SMVector ESVZAR0 RS-485 Modbus Communication Module
Communications Interface Reference Guide

This documentation applies to the ESVZAR0 RS-485/Modbus communications option for the SMVector inverter models up to 10HP. This documentation should be used in conjunction with the SMVector Operating Instructions (Document SV01) that shipped with the drive. These documents should be read in their entirety as they contain important technical data and describe the installation and operation of the drive and this option.

⚠️ **WARNING!**

The information in this document is based on RS-485 Modbus Communication Module software version 1.01. If a future revision of software contains differences in the register numbering or register definitions, drive operation could be seriously affected. If drive parameter P494 does not display **1.01, 1.10 or 1.30**, then writing to any drive register over the Modbus® network **MUST NOT BE ATTEMPTED** as it would have the potential for unexpected consequences potentially resulting in damage to the equipment or harm to personnel. Future releases of module software require that the appropriate documentation be used for implementation.

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All information given in this documentation has been carefully selected and tested for compliance with the hardware and software described. Nevertheless, discrepancies cannot be ruled out. We do not accept any responsibility nor liability for damages that may occur. Any necessary corrections will be implemented in subsequent editions.

Contents

1 Safety Information

General

Some parts of Lenze controllers (frequency inverters, servo inverters, DC controllers) can be live, moving and rotating. Some surfaces can be hot.

Non-authorized removal of the required cover, inappropriate use, and incorrect installation or operation creates the risk of severe injury to personnel or damage to equipment.

All operations concerning transport, installation, and commissioning as well as maintenance must be carried out by qualified, skilled personnel (IEC 364 and CENELEC HD 384 or DIN VDE 0100 and IEC report 664 or DIN VDE0110 and national regulations for the prevention of accidents must be observed).

According to this basic safety information, qualified skilled personnel are persons who are familiar with the installation, assembly, commissioning, and operation of the product and who have the qualifications necessary for their occupation.

Application as directed

Drive controllers are components which are designed for installation in electrical systems or machinery. They are not to be used as appliances. They are intended exclusively for professional and commercial purposes according to EN 61000-3-2. The documentation includes information on compliance with the EN 61000-3-2.

When installing the drive controllers in machines, commissioning (i.e. the starting of operation as directed) is prohibited until it is proven that the machine complies with the regulations of the EC Directive 2006/42/EC (Machinery Directive); EN 60204 must be observed.

Commissioning (i.e. starting of operation as directed) is only allowed when there is compliance with the EMC Directive (2004/108/EEC). The drive controllers meet the requirements of the Low Voltage Directive 2006/95/EC. The harmonised standards of the series EN 50178/DIN VDE 0160 apply to the controllers.

The availability of controllers is restricted according to EN 61800-3. These products can cause radio interference in residential areas. In this case, special measures can be necessary.

Installation

Ensure proper handling and avoid excessive mechanical stress. Do not bend any components and do not change any insulation distances during transport or handling. Do not touch any electronic components and contacts.

Controllers contain electrostatically sensitive components, which can easily be damaged by inappropriate handling. Do not damage or destroy any electrical components since this might endanger your health!

Electrical connection

When working on live drive controllers, applicable national regulations for the prevention of accidents (e.g. VBG 4) must be observed.

The electrical installation must be carried out according to the appropriate regulations (e.g. cable cross-sections, fuses, PE connection). Additional information can be obtained from the documentation.

The documentation contains information about installation in compliance with EMC (shielding, grounding, filters and cables). These notes must also be observed for CE-marked controllers.

The manufacturer of the system or machine is responsible for compliance with the required limit values demanded by EMC legislation.

Operation

Systems including controllers must be equipped with additional monitoring and protection devices according to the corresponding standards (e.g. technical equipment, regulations for prevention of accidents, etc.). You are allowed to adapt the controller to your application as described in the documentation.

DANGER!
- After the controller has been disconnected from the supply voltage, live components and power connection must not be touched immediately, since capacitors could be charged. Please observe the corresponding notes on the controller.
- Do not continuously cycle input power to the controller more than once every three minutes.
- Please close all protective covers and doors during operation.

WARNING!
Network control permits automatic operation of the inverter drive. The system design must incorporate adequate protection to prevent personnel from accessing moving equipment while power is applied to the drive system.

