MAKING MODERN LIVING POSSIBLE




# Operating Instructions

## Modbus RTU

VLT®
THE REAL DRIVE

# Contents

# 1 Safety and Conformity

## 1.1 Safety Precautions

**⚠WARNING**

**The voltage of the frequency converter is dangerous whenever connected to mains. Incorrect installation of the motor, frequency converter or fieldbus may cause death, serious personal injury or damage to the equipment. Consequently, the instructions in this manual, as well as national and local rules and safety regulations, must be complied with.**

**Safety Regulations**

1. The mains supply to the frequency converter must be disconnected whenever repair work is to be carried out. Check that the mains supply has been disconnected and that the necessary time has elapsed before removing motor and mains supply plugs.
2. The [Off] button on the control panel of the frequency converter does not disconnect the mains supply and consequently it must not be used as a safety switch.
3. The equipment must be properly earthed, the user must be protected against supply voltage and the motor must be protected against overload in accordance with applicable national and local regulations.
4. The earth leakage current exceeds 3.5 mA.
5. Protection against motor overload is not included in the factory setting. If this function is desired, set *1-90 Motor Thermal Protection* to data value *ETR trip 1 [4]* or *data value ETR warning 1 [3]*.
6. Do not remove the plugs for the motor and mains supply while the frequency converter is connected to mains. Check that the mains supply has been disconnected and that the necessary time has elapsed before removing motor and mains plugs.
7. Note that the frequency converter has more voltage sources than L1, L2 and L3, when load sharing (linking of DC intermediate circuit) or external 24 V DC are installed. Check that all voltage sources have been disconnected and that the necessary time has elapsed before commencing repair work.

### 1.1.1 Safety Precautions - Continued

**Warning against unintended start**

1. The motor can be brought to a stop with digital commands, bus commands, references or a local stop, while the frequency converter is connected to mains. If personal safety considerations (e.g. risk of personal injury caused by contact with moving machine parts following an unintentional start) make it necessary to ensure that no unintended start occurs, these stop functions are not sufficient. In such cases the mains supply must be disconnected or the Safe Stop function must be activated.
2. The motor may start while setting the parameters. If this means that personal safety may be compromised (e.g. personal injury caused by contact with moving machine parts), motor starting must be prevented, for instance by use of the Safe Stop function or secure disconnection of the motor connection.
3. A motor that has been stopped with the mains supply connected, may start if faults occur in the electronics of the frequency converter, through temporary overload or if a fault in the power supply grid or motor connection is remedied. If unintended start must be prevented for personal safety reasons (e.g. risk of injury caused by contact with moving machine parts), the normal stop functions of the frequency converter are not sufficient. In such cases the mains supply must be disconnected or the Safe Stop function must be activated.

**NOTE**

**When using the Safe Stop function, always follow the instructions in the section *Safe Stop* of the Design Guide.**

4. Control signals from, or internally within, the frequency converter may in rare cases be activated in error, be delayed or fail to occur entirely. When used in situations where safety is critical, e.g. when controlling the electromagnetic brake function of a hoist application, these control signals must not be relied on exclusively.

1

**⚠WARNING**

### High Voltage

**Touching the electrical parts may be fatal - even after the equipment has been disconnected from mains.**
**Also make sure that other voltage inputs have been disconnected, such as external 24 V DC, load sharing (linkage of DC intermediate circuit), as well as the motor connection for kinetic back up.**
**Systems where frequency converters are installed must, if necessary, be equipped with additional monitoring and protective devices according to the valid safety regulations, e.g law on mechanical tools, regulations for the prevention of accidents etc. Modifications on the frequency converters by means of the operating software are allowed.**

## NOTE

**Hazardous situations shall be identified by the machine builder/integrator who is responsible for taking necessary preventive means into consideration. Additional monitoring and protective devices may be included, always according to valid national safety regulations, e.g. law on mechanical tools, regulations for the prevention of accidents.**

## NOTE

**Crane, Lifts and Hoists:**
**The controlling of external brakes must always have a redundant system. The frequency converter can in no circumstances be the primary safety circuit. Comply with relevant standards, e.g.**
**Hoists and cranes: IEC 60204-32**
**Lifts: EN 81**

**Protection Mode**
Once a hardware limit on motor current or DC link voltage is exceeded the frequency converter will enter "Protection mode". "Protection mode" means a change of the PWM modulation strategy and a low switching frequency to minimize losses. This continues 10 s after the last fault and increases the reliability and the robustness of the frequency converter while re-establishing full control of the motor.
In hoist applications "Protection mode" is not usable because the frequency converter will usually not be able to leave this mode again and therefore it will extend the time before activating the brake – which is not recommendable.
The "Protection mode" can be disabled by setting *14-26 Trip Delay at Inverter Fault* to zero which means that the frequency converter will trip immediately if one of the hardware limits is exceeded.

## NOTE

**It is recommended to disable protection mode in hoisting applications (*14-26 Trip Delay at Inverter Fault* = 0)**

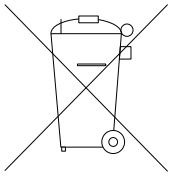
### 1.2.1 Caution

**⚠CAUTION**

**The DC link capacitors remain charged after power has been disconnected. Be aware that there may be high voltage on the DC link even when the Control Card LEDs are turned off. A red LED is mounted on a circuit board inside the frequency converter to indicate the DC bus voltage. The red LED will stay lit until the DC link is 50 V DC or lower. To avoid electrical shock hazard, disconnect the frequency converter from mains before carrying out maintenance. When using a PM-motor, make sure it is disconnected. Before doing service on the frequency converter wait at least the amount of time indicated below:**

| Voltage [V] | Power [kW] | Waiting Time [min] |
|---|---|---|
| 380-500 | 0.25-7.5 | 4 |
| | 11-75 | 15 |
| | 90-200 | 20 |
| | 250-800 | 40 |
| 525-690 | 11-75 (frame size B and C) | 15 |
| | 37-315 (frame size D) | 20 |
| | 355-1000 | 30 |

### 1.2.2 Protection Mode



Equipment containing electrical components may not be disposed of together with domestic waste.
It must be separately collected with electrical and electronic waste according to local and currently valid legislation.

### 1.3.1 Software Version

**Design Guide**
**Software version: 6.4x**

This Design Guide can be used for all frequency converters with software version 6.4x.
The software version number can be seen from *15-43 Software Version*.

## 1.4 CE Labelling

### 1.4.1 CE Conformity and Labelling

**The machinery directive (2006/42/EC)**
Frequency converters do not fall under the machinery directive. However, if a frequency converter is supplied for use in a machine, Danfoss provide information on safety aspects relating to the frequency converter.
**What is CE Conformity and Labelling?**
The purpose of CE labelling is to avoid technical trade obstacles within EFTA and the EU. The EU has introduced the CE label as a simple way of showing whether a product complies with the relevant EU directives. The CE label says nothing about the specifications or quality of the product. Frequency converters are regulated by two EU directives:
**The low-voltage directive (2006/95/EC)**
Frequency converters must be CE labelled in accordance with the low-voltage directive of January 1, 1997. The directive applies to all electrical equipment and appliances used in the 50 - 1000 V AC and the 75 - 1500 V DC voltage ranges. Danfoss CE-labels in accordance with the directive and issues a declaration of conformity upon request.
**The EMC directive (2004/108/EC)**
EMC is short for electromagnetic compatibility. The presence of electromagnetic compatibility means that the mutual interference between different components/ appliances does not affect the way the appliances work. The EMC directive came into effect January 1, 1996. Danfoss CE-labels in accordance with the directive and issues a declaration of conformity upon request. To carry out EMC-correct installation, see the instructions in this Design Guide. In addition, Danfoss specify which standards our products comply with. Danfoss offer the filters presented in the specifications and provide other types of assistance to ensure the optimum EMC result.

The frequency converter is most often used by professionals of the trade as a complex component forming part of a larger appliance, system or installation. The EMC directive (2004/108/EC)

### 1.4.2 What Is Covered

The EU "*Guidelines on the Application of Council Directive 2004/108/EC*" outline three typical situations of using a frequency converter. See below for EMC coverage and CE labelling.

1. The frequency converter is sold directly to the end-consumer. The frequency converter is for example sold to a DIY market. The end-consumer is a layman. Installing the frequency converter for use with a hobby machine, a kitchen appliance, etc. For such applications, the frequency converter must be CE labelled in accordance with the EMC directive.
2. The frequency converter is sold for installation in a plant. The plant is built up by professionals of the trade. It could be a production plant or a heating/ventilation plant designed and installed by professionals of the trade. Neither the frequency converter nor the finished plant has to be CE labelled under the EMC directive. However, the unit must comply with the basic EMC requirements of the directive. This is ensured by using components, appliances, and systems that are CE labelled under the EMC directive.
3. The frequency converter is sold as part of a complete system. The system is being marketed as complete and could e.g. be an air-conditioning system. The complete system must be CE labelled in accordance with the EMC directive. The manufacturer can ensure CE labelling under the EMC directive either by using CE labelled components or by testing the EMC of the system. If only CE labelled components are used, it is unneccessary to test the entire system.

### 1.4.3 Danfoss Frequency Converter and CE Labelling

CE labelling is a positive feature when used for its original purpose, i.e. to facilitate trade within the EU and EFTA.

However, CE labelling may cover many different specifications. Check what a given CE label specifically covers.

The covered specifications can be very different and a CE label may therefore give the installer a false feeling of security when using a frequency converter as a component in a system or an appliance.

Danfoss CE labels the frequency converters in accordance with the low-voltage directive. This means that if the frequency converter is installed correctly, we guarantee compliance with the low-voltage directive. Danfoss issues a declaration of conformity that confirms our CE labelling in accordance with the low-voltage directive.

The CE label also applies to the EMC directive provided that the instructions for EMC-correct installation and filtering are followed. On this basis, a declaration of conformity in accordance with the EMC directive is issued.

The Design Guide offers detailed instructions for installation to ensure EMC-correct installation. Furthermore,

1

Danfoss specifies which our different products comply with.

Danfoss provides other types of assistance that can help to obtain the best EMC result.

### 1.4.4 Compliance with EMC Directive 2004/108/ECEMC Directive 2004/108/EC

As mentioned, the frequency converter is mostly used by professionals of the trade as a complex component forming part of a larger appliance, system, or installation. Note that the responsibility for the final EMC properties of the appliance, system or installation rests with the installer. As an aid to the installer, Danfoss has prepared EMC installation guidelines for the Power Drive system. The standards and test levels stated for Power Drive systems are complied with, provided that the EMC-correct instructions for installation are followed, see the section *EMC Immunity* in the Design Guide.

### 1.5.1 Air Humidity

The frequency converter has been designed to meet the IEC/EN 60068-2-3 standard, EN 50178 pkt. 9.4.2.2 at 50° C.

### 1.5.2 Aggressive Environments

A frequency converter contains a large number of mechanical and electronic components. All are to some extent vulnerable to environmental effects.

**⚠CAUTION**

**The frequency converter should not be installed in environments with airborne liquids, particles, or gases capable of affecting and damaging the electronic components. Failure to take the necessary protective measures increases the risk of stoppages, thus reducing the life of the frequency converter.**

**Degree of protection as per IEC 60529**
The Safe Stop function may only be installed and operated in a control cabinet with degree of protection IP54 or higher (or equivalent environment). This is required to avoid cross faults and short circuits between terminals, connectors, tracks and safety-related circuitry caused by foreign objects.

Liquids can be carried through the air and condense in the frequency converter and may cause corrosion of components and metal parts. Steam, oil, and salt water may cause corrosion of components and metal parts. In such environments, use equipment with enclosure rating IP54/55. As an extra protection, coated printed circuit boards can be ordered as an option.

Airborne Particles such as dust may cause mechanical, electrical, or thermal failure in the frequency converter. A typical indicator of excessive levels of airborne particles is dust particles around the frequency converter fan. In very dusty environments, use equipment with enclosure rating IP54/55 or a cabinet for IP00/IP20/TYPE 1 equipment.

In environments with high temperatures and humidity, corrosive gases such as sulphur, nitrogen, and chlorine compounds cause chemical processes on the frequency converter components.

Such chemical reactions rapidly affect and damage the electronic components. In such environments, mount the equipment in a cabinet with fresh air ventilation, keeping aggressive gases away from the frequency converter. An extra protection in such areas is a coating of the printed circuit boards, which can be ordered as an option.

**NOTE**

**Mounting frequency converters in aggressive environments increases the risk of stoppages and considerably reduces the life of the converter.**

Before installing the frequency converter, check the ambient air for liquids, particles, and gases. This is done by observing existing installations in this environment. Typical indicators of harmful airborne liquids are water or oil on metal parts, or corrosion of metal parts.

Excessive dust particle levels are often found on installation cabinets and existing electrical installations. One indicator of aggressive airborne gases is blackening of copper rails and cable ends on existing installations.

D and E enclosures have a stainless steel back-channel option to provide additional protection in aggressive environments. Proper ventilation is still required for the internal components of the frequency converter. Contact Danfoss for additional information.

