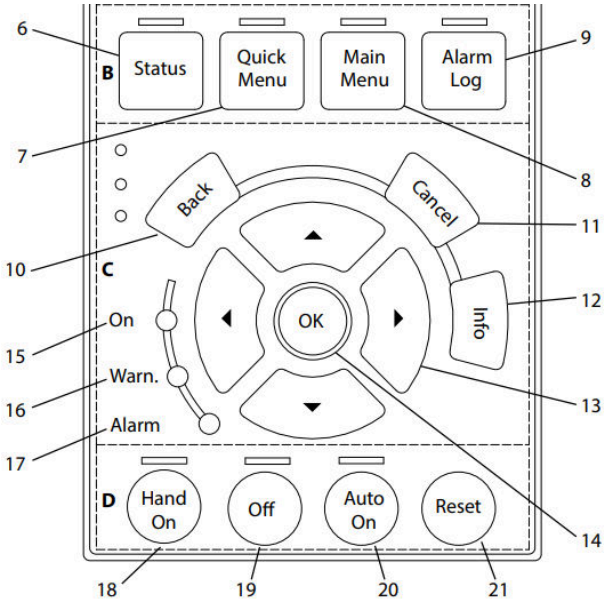
The control signal and motor cables must be shielded to comply with radio interference regulations in accordance with IEC 61800-3 category C2/C3 and EMC specifications. The shielding of the motor and control cables must be connected to the ground terminal in the frequency converter and in the motor or sensors, PLC, etc.
If unshielded cables are used, signal interference may occur at the control inputs. Such interference will not normally cause damage to the frequency converter, but it will disrupt the control system.

	RFI filter	
	H1	**H3**
Max. motor cable length	150 m	50 m

Please note!!! Reinforcement intended as mechanical protection (e.g., ground cable) is not suitable for EMC-compliant installation.

Our preference for signal cables is for cables with twisted cores.

2.3 Test description



Pos.	Key	Function
6	Status	Displays the operating data.
7	Quick Menu	Provides access to the parameters for programming the initial setup.
8	Main Menu	Provides access to all programmable parameters.
9	Alarm Log	Displays an overview of active warnings, the last 10 alarms, and the maintenance log.
10	Back	Returns you to the previous step in the menu structure.
11	Cancel	Cancels your last change or command.
12	Info	Press this to display a description of the selected function.
13	Navigation keys	Press to move to other options in the menu.
14	OK	This allows you to access parameter groups or confirm a selection.
18	Hand On	Start the frequency converter in local control.
19	Off	Stops the motor.
20	Auto On	Sets the system to external control mode.
21	Reset	This allows you to manually reset the frequency converter.

3 PARAMETERS

3.1 Viewing and changing a parameter

As an example, we want to view and change the minimum frequency (P 4-12).
Press the Main Menu button (8), select "Limits / Warnings" and press OK(14). Select menu "4-1 Motor limits" and press OK (14). Use the navigation keys (13) to scroll down and select parameter "4-12 Motor speed Low limit", then press OK (14) to adjust the parameter. To return to the main menu, press Status (6).

3.1.1 Adjusting the multimonitor menu

To adjust the display fields, follow the steps below:

1. Press Main Menu (8);
2. The "Operation/Display" menu is selected; press OK (14);
3. Select "LCP Display" and press OK (14);
4. Select the desired display line and press OK (14);
5. Now enter the desired parameter, see section 3.5, and press OK (14).
6. To return to the main menu, press Status (6).

3.2 Parameter group settings

This parameter group contains the following menus:

Group	Function
0-** Operation/display	Parameters relating to the basic functions of the frequency converter, the function of the LCP keys, and the configuration of the LCP display.
1-** Load & motor	Parameters for motor settings.
2-** Brakes	Parameters for setting brake functions in the frequency converter.
3-** Ref./Ramp.	Parameters for using references, setting limits, and configuring the frequency converter's response to changes.
4-** Limit/warning.	Parameters for configuring limits and warnings.
5-** Digital In/Out	Parameters for configuring the digital inputs and outputs.
6-** Analog In/Out	Parameters for configuring analog inputs and outputs.
8-** Comm. and options	Parameter group for configuring communication and options.
9-** PROFIdrive	Parameter group for Profibus-specific parameters (VLT® PROFIBUS DP MCA 101 required)
10-** CAN fieldbus	Parameter group for DeviceNet-specific parameters (VLT® DeviceNet MCA 104 required).
13-** Smart Logic	Parameter group for Smart Logic Control.
14-** Special functions	Parameter group for configuring special functions of the frequency converter.
15-** Drive info	Parameter group with information about the frequency converter, such as operating data, hardware configuration, and software versions.
16-** Data readouts	Parameter group for data readouts, such as current references, voltage, control, alarms, warnings, and status words.
18-** Info & readouts	This parameter group contains the last 10 logs for preventive maintenance.
20-** Inverter with feedback	This parameter group is used to configure the PID controller for feedback that controls the output frequency of the unit.
21-** Output with feedback	Parameters for configuring the 3 PID controllers for extended feedback.
22-** Application functions	Parameters for water applications.
23-** Time-based functions	Parameters for actions to be performed on a daily or weekly basis.
24-** Application functions 2	Parameters for the frequency converter bypass.
25-** Cascade controller	Parameters for configuring the standard cascade controller for sequential control of multiple pumps.
26-** Anal. I/O option MCB 109	Parameters for configuring the VLT® Analog I/O MCB 109.
27-** Cascade CTL option	Parameters for configuring the extended cascade control.
29-** Water Application Functions	Parameters for setting water-specific functions.
30-** Special Functions	Parameters for configuring special functions.
31-** Bypass option	Parameters for configuring the bypass function.
35-** Sensor input option	Parameters for configuring the sensor input function.

3.3 Save and load parameter settings + factory settings

To copy and load parameters using the display (LCP), follow the steps below.

- Set parameter 0-50 to (1) OK (copy everything to LCP)
- Set parameter 0-50 to (2) OK (load everything from LCP)

To reset to factory settings, perform the steps below.

- Set parameter 14-22 to initialize (2);
- Press OK;
- Disconnect the controller from the power supply;
- Reconnect the power supply to the controller;
- The controller will display "initializing";
- The controller now has the factory settings.

3.4 Alarms and warnings

Active errors and error history are displayed in the Alarm Log menu (keypad "9").

3.4.1 Alarm description (errors)

Code	Alarm
11	Thermistor overheating
12	Torque limitation
13	Overcurrent
14	Ground fault
15	Incompatible hardware
16	Short circuit
17	Control word timeout
18	Start failed
20	Temperature input error
21	Parameter error
22	Mechanical brake in hoisting application
23	Internal fans
24	External fans
25	Short circuit braking resistor
26	Brake resistor power limitation
27	Short circuit brake chopper
28	Brake test
29	Temp. Heat sink
30	Motor phase U missing
31	Motor phase V missing
32	Motor phase W missing
33	Inrush error
34	Fieldbus communication error
35	Optical error
36	Power failure
37	Phase imbalance
38	Internal error
39	Sensor heat sink
40	Overload DI terminal 27
41	Overload DI terminal 29
42	Overload X30/6-7
43	External power supply (optional)
45	Ground fault 2
46	Input card power supply
47	24V power supply low
48	1.8V low power supply
49	Speed limit
50	AMA calibration failed
51	AMA check Unom and Inom
52	AMA low Inom
53	AMA engine too large
54	AMA engine too small
55	AMA parameters out of range

Code	Alarm
56	AMA interrupted by user
57	AMA timeout
58	AMA internal error
59	Current limitation
60	Ext. Lock
61	Feedback error
62	Output frequency at max. limit
63	Mechanical brake low
64	Voltage limit
65	Control card overtemperature
66	Heat sink temperature low
67	Option configuration has been changed
68	Safe torque off
69	Power supply card temperature
70	Invalid FC configuration
71	PTC 1 Safe torque off
72	Dangerous malfunction
73	Automatic restart STO
74	PTC thermistor
75	Invalid profile
76	Power unit setup
77	Low power mode
78	Tracking error
79	Invalid PS configuration
80	Frequency set to default value.
81	CSIV corrupt
82	CSIV parameter error
83	Invalid option combination
84	No safety option
88	Option detection
89	Mechanical brake slides
90	Feedback monitoring
91	AI 54 incorrectly set
92	No flow
93	Dry pump
94	End of curve
95	Defective tire
98	Clock error