Table 1: Pictographs used in these instructions

Pictograph	Signal word	Meaning	Consequences if ignored
	DANGER!	Warning of Hazardous Electrical Voltage.	Reference to an imminent danger that may result in death or serious personal injury if the corresponding measures are not taken.
	WARNING!	Impending or possible danger for persons	Death or injury
STOP	STOP!	Possible damage to equipment	Damage to drive system or its surroundings
i	NOTE	Useful tip: If observed, it will make using the drive easier	

2   Introduction

This reference guide assumes that the reader has a working knowledge of the Modbus RTU Protocol and familiarity with the programming and operation of motion control equipment. This guide is intended as a reference only.

Modbus is an internationally accepted asynchronous serial protocol designed for commercial and industrial automation applications. The Modbus RTU architecture is based upon a PLC to device communication structure and, as such is Master-Slave in orientation. The SMV drive, in this case, always acts as the slave in this network, responding to commands and requests from the Master.

While the Modbus RTU protocol does not specify the physical layer, the ESVZAR0 module uses the RS-485 physical interface which is quite common and well suited for the industrial environment. The ESVZAR0 module provides both galvanic and optical isolation of this physical interface.

2.1   Module Specifications

Table 2 identifies the Modbus serial communication specifications. If the specification is fixed (non-adjustable) the value is shown under "Range", if the specification is selectable, Table 2 identifies the Parameter and available range of selections.

Table 2: Modbus Specifications

Description	Type	Range
Baud Rate	Selectable	P411 (2400, 4800, 9600, 19200, 38400, 57600, or 115200 bps)
Data Bits	Fixed	8
Parity / Stop Bits	Selectable	P412 (None/1, None/2, Even/1, Odd/1)
Network Address	Selectable	P410 (1 - 247)

Typical communications between master and slave would be:

- Write commands from Master
- Run command
- Frequency Reference
- Modification of Drive operating parameters
- Requests from Master
- Reporting of drive status
- Fault status (and fault history)

The SMVector drive most nearly conforms to the Modicon® Micro 84 in capabilities. This may be of importance when configuring networks for DDE Servers.

2.2   Module Identification

Figure 1 illustrates the labels on the SMV RS-485 communications module. The SMVector RS-485 module is identifiable by:

- Two labels affixed to either side of the module.

- The color coded identifier label in the center of the module.

Right-hand Label:
Ratings & Certifications

COMM I/O ONLY
S/N: 123456789

ᶜ(UL)ᵤₛ
LISTED

E S V Z A R 0 – 0 0 0 X X 1 A 1 0

Fieldbus Identifier:
R = RS-485 (Modbus RTU/LECOM)

R0

Left-hand Label:
Module Data

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SMV RS-485	A
TYPE: ESVZAR0	B
ID-NO: 12345678	C
	D
ESVZAR0-000XX1A10	
	E

A: Fieldbus Protocol
B: Model Number
C: Lenze Order Number
D: Firmware Revision
E: Hardware Revision
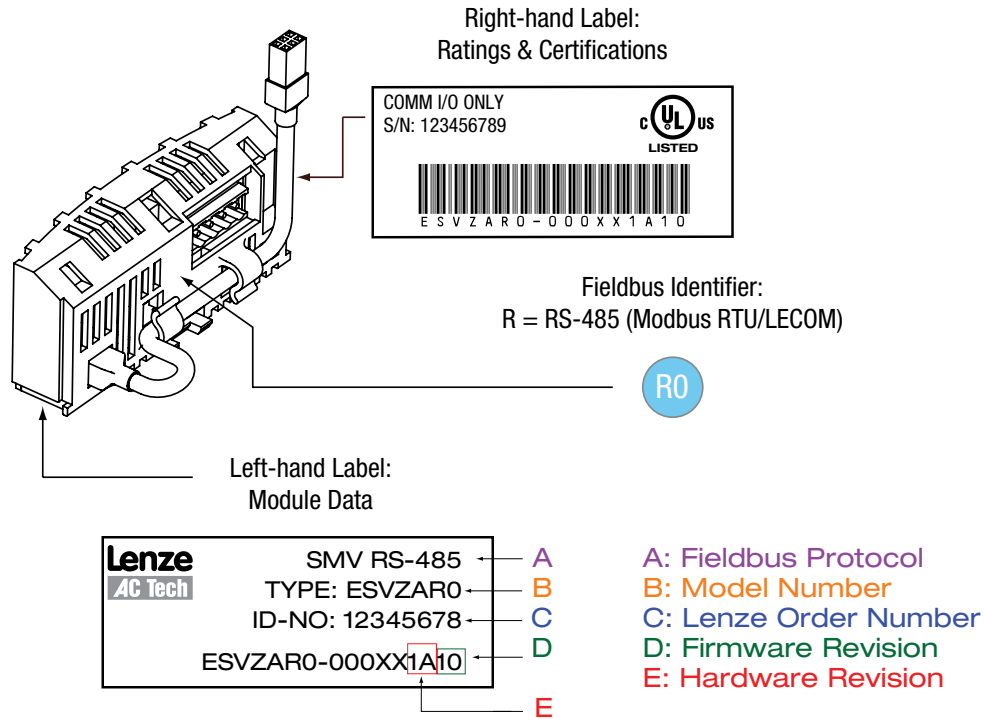
Figure 1: RS-485 Module Labels