### 1.5.3 Vibration and Shock

The frequency converter has been tested according to the procedure based on the shown standards:

The frequency converter complies with requirements that exist for units mounted on the walls and floors of production premises, as well as in panels bolted to walls or floors.

- IEC/EN 60068-2-6: Vibration (sinusoidal) - 1970
- IEC/EN 60068-2-64: Vibration, broad-band random

# 2 Introduction

2

## 2.1 Introduction

This manual explains how to physically establish and configure communication between the Danfoss FC Series and a controller using the Modbus RTU protocol.

This instruction is intended to be used for both instruction and reference. It only briefly touches on the basics of the Modbus protocol whenever necessary to gain an understanding of the Modbus RTU. This instruction is also intended to serve as a guideline to specify and optimise the communication system. Even experienced Modbus programmers, should read these entire operating instructions before starting programming since important information can be found in all sections.

### 2.1.1 Modbus RTU Overview

Regardless of the type of physical communication networks, the Modbus RTU Overview describes the process a controller uses to request access to another device. This process includes how the Modbus RTU responds to requests from another device, and how errors are detected and reported. It also establishes a common format for the layout and contents of message fields.
During communications over a Modbus RTU network, the protocol determines:

- How each controller learns its device address
- Recognizes a message addressed to it
- Determines which actions to take
- Extracts any data or other information contained in the message

If a reply is required, the controller constructs the reply message and sends it.
Controllers communicate using a master-slave technique in which only one device (the master) can initiate transactions (called queries). The other devices (slaves) respond by supplying the requested data to the master, or by taking the action requested in the query.
The master can address individual slaves, or can initiate a broadcast message to all slaves. Slaves return a message (called a response) to queries that are addressed to them individually. No responses are returned to broadcast queries from the master. The Modbus RTU protocol establishes the format for the master's query by placing into it the device (or broadcast) address, a function code defining the requested action, any data to be sent, and an error-checking field. The slave's response message is also constructed using Modbus protocol. It contains fields confirming the action taken, any data to be returned, and an error-checking field. If an error occurs in receipt of the message, or if the slave is unable to perform the requested action, the slave constructs an error message, and sends it in response, or a time-out occurs.

# 3 RS-485 Installation and Set-up



## 3.1.1 Overview

The Modbus RTU protocol is based on the built-in RS-485 (EIA-485) interface on the FC Drive series control card. RS-485 is a two-wire bus-interface that allows multi-drop network topology i.e. nodes can be connected as a bus (daisy chain), or via drop cables from a common trunk line. Danfoss uses the two-wire system where the communication between master and slave is half-duplex, i.e. it cannot transmit and receive at the same time.

Each signal uses one twisted-pair line — two wires twisted around themselves. This is known as balanced data transmission or differential voltage transmission (see *Illustration 3.1*). The signal on one wire is ideally the exact opposite of the signal on the second wire. In other words, if one wire is transmitting a high, the other wire transmits a low, and vice versa (see *Illustration 3.2*).
Since RS-485 is a multipoint communication system, all devices are connected to the single twisted-pair cable.

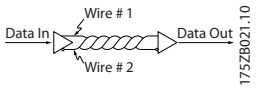



**Illustration 3.1 Balanced Data Transmission**

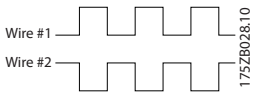



**Illustration 3.2 Differential Concept**

The Modbus RTU uses master/slave architecture, where each slave device has its unique address and responds only to packets addressed to this device.
The packets are generated by the master (Controller), which periodically polls all connected slave devices. Data travels over the single line in both directions.

According to the EIA-485 specification a total number of 32 nodes can be connected to one Modbus RTU network segment, and a total of 247 nodes in a network are supported. Network segments are divided with repeaters.

## NOTE

**Each repeater counts for a node in each segment it is installed. Every node connected to the same network must have a unique nodes address, across all segments.**

## 3.1.2 Cable Specifications

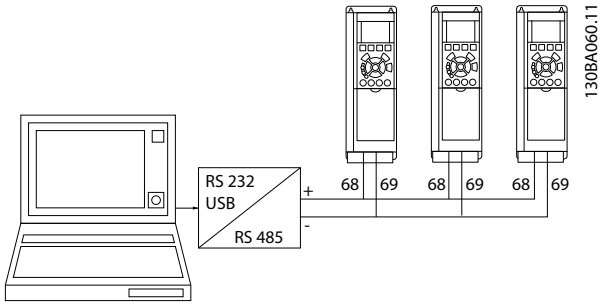
When choosing a transmission line for RS-485, it is necessary to examine the required distance of the cable and the data rate of the system. Losses in a transmission line are a combination of AC losses (skin effect), DC conductor loss, leakage, and AC losses in the dielectric. In high-quality cable, the conductor losses and the dielectric losses are on the same order of magnitude.

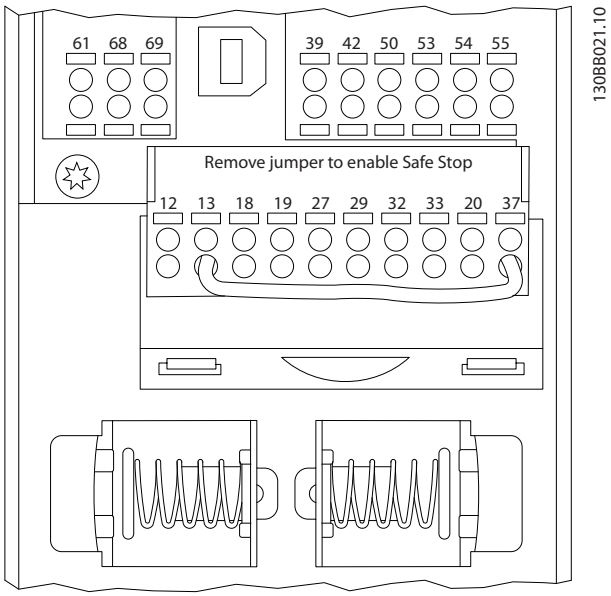
The recommended maximum Modbus cable length between the frequency converter and the Controller must not exceed 30 m (100 feet). While the RS-485 specification does not specify cabling, the recommendation is 0.25 $mm^2$/24 AWG shielded twisted-pair cable with a shunt capacitance of 16 pF/ft and 100 Ω impedance. Another choice is the same cable commonly used in the twisted-pair Ethernet cabling. This cable is commonly referred to as Category 5 cable. The cable has a maximum capacitance of 17 pF/ft (14.5 pF/ft typical) and characteristic impedance of 100 Ω.

## 3.1.3 Network Connection

One or more frequency converters can be connected to a control (or master) using the RS-485 standardized interface. Terminal 68 is connected to the P signal (TX+, RX+), while terminal 69 is connected to the N signal (TX-,RX-).

If more than one frequency converter is connected to a master, use parallel connections.





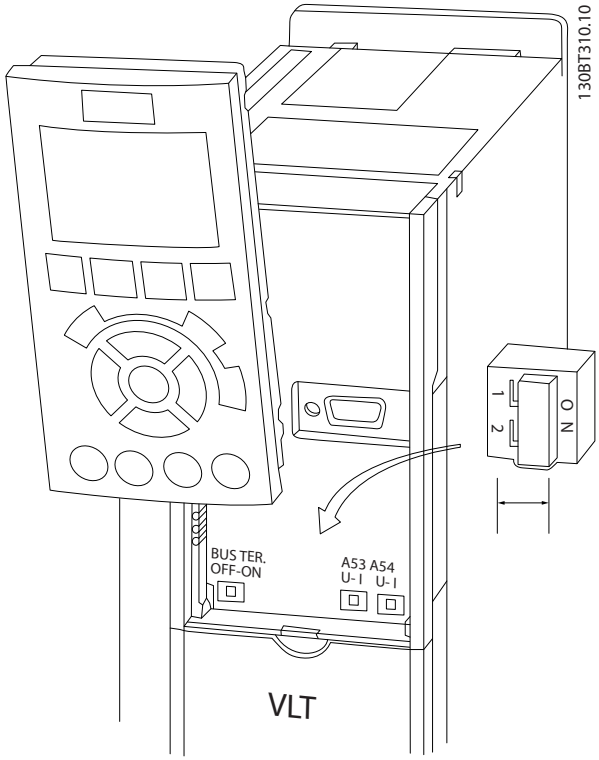
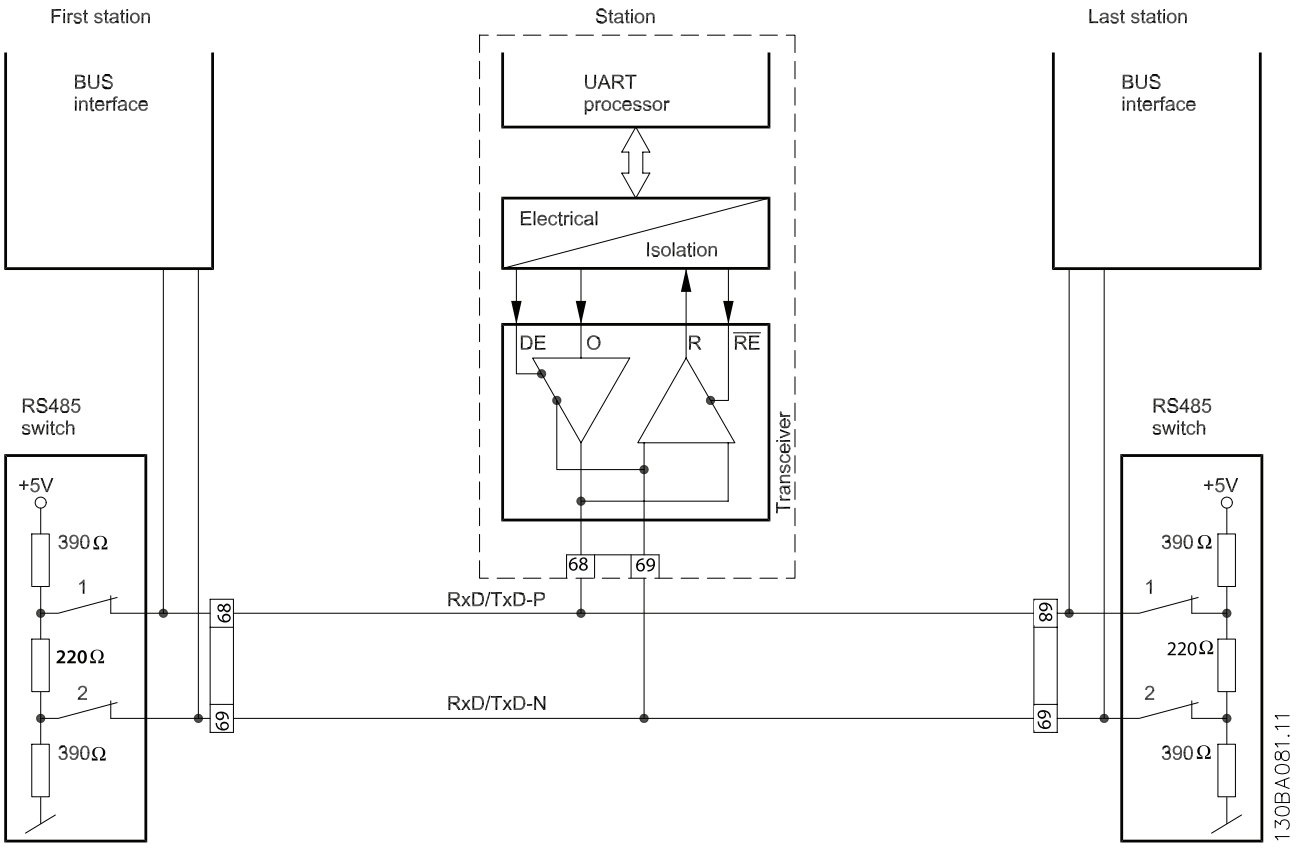




**Illustration 3.3 Control Card Terminals**

## 3.1.4 RS-485 Bus Termination

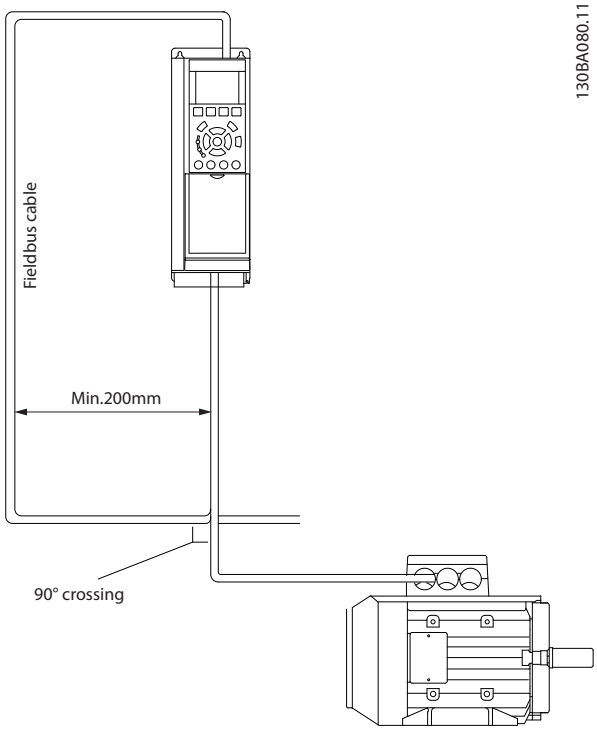
The RS-485 bus terminate by a resistor network at both ends only. For this purpose, set switch S801 on the control card for "On".