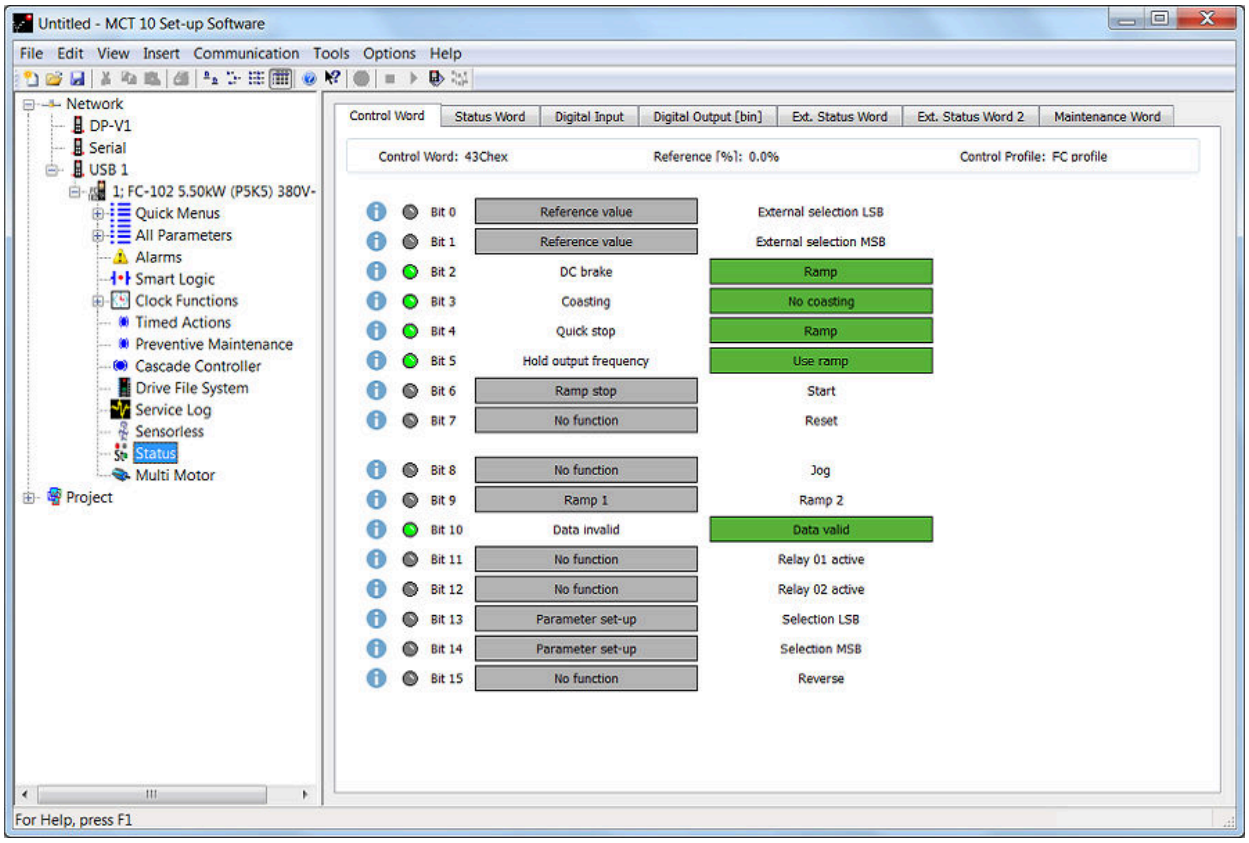
3.5 Monitoring values

The overview below contains the most common settings for the monitoring fields. Other settings can be found in section 3.2.3 of the programming manual.

Code	Option	Function
0	None	No display value selected
89	Date and time display	
1501	Number of operating hours	Displays the number of hours the motor has been in operation.
1601	Reference (unit)	Total reference in the selected unit.
1602	Reference %	Total reference in percent
1610	Power (kW)	Current motor power in kW
1612	Motor voltage	Voltage supplied to the motor
1614	Motor current	Phase current of the motor, measured as effective value.
1615	Frequency (%)	Motor frequency
1616	Torque (Nm)	Current motor load as a percentage of nominal motor torque
1617	Speed (RPM)	Speed in RPM
1618	Motor therm.	Thermal load of the motor
1623	Engine shaft power (kW)	Reading of the mechanical power delivered by the engine shaft.
1630	DC connection voltage	DC intermediate circuit voltage in the frequency converter.
1634	Heat sink temperature	Current temperature of the heat sink
1658	DIP output (%)	Displays the output value of the DIP controller with feedback as a percentage
1660	Digital input	Displays the status of the digital inputs.
1662	Analog input 53	The current value of input 53
1664	Analog input 54	The current value of input 54

4 MCT10

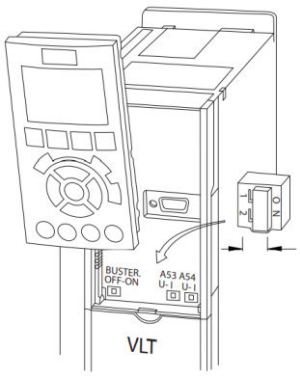
In MCT10, you can change and view the parameters via your PC.



