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Operating Instructions

VLT® DriveMotor FCP 106 and FCM 106 BACnet

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Contents

1 Introduction

1.1 Purpose of the Manual

This manual provides the information required to install and set up communication using BACnet protocol.

First-time users can obtain the most essential information for quick installation and set-up in these chapters

chapter 1 Introduction

chapter 3 Installation

chapter 4 System Configuration

For more detailed information including the full range of set-up options and diagnosis tools refer to the chapters:

chapter 6 Parameters

chapter 7 Troubleshooting

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1.2 Additional Resources

Literature available:

- *VLT® DriveMotor FCP 106 and FCM 106 Operating Instructions,* for information required to install and commission the frequency converter.
- *VLT® DriveMotor FCP 106 and FCM 106 Design Guide,* provides information required for integration of the frequency converter into a diversity of applications.
- *VLT® DriveMotor FCP 106 and FCM 106 Programming Guide*, for how to program the unit, including complete parameter descriptions.
- *VLT® LCP Instruction*, for operation of the local control panel (LCP).
- *VLT® LOP Instruction*, for operation of the local operation pad (LOP).
- *Modbus RTU Operating Instructions*, *Operating Instructions VLT® DriveMotor FCP 106 and FCM 106 BACnet* and *Operating Instructions VLT® DriveMotor FCP 106 and FCM 106 Metasys*, for information required for controlling, monitoring, and programming the frequency converter.
- *PC-based Configuration Tool MCT 10,* enables configuration of the frequency converter from a Windows™ based PC environment.
- *Danfoss VLT® Energy Box* software, for energy calculation in HVAC applications.

Technical literature and approvals are available online at *www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/Technical+Documentation.*

Danfoss VLT® Energy Box software is available at *www.danfoss.com/BusinessAreas/DrivesSolutions*, PC software download area.

1.3 Abbreviations and Conventions

ACI	Acyclical Control Interval
ACK	Acknowledge
ADF	Internal Floating Points
ADI	Internal Integers
AI	Analog Inputs
AO	Analog Outputs
AOC	Application Orientated Controller
AV	Analog Values
BI	Binary Inputs
BMS	Building Management System
BO	Binary Outputs
BV	Binary Values
COS	Change Of State
CTW	Control Word
EEPROM	Electrical Erasable Programmable Read Only Memory
EIA	Electronic Industries Association: Specifies of the EIA Standard RS-485-A
EMC	Electromagnetic Compatibility
HPFB	High Performance Field Bus
I/O	Input/Output
ISO	International Standards Organization
JCI	Johnson Controls Inc. developers of the METASYS N2 protocol
LCP	Local Control Panel
LED	Light Emitting Diode
MAV	Main Actual Value
MRV	Main Reference Value
N2	METASYS N2
N2 master	A N2 master is either a PC with JCI software or a dedicated JCI controller
NAK	Not acknowledged
NPA	N2 Point Address (Each N2 Point Type has a address range from 0 to 255)
NPT	N2 Point Type
PC	Personal Computer
PDU	Protocol Data Unit
PELV	Protected Extra Low Voltage
PLC	Programmable Logic Control
PNU	Parameter Number
STW	Status Word

Table 1.1 Abbreviations

1

Conventions

- Numbered lists indicate procedures.
- Bullet lists indicate
  - other information, and
  - description of illustrations.
- Italicised text indicates
  - cross reference
  - link
  - parameter name
- * indicates default setting of a parameter.

1.4 Technical Overview

BACnet (Building Automation and Control Network) is an open data communications protocol, American National Standard (ANSI/ASHRAE 135-2008). BACnet enables computer-based control equipment from different manufacturers to work together. BACnet is designed to handle many types of building controls, including HVAC, lighting, security, fire, access control, maintenance, and waste management. BACnet permits flexibility for expansion and different equipment combinations.

Conformance Classes, Function Groups, and the PICS: Evaluating the capabilities of a BACnet device is potentially a formidable task, given the great choice of Objects, Properties, and Services, which can be implemented. It is not necessary for every BACnet device to have a full BACnet implementation, to carry out its task. The ASHRAE BACnet Committee recognised this problem and responded with aids to evaluation in the form of "Conformance Classes," "Function Groups" and the "Protocol Implementation Conformance Statement" (PICS).

The BACnet protocol defines 6 levels of Conformance Classes, each of which specifies the minimum subset of Services implemented on the device. The lowest level, Conformance Class 1, requires only that the BACnet device contains a Device Object and that it is able to execute (respond to) a ReadProperty Service request. Each successive Conformance Class level adds Service Requests that must be executable by the device, as well as the Service Requests it must be able to initiate. Conformance Class 6 requires 21 types of Service Requests (of the 32 overall) to be implemented, of which 20 must be initiable and 17 executable. Conformance Class thus provides a measure of the ability of the device to communicate.

Function Groups specify a combination of Objects and Services necessary to carry out certain building automation functions. They are specified independently of Conformance Class, though the implementation of some of the Function Groups automatically confers some Conformance Class higher than 1.

Background information	
Protocol name	BACnet
Technology developer	ASHRAE
Year introduced	1995
Governing standards	ANSI/ASHRAE Standard 135-2008 version 4, ISO 16484-5
Openness	Open specification
Physical characteristics	
Network topology	Bus
Physical media	Shielded twisted pair
Max. Distance at low speed	1200 m
Transport mechanism	
Communication methods	MS/TP
Baud Rates Supported	9600, 19200, 38400, 76800
Termination	120 Ω

Table 1.2 Overview

1.4.1 Assumptions

This manual assumes that

- the BACnet Protocol is used with the FCP 106 or FCM 106 frequency converter.
- the system is equipped with a firmware supporting the BACnet communication services required by the application
- all requirements stipulated in the BACnet standard, as well as those pertaining to the frequency converter are strictly observed as well as all limitations therein fully respected.

1.4.2 Background Knowledge

The Danfoss BACnet Protocol is designed to communicate with any system complying with the BACnet MS/TP standard. Familiarity with the PC, BMS or PLC used as a master in the system is assumed. Issues regarding hardware or software produced by other manufacturers are beyond the scope of this manual and are not the responsibility of Danfoss.

In case of questions regarding set-up of master-to-master communication or communication to a non-Danfoss follower, consult the appropriate manuals.

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2 Safety

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The following symbols are used in this document:

⚠WARNING

Indicates a potentially hazardous situation which could result in death or serious injury.

⚠CAUTION

Indicates a potentially hazardous situation which could result in minor or moderate injury. It may also be used to alert against unsafe practices.

NOTICE

Indicates important information, including situations that may result in damage to equipment or property.

2.1 Qualified Personnel

Correct and reliable transport, storage, installation, operation and maintenance are required for the trouble-free and safe operation of the frequency converter. Only qualified personnel is allowed to install or operate this equipment.

Qualified personnel is defined as trained staff, who are authorised to install, commission, and maintain equipment, systems and circuits in accordance with pertinent laws and regulations. Additionally, the personnel must be familiar with the instructions and safety measures described in this document.