### 3.1.5 EMC Precautions

The following EMC precautions are recommended to achieve interference-free operation of the RS-485 network.

Relevant national and local regulations, for example regarding protective earth connection, must be observed. The RS-485 communication cable must be kept away from motor and brake resistor cables to avoid coupling of high frequency noise from one cable to another. Normally a distance of 200 mm (8 inches) is sufficient, but keeping the greatest possible distance between the cables is generally recommended, especially where cables run in parallel over long distances. When crossing is unavoidable, the RS-485 cable must cross motor and brake resistor cables at an angle of 90º.



# 4 Modbus RTU Message Framing Structure



## 4.1.1 Frequency Converter with Modbus RTU

The controllers are set up to communicate on the Modbus network using RTU (Remote Terminal Unit) mode, with each byte in a message containing 8-bit hexadecimal characters. The format for each byte is shown in *Table 4.1*.

| Start bit | Data byte | | | | | | | | Stop/ parity | Stop |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |

**Table 4.1 The Format for each Byte**

| | |
|---|---|
| Bits Per Byte | 1 start bit<br>8 data bits, least significant bit sent first<br>1 bit for even/odd parity; no bit for no parity<br>1 stop bit if parity is used; 2 bits if no parity |

## 4.1.2 Timing Constraints

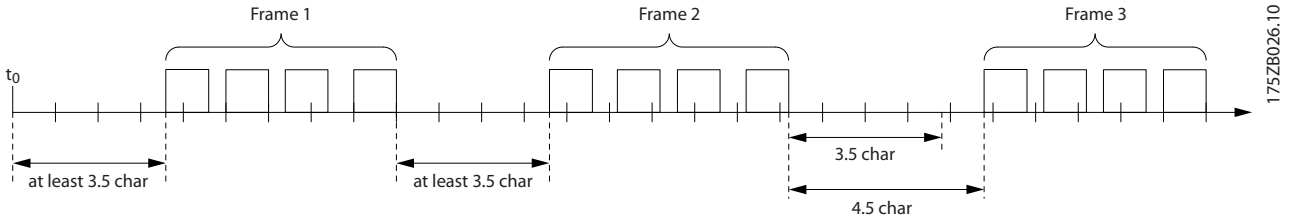
The Modbus Standard specifies two timing constraints. *Table 4.1* illustrates the inter-character timing which determines that a message has been received.

## NOTE

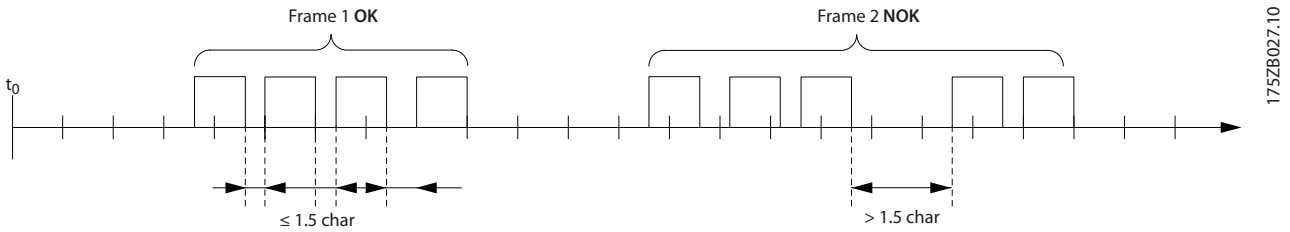
**It is very important that the controller wait at least 3.5 character length otherwise the nodes can not separate the telegrams.**

## NOTE

**if the baud rate is greater than 19200, then the 3.5 character time is replaced by a timeout time of 1.75 ms.**




There is an additional timing constraint, the framing error time, as shown in *Illustration 4.1*. The Modbus specification states that if a framing error occurs, the message should be considered invalid and discarded. The variable speed frequency converter notes the occurrence of framing errors and maintains a counter for them, but it does not discard the message.



### 4.1.3 Modbus RTU Message Structure

The transmitting device places a Modbus RTU message into a frame with a known beginning and ending point. This allows receiving devices to begin at the start of the message, read the address portion, determine which device is addressed (or all devices, if the message is broadcast), and to recognise when the message is completed. Partial messages are detected and errors set as a result. Characters for transmission must be in hexadecimal 00 to FF format in each field. The frequency converter continuously monitors the network bus, also during 'silent' intervals. When the first field (the address field) is received, each frequency converter or device decodes it to determine which device is being addressed. Modbus RTU messages addressed to zero are broadcast messages. No response is permitted for broadcast messages. A typical message frame is shown in *Table 4.2*.

| Start | Address | Function | Data | CRC check | End |
|---|---|---|---|---|---|
| T1-T2-T3-T4 | 8 bits | 8 bits | N x 8 bits | 16 bits | T1-T2-T3-T4 |

**Table 4.2 Typical Modbus RTU Message Structure**

### 4.1.4 Start/Stop Field

Messages start with a silent period of at least 3.5 character intervals. This is implemented as a multiple of character intervals at the selected network baud rate (shown as Start T1-T2-T3-T4). The first field to be transmitted is the device address. Following the last transmitted character, a similar period of at least 3.5 character intervals marks the end of the message. A new message can begin after this period. The entire message frame must be transmitted as a continuous stream. If a silent period of more than 1.5 character intervals occurs before completion of the frame, the receiving device flushes the incomplete message and assumes that the next byte will be the address field of a new message. Similarly, if a new message begins before 3.5 character intervals after a previous message, the receiving device considers it a continuation of the previous message. This causes a time-out (no response from the slave), since the value in the final CRC field is not valid for the combined messages.

### 4.1.5 Address Field

The address field of a message frame contains 8 bits. Valid slave device addresses are in the range of 0 – 247 decimal. The individual slave devices are assigned addresses in the range of 1 – 247. (0 is reserved for broadcast mode, which all slaves recognize.) A master addresses a slave by placing the slave address in the address field of the message. When the slave sends its response, it places its own address in this address field to let the master know which slave is responding.

### 4.1.6 Function Field

The function field of a message frame contains 8 bits. Valid codes are in the range of 1-FF. Function fields are used to send messages between master and slave. When a message is sent from a master to a slave device, the function code field tells the slave what kind of action to perform. When the slave responds to the master, it uses the function code field to indicate either a normal (error-free) response, or that some kind of error occurred (called an exception response). For a normal response, the slave simply echoes the original function code. For an exception response, the slave returns a code that is equivalent to the original function code with its most significant bit set to logic 1. In addition, the slave places a unique code into the data field of the response message. This tells the master what kind of error occurred, or the reason for the exception. Also refer to the sections *4.1.10 Function Codes Supported by Modbus RTU* and *9.1.1 Modbus Exception Codes*.

### 4.1.7 Data Field

The data field is constructed using sets of two hexadecimal digits, in the range of 00 to FF hexadecimal. These are made up of one RTU character. The data field of messages sent from a master to slave device contains additional information which the slave must use to take the action defined by the function code. This can include items such as coil or register addresses, the quantity of items to be handled, and the count of actual data bytes in the field.

### 4.1.8 CRC Check Field

Messages include an error-checking field, operating on the basis of a Cyclical Redundancy Check (CRC) method. The CRC field checks the contents of the entire message. It is applied regardless of any parity check method used for the individual characters of the message. The CRC value is calculated by the transmitting device, which appends the CRC as the last field in the message. The receiving device recalculates a CRC during receipt of the message and compares the calculated value to the actual value received in the CRC field. If the two values are unequal, a bus time-out occurs. The error-checking field contains a 16-bit binary value implemented as two 8-bit bytes. When this is done, the low-order byte of the field is appended first, followed by the high-order byte. The CRC high-order byte is the last byte sent in the message.

4

### 4.1.9 Coil and Register Addressing

In Modbus, all data are organized in coils and holding registers. Coils hold a single bit, whereas holding registers hold a 2-byte word (i.e. 16 bits). All data addresses in Modbus messages are referenced to zero. The first occurrence of a data item is addressed as item number zero. For example: The coil known as 'coil 1' in a programmable controller is addressed as coil 0000 in the data address field of a Modbus message. Coil 127 decimal is addressed as coil 007EHEX (126 decimal).
Holding register 40001 is addressed as register 0000 in the data address field of the message. The function code field already specifies a 'holding register' operation. Therefore, the '4XXXX' reference is implicit. Holding register 40108 is addressed as register 006BHEX (107 decimal).

See *4.1.11 Coil Addresses* for details regarding Coil Addresses and *4.1.12 Register Addresses* for details regarding Register Addresses

### 4.1.10 Function Codes Supported by Modbus RTU

Danfoss FC Series Modbus RTU supports use of the following function codes in the function field of a message.

| Function | Function Code |
|---|---|
| Read coils | 1 hex |
| Read holding registers | 3 hex |
| Write single coil | 5 hex |
| Write single register | 6 hex |
| Write multiple coils | F hex |
| Write multiple registers | 10 hex |
| Get comm. event counter | B hex |
| Report slave ID | 11 hex |

| Function | Function Code | Sub-function code | Sub-function |
|---|---|---|---|
| Diagnostics | 8 | 1 | Restart communication |
| | | 2 | Return diagnostic register |
| | | 10 | Clear counters and diagnostic register |
| | | 11 | Return bus message count |
| | | 12 | Return bus communication error count |
| | | 13 | Return bus exception error count |
| | | 14 | Return slave message count |

### 4.1.11 Coil Addresses

*Table 4.3* shows the coils addresses. Notice that the coil known as 'coil 1' in a programmable controller is addressed as coil 0000 in the data address field of a Modbus message.

| Coil Number | Description | | Signal Direction |
|---|---|---|---|
| 1-16 | Frequency converter control word (see *Table 4.4*) | | Master to slave |
| 17-32 | Frequency converter speed or set-point reference Range 0x0 – 0xFFFF (-200% ... ~200%) | | Master to slave |
| 33-48 | Frequency converter status word (see *Table 4.5*) | | Slave to master |
| 49-64 | Open loop mode: Frequency converter output frequency Closed loop mode: frequency converter feedback signal | | Slave to master |
| 65 | Parameter write control (master to slave) | | Master to slave |
| | 0 = | Parameter changes are written to the RAM of the frequency converter | |
| | 1 = | Parameter changes are written to the RAM and EEPROM of the frequency converter. | |
| 66-65536 | Reserved | | |

**Table 4.3 Coil Addresses**

| Control Word (FC profile) | | |
|---|---|---|
| **Coil** | **0** | **1** |
| 00 | Reference value | External selection lsb |
| 01 | Reference value | External selection msb |
| 02 | DC brake | Ramp |
| 03 | Coasting | No coasting |
| 04 | Quick stop | Ramp |
| 05 | Hold output frequency | Use ramp |
| 06 | Ramp stop | Start |
| 07 | No function | Reset |
| 08 | No function | Jog |
| 09 | Ramp 1 | Ramp 2 |
| 10 | Data invalid | Data invalid |
| 11 | Relay 01 open | Relay 01 active |
| 12 | Relay 02 open | Relay 02 active |
| 13 | Parameter set-up | Selection lsb |
| 15 | No function | Reverse |

**Table 4.4 Control Word (FC profile)**

| Status Word (FC profile) | | |
|---|---|---|
| **Coil** | **0** | **1** |
| 00 | Control not ready | Control ready |
| 01 | Drive not ready | Drive ready |
| 02 | Coasting | Enable |
| 03 | No error | Trip |
| 04 | No error | Error (no trip) |
| 05 | Reserved | - |
| 06 | No error | Triplock |
| 07 | No warning | Warning |
| 08 | Speed # reference | Speed = reference |
| 09 | Local operation | Bus control |
| 10 | Out of frequency limit | Frequency limit OK |
| 11 | No operation | In operation |
| 12 | Drive OK | Stopped, auto start |
| 13 | Voltage OK | Voltage exceeded |
| 14 | Torque OK | Torque exceeded |
| 15 | Tlmer OK | Timer exceeded |

**Table 4.5 Status Word (FC profile)**

See *7 FC Control Profile* for detail on the Control word, reference, status word and Main Actual Value. The Coil 65 decimal determines whether data written to the frequency converter are stored in EEPROM and RAM (coil 65 = 1) or only in RAM (coil 65 =0). Notice that coil 65 needs to be set On before writing to register are stored in EEPROM.