5 APPLICATIONS

5.1 Application example 0 - 10 Volt tracking control

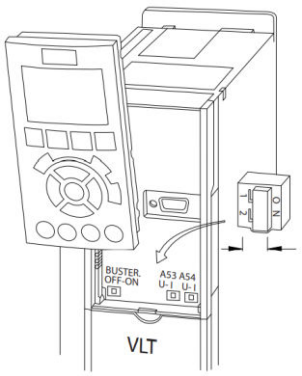
Parameter	Description	Setting	Code
0-01	Language	Dutch	7
0-02	Engine speed unit	Hz	1
0-20	Display line 1.1 small	Reference	1601
0-21	Display line 1.2 small	none	0
0-22	Display line 1.3 small	Analog input 53	1662
0-23	Display line 2 large	Frequency	1613
0-24	Display line 3 large	Motor current	1614
1-20	Motor power	Nominal motor power in kW nameplate	
1-22	Motor voltage	Nominal motor voltage in volts on type plate	
1-23	Motor frequency	Nominal motor frequency in Hz on nameplate	
1-24	Motor current	Nominal motor current in Amp. nameplate	
1-25	Motor speed	Nominal motor speed in rpm nameplate	
3-02	Minimum reference	Minimum frequency	
3-03	Maximum reference	maximum frequency	
3-15	Reference source 1	Analog input 53	1
3-41	Ramp 1 start-up time	10 sec	
3-42	Ramp 1 run-out time	10 sec	
5-01	Terminal 27 mode	Input	0
5-02	Terminal 29 mode	input	0
5-10	Terminal 18 digital input	Start	8
5-11	Terminal 19 digital input	Not in use	0
5-12	Terminal 27 digital input	Not in use	0
5-13	Terminal 29 digital input	Not in use	0
5-14	Terminal 32 digital input	Not in use	0
5-15	Terminal 33 digital input	Not in use	0
6-10	Terminal 53 Low voltage	0 volts (or 2)	
6-11	Terminal 53 High voltage	10 volts	
1-29	Automatic adjustment (AMA)	Limited AMA / Full AMA with separate motor	2 (1)



- Ensure that switch A53 is set to voltage (U), see image above.
- The 0-10 Volt signal is connected to AI1 on terminals 53 (+) and 55 (-).
- The tracking control is started by connecting 18 (DI) to 12 (+24 V).

5.2 Application example 4 - 20 mA tracking control

Parameter	Description	Setting	Code
0-01	Language	Dutch	7
0-02	Engine speed unit	Hz	1
0-20	Display line 1.1 small	Reference	1601
0-21	Display line 1.2 small	Analog input 54	1664
0-22	Display line 1.3 small	Motor current	1614
0-23	Display line 2 large	Frequency	1613
0-24	Display line 3 large	Digital input	1660
1-20	Motor power	Nominal motor power in kW type plate	
1-22	Motor voltage	Nominal motor voltage in volts on nameplate	
1-23	Motor frequency	Nominal motor frequency in Hz on nameplate	
1-24	Motor current	Nominal motor current in Amp. nameplate	
1-25	Motor speed	Nominal motor speed in rpm nameplate	
3-02	Minimum reference	Minimum frequency	
3-03	Maximum reference	maximum frequency	
3-15	Reference source 1	Analog input 54	2
3-41	Ramp 1 start-up time	10 sec	
3-42	Ramp 1 runout time	10 sec	
5-01	Terminal 27 mode	Input	0
5-02	Terminal 29 mode	input	0
5-10	Terminal 18 digital input	Start	8
5-11	Terminal 19 digital input	Not in use	0
5-12	Terminal 27 digital input	Not in use	0
5-13	Terminal 29 digital input	Not in use	0
5-14	Terminal 32 digital input	Not in use	0
5-15	Terminal 33 digital input	Not in use	0
6-22	Terminal 54 Low current	4 mA or (0)	
6-23	Terminal 54 High voltage	20 mA	
1-29	Automatic adjustment (AMA)	Limited AMA / Full AMA with separate motor	2 (1)



- Ensure that switch A54 is set to current (I), see image above.
- The 4-20 mA signal is connected to AI 2 on terminals 54 (+) and 55 (-).
- The follow control is started by connecting 18 (DI) to 12 (+24 V).