2.2 Safety Precautions

⚠WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input power. Failure to perform installation, start up, and maintenance by qualified personnel could result in death or serious injury.

- **Only qualified personnel are permitted to perform installation, start up, and maintenance.**

⚠WARNING

UNINTENDED START

When the frequency converter is connected to AC mains, the motor may start at any time, causing risk of death, serious injury, equipment, or property damage. The motor can start by means of an external switch, a serial bus command, an input reference signal from the LCP or LOP, or after a cleared fault condition.

- **Disconnect the frequency converter from mains whenever personal safety considerations make it necessary to avoid unintended motor start.**
- **Press [Off/Reset] on the LCP, before programming parameters.**
- **The frequency converter, motor, and any driven equipment must be in operational readiness when the frequency converter is connected to AC mains.**

⚠WARNING

DISCHARGE TIME

The frequency converter contains DC-link capacitors, which can remain charged even when the frequency converter is not powered. Failure to wait the specified time after power has been removed before performing service or repair work, could result in death or serious injury.

1. **Stop motor.**
2. **Disconnect AC mains, permanent magnet type motors, and remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other frequency converters.**
3. **Wait for the capacitors to discharge fully, before performing any service or repair work. The duration of waiting time is specified in *Table 2.1*.**

Voltage [V]	Power Range[1)] [kW]	Minimum waiting time (min)
3x400	0.55–7.5	4
High voltage can be present even when the warning LED indicator lights are off.		

Table 2.1 Discharge Time

1) Power ratings relate to NO, see VLT® DriveMotor FCP 106 and FCM 106 Operating Instructions.

⚠WARNING

EQUIPMENT HAZARD

Contact with rotating shafts and electrical equipment can result in death or serious injury.

- **Ensure that only trained and qualified personnel perform installation, start up, and maintenance.**
- **Ensure that electrical work conforms to national and local electrical codes.**
- **Follow the procedures in this manual.**

⚠CAUTION

WINDMILLING

Unintended rotation of permanent magnet motors causes risk of personal injury and equipment damage.

- **Ensure that permanent magnet motors are blocked to prevent unintended rotation.**

⚠WARNING

LEAKAGE CURRENT HAZARD

Follow national and local codes regarding protective earthing of equipment with a leakage current exceeding 3.5 mA. Frequency converter technology implies high frequency switching at high power. This switching generates a leakage current in the ground connection. A fault current in the frequency converter at the output power terminals can contain a DC component which can charge the filter capacitors and cause a transient ground current. The ground leakage current depends on various system configurations including RFI filtering, screened motor cables, and frequency converter power. EN/IEC61800-5-1 (Power Drive System Product Standard) requires special care because the leakage current exceeds 3.5 mA. See EN60364-5-54 paragraph 543.7 for further information.

- **Ensure correct grounding of the equipment by a certified electrical installer.**
- **Grounding must be reinforced in one of the following ways:**
  - **Ensure ground wire with cross-section of at least 10 mm^2, or**
  - **Ensure 2 separate ground wires, both complying with the dimensioning rules.**

NOTICE

HIGH ALTITUDES

For installation at altitudes above 2000 m, contact Danfoss regarding PELV.

⚠CAUTION

SHOCK HAZARD

The frequency converter can cause a DC current in the PE conductor.

- **When a residual current-operated protective device (RCD) is used for protection against electrical shock, only an RCD of Type B is permitted on the supply side.**

Failure to follow the recommendation means the RCD may not provide the intended protection.

⚠WARNING

GROUNDING HAZARD

For operator safety, it is important to ground the frequency converter properly in accordance with national and local electrical codes, as well as the instructions in this manual. Ground currents are higher than 3.5 mA. Failure to ground the frequency converter properly could result in death or serious injury.
It is the responsibility of the user or certified electrical installer, to ensure correct grounding of the equipment in accordance with national and local electrical codes and standards.

- **Follow all local and national electrical codes to ground electrical equipment properly.**
- **Establish proper protective grounding for equipment with current higher than 3.5 mA.**
- **A dedicated ground wire is required for input power, motor power, and control wiring.**
- **Use the clamps provided with on the equipment for proper ground connections.**
- **Do not ground one frequency converter to another in a "daisy chain" fashion.**
- **Keep the ground wire connections as short as possible.**
- **Use of high-strand wire to reduce electrical noise is recommended.**
- **Follow motor manufacturer wiring requirements.**

3 Installation

3.1 BACnet Interface

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3.1.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

⚠WARNING

INDUCED VOLTAGE

Induced voltage from output motor cables that run together can charge equipment capacitors even with the equipment turned off and locked out. Failure to run output motor cables separately or use screened cables could result in death or serious injury.

- **run output motor cables separately, or**
- **use screened cables**

⚠CAUTION

SHOCK HAZARD

The frequency converter can cause a DC current in the PE conductor. Failure to follow the recommendation below means that the RCD may not provide the intended protection.

- **When a residual current-operated protective device (RCD) is used for protection against electrical shock, only an RCD of Type B is permitted on the supply side.**

Overcurrent protection

- Additional protective equipment such as short circuit protection or motor thermal protection between frequency converter and motor is required for applications with multiple motors.
- Input fusing is required to provide short circuit and overcurrent protection. If not factory-supplied, the installer provides fuses. See maximum fuse ratings in *VLT® DriveMotor FCP 106 and FCM 106 Operating Instructions*.

Wire Type and Ratings

- All wiring must comply with local and national regulations regarding cross section and ambient temperature requirements.
- Power connection wire recommendation: minimum 75 °C rated copper wire.

See *VLT® DriveMotor FCP 106 and FCM 106 Operating Instructions* for recommended wire sizes and types.

3.1.2 Special Conditions

Electrical ratings

The frequency converter rating, shown on the nameplate, is based on a typical 3-phase mains power supply within the specified voltage, current and temperature range, expected for most applications.

The frequency converters also support other special applications, which affect the electrical ratings of the frequency converter.
Special conditions which can affect the electrical ratings:

- Single phase applications
- High temperature applications which require derating of the electrical ratings
- Marine applications with more severe environmental conditions.

Other applications can also affect the electrical ratings.

Consult the relevant sections in this manual and in the *VLT® DriveMotor FCP 106 and FCM 106 Design Guide* for information about the electrical ratings.

Installation requirements

The overall electrical safety of the frequency converter requires special installation considerations regarding:

- Fuses and circuit breakers for overcurrent and short circuit protection
- Selection of power cables (mains, motor, brakeloadsharing, and relay)
- Grid configuration (grounded delta transformer leg, IT, TN, and so on)
- Safety of low-voltage ports (PELV conditions).

Consult the relevant clauses in this manual and in the *VLT® DriveMotor FCP 106 and FCM 106 Operating Instructions* for information about the installation requirements.