### 4.1.12 Register Addresses

*Table 4.6* shows the register addresses.

| Holding registers | |
|---|---|
| **Modbus Register Number** | **Description** |
| 00001-00006 | Reserved |
| 00007 | Last error code from an FC data object interface |
| 00008 | Reserved |
| 00009 | Parameter index* |
| 00010-00099 | 000 parameter group (parameters 001 through 099) |
| 00100-00199 | 100 parameter group (parameters 100 through 199) |
| 00200-00299 | 200 parameter group (parameters 200 through 299) |
| ... | ... |
| 02810-02873 | Write data block (PCD Write via *8-42 PCD write configuration*) |
| 02910-02973 | Read data block (PCD Read via *8-43 PCD read configuration*) |
| ... | ... |
| 00300-00399 | 300 parameter group (parameters 300 through 399) |
| 00400-00499 | 400 parameter group (parameters 400 through 499) |
| ... | ... |
| 28000-28999 | 2800 parameter group (parameters 2800 through 2899) |
| ... | ... |
| 50000 | Control word (CTW) |
| 50010 | Bus reference (Ref) |
| 50200 | Status word (STW). |
| 50210 | Main Actual Value (MAV) |

### 4.1.13 Parameter Handling

Each parameter number is translated to a register address. The parameter number is translated to Modbus holding address as parameter number x 10 DECIMAL.
Notice that holding register 40001 is addressed as register 0000 in the data address field of the message. The function code field already specifies a 'holding register' operation. Therefore, the '4XXXX' reference is implicit. Example: *3-41 Ramp 1 up time* is address as holding register 3410. In the message field of the telegram it will be addressed as register 2809 (D51 Hex).

### 4.1.14 Storage of Data

The Coil 65 decimal determines whether data written to the frequency converter are stored in EEPROM and RAM (coil 65=1) or only in RAM (coil 65=0).

## NOTE

**Coil 65 needs to be set On before changed parameters are stored in EEPROM and after a Power cycle coil 65 is set back to default Off, meaning only in RAM.**

### 4.1.15 IND

The array index is set in holding register 9 and used when accessing array parameters. Some parameters like *8-43 PCD read configuration* have structures of an index and the Modbus protocol does not support index parameters in the telegram frame. To read or write to those parameters requires that register 009 Parameter index contains the index number, before a read or write is done. Example: Setup *8-43 PCD Read Configuration* index 2 to the value [1613] Frequency.

1. Write [2] to register 009 Parameter index
2. Write [1613] to holding register 8430
3. Write [0] to register 009 Parameter index to set it back to default 0

Notice after a power cycle register 009 Parameter index is set it back to default 0.

### 4.1.16 Text Blocks

Parameters stored as text strings are accessed in the same way as the other parameters. The maximum text block size is 20 characters. If a read request for a parameter is for more characters than the parameter stores, the response is truncated. If the read request for a parameter is for fewer

characters than the parameter stores, the response is space filled.

## NOTE

**Text blocks are only used together with Function code 11 hex Report slave ID.**

### 4.1.17 Conversion Factor

Since a parameter value can only be transferred as a whole number, a conversion factor must be used to transfer decimals.
The conversion index for each parameter can be found in the Programming guide.
Example: *4-12 Motor Speed Low Limit [Hz]* has a conversion factor of 0.1. To set the Motor Speed Low Limit frequency to 10 Hz, transfer the value 100. A conversion factor of 0.1 means that the value transferred is multiplied by 0.1. The value 100 is thus perceived as 10.0.

| Conversion index | Conversion factor |
|---|---|
| 100 | |
| 75 | |
| 74 | |
| 67 | |
| 6 | 1000000 |
| 5 | 100000 |
| 4 | 10000 |
| 3 | 1000 |
| 2 | 100 |
| 1 | 10 |
| 0 | 1 |
| -1 | 0.1 |
| -2 | 0.01 |
| -3 | 0.001 |
| -4 | 0.0001 |
| -5 | 0.00001 |
| -6 | 0.000001 |
| -7 | 0.0000001 |

**Table 4.6 Conversion Table**

### 4.1.18 Parameter Values

One Modbus holding register is specified as a 16 bit register, i.e. the data range goes from 0–65535. Some parameters in the frequency converterhave data types of 32 bit, so to be able the read or write to these parameters two registers need to be accessed to have the correct data value read or written.

In order to read and write the different supported data types, the following conversions must be used.

**UNSIGNED32 and SIGNED32**
An unsigned and signed integer of 4 bytes fills two registers with the following byte mapping.

| Register 1 | | Register 2 | |
|---|---|---|---|
| Byte 3 | Byte 2 | Byte 1 | Byte 0 |

Example:
Register Address: 40201–Value 0x0102
Register Address: 40202–Value 0x0304

A read of an UNSIGNED32/SIGNED32 from Modbus register 40201 with the quantity of 2, is: 0x01020304.

**UNSIGNED16 and SIGNED16**
An unsigned and signed integer of 2 bytes fills one register with the following byte mapping.

| Register 1 | |
|---|---|
| Byte 1 | Byte 0 |

Example:
Register Address: 40201–Value 0x0102

A read of an UNSIGNED16 from register 40201 with the quantity of 1, is: 0x0102.

**UNSIGNED8 and SIGNED8**
An unsigned and signed integer of 1 byte fills one register with the following byte mapping.

| Register 1 | |
|---|---|
| 0x00 | Byte 0 |

The data type for each parameter can be found in the Programming guide.

# 5 How to Control the Frequency Converter

## 5.1 How to Control the Frequency Converter

Modbus RTU provides access to control the frequency converter via the Control Word like start/stop and to control the speed of the frequency converter via a bus reference. In the same way it also provides information of the frequency converter status like running, alarm etc. via the Status Word and the Main Actual Value, i.e. the actual running speed.



| Control Method | Address | | Function Code (hex) |
|---|---|---|---|
| Coils | 1-16 | Control word | 05 Write single coil |
| | 17-32 | Reference | 0F Write Multiple coils |
| | 33-48 | Status word | 01 Read coils |
| | 49-64 | Main Actual Value | |
| | 65 | Parameter Write Control | 05 Write single coil<br>01 Read coils |
| Register 50000 group | 50000 | Control Word | 06 Write single register |
| | 50010 | Reference | |
| | 50200 | Status word | 03 Read holding register |
| | 50210 | Main Actual Value | |
| Register 28-1x and 29-10 group | 2810 | Control word | 06 Write single register<br>0F Write Multiple register |
| | 2811 | Reference | |
| | 2812-2873 | Register write via *8-42 PCD Write configuration* | |
| | 2910 | Status word | 03 Read holding register |
| | 2911 | Main Actual Value | |
| | 2912-2973 | Register read via *8-43 PCD Read configuration* | |

## NOTE

**Danfoss recommends only using one of the three mentioned ways to control the frequency converter!**

## NOTE

**Danfoss recommends register 2810-2873 and 2910-2973 to control the frequency converter ensuring compatibility with all controllers.**

## 5.2 Parameter for Modbus RTU

### 5.2.1 Important Parameters for Modbus RTU

Set the following parameters to enable the Modbus RTU for the frequency converter.

| Parameter no. | Setting |
|---|---|
| *8-30 Protocol* | Modbus RTU [2] |
| *8-31 Address* | 1-247 |
| *8-32 FC Port Baud Rate* | 2400-19200 |
| *8-33 Parity / Stop Bits* | Even parity, 1 Stop Bit [0] default<br>Odd Parity, 1 Stop Bit [1]<br>No Parity, 1 Stop Bit [2]<br>No Parity, 1 Stop Bits [3] |

## NOTE

***8-32 FC Port Baud Rate* and *8-33 Parity / Stop Bits* should match the setting on the controller and other slaves on the network.**

Other important parameters to setup are how the control of the frequency converter should be established and what should happen with the motor control in case of bus time out.

See also *8 Parameters*.

### 5.2.2 Access via PCD write/read

The advantage of using the PCD write/read configuration is that the controller can write or read more data in one telegram. Up to 63 registers can be read or written to via the Function code Read Holding register or Write Multiple Registers in one telegram. The structure is also flexible so that only two registers can be written to and 10 registers can be read from the controller.

The PCD write list is data send from the controller to the frequency converter like Control word, Reference and application dependent data like Minimum reference and Ramp times.

## NOTE

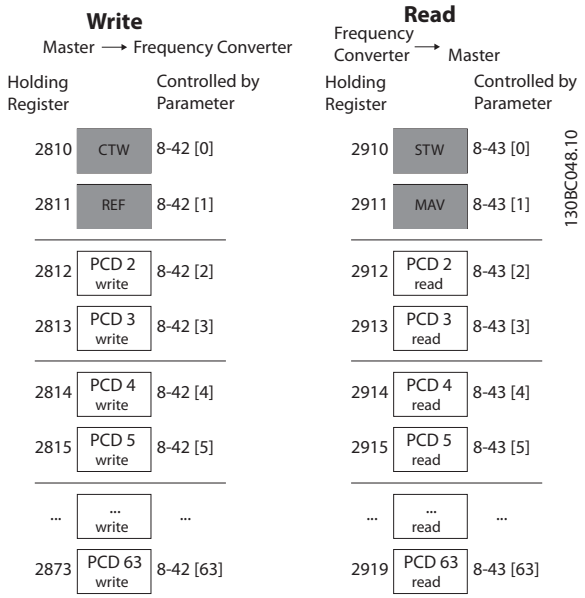
**The Control word and Reference is always sent in the list from the controller to the frequency converter.**

The PCD write list is setup in *8-42 PCD write configuration*.

The PCD read list is data send from the frequency converter to the controller like Status word, Main Actual Value and application dependent data like Running Hours, Motor current and Alarm word.

## NOTE

**The Status word and Main Actual Value is always sent in the list from the frequency converter to the Controller.**




## NOTE

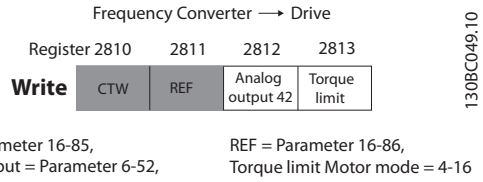
**The boxes marked in grey are not changeable, they are the default values.**

## NOTE

**32 bit parameters must be mapped inside the 32 bit boundaries, (PCD2 & PCD3 or PCD4 & PCD5 etc.) where the parameter number is mapped twice to*8-42 PCD write configuration* or *8-43 PCD read configuration*.**

### 5.2.3 Mapping the Holding Registers to Drive Parameters

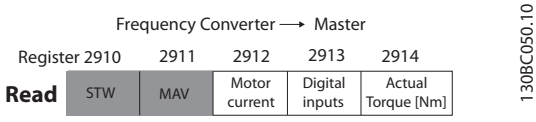
**Example:**
The PLC sends control word, reference, set the analog output 42 and set the torque limit




CTW = Parameter 16-85,
Analog output = Parameter 6-52,

REF = Parameter 16-86,
Torque limit Motor mode = 4-16

**Example:**
The frequency converter sends status word, main actual value, actual motor current, digital inputs and torque [Nm]




STW = Parameter 16-03,
Motor Current = Parameter 16-14,
Actual Torque [Nm]

MAV = Parameter 16-05,
Digital Inputs = Parameter 16-60

**Example, continued**
The input and output data of the Modbus RTU has to be mapped to the Parameter of the frequency converter. This is done in *8-42 PCD write configuration* and *8-43 PCD read configuration*.

130BC198.10

| | | |
|---|---|---|
| 842.0 | PCD write configuration | FC Port CTW 1 |
| 842.1 | PCD write configuration | FC Port REF 1 |
| 842.2 | PCD write configuration | Terminal 42 Output B... |
| 842.3 | PCD write configuration | Torque Limit Motor M... |
| 842.4 | PCD write configuration | None |

## NOTE

**Grey lines are fixed, red are user selectable.**

Following parameters has to be set up in the frequency converter:

130BC199.10

| | | |
|---|---|---|
| 843.0 | PCD read configuration | Status Word |
| 843.1 | PCD read configuration | Main Actual Value [%] |
| 843.2 | PCD read configuration | Motor Current |
| 843.3 | PCD read configuration | Digital Input |
| 843.4 | PCD read configuration | Torque [Nm] |
| 843.5 | PCD read configuration | None |

## NOTE

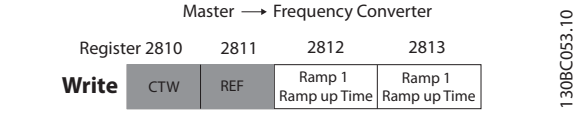
**The motor current in *16-14 Motor Current* is 32 bit. This mapping is only mapping the lower 16 bit, so the maximum motor current readout is 327 Amps.**

For higher Amp readout, user 32 bit readout.

Mapping a 32 bit parameter as 16 bit always accesses the 16 lower bits.