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3   Installation

3.1   Mechanical Installation

1. Ensure that for safety reasons the AC supply has been disconnected before opening the terminal cover.

2. Insert the RS-485 option module in the terminal cover and securely "click" into position as illustrated in Figure 2.

3. Wire the network cables to the connector provided, as detailed in paragraphs 3.2 (RS-485 Terminal Block) and 3.3 (Electrical Installation), and plug the connector into the option module.

4. Align terminal cover for re-fitting, connect the module umbilical cord to the drive then close the cover and secure, as shown in Figure 3.

NEMA 1 (IP31) Models   NEMA 4X (IP65) Models
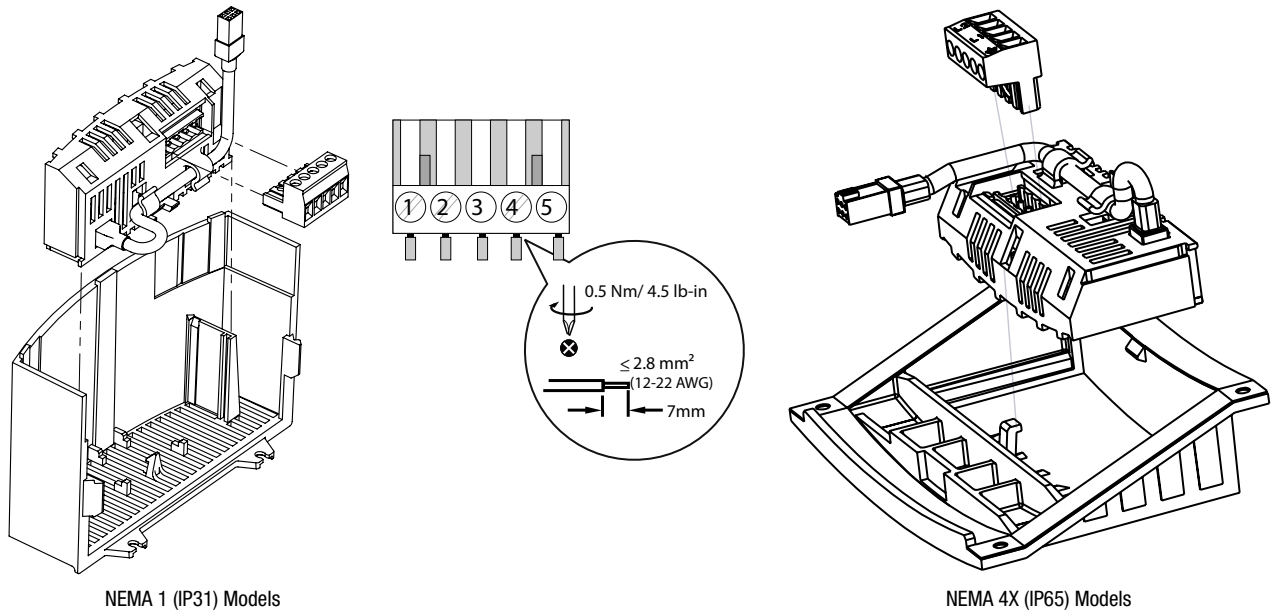
Figure 2: Installing the RS-485 Communications Module