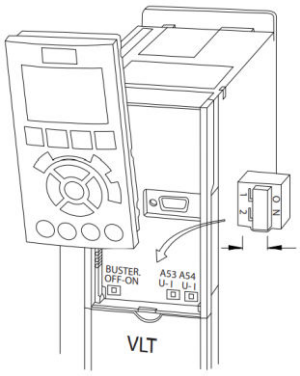
5.3 Application example Up – down control

Parameter	Description	Setting	Code
0-0	Language	Dutch	7
0-02	Engine speed unit	Hz	1
0-20	Display line 1.1 small	Reference	1601
0-21	Display line 1.2 small	none	0
0-22	Display line 1.3 small	DigiPot Reference %	1653
0-23	Display line 2 large	Frequency	1613
0-24	Display line 3 large	Motor current	1614
1-20	Motor power	Nominal motor power in kW nameplate	
1-22	Motor voltage	Nominal motor voltage in volts on nameplate	
1-23	Motor frequency	Nominal motor frequency in Hz on nameplate	
1-24	Motor current	Nominal motor current in Amp. nameplate	
1-25	Motor speed	Nominal motor speed in rpm nameplate	
3-02	Minimum reference	Minimum frequency	
3-03	Maximum reference	maximum frequency	
3-15	Reference source 1	Digital potentiometer	20
3-41	Ramp 1 start-up time	50 sec	
3-42	Ramp 1 run-out time	50 sec	
3-90	Step size	0.10	
3-91	Ramp time	50 sec	
3-92	Voltage recovery	Reference retention after power failure	0
3-93	Maximum limit	100%	
3-94	Minimum limit	10%	
3-95	On/off delay	0	
4-14	Motor speed high	Maximum frequency	
5-01	Terminal 27 mode	Input	0
5-02	Terminal 29 mode	input	0
5-10	Terminal 18 digital input	Start	8
5-11	Terminal 19 digital input	Not in use	0
5-12	Terminal 27 digital input	Not in use	0
5-13	Terminal 29 digital input	Clear DigiPot	57
5-14	Terminal 32 digital input	Increase DigiPot	55
5-15	Terminal 33 digital input	Lower DigiPot	56
14-01	Switching frequency	Adjust if excessive motor noise	
1-29	Automatic adjustment (AMA)	Limited AMA / Full AMA with separate motor	2 (1)

- The control is started by connecting 18 (DI 1) to 12 (+24 V).
- Speed up, connect terminal 32 (DI) to 12 (+24 V).
- Speed down, connect terminal 33 (DI) to 12 (+24 V).
- Reset speed, connect terminal 29 (DI) to 12 (+24 V).