### 5.2.4 Mapping the Holding Registers to Drive Parameters, 32 bits

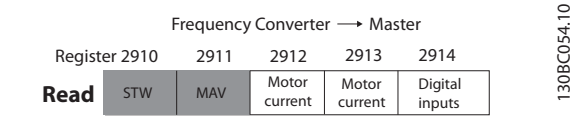
**Example:**
The PLC sends control word, reference and Ramp 1 Ramp up Time




CTW = Parameter 16-85,
Ramp 1 Ramp up time 3-41,

REF = Parameter 16-86,

**Example:**
The frequency converter sends status word, main actual value, actual motor current and digital inputs




STW = Parameter 16-03,
Motor Current = Parameter 16-14,

MAV = Parameter 16-05,
Digital Inputs = Parameter 16-60

**Example 32 bit, continued**
Following parameters has to be set up in the frequency converter:

130BC200.10

| | | |
|---|---|---|
| 842.0 | PCD write configuration | FC Port CTW 1 |
| 842.1 | PCD write configuration | FC Port REF 1 |
| 842.2 | PCD write configuration | Ramp 1 Ramp up Time |
| 842.3 | PCD write configuration | Ramp 1 Ramp up Time |

| | | |
|---|---|---|
| 843.0 | PCD read configuration | Status Word |
| 843.1 | PCD read configuration | Main Actual Value [%] |
| 843.2 | PCD read configuration | Motor Current |
| 843.3 | PCD read configuration | Motor Current |
| 843.4 | PCD read configuration | Digital Input |

## NOTE

**The motor current in parameter 16-14 is mapped as 32 bit. Motor current can be readout up to 42949672 Amps.**

# 6 Function Code Examples

## 6.1 Examples

The following examples illustrate various Modbus RTU commands. If an error occurs, refer to *9.1.1 Modbus Exception Codes*.

### 6.1.1 Read Coil Status (01 HEX)

**Description**
This function reads the ON/OFF status of discrete outputs (coils) in the frequency converter. Broadcast is never supported for reads.

**Query**
The query message specifies the starting coil and quantity of coils to be read. Coil addresses start at zero, i.e. coil 33 is addressed as 32.

Example of a request to read coils 33-48 (Status Word) from slave device 01.

| Field Name | Example (HEX) |
|---|---|
| Slave Address | 01 (frequency converter address) |
| Function | 01 (read coils) |
| Starting Address HI | 00 |
| Starting Address LO | 20 (32 decimals) Coil 33 |
| No. of Points HI | 00 |
| No. of Points LO | 10 (16 decimals) |
| Error Check (CRC) | - |

**Response**
The coil status in the response message is packed as one coil per bit of the data field. Status is indicated as: 1 = ON; 0 = OFF. The LSB of the first data byte contains the coil addressed in the query. The other coils follow toward the high order end of this byte, and from 'low order to high order' in subsequent bytes.
If the returned coil quantity is not a multiple of eight, the remaining bits in the final data byte will be padded with zeros (toward the high order end of the byte). The Byte Count field specifies the number of complete bytes of data.

| Field Name | Example (HEX) |
|---|---|
| Slave Address | 01 (frequency converter address) |
| Function | 01 (read coils) |
| Byte Count | 02 (2 bytes of data) |
| Data (Coils 40-33) | 07 |
| Data (Coils 48-41) | 06 (STW=0607hex) |
| Error Check (CRC) | - |

**NOTE**
**Coils and registers are addressed explicit with an off-set of -1 in Modbus.**
**I.e. Coil 33 is addressed as Coil 32.**

### 6.1.2 Force/Write Single Coil (05 HEX)

**Description**
This function forces the coil to either ON or OFF. When broadcast the function forces the same coil references in all attached slaves.

**Query**
The query message specifies the coil 65 (parameter write control) to be forced. Coil addresses start at zero, i.e. coil 65 is addressed as 64. Force Data = 00 00HEX (OFF) or FF 00HEX (ON).

| Field Name | Example (HEX) |
|---|---|
| Slave Address | 01 (frequency converter address) |
| Function | 05 (write single coil) |
| Coil Address HI | 00 |
| Coil Address LO | 40 (64 decimal) Coil 65 |
| Force Data HI | FF |
| Force Data LO | 00 (FF 00 = ON) |
| Error Check (CRC) | - |

**Response**
The normal response is an echo of the query, returned after the coil state has been forced.

| Field Name | Example (HEX) |
|---|---|
| Slave Address | 01 |
| Function | 05 |
| Force Data HI | FF |
| Force Data LO | 00 |
| Quantity of Coils HI | 00 |
| Quantity of Coils LO | 01 |
| Error Check (CRC) | - |

### 6.1.3 Force/Write Multiple Coils (0F HEX)

This function forces each coil in a sequence of coils to either ON or OFF. When broadcast the function forces the same coil references in all attached slaves.

**The query** message specifies the coils 17 to 32 (speed set-point) to be forced.

## NOTE

**Coil addresses start at zero, i.e. coil 17 is addressed as 16.**

| Field Name | Example (HEX) |
|---|---|
| Slave Address | 01 (frequency converter address) |
| Function | 0F (write multiple coils) |
| Coil Address HI | 00 |
| Coil Address LO | 10 (coil address 17) |
| Quantity of Coils HI | 00 |
| Quantity of Coils LO | 10 (16 coils) |
| Byte Count | 02 |
| Force Data HI (Coils 8-1) | 20 |
| Force Data LO (Coils 16-9) | 00 (ref. = 2000 hex) |
| Error Check (CRC) | - |

**Response**

The normal response returns the slave address, function code, starting address, and quantity of coils forced.

| Field Name | Example (HEX) |
|---|---|
| Slave Address | 01 (frequency converter address) |
| Function | 0F (write multiple coils) |
| Coil Address HI | 00 |
| Coil Address LO | 10 (coil address 17) |
| Quantity of Coils HI | 00 |
| Quantity of Coils LO | 10 (16 coils) |
| Error Check (CRC) | - |

### 6.1.4 Read Holding Registers (03 HEX)

**Description**

This function reads the contents of holding registers in the slave.

**Query**

The query message specifies the starting register and quantity of registers to be read. Register addresses start at zero, i.e. registers 1-4 are addressed as 0-3.

Example: Read *3-03 Maximum Reference*, register 03030.

| Field Name | Example (HEX) |
|---|---|
| Slave Address | 01 |
| Function | 03 (read holding registers) |
| Starting Address HI | 0B (Register address 3029) |
| Starting Address LO | D5 (Register address 3029) |
| No. of Points HI | 00 |
| No. of Points LO | 02 - (Par. 3-03 is 32 bits long, i.e. 2 registers) |
| Error Check (CRC) | - |

**Response**

The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

Example: Hex 0016E360=1.500.000=1500 RPM.

| Field Name | Example (HEX) |
|---|---|
| Slave Address | 01 |
| Function | 03 |
| Byte Count | 04 |
| Data HI (Register 3030) | 00 |
| Data LO (Register 3030) | 16 |
| Data HI (Register 3031) | E3 |
| Data LO (Register 3031) | 60 |
| Error Check (CRC) | - |

### 6.1.5 Preset Single Register (06 HEX)

**Description**

This function presets a value into a single holding register.

**Query**

The query message specifies the register reference to be preset. Register addresses start at zero, i.e. register 1 is addressed as 0.

Example: Write to *1-00 Configuration Mode*, register 1000.

| Field Name | Example (HEX) |
|---|---|
| Slave Address | 01 |
| Function | 06 |
| Register Address HI | 03 (Register address 999) |
| Register Address LO | E7 (Register address 999) |
| Preset Data HI | 00 |
| Preset Data LO | 01 |
| Error Check (CRC) | - |

**Response**

The normal response is an echo of the query, returned after the register contents have been passed.

| Field Name | Example (HEX) |
|---|---|
| Slave Address | 01 |
| Function | 06 |
| Register Address HI | 03 |
| Register Address LO | E7 |
| Preset Data HI | 00 |
| Preset Data LO | 01 |
| Error Check (CRC) | - |

### 6.1.6 Preset Multiple Registers (10 HEX)

**Description**
This function presets values into a sequence of holding registers.

**Query**
The query message specifies the register references to be preset. Register addresses start at zero, i.e. register 1 is addressed as 0. Example of a request to preset two registers (set parameter 1-24=738 (7.38 A)):

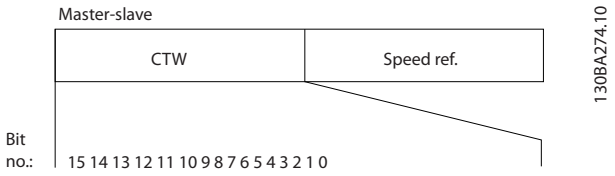
| Field Name | Example (HEX) |
|---|---|
| Slave Address | 01 |
| Function | 10 |
| Starting Address HI | 04 |
| Starting Address LO | D7 |
| No. of Registers HI | 00 |
| No. of registers LO | 02 |
| Byte Count | 04 |
| Write Data HI (Register 4: 1049) | 00 |
| Write Data LO (Register 4: 1049) | 00 |
| Write Data HI (Register 4: 1050) | 02 |
| Write Data LO (Register 4: 1050) | E2 |
| Error Check (CRC) | - |

**Response**
The normal response returns the slave address, function code, starting address, and quantity of registers preset.

| Field Name | Example (HEX) |
|---|---|
| Slave Address | 01 |
| Function | 10 |
| Starting Address HI | 04 |
| Starting Address LO | D7 |
| No. of Registers HI | 00 |
| No. of registers LO | 02 |
| Error Check (CRC) | - |

# 7 FC Control Profile

## 7.1.1 Control Word According to FC Profile (8-10 Protocol = FC profile)




| Bit | Bit value = 0 | Bit value = 1 |
|---|---|---|
| 00 | Reference value | external selection lsb |
| 01 | Reference value | external selection msb |
| 02 | DC brake | Ramp |
| 03 | Coasting | No coasting |
| 04 | Quick stop | Ramp |
| 05 | Hold output frequency | use ramp |
| 06 | Ramp stop | Start |
| 07 | No function | Reset |
| 08 | No function | Jog |
| 09 | Ramp 1 | Ramp 2 |
| 10 | Data invalid | Data valid |
| 11 | Relay 01 open | Relay 01 active |
| 12 | Relay 02 open | Relay 02 active |
| 13 | Parameter set-up | selection lsb |
| 15 | No function | Reverse |

**Explanation of the Control Bits**

Bits 00/01
Bits 00 and 01 are used to choose between the four reference values, which are pre-programmed in *3-10 Preset Reference* according to the *Table 7.1*.

| Programmed ref. value | Parameter | Bit 01 | Bit 00 |
|---|---|---|---|
| 1 | *3-10 Preset Reference* [0] | 0 | 0 |
| 2 | *3-10 Preset Reference* [1] | 0 | 1 |
| 3 | *3-10 Preset Reference* [2] | 1 | 0 |
| 4 | *3-10 Preset Reference* [3] | 1 | 1 |

**Table 7.1 Control bits**

## NOTE

**Make a selection in *8-56 Preset Reference Select* to define how Bit 00/01 gates with the corresponding function on the digital inputs.**

Bit 02, DC brake
Bit 02 = '0' leads to DC braking and stop. Set braking current and duration in *2-01 DC Brake Current* and *2-02 DC Braking Time*.
Bit 02 = '1' leads to ramping.

Bit 03, Coasting
Bit 03 = '0': The frequency converter immediately "lets go" of the motor, (the output transistors are "shut off") and it coasts to a standstill.
Bit 03 = '1': The frequency converter starts the motor if the other starting conditions are met.

Make a selection in *8-50 Coasting Select* to define how Bit 03 gates with the corresponding function on a digital input.

Bit 04, Quick stop
Bit 04 = '0': Makes the motor speed ramp down to stop (set in *3-81 Quick Stop Ramp Time*).

Bit 05, Hold output frequency
Bit 05 = '0': The present output frequency (in Hz) freezes. Change the frozen output frequency only with the digital inputs (*5-10 Terminal 18 Digital Input* to *5-13 Terminal 29 Digital Input*) programmed to *Speed up = 21* and *Slow down = 22*.

## NOTE

**If Freeze output is active, the frequency converter can only be stopped by the following:**

- **Bit 03 Coasting stop**
- **Bit 02 DC braking**
- **Digital input (*5-10 Terminal 18 Digital Input* to *5-13 Terminal 29 Digital Input*) programmed to *DC braking = 5*, *Coasting stop = 2*, or *Reset and coasting stop = 3*.**

Bit 06, Ramp stop/start
Bit 06 = '0': Causes a stop and makes the motor speed ramp down to stop via the selected ramp down parameter.
Bit 06 = '1': Permits the frequency converter to start the motor, if the other starting conditions are met.

Make a selection in *8-53 Start Select* to define how Bit 06 Ramp stop/start gates with the corresponding function on a digital input.

Bit 07, Reset Bit 07 = '0': No reset.
Bit 07 = '1': Resets a trip. Reset is activated on the signal's leading edge, i.e. when changing from logic '0' to logic '1'.

Bit 08, Jog
Bit 08 = '1': The output frequency is determined by *3-11 Jog Speed [Hz]*.