NEMA 1 (IP31) Models   NEMA 4X (IP65) Models
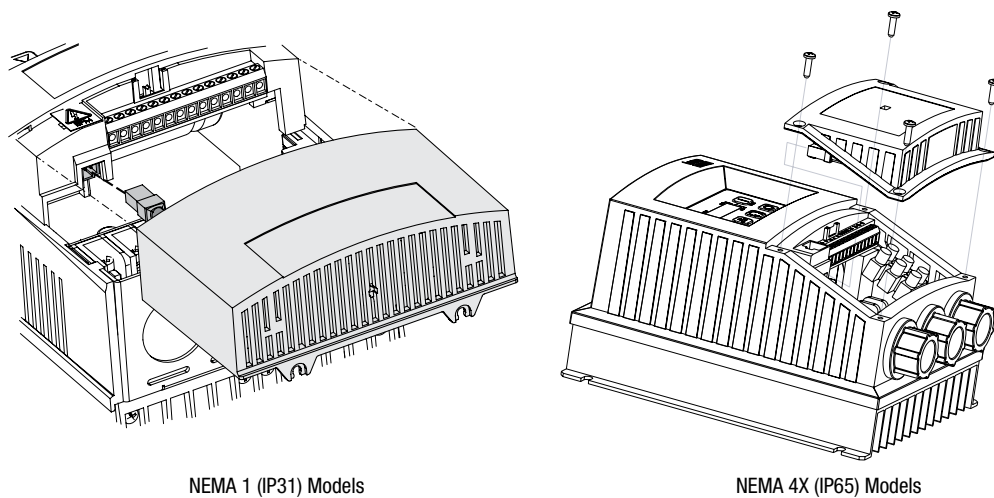
Figure 3: Re-installing the Terminal Cover
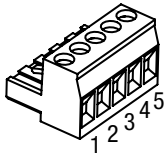
3.2 RS-485 Terminal Block

Table 3 describes the RS-485 terminal block. The 5 pole connector provides 2-wire connection to the network.

Table 3: RS-485 Terminal Block

Terminal	Description	Important	Connector
1	Earth ground / shield	For reliable communication make sure terminal is connected to the Modbus network GND/common. If only two wires are used (TXA and TXB) in the network, connect Terminal 1 to chassis/earth GND.	
2	TXA	If controller is located at either end of the network, a terminating resistor (120ohm typical) should be connected across TXA and TXB	
3	No connection		
4	TXB		
5	No connection		

Protection against contact

- All terminals have basic isolation (single insulating distance)
- Protection against contact can only be ensured by additional measures (i.e. double insulation)

3.3 Electrical Installation

3.3.1 Cable Types

For RS-485 Modbus networks, use a quality shielded twisted pair cable. The use of low quality cable will result in excess signal attenuation and data loss.

3.3.2 Connections and Shielding

To ensure good system noise immunity all networks cables should be correctly grounded:

- Minimum grounding recommendation: ground the network cable once in every cubical.
- Ideal grounding recommendation: ground the network cable on or as near to each drive as possible.
- For wiring of cable to the connector plug the unscreened cable cores should be kept as short as possible; recommended maximum of 20mm. The shield connection of terminal 1 should also be wired to earth (PE).

Connect to drive earth (PE)

20mm max
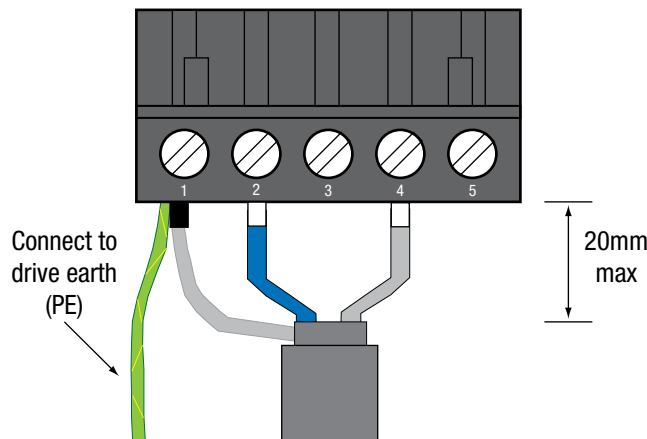
Figure 4: Connector Wiring Diagram

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3.3.3 Network Termination

For an RS-485 network it is essential to install the specified termination resistors (120Ω), i.e. one at both ends of a network segment. Failure to do so will result in signals being reflected back along the cable which will cause data corruption.