5.4 Application example PID control

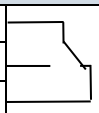
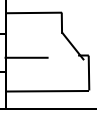
Parameter	Description	Setting	Code
0-01	Language	Dutch	7
0-02	Engine speed unit	Hz	1
0-20	Display line 1.1 small	Reference	1601
0-21	Display line 1.2 small	none	0
0-22	Display line 1.3 small	Feedback	1652
0-23	Display line 2 large	Frequency	1613
0-24	Display line 3 large	Motor current	1614
1-00	Configuration mode	With feedback	3
1-20	Motor power	Nominal motor power in kW nameplate	
1-22	Motor voltage	Nominal motor voltage in volts on nameplate	
1-23	Motor frequency	Nominal motor frequency in Hz on nameplate	
1-24	Motor current	Nominal motor current in Amp. nameplate	
1-25	Motor speed	Nominal motor speed in rpm nameplate	
3-02	Minimum reference	Minimum operating reference (range sensor) 20-12	
3-03	Maximum reference	maximum working reference (range sensor) 20-12	
3-11	Jog speed	40 Hz. (a fixed frequency)	
3-15	Reference source 1	No function	0
3-41	Ramp 1 start-up time	10 sec	
3-42	Ramp 1 run-out time	10 sec	
4-12	Motor speed Low limit	Minimum frequency	
4-14	Motor speed High limit	Maximum frequency (50/60)	
5-01	Terminal 27 mode	Input	0
5-02	Terminal 29 mode	entrance	0
5-10	Terminal 18 digital input	Start	8
5-11	Terminal 19 digital input	Jog	14
5-12	Terminal 27 digital input	External lock	7
5-13	Terminal 29 digital input	Not in use	0
5-14	Terminal 32 digital input	Not in use	0
5-15	Terminal 33 digital input	Reset	1
6-00	Live zero timeout	10 sec	
6-01	Live zero function	Stop/trip	5
6-22	Terminal 54 Low voltage	0 mA (or 4)	
6-23	Terminal 54 High voltage	20 mA	
6-24	Terminal 54 low ref feedback.	0 (range sensor)	
6-25	Terminal 54 high ref feedback.	10 (range sensor)	
6-27	Terminal 54 Live zero	on	1
20-00	Source feedback 1	Analog input 54	2
20-12	Reference/feedback unit	bar	71
20-13	min reference feedback	0 bar	
20-14	max reference feedback.	10 bar	
20-21	Setpoint 1	Enter working pressure	
20-83	PID start speed	25 Hz	
20-93	PID prop. gain	1.5	
20-94	PID integration time	1 sec	
22	Low speed detection	enabled	1
22-23	No flow function	sleep mode	1
22-24	Delay no flow	10 sec	
22-40	Minimum rotation time	5 sec	
22-41	Minimum stop time	2 sec	
22-44	Reaction/feedback difference	5	
22-45	Boost setting	10	
22-46	Maximum boost time	15 sec	
1-29	Automatic adjustment (AMA)	Limited AMA / Full AMA with separate engine	2 (1)



- Ensure that switch A54 is set to current (I), see image above.
- The 4-20 mA pressure sensor is connected to AI 2, on terminals 54 (-) and 12 (+).
- PID control is started by connecting 18 (DI) to 12 (+24 V).
- Water thermostat (nc) or float must be connected to 27 (DI) and to 12 (+24V).
- A fault can be reset remotely by connecting 33 (DI) to 12 (+24 V).
- Fixed speed is activated by connecting 19 (DI) to 12 (+24 V); the start contact is not required for this.