3.1.3 Cabling

Cable lengths and number of nodes
For the correct function of a BACnet MS/TP system, it is mandatory to fulfill installation of the communication cables given in this manual. Under correct installation it is possible to have up to 250 nodes (125 masters and 125 slaves) on 1,200 m (4,000 ft) cable.

The use of drop cable connection (i.e. T-connection) is not allowed in a BACnet MS/TP system. Drop cables lead to reflection and malfunction of the system. In locations where the cabling demands a T-connection the use of repeaters is recommended.

NOTICE

A repeater is a node in each of the 2 segments it connects. The number of frequency converters is based on a single master system. If there are 2 or more devices (e.g. PC tools, Routers), reduce the number of frequency converters correspondingly.

- Maximum length of an MS/TP segment: 1,200 m (4,000 ft)
- Characteristic impedance: 100 to 130 Ω
- Resistance: <110 Ω/km
- Distributed capacitance: <100 pF/m, between conductors
- Cross section: 0.82 mm^2 conductor area, corresponding to AWG 18
- Cable type: twisted in pairs, 1 x 2, or 2 x 2 wires
- Screening: Copper-braided screen or braided screen and foil screen

NOTICE

Use of the same cable type throughout the entire segment is recommended to avoid impedance mismatch.

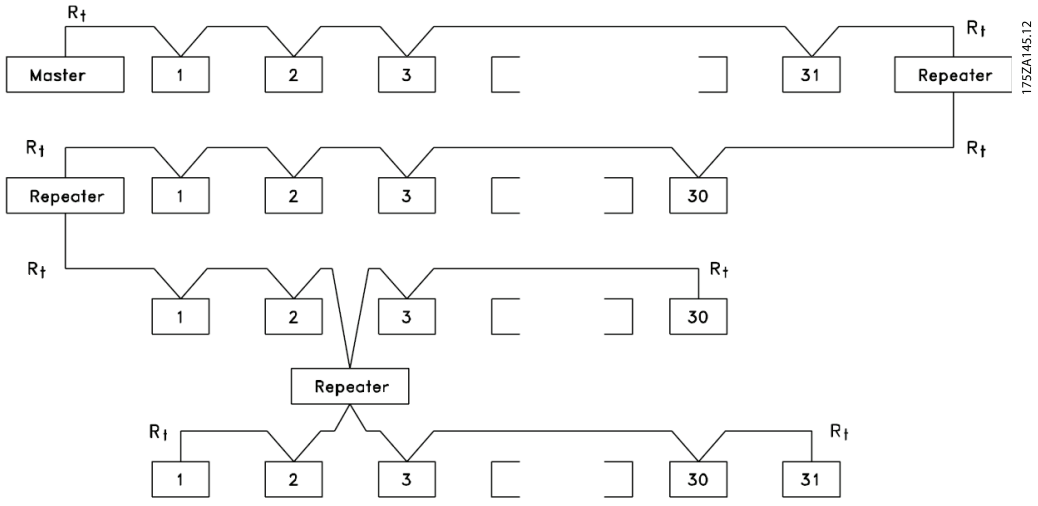

Illustration 3.1 BACnet Interface

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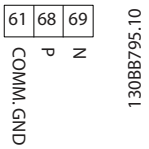
3.1.4 Network Connection

Connect the frequency converter to the RS-485 network as follows (see also *Illustration 3.2*):

1. Connect signal wires to terminal 68 (P+) and terminal 69 (N-) on the main control board of the frequency converter.
2. Connect the cable screen to the cable clamps.
3. Terminal 61 is normally not used. However when there is a large potential difference between frequency converters, connect the screen of the RS-485 cable to terminal 61. Terminal 61 has an RC filter to eliminate current noise on the cable.

NOTICE

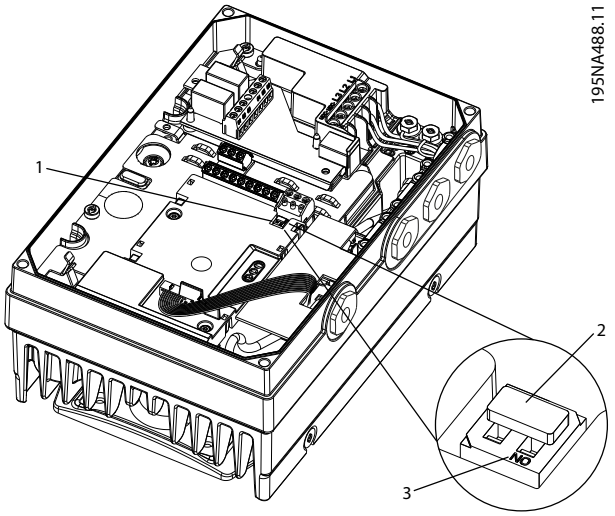
Screened, twisted-pair cables are recommended to reduce noise between conductors.



COMM. GND	Communication ground
P	(P+) Positive
N	(N-) Negative

Illustration 3.2 Network Connection

4. Set the control card DIP switch to ON to terminate the RS-485 bus, and activate RS-485. For position of DIP switch, see *Illustration 3.3*. The factory setting for the DIP switch is OFF.



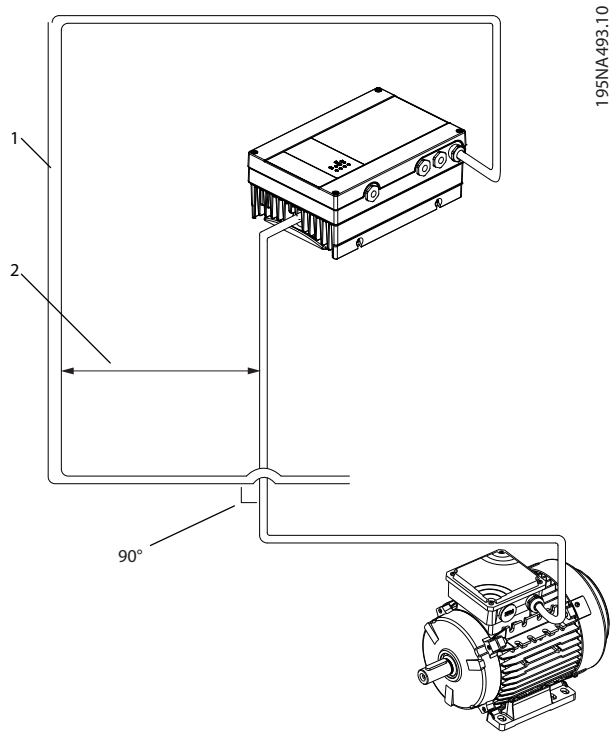
1	DIP switch
2	DIP switch set to factory setting, OFF position
3	DIP switch ON position

Illustration 3.3 DIP Switch set to Factory Setting

3.1.5 Cable Routing

The BACnet communication cable must be kept away from motor and brake resistor cables to avoid coupling of high frequency noise from one cable to the other. Normally a distance of 200 mm is sufficient, but maintaining the greatest possible distance between cables is generally recommended, especially where cables run in parallel over long distances.