An external 120Ω 1/4W resistor can be connected as shown in Figure 5.
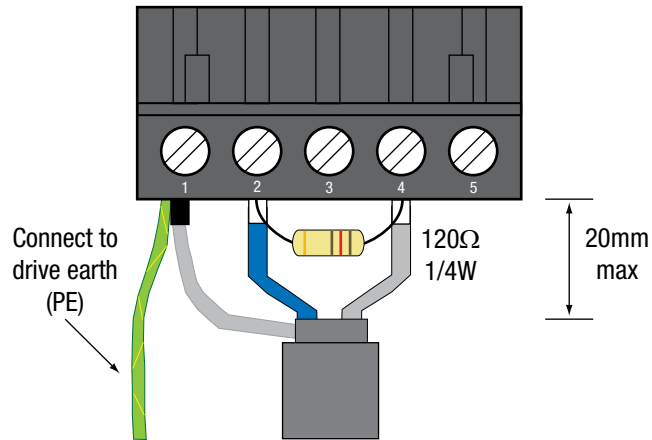
Figure 5: Network Termination Resistor

4 Extended Parameters for Modbus RTU

In addition to the drive parameters that are detailed in the Operating Instructions (SV01), the installation of the RS485/Modbus RTU module will give access to the 400 series parameters that are exclusive to this communication module. Table 4 lists these 400 Series parameters.

4.1 Parameter Menu

Table 4: 400 Series Parameters for Modbus RTU Operation

Code		Possible Settings		IMPORTANT
No.	Name	Default	Selection	
RS485/Modbus: Modbus Module Specific parameters				
P400	Network Protocol		0 Not Active	
			1 Remote Keypad	
			2 Modbus RTU	
P401	Module Revision	01.0.0	Display reads 01.x.x where: 01 = RS485/Modbus Module x.x = Module Revision	Read only
P402	Module Status	0	0 Not Initialized	Read only Online state "3" indicates that the communications between the drive and module are working properly.
			1 Initialization: Module to EPM	
			2 Initialization: EPM to Module	
			3 Online	
			4 Failed Initialization Error	
			5 Time-out Error	
			6 Initialization Failed	Module type mismatch (P401)
			7 Initialization Error	Protocol Selection mismatch (P400)
P403	Module Reset	0	0 No Action	
			1 Reset Module parameter values to default.	Returns module parameters 401…499 to the default values shown in this manual.
P404	Module Time-out Action	3	0 Ignore	• Action to be taken in the event of a Module/Drive Time-out. • Time-out is fixed at 200ms. • Selection 1 (STOP) is by the method selected in P111.
			1 STOP (see P111)	
			2 Quick Stop	
			3 Fault (F_ntF)	
P405	Network Fault	0	0 No Fault	Read only, see P425 and P426
			1 Network Time-out, F_nF1	
P406	Proprietary		Manufacturer specific	Read only
RS485/Modbus: System bus parameters				
P410	Network address	1	1 247	The Drive does not support the Modbus "broadcast" function.
P411	Network Baud Rate	2	0 2400 bps	
			1 4800 bps	
			2 9600 bps	
			3 19200 bps	
			4 38400 bps	
			5 57600 bps	
			6 115200 bps	
P412	Network Data Format	0	0 8 Data bits, No Parity, 2 stop bits	
			1 8 Data bits, No Parity, 1 stop bit	
			2 8 Data bits, Even Parity, 1 stop bit	
			3 8 Data bits, Odd Parity, 1 stop bit	