Bit 09, Selection of ramp 1/2
Bit 09 = "0": Ramp 1 is active (*3-41 Ramp 1 Ramp up Time* to *3-42 Ramp 1 Ramp Down Time*).
Bit 09 = "1": Ramp 2 (*3-51 Ramp 2 Ramp up Time* to *3-52 Ramp 2 Ramp down Time*) is active.

Bit 10, Data not valid/Data valid
Tell the frequency converter whether to use or ignore the control word.
Bit 10 = '0': The control word is ignored. Bit 10 = '1': The control word is used. This function is relevant because the telegram always contains the control word, regardless of the telegram type. Turn off the control word if not wanting to use it when updating or reading parameters.

Bit 11, Relay 01
Bit 11 = "0": Relay not activated.
Bit 11 = "1": Relay 01 activated provided that *Control word bit 11 = 36* is chosen in *5-40 Function Relay*.

Bit 12, Relay 02
Bit 12 = "0": Relay 02 is not activated. Bit 12 = "1": Relay 02 is activated provided that *Control word bit 12 = 37* is chosen in *5-40 Function Relay*.

Bit 13, Selection of set-up
Use bit 13 to choose from the 2 menu set-ups according to the table.

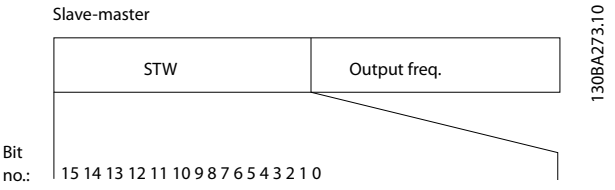
| Set-up | Bit 13 |
|---|---|
| 1 | 0 |
| 2 | 1 |

The function is only possible when *Multi Set-Ups = 9* is selected in *0-10 Active Set-up*.

Make a selection in *8-55 Set-up Select* to define how Bit 13 gates with the corresponding function on the digital inputs.

Bit 15 Reverse
Bit 15 = '0': No reversing.
Bit 15 = '1': Reversing. In the default setting, reversing is set to digital in *8-54 Reversing Select*. Bit 15 causes reversing only when Ser. communication, Logic or Logic and is selected.

## 7.1.2 Status Word According to FC Profile (STW) (*8-30 Protocol* = FC profile)




| Bit | Bit = 0 | Bit = 1 |
|---|---|---|
| 00 | Control not ready | Control ready |
| 01 | Drive not ready | Drive ready |
| 02 | Coasting | Enable |
| 03 | No error | Trip |
| 04 | No error | Error (no trip) |
| 05 | Reserved | - |
| 06 | No error | Triplock |
| 07 | No warning | Warning |
| 08 | Speed ≠ reference | Speed = reference |
| 09 | Local operation | Bus control |
| 10 | Out of frequency limit | Frequency limit OK |
| 11 | No operation | In operation |
| 12 | Drive OK | Stopped, auto start |
| 13 | Voltage OK | Voltage exceeded |
| 14 | Torque OK | Torque exceeded |
| 15 | Timer OK | Timer exceeded |

**Explanation of the Status Bits**
Bit 00, Control not ready/ready
Bit 00 = '0': The frequency converter trips.
Bit 00 = '1': The frequency converter controls are ready but the power component does not necessarily receive any power supply (in case of external 24 V supply to controls).

Bit 01, Drive ready
Bit 01 = '1': The frequency converter is ready for operation but the coasting command is active via the digital inputs or via serial communication.

Bit 02, Coasting stop
Bit 02 = '0': The frequency converter releases the motor.
Bit 02 = '1': The frequency converter starts the motor with a start command.

Bit 03, No error/trip
Bit 03 = '0' : The frequency converter is not in fault mode.
Bit 03 = '1': The frequency converter trips. To re-establish operation, press [Reset].

Bit 04, No error/error (no trip)
Bit 04 = '0': The frequency converter is not in fault mode.
Bit 04 = "1": The frequency converter shows an error but does not trip.

Bit 05, Not used
Bit 05 is not used in the status word.

Bit 06, No error / triplock
Bit 06 = '0': The frequency converter is not in fault mode.
Bit 06 = "1": The frequency converter is tripped and locked.

Bit 07, No warning/warning
Bit 07 = '0': There are no warnings.
Bit 07 = '1': A warning has occurred.

Bit 08, Speed≠ reference/speed = reference
Bit 08 = '0': The motor is running but the present speed is different from the preset speed reference. It might e.g. be the case when the speed ramps up/down during start/stop.
Bit 08 = '1': The motor speed matches the preset speed reference.

Bit 09, Local operation/bus control
Bit 09 = '0': [Off/Reset] is activate on the control unit or *Local control* in *F-02 Operation Method* is selected. It is not possible to control the frequency converter via serial communication.
Bit 09 = '1' It is possible to control the frequency converter via the fieldbus/serial communication.

Bit 10, Out of frequency limit
Bit 10 = '0': The output frequency has reached the value in *4-12 Motor Speed Low Limit [Hz]* or *4-14 Motor Speed High Limit [Hz]*.
Bit 10 = "1": The output frequency is within the defined limits.

Bit 11, No operation/in operation
Bit 11 = '0': The motor is not running.
Bit 11 = '1': The frequency converter has a start signal or the output frequency is greater than 0 Hz.

Bit 12, Drive OK/stopped, autostart:
Bit 12 = '0': There is no temporary over temperature on the inverter.
Bit 12 = '1': The inverter stops because of over temperature but the unit does not trip and will resume operation once the over temperature stops.

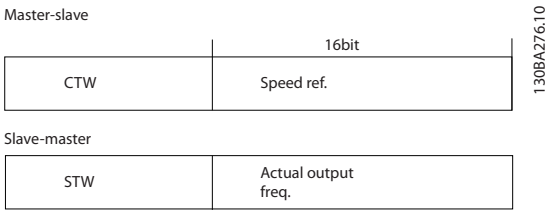
Bit 13, Voltage OK/limit exceeded
Bit 13 = '0': There are no voltage warnings.
Bit 13 = '1': The DC voltage in the frequency converter's intermediate circuit is too low or too high.

Bit 14, Torque OK/limit exceeded
Bit 14 = '0': The motor current is lower than the torque limit selected in *4-18 Current Limit*.
Bit 14 = '1': The torque limit in *4-18 Current Limit* is exceeded.

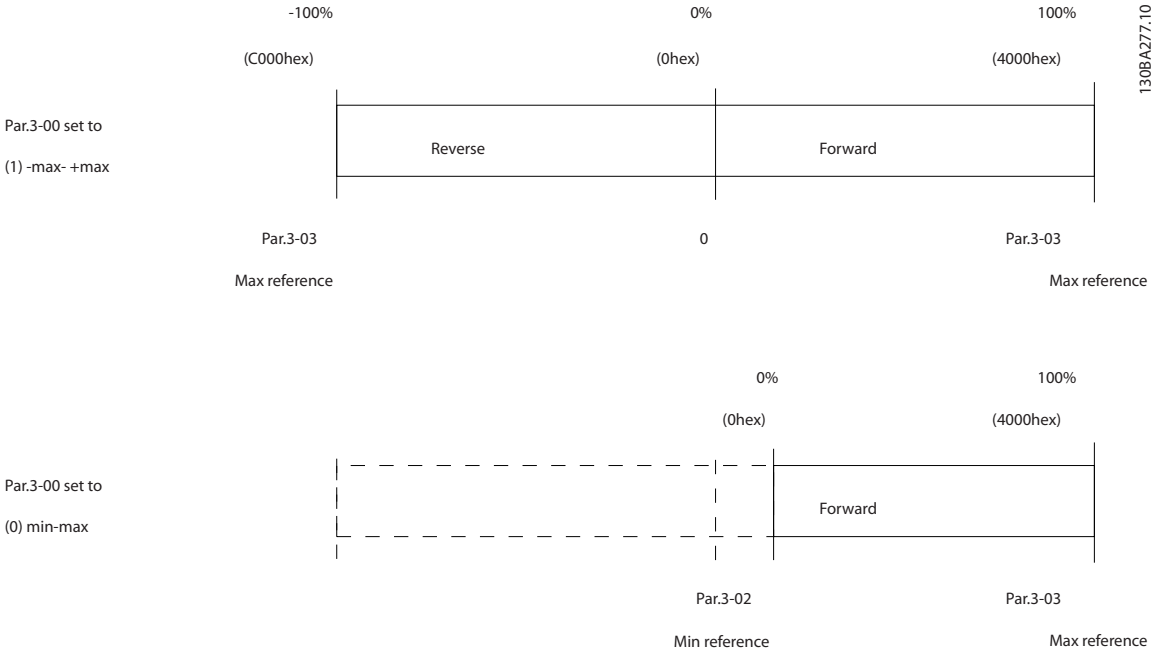
Bit 15, Timer OK/limit exceeded
Bit 15 = '0': The timers for motor thermal protection and thermal protection are not exceeded 100%.
Bit 15 = '1': One of the timers exceeds 100%.

## 7.1.3 Bus Speed Reference Value

Speed reference value is transmitted to the frequency converter in a relative value in %. The value is transmitted in the form of a 16-bit word; in integers (0-32767) the value 16384 (4000 Hex) corresponds to 100%. Negative figures are formatted by means of 2's complement. The Actual Output frequency (MAV) is scaled in the same way as the bus reference.




The reference and MAV are scaled as follows:


-100%
0%
100%
(C000hex)
(0hex)
(4000hex)
130BA277.10
Par.3-00 set to
(1) -max- +max
Reverse
Forward
Par.3-03
0
Par.3-03
Max reference
Max reference
0%
100%
(0hex)
(4000hex)
Par.3-00 set to
(0) min-max
Forward
Par.3-02
Par.3-03
Min reference
Max reference

7

# 8 Parameters

## 8.1 Parameters: 8-** Communications and Options

### 8.1.1 8-0* General Settings

**8-01 Control Site**

| Option: | | Function: |
|---|---|---|
| | | The setting in this parameter overrides the settings in *8-50 Coasting Select* to *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 Word Source**

Select the source of the control word: one of two serial interfaces or four installed options. During initial power-up, the frequency converter automatically sets this parameter to [3] *Option A* if it detects a valid Fieldbus option installed in slot A. If the option is removed, the frequency converter detects a change in the configuration, sets *8-02 Control Word Source* back to default setting RS-485, and the frequency converter trips. If an option is installed after initial power-up, the setting of *8-02 Control Word Source* does not change, but the frequency converter trips and displays: Alarm 67 *Option Changed*.
When retrofitting a bus option into a frequency converter, that did not have a bus option installed to begin with, take an ACTIVE decision to move the control to Bus based. This is done for safety reasons in order to avoid an accidental change.

| Option: | | Function: |
|---|---|---|
| [0] | None | |
| [1] * | FC RS485 | |
| [2] | FC USB | |
| [3] | Option A | |
| [4] | Option B | |
| [5] | Option C0 | |
| [6] | Option C1 | |
| [30] | External Can | |

## NOTE

**This parameter cannot be adjusted while the motor is running.**

**8-03 Control Word Timeout Time**

| Range: | | Function: |
|---|---|---|
| 1.0 s* | [Application dependant] | Enter the maximum time expected to pass between the reception of two consecutive telegrams. If this time is exceeded, it indicates that the serial communication has stopped. The function selected in *8-04 Control Word Timeout Function*is then carried out. A valid control word triggers the time-out counter. |

**8-04 Control Word Timeout Function**

Select the time-out function. The time-out function activates when the control word fails to be updated within the time period specified in *8-03 Control Word Timeout Time*.

| Option: | | Function: |
|---|---|---|
| [0] * | Off | Resumes control via serial bus (Fieldbus or standard) using the most recent control word. |
| [1] | Freeze output | Freezes output frequency until communication resumes. |
| [2] | Stop | Stops with auto restart when communication resumes. |
| [3] | Jogging | Runs the motor at JOG frequency until communication resumes. |
| [4] | Max. speed | Runs the motor at maximum frequency until communication resumes. |
| [5] | Stop and trip | Stops the motor, then resets the frequency converter to restart: via the Fieldbus, via the reset button on the , or via a digital input. |
| [7] | Select setup 1 | Changes the set-up upon reestablishment of communication following a control word time-out. If communication resumes after a time-out, *8-05 End-of-Timeout Function* defines whether to resume the set-up used before the time-out, or to retain the set-up endorsed by the time-out function. |
| [8] | Select setup 2 | See [7] *Select setup 1* |
| [9] | Select setup 3 | See [7] *Select setup 1* |
| [10] | Select setup 4 | See [7] *Select setup 1* |
| [26] | Trip | |

## NOTE

**To change the set-up after a time-out, the following configuration is required:**
**Set *0-10 Active Set-up* to [9] *Multi set-up* and select the relevant link in *0-12 This Set-up Linked to*.**