When crossing is unavoidable, the BACnet cable must cross motor and brake resistor cables at an angle of 90°.



1	Fieldbus cable
2	Minimum 200 mm distance

Illustration 3.4 Cable Routing

3.2 Bus Cabling

3.2.1 EMC Precautions

The following EMC precautions are recommended to achieve interference-free operation of the BACnet network. More EMC information is available in the *VLT® DriveMotor FCP 106 and FCM 106 Design Guide*.

NOTICE

Ensure compliance with relevant national and local regulations, for example in PE connection.

3.2.2 Screen

For installing the bus cable on MS/TP, 2 different strategies can be followed, each with advantages and disadvantages:

- single ground of screen
- multiple ground of screen

3.2.3 Single Ground Screen

The single ground screen is specified in the ANSI/ASRAHE 135-2004 standard. The solution benefits by having only one ground connection of the screen, by doing so the risk of ground loop of equalising current is heavily reduced. In these systems the screen of the MS/TP cables must be isolated from ground at all stations, except one. At each station, the screens from the 2 cables must be connected with each other, and isolated from ground. The best solution for this connection is to use shrink tubes. The single ground sscreen is a good approach where the system uses long bus cables. For connection of 2 buildings over the same MS/TP bus cable, consider the use of fibre optic cable. Fibre optic cable prevents a lightning stroke transferring from one building to another, and the problem with difference in ground potential can be ignored.

3.2.4 Multiple Ground Screens

When the distance between the individual frequency converter is limited (for example, inside a cabinet or in one control room), Danfoss recommends connecting the screen to ground at both ends of the bus cable. This ensures the maximum protection from EMC noise. Connecting the screen at each end requires that each BACnet device has the same ground potential or an equalizing current flow in the screen of the cable. It causes disturbance and poor performance of the system. Low impedance to ground connection of the screen can be achieved by connecting the surface of the screen to ground, with a cable clamp or a conductive cable gland. The various clamps and brackets supplied enable a proper ground connection of the BACnet cable screen.

Danfoss recommends connection of the screen to ground at both ends of the bus cable, to ensure maximum protection from EMC noise. Connecting the screen at each end requires that each BACnet device has the same ground potential, otherwise an equalising current flows in the screen of the cable. This current causes disturbance and poor performance of the system. Alternatively, the screen can be isolated from the housing of the frequency converter using shrink-tubing. Routing of the BACnet cable must be established with correct distance to other cables, such as mains or motor cable

4 System Configuration

4.1 Configuring BACnet

4.1.1 Initialisation Procedure

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Parameter	Default Value	Setting for BACnet
8-01 Control Site	Digital and control word	Digital and control word
8-02 Control Source	FC RS-485	FC RS-485
8-03 Control Timeout Time	1 s	1)
8-04 Control Timeout Function	Off	1)

Table 4.1 General Settings

Parameter	Default Value	Setting for BACnet
8-30 Protocol	FC	BACnet
8-31 Address	1	1 3)
8-32 Baud Rate	9600	9600 baud
8-35 Minimum Response Delay	10 ms	10 ms
8-36 Maximum Response Delay	5,000 ms	5,000 ms

Table 4.2 FC Port Settings

1) Depending on the application.

2) Depending on the BMS system

3) The address setting is dependent on the system. Each device connected to the BACnet MS/TP must have a unique address on this MS/TP network. See also chapter 6.1 Parameter List.

Parameter	Default Value	Setting for BACnet
8-50 Coasting Select	Logic-or	Set according to the wiring of the application
8-52 DC Brake Select	Logic-or	Logic-or
8-53 Start Select	Logic-or	Logic-or
8-54 Reversing Select	Digital input	Digital input
8-55 Set-up Select	Logic-or	Logic-or
8-56 Preset Reference Select	Logic-or	Logic-or

Table 4.3 Digital/Bus Settings

Name	Default Value	Setting for BACnet
8-70 BACnet Device Instance	1	1 1)
8-72 MS/TP Max Masters	127	Dependent on the Number of Masters in the system
8-74 "I-Am" Service	At power up	At power up
8-75 Initialisation Password	“admin”	“admin”

Table 4.4 BACnet Settings

1) The device instance setting is dependent on the system. Each device connected to the BACnet MS/TP must have a unique device instance in the complete system.

4.1.2 Control Word Time-out Function

8-03 Control Timeout Time and *8-04 Control Timeout Function* are not used.

4.2 BACnet Set-up Example

This example shows the necessary steps to set up the BACnet interface with the following system requirements:

- MS/TP running at 38,400 Baud
- MAC address 20 for the frequency converter on the MS/TP network
- Device Instance number 1025 for the frequency converter
- Highest number of a Master device is 35
- Start/stop of frequency converter from BACnet only
- Reference from BACnet
- Read status of frequency converter (Actual speed)

Set the following parameters	
Parameter	**Value**
8-30 Protocol	[5] BACnet
8-31 Address	20
8-32 Baud Rate	[4] 38,400 Baud
8-50 Coasting Select	[1] Bus
8-70 BACnet Device Instance	1025
8-72 MS/TP Max Masters	35

Table 4.5 BACnet Set-up Example

After the parameters have been set according to *Table 4.5*, the frequency converter has to be unpowered and repowered before the changes take effect. When the frequency converter is detected by the BMS, it can be controlled by BV:1, which starts the motor if set to [1]. Setting AV:1 sets the speed reference of the frequency converter. The actual speed can be monitored via AV:3. See also *chapter 5.1.1 Analog Input and Output Objects*.

5 BACnet Objects

5.1 Network Frequency Converter Control Inputs and -Outputs

5.1.1 Analog Input and Output Objects

Control the frequency converter from the BACnet network using 'objects'. The various types of 'objects' and their descriptions are shown in the following tables.

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	Object_Name	Present_Value	
ID	Default name	Parameter	Unit
AI:0	Analog Input 53	1662	mA/Voltage
AI:1	Analog Input 54	1664	mA/Voltage

Table 5.1 Analog Inputs Object Map

	Object_Name	Present_Value				
ID	Default name	Parameter	Unit	Writeable	Cmd.able	Timeout
AO:0	Terminal 42 Output Bus Control	696	N_2	x	x	x
AO:2	Terminal 45 Output Bus Control	676	N_2	x	x	x

Table 5.2 Analog Outputs

	Object_Name			Present_Value				
ID	Default name	Writeable	EEPROM	Parameter	Unit	Writeable	Cmd.able	Timeout
AV:0	Reserved for VFD profile							
AV:1	Input Reference 1	x	x	1)	%	x	x	x
AV:2	Input Reference 2			1)	%	x	x	x
AV:3	Output Speed	x	x	2)	%			
AV:4	PI Feedback			3)	%			
AV:5	Motor Current	x	x	1614	Amps			
AV:6	Power	x	x	1610	kW			
AV:7	Reserved for VFD profile							
AV:8								
AV:9								
AV:10								
AV:11								
AV:12								
AV:13								
AV:14								
AV:15	Motor Thermal			1618	%			
AV:16	Reserved for VFD profile							
AV:17								
AV:18								
AV:19								
AV:20								
AV:21	Operating Hours			1500	Hours			