Code		Possible Settings		IMPORTANT
No.	Name	Default	Selection	
P425	Network Message time-out	10.0	0.0 {s} 300.0	
P426	Network Message time-out action	4	0 Not active	
			1 STOP (see P111)	
			2 Quick stop	
			3 Inhibit	
			4 Trip fault, *F_nF1*	
P427	Valid Network messages Received	0	0 {messages} 9999	• Read-only • When number of messages exceed 9999, counter resets to 0 and continues.
RS485/Modbus: Module Specific parameters				
P494	Communication Module software version			• Read only • Format: x.yz
P495	Internal Code			• Read only • Alternating Display: xxx-; -yy
P498	Missed Messages Drive to Module			• Read only
P499	Missed Messages Module to Drive			• Read only

5   Modbus Protocol Details

5.1   Data Transmission

This drive uses the RTU (Remote Terminal Unit) transmission mode of the Modbus Protocol and operates as a Slave device on the network. All devices communicating with the drive(s) must be a Modbus Master.

5.2   Register Numbering

Modbus 3X and 4X register numbers are always **one greater** than the actual drive register numbers. For example: drive register #24 would correspond to Modbus 3X / 4X register #25.

All the register numbers referred to in this document are **drive** register numbers.

5.3   Supported Function Codes

The Modbus function codes supported by the drive are:

03 - Read Holding Register (4X references)
04 - Read Input Register (3X references)

> **NOTE**
> We do not differentiate between 4X and 3X references. Therefore, function codes 03 and 04 are treated identically.

Typically only one register (or one word of data) can be read at a time. Exceptions to this rule are:

- Register #24 (Command Frequency) can be read as a single register or as a group of 6 drive status registers (#24-29).

- Register #32 (low word of Total kWh) can be read as a single register or as a group of 2 registers (#32-33).

- Register #60 (low word of Total Runtime Hours) can be read as a single register or as a group of 2 registers (#60-61).

- Register #64 (low word of Total Power On Hours) can be read as a single register or as a group of 2 registers (#64-65).

- In some instances, multiple words can be read for a single register. When this is done for the registers below, the response from the drive will be for the number of words, rather than the number of registers, requested:

- Register #500 (Fault History) can be read as 1 word (returning the two most recent faults) or as 4 words (returning the entire fault history).

- Register #511 (Total kWh) can be read as 1 word (returning only the low word of the 32-bit register value) or as 2 words (returning the complete 32-bit register value).

- Register #540 (Total Runtime Hours) can be read as 1 word (returning only the low word of the 32-bit register value) or as 2 words (returning the complete 32-bit register value).

- Register #541 (Total Power On Hours) can be read as 1 word (returning only the low word of the 32-bit register value) or as 2 words (returning the complete 32-bit register value).

06 - Preset Single Register (4X references)

Write a single register.

16 - Preset Multiple Registers (4X references)

While code 16 is supported it's implementation is limited to addressing only one register per write.

6 Modbus Message Details

These abbreviations will be used throughout this section to illustrate the message structure:

R   Read

W   Write

RS   Response

SA   Slave Address (01 ... F7 hex)

EC   Exception Code

RH   Register Address (high byte)

RL   Register Address (low byte)

DxH   Data (high byte)

DxL   Data (low byte)

CRCH   Cyclic Redundancy Check (high byte)

CRCL   Cyclic Redundancy Check (low byte)

6.1 Register Reading

6.1.1 Message structure for reading one 16-bit register

All registers except #1

R	SA	03	RH	RL	00	01	CRCH	CRCL

RS	SA	03	02	DH	DL	CRCH	CRCL

6.1.2 Message structure for reading two 16-bit registers

Registers 32, 60 and 64 only

R	SA	03	RH	RL	00	02	CRCH	CRCL

RS	SA	03	04	D1H	D1L	D2H	D2L	CRCH	CRCL

D1H and D1L are the high and low bytes of the first 16-bit register value (32, 60, 64)

D2H and D2L are the high and low bytes of the second 16-bit register value (33, 61, 65)

Example: Total Run-time Hours = 305419896 (12345678h)