### 8-05 End-of-Timeout Function

| Option: | | Function: |
|---|---|---|
| | | Select the action after receiving a valid control word following a time-out. This parameter is active only when *8-04 Control Timeout Function* is set to [Set-up 1-4]. |
| [0] | Hold set-up | Retains the set-up selected in *8-04 Control Timeout Function* and displays a warning, until *8-06 Reset Control Timeout* toggles. Then the frequency converter resumes its original set-up. |
| [1] * | Resume set-up | Resumes the set-up active before the time-out. |

### 8-06 Reset Control Word Timeout

This parameter is active only when [0] *Hold set-up* has been selected in *8-05 End-of-Timeout Function*.

| Option: | | Function: |
|---|---|---|
| [0] * | Do not reset | Retains the set-up specified in *8-04 Control Word Timeout Function*, following a control word time-out. |
| [1] | Do reset | Returns the frequency converter to the original set-up following a control word time-out. The frequency converter performs the reset and then immediately reverts to the [0] *Do not reset* setting |

### 8-08 Readout Filtering

If the speed feedback value readouts on fieldbus are fluctuating, this function is used. Select filtered if the function is required. A power-cycle is required for changes to take effect.

| Option: | | Function: |
|---|---|---|
| [0] * | Motor Data Std-Filt. | Select [0] for normal bus readouts. |
| [1] | Motor Data LP-Filter | Select [1] for filtered bus readouts of the following parameters:<br>*16-10 Power [kW]*<br>*16-11 Power [hp]*<br>*16-12 Motor Voltage*<br>*16-14 Motor Current*<br>*16-16 Torque [Nm]*<br>*16-17 Speed [RPM]*<br>*16-22 Torque [%]*<br>*16-25 Torque [Nm] High* |

## 8.1.2 8-1* Ctrl. Word Settings

### 8-10 Control Word Profile

Select the interpretation of the control and status words corresponding to the installed Fieldbus. Only the selections valid for the Fieldbus installed in slot A will be visible in the display. For guidelines in selection of [0] *FC profile* and [1] *PROFIdrive profile* refer to *Serial communication via RS 485 Interface* section. For additional guidelines in the selection of [1] *PROFIdrive profile*, [5] *ODVA* and [7] *CANopen DSP 402* , see Operating Instructions for the installed Fieldbus.

| Option: | | Function: |
|---|---|---|
| [0] * | FC profile | |
| [1] | PROFIdrive profile | |
| [5] | ODVA | |
| [7] | CANopen DSP 402 | |
| [8] | MCO | |

### 8-13 Configurable Status Word STW

| Option: | | Function: |
|---|---|---|
| [0] | No function | The input is always low. |
| [1] * | Profile Default | Depended on the profile set in *8-10 Control Profile*. |
| [2] | Alarm 68 Only | The input goes high whenever Alarm 68 is active and goes low whenever no alarm 68 is actived |
| [3] | Trip excl Alarm 68 | The input goes high whenever Trip on other Alarms then Alarm 68 is active. |
| [10] | T18 DI status | The input goes high whenever T18 has 24 V and goes low whenever T18 has 0 V |
| [11] | T19 DI status | The input goes high whenever T19 has 24 V and goes low whenever T19 has 0 V |
| [12] | T27 DI status | The input goes high whenever T27 has 24 V and goes low whenever T27 has 0 V |
| [13] | T29 DI status | The input goes high whenever T29 has 24 V and goes low whenever T29 has 0 V |
| [14] | T32 DI status | The input goes high whenever T32 has 24 V and goes low whenever T32 has 0 V |
| [15] | T33 DI status | The input goes high whenever T33 has 24 V and goes low whenever T33 has 0 V |
| [16] | T37 DI status | The input goes high whenever T37 has 0 V and goes low whenever T37 has 24 V |
| [21] | Thermal warning | The thermal warning turns on when the temperature exceeds the limit in the motor, the frequency converter, the brake resistor, or the thermistor. |
| [30] | Brake fault (IGBT) | Goes high when the brake IGBT is short-circuited. |
| [40] | Out of ref range | If Comparator 0 is evaluated as TRUE, the input goes high. Otherwise, it will be low. |

| 8-13 Configurable Status Word STW | | |
|---|---|---|
| Option: | | Function: |
| [60] | Comparator 0 | If Comparator 0 is evaluated as TRUE, the input goes high. Otherwise, it will be low. |
| [61] | Comparator 1 | If Comparator 1 is evaluated as TRUE, the input goes high. Otherwise, it will be low. |
| [62] | Comparator 2 | If Comparator 2 is evaluated as TRUE, the input goes high. Otherwise, it will be low. |
| [63] | Comparator 3 | If Comparator 3 is evaluated as TRUE, the input goes high. Otherwise, it will be low. |
| [64] | Comparator 4 | If Comparator 4 is evaluated as TRUE, the input goes high. Otherwise, it will be low. |
| [65] | Comparator 5 | If Comparator 5 is evaluated as TRUE, the input goes high. Otherwise, it will be low. |
| [70] | Logic Rule 0 | If Logic Rule 0 is evaluated as TRUE, the input goes high. Otherwise, it will be low. |
| [71] | Logic Rule 1 | If Logic Rule 1 is evaluated as TRUE, the input goes high. Otherwise, it will be low. |
| [72] | Logic Rule 2 | If Logic Rule 2 is evaluated as TRUE, the input goes high. Otherwise, it will be low. |
| [73] | Logic Rule 3 | If Logic Rule 3 is evaluated as TRUE, the input goes high. Otherwise, it will be low. |
| [74] | Logic Rule 4 | If Logic Rule 4 is evaluated as TRUE, the input goes high. Otherwise, it will be low. |
| [75] | Logic Rule 5 | If Logic Rule 5 is evaluated as TRUE, the input goes high. Otherwise, it will be low. |
| [80] | SL digital out A | SL Controller Action. The input goes high whenever the Smart Logic Action [38] Set dig. out. A high is executed. The input goes low whenever the Smart Logic Action [32] Set dig. out. A low is executed. |
| [81] | SL digital out B | SL Controller Action. The input goes high whenever the Smart Logic Action [39] Set dig. out. A high is executed. The input goes low whenever the Smart Logic Action [33] Set dig. out. A low is executed. |
| [82] | SL digital out C | SL Controller Action. The input goes high whenever the Smart Logic Action [40] Set dig. out. A high is executed. The input goes low whenever the Smart Logic Action [34] Set dig. out. A low is executed. |
| [83] | SL digital out D | SL Controller Action. The input goes high whenever the Smart Logic Action [41] Set dig. out. A high is executed. The input goes low whenever the Smart Logic Action [35] Set dig. out. A low is executed. |
| [84] | SL digital out E | SL Controller Action. The input goes high whenever the Smart Logic Action [42] Set dig. out. A high is executed. The input goes low whenever the Smart Logic Action [36] Set dig. out. A low is executed. |
| [85] | SL digital out F | SL Controller Action. The input goes high whenever the Smart Logic Action [43] Set dig. out. A high is executed. The input goes low whenever the Smart Logic Action [37] Set dig. out. A low is executed |
| [86] | ATEX ETR cur. alarm | Selectable if par. 1-90 is set to [20] or [21]. If the alarm 164 ATEX ETR cur.lim.alarm is active, the output will be 1. |
| [87] | ATEX ETR freq. alarm | Selectable if par. 1-90 is set to [20] or [21]. If the alarm 166 ATEX ETR freq.lim.alarm is active, the output will be 1. |
| [88] | ATEX ETR cur. warning | Selectable if par. 1-90 is set to [20] or [21] ]. If the alarm 163 ATEX ETR cur.lim.warning is active, the output will be 1. |
| [89] | ATEX ETR freq. warning | Selectable if par. 1-90 is set to [20] or [21]. If the warning 165 ATEX ETR freq.lim.warning is active, the output will be 1. |
| [90] | Safe Function active | |
| [91] | Safe Opt. Reset req. | |

| 8-14 Configurable Control Word CTW | | |
|---|---|---|
| Option: | | Function: |
| | | Selection of control word bit 10 if it is active low or active high. |
| [0] | None | |
| [1] * | Profile default | |
| [2] | CTW Valid, active low | |
| [3] | Safe Option Reset | |

## 8.1.3 8-3* FC Port Settings

| 8-30 Protocol | | |
|---|---|---|
| Option: | | Function: |
| [0] * | FC | Communication according to the FC Protocol as described in the *Design Guide, RS485 Installation and Set-up*. |
| [1] | FC MC | Select the protocol for the FC (standard) port. |
| [2] * | Modbus RTU | |

| 8-31 Address | | |
|---|---|---|
| **Range:** | | **Function:** |
| Size related* | [ 1. - 255. ] | Enter the address for the FC (standard) port.<br>Valid range: 1 - 126. |

| 8-32 FC Port Baud Rate | | |
|---|---|---|
| **Option:** | | **Function:** |
| [0] | 2400 Baud | Baud rate selection for the FC (standard) port. |
| [1] | 4800 Baud | |
| [2] * | 9600 Baud | |
| [3] | 19200 Baud | |
| [4] | 38400 Baud | |
| [5] | 57600 Baud | |
| [6] | 76800 Baud | |
| [7] | 115200 Baud | |

| 8-33 Parity / Stop Bits | | |
|---|---|---|
| **Option:** | | **Function:** |
| [0] * | Even Parity, 1 Stop Bit | |
| [1] | Odd Parity, 1 Stop Bit | |
| [2] | No Parity, 1 Stop Bit | |
| [3] | No Parity, 2 Stop Bits | |

| 8-34 Estimated cycle time | | |
|---|---|---|
| **Range:** | | **Function:** |
| 0 ms* | [0 - 1000000 ms] | In noisy environments, the interface may be blocked by due to overload of bad frames. This parameter specifies the time between two consecutive frames on the network. If the interface does not detect valid frames in that time it flushes the receive buffer. |

| 8-35 Minimum Response Delay | | |
|---|---|---|
| **Range:** | | **Function:** |
| 10 ms* | [Application dependant] | Specify the minimum delay time between receiving a request and transmitting a response. This is used for overcoming modem turnaround delays. |

| 8-36 Max Response Delay | | |
|---|---|---|
| **Range:** | | **Function:** |
| Application dependent* | [Application dependant] | Specify the maximum permissible delay time between transmitting a request and receiving a response. Exceeding this delay time will cause control word time-out. |

| 8-37 Max Inter-Char Delay | | |
|---|---|---|
| **Range:** | | **Function:** |
| Application dependent* | [Application dependant] | Specify the maximum permissible time interval between receipt of two bytes. This parameter activates time-out if transmission is interrupted.<br>This parameter is active only when *8-30 Protocol* is set to *[1] FC MC* protocol. |

## 8.1.4 8-4* FC MC protocol set

| 8-41 Parameters for signals | | |
|---|---|---|
| **Option:** | | **Function:** |
| [0] * | None | This parameter contains a list of signals available for selection in *8-42 PCD write configuration* and *8-43 PCD read configuration*. |
| [15] | Readout: actual setup | |
| [302] | Minimum Reference | |
| [303] | Maximum Reference | |
| [312] | Catch up/slow Down Value | |
| [341] | Ramp 1 Ramp up Time | |
| [342] | Ramp 1 Ramp Down Time | |
| [351] | Ramp 2 Ramp up Time | |
| [352] | Ramp 2 Ramp down Time | |
| [380] | Jog Ramp Time | |
| [381] | Quick Stop Ramp Time | |
| [411] | Motor Speed Low Limit [RPM] | |
| [412] | Motor Speed Low Limit [Hz] | |
| [413] | Motor Speed High Limit [RPM] | |
| [414] | Motor Speed High Limit [Hz] | |
| [416] | Torque Limit Motor Mode | |
| [417] | Torque Limit Generator Mode | |
| [590] | Digital & Relay Bus Control | |
| [593] | Pulse Out #27 Bus Control | |
| [595] | Pulse Out #29 Bus Control | |
| [597] | Pulse Out #X30/6 Bus Control | |
| [653] | Term 42 Output Bus Ctrl | |
| [663] | Terminal X30/8 Bus Control | |
| [673] | Terminal X45/1 Bus Control | |
| [683] | Terminal X45/3 Bus Control | |
| [748] | PCD Feed Forward | |
| [890] | Bus Jog 1 Speed | |
| [891] | Bus Jog 2 Speed | |
| [1472] | Legacy Alarm Word | |
| [1473] | Legacy Warning Word | |
| [1474] | Leg. Ext. Status Word | |
| [1500] | Operating Hours | |
| [1501] | Running Hours | |