	Object_Name			Present_Value				
ID	Default name	Writeable	EEPROM	Parameter	Unit	Writeable	Cmd.able	Timeout
AV:22	Running Hours			1501	Hours			
AV:23	kWh Counter			1502	kWh			
AV:24	Motor Voltage			1612	V			
AV:25	Frequency			1613	Hz			
AV:27	DC Link Voltage			1630	V			
AV:28	Heatsink Temp.			1634	°C			
AV:29	Inverter Thermal			1635	%			
AV:31	Bus Feedback 1			894	N_2	x		
AV:32	Reserved for P, I							
AV:33								
AV:37	Reserved for P, I							
AV:38								
AV:39								
AV:42	Reserved for P, I							
AV:43								
AV:44								
AV:46								
AV:47								
AV:48								
AV:49								
AV:50	Alarm Log: Error Code			1530	NONE			
AV:51	Fault Code			[4]	NONE			
AV:52	PID Start Speed			2083	Hz	x		
AV:53	On Reference Bandwidth			2084	%	x		
AV:54	PID Proportional Gain			2093	NONE	x		
AV:55	PID Integral Time			2094	S	x		

Table 5.3 Analog Values

[1] Either AV:1 or AV:2 controls the frequency converter reference. Only one of them can control the frequency converter at a time and BV:2 decides which one.

[2] This value is not directly available in the frequency converter. The value must be calculated as follows:

$$AV\#3 = \frac{Par.\ 16-13}{Par.\ 4-14} \times 100\%$$

[3] This value is not directly available in the frequency converter. The value must be calculated as follows:

$$AV\#4 = \frac{Par.\ 16-52}{Par.\ 3-03} \times 100\%$$

[4] Frequency converter fault codes are transmitted as an analog value in AV:51. The fault codes are mapped as shown in *Table 5.4*. The frequency converter alarm codes are shown as well for comparison.

Table 5.4 shows the mapping of the frequency converter alarm codes and their mapping to the BACnet's fault codes.

5

Fault codes	Fault code	Frequency converter alarms	Fault descriptions
Communication Error	1	17	Loss of communication with the network
Over Current	2	59	Instantaneous output current has exceeded frequency converter rated or programmed value
Over Temperature	3	69	Heat sink temperature limit has been reached
Over Speed Deviation	4	N.A.	N.A.
Over Voltage	5	7	DC link voltage has exceeded frequency converter limit
Under Voltage	6	8	DC link voltage is lower than required frequency converter limit
Short Circuit	7	16	Frequency converter output has shorted phase-to-phase
Ground Fault	8	14	Frequency converter output grounding current has exceeded manufacturer limitations
Motor Overload	9	10	Motor is overloaded
Inverter Overload	10	9	Timed over current fault
Over Torque Detection	11	N.A.	N.A.
External Fault	12	2, 24, 43, 60, 63,	External fault has been activated in the frequency converter. This is a hard fault that must be reset.
Operator Interface Error	13	46, 47, 50, 51, 52, 53, 54, 55, 56, 57, 58	Inverter programming or operational interface malfunction
Load Loss	14	93, 94, 95	Load on the Motor is less than programmed limit of system. An Example is a broken belt or coupling
Configuration Error	15	40, 41	Errors exist in the programmed or operational configuration of the inverter
Feedback Failure	16	N.A.	N.A.
Output Phase Loss	17	30, 31, 32	One or more of the output phases from the inverter to the motor are open
Motor Stall	18	11	Motor is operating in stall region and not able to accelerate
Power Unit Error	19	N.A.	N.A.
Input Phase/DC Ripple	20	4	Input single phase or low line voltage condition
Internal Drive Failure	21	38	Manufacturer defined internal operations that have failed their-self checks.

Table 5.4 Mapping of Fault Codes

5.1.2 Binary Input and Output Objects

	Object_Name	Present_Value	
ID	**Default name**	**Parameter**	**Bit number**
BI:2	Digital input Term 29	1660	2
BI:3	Digital input Term 27	1660	3
BI:4	Digital input Term 19	1660	4
BI:5	Digital input Term 18	1660	5
BI:10..BI:15 are reserved for P1660/x			

Table 5.5 Binary Inputs

	Object_Name	Present_Value				
ID	**Default name**	**Parameter**	**Bit number**	**Writeable**	**Cmd.able**	**Timeout**
BO:4	Relay 1	590	4	x	x	x
BO:5	Relay 2	590	5	x	x	x

Table 5.6 Binary Outputs

	Object_Name			Present_Value					
ID	Default name	Writeable	EEPROM	Parameter	Bit number	Writeable	Cmd.able	EEPROM	Timeout
BV:0	Reserved for VFD profile								
BV:1	RUN/STOP Command	x	x	CTW=0x47C + Reversing bit 15	6 reverse 15	x	x		x
BV:2	REF 1/REF 2 Select	x	x	Note 1	n/a	x	x	x	x
BV:3	Fault Reset Command	x	x	CTW	7	x			
BV:4	RUN/STOP Monitor	x	x	STW	1				
BV:5	OK/FAULT Monitor	x	x	STW	3, 6, 7				
BV:6	HAND/AUTO Reference	x	x	16-95	1				
BV:7	Reserved for VFD profile								
BV:8									
BV:9									
BV:10									
BV:11									
BV:12									
BV:13									
BV:14									
BV:15									
BV:16									
BV:17									
BV:18									
BV:19									
BV:20									
BV:21	Warning	x	x	STW	7				
BV:22	Trip	x	x	STW	3				
BV:23	Triplock			STW	6				
BV:24	Coasting			CTW	3	x	x		x
BV:25	CW/CCW			CTW	15	x	x		x
BV:26	Jog			CTW	8	x	x		x
BV:27	Reset			CTW	7	x	x		x
BV:28	Reset KWh Counter			1506	n/a	x			
BV:29	Reset Running Hours Counter			1507	n/a	x			
BV:31	Speed = reference			STW	8				
BV:32	Bus control			STW	9				
BV:33	Running	x	x	STW	11				
BV:34	Ramp 1/ Ramp 2			CTW	9	x	x		

Table 5.7 Binary Values

5.1.3 Multi-state Value Objects

	Object_Name	Present_Value				
ID	Default name	Parameter	Bit number	Writeable	Cmd.able	Timeout
MSV:0	Smart Logic Controller State	1638	n/a			
MSV:1	Active Setup	CTW	13	x	x	x

Table 5.8 Multi-state Value

5.2 Frequency Converter Feedback to Network

5

The BACnet option provides several output variables (nvo's) objects to the network, containing important frequency converter-, motor- and I/O feedback data. The BACnet option transmits bound network variables only and sends feedback data when there is a change in value.

Influence of the digital input terminals upon the FC Control Mode, *8-50 Coasting Select* to *8-56 Preset Reference Select*
The influence of the digital input terminals upon control of the frequency converter can be programmed in *8-50 Coasting Select* to *8-56 Preset Reference Select*.