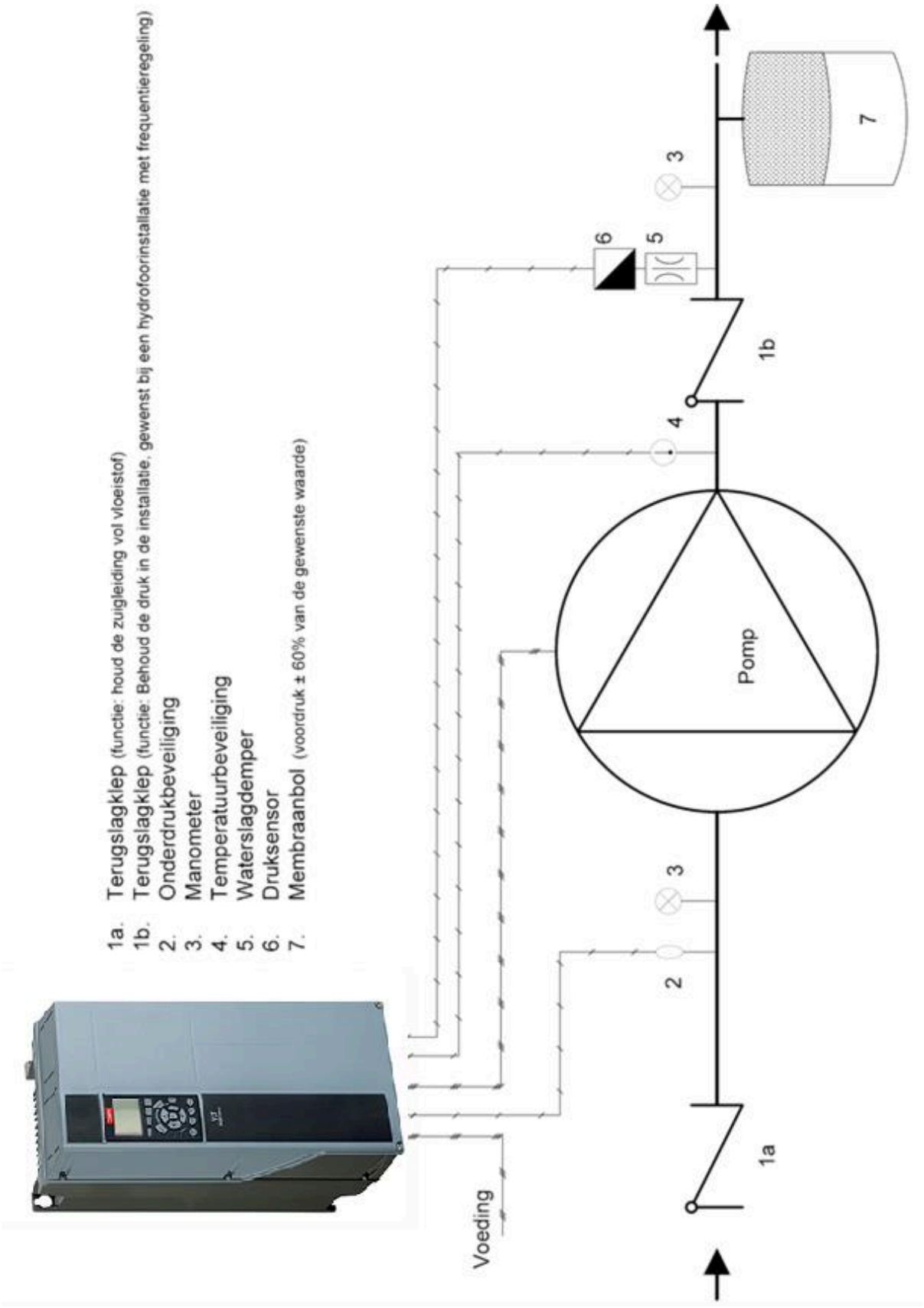
5.5 Connection terminals

Basic I/O board			
Connection terminal		**signal**	**description (PID settings)**
50	$+10V_{ref}$	Reference output	Power supply for potentiometer, etc.
53	AI1+	Analog input, 0-10Vdc or 0/4-20 mA	Voltage input for frequency reference
54	AI2+	Analog input 0-10Vdc or 0/4-20mA	Programmable current input
55	AI-	Analog input ground	
12	+24V	Control voltage output	Power supply for contacts, etc. max 0.1A
13	+24V	Control voltage output	Power supply for contacts, etc. max 0.1A
18	DI	Digital input	
19	DI	Digital input	
20	GND	I/O ground	Ground inputs and outputs
27	DI	Digital input	
29	DI	Digital input	
32	DI	Digital input	
33	DI	Digital input	
37	DI	Digital input	
39	AO1+	Analog output	Programmable range 0/4 - 20mA
42	AO-/GND		
61	GND	COM RS-485	
68	+	P RS-485	
69	-	N RS-485	

Relay board 1				
1	RO1 com		Relay output 1	Programmable
2	RO1 no			
3	RO1 nc			
4	RO2 com		Relay output 2	Programmable
5	RO2 no			
6	RO2 nc			

6 PRESSURE BOOSTER SYSTEMS

6.1 Connection diagram for hydrophore system (PID)



6.2 Adjustment aid for hydrophore systems

To ensure that a hydrophore unit with a Danfoss VLT switches off correctly, a number of parameters must be adjusted as follows:

- Set the Danfoss VLT HVAC FC 102 to manual control (Hand On "18").
- Ensure that the installation is filled with medium.
- Close the pressure pipe and slowly increase the frequency to the desired value P20-21 (setpoint 1).
- Set the Danfoss VLT HVAC FC 102 back to automatic (Auto On "20").

Note: For an installation with pre-pressure from a silo.
Ensure that the pre-pressure of the lowest level of the silo is used. If there are large differences in the level and therefore the pre-pressure, the motor may not go below the sleep frequency and the control may not be able to enter sleep mode.

Frequency with a closed pipe and the desired value	Increase the minimum frequency by
up to 40 Hz	± 1.0 Hz
40 to 44 Hz	± 0.7 Hz
44 to 47 Hz	± 0.5 Hz
47 to 49 Hz	± 0.2 Hz

Now enter the minimum frequency obtained according to the table above.

Example:
Frequency with a closed pipe and desired pressure is 44.5 Hz.
Minimum frequency: 45.0 Hz.

If the application works with a 2nd desired value, care must be taken to ensure that the minimum frequency is linked to the lowest desired value.

NOTES

The parameters listed in this booklet are only examples,
and no rights can be derived from them.

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