| 8-41 Parameters for signals | | |
|---|---|---|
| Option: | | Function: |
| [1502] | kWh Counter | |
| [1600] | Control Word | |
| [1601] | Reference [Unit] | |
| [1602] | Reference % | |
| [1603] | Status Word | |
| [1605] | Main Actual Value [%] | |
| [1609] | Custom Readout | |
| [1610] | Power [kW] | |
| [1611] | Power [hp] | |
| [1612] | Motor Voltage | |
| [1613] | Frequency | |
| [1614] | Motor Current | |
| [1615] | Frequency [%] | |
| [1616] | Torque [Nm] | |
| [1617] | Speed [RPM] | |
| [1618] | Motor Thermal | |
| [1619] | KTY sensor temperature | |
| [1620] | Motor Angle | |
| [1621] | Torque [%] High Res. | |
| [1622] | Torque [%] | |
| [1625] | Torque [Nm] High | |
| [1630] | DC Link Voltage | |
| [1632] | Brake Energy /s | |
| [1633] | Brake Energy /2 min | |
| [1634] | Heatsink Temp. | |
| [1635] | Inverter Thermal | |
| [1638] | SL Controller State | |
| [1639] | Control Card Temp. | |
| [1650] | External Reference | |
| [1651] | Pulse Reference | |
| [1652] | Feedback [Unit] | |
| [1653] | Digi Pot Reference | |
| [1657] | Feedback [RPM] | |
| [1660] | Digital Input | |
| [1661] | Terminal 53 Switch Setting | |
| [1662] | Analog Input 53 | |
| [1663] | Terminal 54 Switch Setting | |
| [1664] | Analog Input 54 | |
| [1665] | Analog Output 42 [mA] | |
| [1666] | Digital Output [bin] | |
| [1667] | Freq. Input #29 [Hz] | |
| [1668] | Freq. Input #33 [Hz] | |
| [1669] | Pulse Output #27 [Hz] | |
| [1670] | Pulse Output #29 [Hz] | |
| [1671] | Relay Output [bin] | |
| [1672] | Counter A | |
| [1673] | Counter B | |
| [1674] | Prec. Stop Counter | |
| [1675] | Analog In X30/11 | |
| [1676] | Analog In X30/12 | |
| [1677] | Analog Out X30/8 [mA] | |
| [1678] | Analog Out X45/1 [mA] | |

| 8-41 Parameters for signals | | |
|---|---|---|
| Option: | | Function: |
| [1679] | Analog Out X45/3 [mA] | |
| [1680] | Fieldbus CTW 1 | |
| [1682] | Fieldbus REF 1 | |
| [1684] | Comm. Option STW | |
| [1685] | FC Port CTW 1 | |
| [1686] | FC Port REF 1 | |
| [1690] | Alarm Word | |
| [1691] | Alarm Word 2 | |
| [1692] | Warning Word | |
| [1693] | Warning Word 2 | |
| [1694] | Ext. Status Word | |
| [1860] | Digital Input 2 | |
| [3310] | Sync Factor Master | |
| [3311] | Sync Factor Slave | |
| [3401] | PCD 1 Write to MCO | |
| [3402] | PCD 2 Write to MCO | |
| [3403] | PCD 3 Write to MCO | |
| [3404] | PCD 4 Write to MCO | |
| [3405] | PCD 5 Write to MCO | |
| [3406] | PCD 6 Write to MCO | |
| [3407] | PCD 7 Write to MCO | |
| [3408] | PCD 8 Write to MCO | |
| [3409] | PCD 9 Write to MCO | |
| [3410] | PCD 10 Write to MCO | |
| [3421] | PCD 1 Read from MCO | |
| [3422] | PCD 2 Read from MCO | |
| [3423] | PCD 3 Read from MCO | |
| [3424] | PCD 4 Read from MCO | |
| [3425] | PCD 5 Read from MCO | |
| [3426] | PCD 6 Read from MCO | |
| [3427] | PCD 7 Read from MCO | |
| [3428] | PCD 8 Read from MCO | |
| [3429] | PCD 9 Read from MCO | |
| [3430] | PCD 10 Read from MCO | |
| [3440] | Digital Inputs | |
| [3441] | Digital Outputs | |
| [3450] | Actual Position | |
| [3451] | Commanded Position | |
| [3452] | Actual Master Position | |
| [3453] | Slave Index Position | |
| [3454] | Master Index Position | |
| [3455] | Curve Position | |
| [3456] | Track Error | |
| [3457] | Synchronizing Error | |
| [3458] | Actual Velocity | |
| [3459] | Actual Master Velocity | |
| [3460] | Synchronizing Status | |
| [3461] | Axis Status | |
| [3462] | Program Status | |
| [3464] | MCO 302 Status | |
| [3465] | MCO 302 Control | |
| [3470] | MCO Alarm Word 1 | |

| 8-41 Parameters for signals | | |
|---|---|---|
| **Option:** | | **Function:** |
| [3471] | MCO Alarm Word 2 | |
| [4280] | Safe Option Status | |
| [4285] | Active Safe Func. | |
| [4286] | Safe Option Info | |

| 8-42 PCD write configuration | | |
|---|---|---|
| **Range:** | | **Function:** |
| Application dependent* | [0 - 9999 ] | |

| 8-43 PCD read configuration | | |
|---|---|---|
| **Range:** | | **Function:** |
| Application dependent* | [0 - 9999 ] | |

## 8.1.5 8-5* Digital/Bus

Parameters for configuring the control word Digital/Bus merging.

## NOTE

**These parameters are active only when *8-01 Control Site* is set to [0] *Digital and control word*.**

| 8-50 Coasting Select | | |
|---|---|---|
| **Option:** | | **Function:** |
| | | Select control of the coasting function via the terminals (digital input) and/or via the bus. |
| [0] | Digital input | Activates Start command via a digital input. |
| [1] | Bus | Activates Start command via the serial communication port or fieldbus option. |
| [2] | Logic AND | Activates Start command via the fieldbus/serial communication port, AND additionally via one of the digital inputs. |
| [3] * | Logic OR | Activates Start command via the fieldbus/serial communication port OR via one of the digital inputs. |

| 8-51 Quick Stop Select | | |
|---|---|---|
| Select control of the Quick Stop function via the terminals (digital input) and/or via the bus. | | |
| **Option:** | | **Function:** |
| [0] | Digital input | |
| [1] | Bus | |
| [2] | Logic AND | |
| [3] * | Logic OR | |

| 8-52 DC Brake Select | | |
|---|---|---|
| **Option:** | | **Function:** |
| | | Select control of the DC brake via the terminals (digital input) and/or via the fieldbus.<br>**NOTE**<br>**Only selection [0] Digital input is available when *1-10 Motor Construction* is set to [1] PM non-salient SPM.** |
| [0] | Digital input | Activates Start command via a digital input. |
| [1] | Bus | Activates Start command via the serial communication port or fieldbus option. |
| [2] | Logic AND | Activates Start command via the fieldbus/serial communication port, AND additionally via one of the digital inputs. |
| [3] * | Logic OR | Activates Start command via the fieldbus/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) and/or via the fieldbus. |
| [0] | Digital input | Activates Start command via a digital input. |
| [1] | Bus | Activates Start command via the serial communication port or fieldbus option. |
| [2] | Logic AND | Activates Start command via the fieldbus/serial communication port, AND additionally via one of the digital inputs. |
| [3] * | Logic OR | Activates Start command via the fieldbus/serial communication port OR via one of the digital inputs. |

| 8-54 Reversing Select | | |
|---|---|---|
| **Option:** | | **Function:** |
| [0] | Digital input | Select control of the frequency converter reverse function via the terminals (digital input) and/or via the Fieldbus. |
| [1] | Bus | Activates the Reverse command via the serial communication port or Fieldbus option . |
| [2] | Logic AND | Activates the Reverse command via the Fieldbus/serial communication port, AND additionally via one of the digital inputs. |
| [3] * | Logic OR | Activates the Reverse command via the Fieldbus/serial communication port OR via one of the digital inputs. |

8

| 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 fieldbus. |
| [0] | Digital input | Activates the set-up selection via a digital input. |
| [1] | Bus | Activates the set-up selection via the serial communication port or fieldbus option. |
| [2] | Logic AND | Activates the set-up selection via the fieldbus/ serial communication port, AND additionally via one of the digital inputs. |
| [3] * | Logic OR | Activate the set-up selection via the fieldbus/ 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 fieldbus. |
| [0] | Digital input | Activates Preset Reference selection via a digital input. |
| [1] | Bus | Activates Preset Reference selection via the serial communication port or fieldbus option. |
| [2] | Logic AND | Activates Preset Reference selection via the fieldbus/serial communication port, AND additionally via one of the digital inputs. |
| [3] * | Logic OR | Activates the Preset Reference selection via the fieldbus/serial communication port OR via one of the digital inputs. |

## 8.1.6 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 - 0 ] | This parameter shows the number of valid telegrams detected on the bus. |

| 8-81 Bus Error Count | | |
|---|---|---|
| **Range:** | | **Function:** |
| 0 * | [0 - 0 ] | 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 - 0 ] | This parameter shows the number of valid telegrams addressed to the slave, sent by the frequency converter. |

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

## 8.1.7 8-9* Bus Jog

| 8-90 Bus Jog 1 Speed | | |
|---|---|---|
| **Range:** | | **Function:** |
| 100 RPM* | [ 0 - par. 4-13 RPM] | Enter the jog speed. Activate this fixed jog speed via the serial port or fieldbus option. |

| 8-91 Bus Jog 2 Speed | | |
|---|---|---|
| **Range:** | | **Function:** |
| 200 RPM* | [ 0 - par. 4-13 RPM] | Enter the jog speed. Activate this fixed jog speed via the serial port or fieldbus option. |

# 9 Troubleshooting

Parameter group *8-8* FC Port Diagnostics* provides information on the Modbus RTU communication. The diagnostics information is both for the network i.e. how many valid or corrupted telegrams have been on the RS-485 network and for each slave i.e. how many telegrams have been send to this slave.

## NOTE

**The diagnostics counter in Parameter group 8-8* will be reset to 0 after a power cycle. Additionally it is possible to reset the counters to 0 via the Modbus Function code 8, sub-function code 1 Restart communication or 10 Clear counters and diagnostic register.**

### 9.1.1 Modbus Exception Codes

For a full explanation of the structure of an exception code response, please refer to *4 Modbus RTU Message Framing Structure*, *Function Field.*

| Modbus Exception Codes | | |
|---|---|---|
| **Code** | **Name** | **Meaning** |
| 1 | Illegal function | The function code received in the query is not an allowable action for the server (or slave). This may be because the function code is only applicable to newer devices, and was not implemented in the unit selected. It could also indicate that the server (or slave) is in the wrong state to process a request of this type, for example because it is not configured and is being asked to return register values. |
| 2 | Illegal data address | The data address received in the query is not an allowable address for the server (or slave). More specifically, the combination of reference number and transfer length is invalid. For a controller with 100 registers, a request with offset 96 and length 4 would succeed, a request with offset 96 and length 5 will generate exception 02. |
| 3 | Illegal data value | A value contained in the query data field is not an allowable value for server (or slave). This indicates a fault in the structure of the remainder of a complex request, such as that the implied length is incorrect. It specifically does NOT mean that a data item submitted for storage in a register has a value outside the expectation of the application program, since the Modbus protocol is unaware of the significance of any particular value of any particular register. |
| 4 | Slave device failure | An unrecoverable error occurred while the server (or slave) was attempting to perform the requested action. |

### 9.1.2 8-80 Bus Message count

If a valid Modbus RTU telegram is sentd on the RS-485 network, the *8-80 Bus Message count* counts one up for the controller request and if the slave responses, then count up again. If the controller is connected and sending valid Modbus telegrams and *8-80 Bus Message Count* is not counting, check the following:

- Check that the cable is mounted correct. See guidelines in *3.1.3 Network Connection*
- Check that the bus cable is terminated correct. See guidelines in *3.1.4 Bus Termination*
- Check that *8-30 Protocol* is set to *[2] Modbus RTU*
- Check that *8-32 FC Port Baud Rate* is set to the same baud rate as the controller
- Check that *8-33 Parity/Stop Bits* is set to the same parity control as the controller

### 9.1.3 8-81 Bus Error Count

*8-81 Bus Error Count* counts up if a Modbus telegram has a CRC error. If *8-81 Bus Error Count* periodical is counting up, it might be EMC noise that disturbs the communication between the controller and the slave. Check the following:

- Check that the bus cable is terminated correct. See guidelines in *3.1.4 Bus Termination*
- Check that screened bus cable is used and that it is connected to earth
- Check that screened motor cable is used and that it is connected to earth
- Stop all running motors. If the *8-81 Bus Error Count* also stops to count then EMC noise is generated from the motors to the bus cable and are disturbing the communication. Follow the EMC guideline in the Operating Instructions.

### 9.1.4 8-82 Slave Messages Rcvd

*8-82 Slave Messages Rcvd* shows the number of telegrams address to this slave. If *8-82 Slave Messages Rcvd* does not count up then check the following:

- Check if the controller is sending a valid Modbus telegram to the address set in *8-31 Address*
- Check that the slave address number is not duplicated on the network

### 9.1.5 8-83 Slave Error

*8-83 Slave Error Count* count shows the number of telegrams that the slave received, but replies with an error. If *8-83 Slave Error Count* count is counting up, check the following:

- Check that the function code is supported. See details in *4.1.10 Function Codes Supported by Modbus RTU*.
- Check if the coils or holding register in within the specify area. See *4.1.11 Coil Addresses* and *4.1.12 Register Addresses*.

# Index

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