NOTICE

***8-01 Control Site* overrules the settings in *8-50 Coasting Select* to *8-56 Preset Reference Select* and Terminal 37, Safe Stop overrules any parameter.**

Each of the digital input signals can be programmed to logic AND, logic OR, or to have no relation to the corresponding bit in the control word. In this way a specific control command i.e. stop/coast, can be initiated by the fieldbus only, fieldbus AND Digital Input, or Fieldbus OR Digital input terminal.

NOTICE

To control the frequency converter via BACnet, set *8-50 Coasting Select* to either *[1] Bus* or to *[2] Logic AND* and set *8-01 Control Site* to*[0] Digital and ctrl. word* or *[2] Control word only*.

5.3 BIBBs

ReadProperty	Execute
WriteProperty	Execute
DeviceCommunicationControl	Execute
ReinitializeDevice	Execute
I-Am	Initiate
I-Have	Initiate
TimeSynchronization	Execute
Who-Has	Execute
Who-Is	Execute

Table 5.9 BIBBs

5.4 Object/Property Support Matrix

For an overview of the object types and properties supported, see *Table 5.10*.

Property	Device	Binary input	Binary output	Binary value	Analog input	Analog output	Analog value	Multistage value
Object identifier	x	x	x	x	x	x	x	x
Object Name	x	x	x	x	x	x	x	x
Object Type	x	x	x	x	x	x	x	x
System Status	x							
Vendor Name	x							
Vendor Identifier	x							
Model Name	x							
Firmware Revision	x							
Appl. Software Revision	x							
Location	x							
Description	x							
Protocol Version	x							
Protocol Revision	x							
Services Supported	x							
Object List	x							
Max. APDU Length	x							
Segmentation Support	x							
Local Time	x							
Local Date	x							
APDU Timeout	x							
Number APDU Retries	x							
Max Master	x							
Max Info Frames	x							
Device Address Binding	x							
Database Revision	x							
Present Value		x	x	x	x	x	x	x
Status Flags		x	x	x	x	x	x	x
Event State		x	x	x	x	x	x	x
Reliability		x	x	x	x	x	x	x
Out-of-Service		x	x	x	x	x	x	x
Number of States								x
State Text								x
Units					x	x	x	
Priority Array			x	x*		x	x*	x*
Relinquish Default			x	x*		x	x*	x*
Polarity		x	x					
Active Text		x	x	x				
Inactive Text		x	x	x				

Table 5.10 Object/Property Support Matrix

**For commandable values only*

6 Parameters

6.1 Parameter List

6.1.1 8-** Comm. and Options

Par. No. #	Parameter description	Default value	2-set-up	Change during operation	Conversion index	Type
8-0* General Settings						
8-01	Control Site	[0] Digital and ctrl.word	All set-ups	TRUE	-	Uint8
8-02	Control Source	[1] FC Port	All set-ups	TRUE	-	Uint8
8-03	Control Timeout Time	1.0 s	1 set-up	TRUE	-1	Uint16
8-04	Control Timeout Function	[0] Off	1 set-up	TRUE	-	Uint8
8-3* FC Port Settings						
8-30	Protocol	[0] FC	1 set-up	TRUE	-	Uint8
8-31	Address	1.0 N/A	1 set-up	TRUE	0	Uint8
8-32	Baud Rate	ExpressionLimit	1 set-up	TRUE	-	Uint8
8-33	Parity / Stop Bits	ExpressionLimit	1 set-up	TRUE	-	Uint8
8-35	Minimum Response Delay	0.01 s	1 set-up	TRUE	-3	Uint16
8-36	Maximum Response Delay	ExpressionLimit	1 set-up	TRUE	-3	Uint16
8-4* FC MC protocol set						
8-42	PCD Write Configuration	ExpressionLimit	All set-ups	TRUE	0	Uint8
8-43	PCD Read Configuration	ExpressionLimit	All set-ups	TRUE	0	Uint8
8-5* Digital/Bus						
8-50	Coasting Select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-51	Quick Stop Select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-52	DC Brake Select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-53	Start Select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-54	Reversing Select	[0] Digital input	All set-ups	TRUE	-	Uint8
8-55	Set-up Select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-56	Preset Reference Select	[3] Logic OR	All set-ups	TRUE	-	Uint8
8-7* BACnet						
8-70	BACnet Device Instance	1 N/A	1 set-up	TRUE	0	Uint32
8-72	MS/TP Max Masters	127.0 N/A	1 set-up	TRUE	0	Uint8
8-73	MS/TP Max Info Frames	1.0 N/A	1 set-up	TRUE	0	Uint16
8-74	"I am" Service	[0] Send at power-up	1 set-up	TRUE	-	Uint8
8-75	Intialisation Password	[admin]	1 set-up	TRUE	0	VisStr[21]
8-79	Protocol Firmware version	ExpressionLimit	1 set-up	TRUE	-2	Uint16
8-8* FC Port Diagnostics						
8-80	Bus Message Count	0.0 N/A	1 set-up	TRUE	0	Uint32
8-81	Bus Error Count	0.0 N/A	1 set-up	TRUE	0	Uint32
8-82	Slave Messages Rcvd	0.0 N/A	1 set-up	TRUE	0	Uint32
8-83	Slave Error Count	0.0 N/A	1 set-up	TRUE	0	Uint32
8-84	Slave Messages Sent	0.0 N/A	1 set-up	TRUE	0	Uint32
8-85	Slave Timeout Errors	0.0 N/A	1 set-up	TRUE	0	Uint32
8-88	Reset FC port Diagnostics	[0] Do not reset	1 set-up	TRUE	-	Uint8
8-9* Bus Feedback						
8-94	Bus Feedback 1	0.0 N/A	All set-ups	TRUE	0	Int16

6.2 Parameter Description

6.2.1 8-0* General Settings

8-01 Control Site		
Option:		**Function:**
		Select *[0] Digital and ctrl.word* for using digital input and control word. Select *[1] Digital* only to use digital inputs only. Select *[2] Control word only* to use control word only. This parameter overrules settings in *parameter 8-50 Coasting Select* to *parameter 8-56 Preset Reference Select*.
[0] *	Digital and ctrl.word	Control by using both digital input and control word.
[1]	Digital only	Control by using digital inputs only.
[2]	Controlword only	Control by using control word only.

8-02 Control Source		
Option:		**Function:**
		NOTICE **This parameter cannot be adjusted while the motor is running.** Select the source of the control word.
[0]	None	
[1] *	FC Port	

8-03 Control Timeout Time		
Range:		**Function:**
1 s*	[0.1 - 6500 s]	Enter the maximum time expected to pass between the reception of 2 consecutive telegrams. If this time is exceeded, it indicates that the serial communication has stopped. The function selected in *parameter 8-04 Control Timeout Function Control Time-out Function* is carried out.

8-04 Control Timeout Function		
Option:		**Function:**
		Select the timeout function. The time-out function is activated when the control word fails to be updated within the time period specified in *parameter 8-03 Control Timeout Time*.
[0] *	Off	

6.2.2 8-3* FC Port Settings

8-30 Protocol		
Option:		**Function:**
		Select the protocol for the integrated RS-485 port.

8-30 Protocol		
Option:		**Function:**
[0]	FC	Communication according to the FC Protocol.
[2]	Modbus RTU	Communication according to the Modbus RTU protocol.
[3]	Metasys N2	Communication protocol. The N2 software protocol is designed to accommodate the unique properties each device may have.
[5]	BACNet	

8-31 Address		
Range:		**Function:**
1*	[0.0 - 247]	Enter the address for the RS-485 port. Valid range: 1-126 for FC-bus OR 1-247 for Modbus.

8-32 Baud Rate		
Option:		**Function:**
		Select the baud rate for the RS-485 port Default refers to the FC Protocol. Changing Protocol in *8-30 Protocol* may change the Baud Rate. Changing Protocol in *8-30 Protocol* may change the Baud Rate.
[0]	2400 Baud	
[1]	4800 Baud	
[2]	9600 Baud	Default setting for • Modbus RTU • BACnet • Metasys N2
[3]	19200 Baud	
[4]	38400 Baud	
[5]	57600 Baud	
[6]	76800 Baud	
[7]	115200 Baud	

8-33 Parity / Stop Bits		
Option:		**Function:**
		Parity and stop bits for the protocol using the FC Port. For some of the protocols, not all options are available. Default refers to the FC Protocol.
[0]	Even Parity, 1 Stop Bit	
[1]	Odd Parity, 1 Stop Bit	
[2]	No Parity, 1 Stop Bit	
[3]	No Parity, 2 Stop Bits	

8-35 Minimum Response Delay		
Range:		**Function:**
0.01 s*	[0.0010 - 0.5 s]	Specify the minimum delay time between receiving a request and transmitting a response. This is used for

8-35 Minimum Response Delay		
Range:		**Function:**
		overcoming modem turnaround delays.

8-36 Maximum Response Delay		
Range:		**Function:**
Size related*	[0.1 - 10.0 s]	Specify the maximum permissible delay time between receiving a request and transmitting the response. If this time is exceeded, no response is returned.

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6.2.3 8-5* Digital/Bus

Parameters for configuring the control word Digital/Bus merging.

8-50 Coasting Select		
Option:		**Function:**
		Select control of the coasting function via the terminals (digital input) and/or via the bus. ***NOTICE*** **This parameter is active only when *parameter 8-01 Control Site* is set to *[0] Digital and control word*.**
[0]	Digital input	Activates coast via a digital input.
[1]	Bus	Activates coast via the serial communication port.
[2]	Logic AND	Activates coast via the fieldbus/serial communication port, AND additionally via one of the digital inputs.
[3] *	Logic OR	Activates coast via the serial communication port OR via one of the digital inputs.

8-51 Quick Stop Select		
Option:		**Function:**
		Select control of the Quick Stop function via the terminals (digital input) and/or via the bus. ***NOTICE*** **This parameter is active only when *parameter 8-01 Control Site* is set to *[0] Digital and control word*.**
[0]	Digital input	Activates Quick Stop via a digital input.
[1]	Bus	Activates Quick Stop via the serial communication port.

8-51 Quick Stop Select		
Option:		**Function:**
[2]	Logic AND	Activates Quick Stop via the serial communication port, AND additionally via one of the digital inputs.
[3] *	Logic OR	Activates Quick Stop via the serial communication port OR via one of the digital inputs.

8-52 DC Brake Select		
Option:		**Function:**
		Select control of the DC brake via the terminals (digital input). ***NOTICE*** **This parameter is active only when *parameter 8-01 Control Site* is set to *[0] Digital and control word*.**
[0]	Digital input	Activates DC brake via a digital input.
[1]	Bus	Activates DC brake via the serial communication port.
[2]	Logic AND	Activates DC brake via the serial communication port, AND additionally via one of the digital inputs.
[3]	Logic OR	Activates DC brake via the serial communication port OR via one of the digital inputs.

8-53 Start Select		
Option:		**Function:**
		Select control of the frequency converter start function via the terminals (digital input). ***NOTICE*** **This parameter is active only when *parameter 8-01 Control Site* is set to *[0] Digital and control word*.**
[0]	Digital input	Activates Start command via a digital input.
[1]	Bus	Activates Start command via the serial communication port.
[2]	Logic AND	Activates Start command via the serial communication port, AND additionally via one of the digital inputs.
[3] *	Logic OR	Activates Start command via the serial communication port OR via one of the digital inputs.

8-54 Reversing Select		
Option:		**Function:**
		Select control of the frequency converter reverse function via the terminals (digital input) and/or via the serial communication port.

8-54 Reversing Select		
Option:		**Function:**
		NOTICE **This parameter is active only when *parameter 8-01 Control Site* is set to *[0] Digital and control word*.**
[0] *	Digital input	Activates Reverse command via a digital input.
[1]	Bus	Activates Reverse command via the serial communication port.
[2]	Logic AND	Activates Reverse command via the serial communication port, AND additionally via one of the digital inputs.
[3]	Logic OR	Activates Reverse command via the serial communication port OR via one of the digital inputs.

8-55 Set-up Select		
Option:		**Function:**
		Select control of the frequency converter set-up selection via the terminals (digital input) and/or via the serial communication port. ***NOTICE*** **This parameter is active only when *parameter 8-01 Control Site* is set to *[0] Digital and control word*.**
[0]	Digital input	Activates the set-up selection via a digital input.
[1]	Bus	Activates the set-up selection via the serial communication port.
[2]	Logic AND	Activates the set-up selection via the serial communication port, AND additionally via one of the digital inputs.
[3] *	Logic OR	Activate the set-up selection via the serial communication port OR via one of the digital inputs.

8-56 Preset Reference Select		
Option:		**Function:**
		Select control of the frequency converter Preset Reference selection via the terminals (digital input) and/or via the serial communication port.
[0]	Digital input	Activates Preset Reference selection via a digital input.
[1]	Bus	Activates Preset Reference selection via the serial communication port.
[2]	Logic AND	Activates Preset Reference selection via the serial communication port, AND additionally via one of the digital inputs.

8-56 Preset Reference Select		
Option:		**Function:**
[3] *	Logic OR	Activates the Preset Reference selection via the serial communication port OR via one of the digital inputs.

6.2.4 8-7* BACnet

8-70 BACnet Device Instance		
Range:		**Function:**
1*	[0 - 4194303]	Enter a unique ID number for the BACnet device.

8-72 MS/TP Max Masters		
Range:		**Function:**
127*	[0 - 127]	Define the address of the master which holds the highest address in this network. Decreasing this value optimises polling for the token.

8-73 MS/TP Max Info Frames		
Range:		**Function:**
1*	[1 - 65534]	Define how many info/data frames the device is allowed to send while holding the token.

8-74 "I am" Service		
Option:		**Function:**
[0] *	Send at power-up	Select when the device should send the “I-Am” service message only at power-up.
[1]	Continuously	Select when the device should send the "I-Am" service message continuously with an interval of approx. 1 min.

8-75 Intialisation Password		
Range:		**Function:**
admin*	[1 - 1]	Enter the password needed for execution of Drive Re-initialisation.

8-79 Protocol Firmware version		
Range:		**Function:**
Size related*	[0 - 65535]	Read the supported protocol version. Index 5 is for BACNet.

6.2.5 8-8* FC Port Diagnostics

These parameters are used for monitoring the Bus communication via the FC Port.

8-80 Bus Message Count		
Range:		**Function:**
0*	[0 - 65536]	This parameter shows the number of valid telegrams detected on the bus.

8-81 Bus Error Count		
Range:		**Function:**
0*	[0 - 65536]	This parameter shows the number of telegrams with faults (e.g. CRC fault), detected on the bus.

8-82 Slave Messages Rcvd		
Range:		**Function:**
0*	[0 - 65536]	This parameter shows the number of valid telegrams addressed to the follower, sent by the frequency converter.

8-83 Slave Error Count		
Range:		**Function:**
0*	[0 - 65536]	This parameter shows the number of error telegrams, which could not be executed by the frequency converter.

8-84 Slave Messages Sent		
Range:		**Function:**
0*	[0 - 65536]	This parameter shows the number of messages sent from the follower.

8-85 Slave Timeout Errors		
Range:		**Function:**
0*	[0 - 65536]	This parameter shows the number of follower timeout errors.

8-88 Reset FC port Diagnostics		
Option:		**Function:**
[0] *	Do not reset	
[1]	Reset counter	

6.2.6 8-9* Bus Feedback

8-94 Bus Feedback 1		
Range:		**Function:**
0*	[-32768 - 32767]	Write a feedback to this parameter via the serial communication port. This parameter must be selected in *20-00 Feedback 1 Source* as a feedback source. (Hex-value 4000 h corresponds to 100% feedback/range is ±200%)

7 Troubleshooting

7.1 Alarm, Warning and Extended Status Word

7.1.1 Alarm and Warning Messages

General
There is a clear distinction between alarms and warnings. In the event of an alarm, the frequency converter enters a fault condition. After the cause for the alarm has been cleared, the master must acknowledge the alarm message to restart operation of the frequency converter. A warning, on the other hand, may appear when a warning condition arises, then disappear when conditions return to normal without interfering with the process.

Alarm words and warning words are shown on the display in hex format. If there is more than one warning or alarm, a sum of all warnings or alarms is shown. Warning words and alarm word are displayed in parameters *16-90 Alarm Word* to *16-95 Ext. Status Word 2*. For more information on the individual alarms and warnings, refer to the *VLT® DriveMotor FCP 106 and FCM 106 Programming Guide*.

Warnings
All warnings within the frequency converter are represented by a single bit within a warning word. A warning word is always an action parameter. Bit status *[0] FALSE* means no warning, while bit status *[1] TRUE* means warning. Each bit status has a corresponding text string message. In addition to the warning word message the master is also notified via a change to bit 7 in the status word.

Alarms
Following an alarm message the frequency converter enters a fault condition. Only after the fault has been rectified and the master has acknowledged the alarm message by setting bit 3 in the control word, can the frequency converter resume operation. All alarms within the frequency converter are represented by a single bit within an alarm word. An alarm word is always an action parameter. Bit status *[0] FALSE* means no alarm, while bit status *[1] TRUE* means alarm.

7.1.2 Alarm Words

Bit (Hex)	Alarm Word (16-90 Alarm Word)
00000001	
00000002	Power card overtemperature
00000004	Earth fault
00000008	
00000010	Control word timeout
00000020	Over current
00000040	
00000080	Motor thermistor overtemperature
00000100	Motor ETR over temperature
00000200	Inverter overloaded
00000400	DC-link undervoltage
00000800	DC-link overvoltage
00001000	Short circuit
00002000	
00004000	Mains phase loss
00008000	AMA not OK
00010000	Live zero error
00020000	Internal fault
00040000	
00080000	Motor phase U is missing
00100000	Motor phase V is missing
00200000	Motor phase W is missing
00800000	Control Voltage Fault
01000000	
02000000	VDD, supply low
10000000	DESAT Earth fault
20000000	Drive initialised
80000000	

Table 7.1 16-90 Alarm Word

Bit (Hex)	Alarm Word 2 (16-91 Alarm Word 2)
00000001	
00000002	Gate drive voltage fault
00000004	Reserved
00000008	Reserved
00000010	Reserved
00000020	
00000040	No flow
00000080	End of Curve
00000100	Broken Belt
00000200	Not used
00000400	Not used
00000800	Flow/Pressure info missing
00001000	Reserved
00002000	Reserved
00004000	Reserved
00008000	Flow/Pressure info missing
00010000	Reserved
00020000	Not used
00040000	Fans error
00080000	Reserved
00100000	Reserved
00200000	Reserved
00400000	Locked Rotor
00800000	Reserved
01000000	Reserved
02000000	Current Limit
04000000	Reserved
08000000	Reserved
10000000	Reserved
20000000	Reserved

Table 7.2 16-91 Alarm Word 2

7.1.3 Warning Words

Bit (Hex)	Warning Word (16-92 Warning Word)
00000001	
00000002	Power card overtemperature
00000004	Earth fault
00000008	
00000010	Control word timeout
00000020	Over current
00000040	
00000080	Motor thermistor overtemperature.
00000100	Motor ETR over temperature
00000200	Inverter overloaded
00000400	DC-link undervoltage
00000800	DC-link overvoltage
00001000	
00002000	
00004000	Mains phase loss
00008000	No motor
00010000	Live zero error
00020000	
00040000	
00080000	
00100000	
00200000	
00400000	
00800000	24 V supply fault
01000000	
02000000	Current limit
04000000	Low temperature
08000000	
10000000	
20000000	
40000000	Not used
80000000	Not used

Table 7.3 16-92 Warning Word

Bit (Hex)	Warning Word 2 (16-93 Warning Word 2)
00000001	
00000002	
00000004	
00000008	Reserved
00000010	Reserved
00000020	
00000040	Dry Pump
00000080	End of Curve
00000100	Broken Belt
00000200	Not used
00000400	Reserved
00000800	Reserved
00001000	Reserved
00002000	Reserved
00004000	Reserved
00008000	Auto DC Braking
00010000	Reserved
00020000	Not used
00040000	Fans warning
00080000	
00100000	Reserved
00200000	Reserved
00400000	Reserved
00800000	Reserved
01000000	Reserved
02000000	Reserved
04000000	Reserved
08000000	Reserved
10000000	Reserved
20000000	Back EMF too high
40000000	Reserved
80000000	Reserved

Table 7.4 16-93 Warning Word 2

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W

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