Register #60 (low word of total run-time hours) = 5678h

Register #61 (high word of total run-time hours) = 1234h

R	SA	03	00	3C	00	02	CRCH	CRCL

RS	SA	03	04	56	78	12	34	CRCH	CRCL

6.1.3   Message structure for reading one 32-bit register

Registers 511, 540 and 541 only

R	SA	03	RH	RL	00	02	CRCH	CRCL

RS	SA	03	04	DHH	DHL	DLH	DLL	CRCH	CRCL

DHH and DHL are the high and low bytes of the high word (i.e. the first 16 bits) of the 32-bit register value

DLH and DLL are the high and low bytes of the low word (i.e. the last 16 bits) of the 32-bit register value

Example: Total Run-time Hours (Register #540) = 305419896 (12345678h)

R	SA	03	01	FF	00	02	CRCH	CRCL

RS	SA	03	04	12	34	56	78	CRCH	CRCL

6.1.4   Message structure for reading one 4 word register

Register 500 only

R	SA	03	01	F4	00	04	CRCH	CRCL

RS	SA	08	D1	D2	D3	D4	D5	D6	D7	D8	CRCH	CRCL

D1 holds the value of Fault 1 (the most recent fault in the fault history)

D2 holds the value of Fault 2 in the fault history

…

D8 holds Fault 8 (the oldest fault in the fault history).

6.1.5   Message structure for reading six 16-bit registers

Register 24 only

R	SA	03	00	18	00	06	CRCH	CRCL

RS	SA	0C	D1H	D1L	D2H	D2L	D3H	D3L
	D4H	D4L	D5H	D5L	D6H	D6L	CRCH	CRCL

Operation	Byte	Register
Command Frequency	D1H D1L	Register #24 (DH DL)
Actual Frequency	D2H D2L	Register #25 (DH DL)
Load	D3H	Register #26 (DH)
Operation Status	D3L	Register #26 (DL)
Rotational Direction	D4H	Register #27 (DH)
Control Mode	D4L	Register #27 (DL)
Speed Command Source	D5H	Register #28 (DH)
Auto/Manual Status	D5L	Register #28 (DL)
Present Fault	D6H	Register #29 (DH)
Command Rotation	D6L	Register #29 (DL)

6.2 Register Writing

6.2.1 Message structure for reading one word

All writable registers

W	SA	06	RH	RL	DH	DL	CRCH	CRCL

RS	SA	06	RH	RL	DH	DL	CRCH	CRCL

6.3 No Response Conditions

The drive will not respond to any message that:

- contains one or more parity errors

- has an invalid CRC value

- was not directed to the drive's network address.

- This drive does not support the broadcast function of the Modbus protocol.

- is not at least 8 bytes long (minimum required for the supported functions)

- is more than 18 bytes long (maximum allowed before input buffer overflow occurs)

6.4 Exception Responses

If a valid message is received (i.e. parity, crc, address and message length all pass validity checks), but the message contents are somehow invalid, the drive will respond with a Modbus exception.

6.4.1 Message structure for an exception response to a read request (03)

W	SA	83	EC	CRCH	CRCL

6.4.2 Message structure for an exception response to a write request (06)

W	SA	86	EC	CRCH	CRCL

6.4.3 Exception Codes (EC)

EC	Description
01	Command rejected; Illegal function
02	Invalid register number
03	Data value is out-of-range
04	Wrong data format
06	Slave device (drive) busy

7 Commissioning

7.1 Drive Monitoring

The network can always read drive parameters as long as the Modbus communications are enabled (i.e. P400 = 2) and configured properly (see P410-412).

7.2 Drive Programming and Control

Network Control must be enabled for the network to program drive parameters or take control of an actual drive. This is done by …

1. Setting P121…P123 equal to 09 (NET ENABLE) and asserting the corresponding TB-13x terminal

2. Setting P100 to 00, 01, 03 or 04. Network control cannot be enabled when P100 is set to 02 (REMOTE KEYPAD ONLY) or 05 (TERMINAL STRIP/REMOTE KEYPAD).

Once network control is enabled, the drive must unlock controls and/or parameters in order to write to any of the drive registers.

7.3 Unlocking & Locking Drive Controls & Parameters

Writing to Register #48 (Unlock Controls) with a value of 0 will unlock write access to the Drive Control register (#1) only. Write commands to any other drive registers will not be allowed.

Writing to Register #48 (Unlock Controls) with a value equal to the drive's programming password (P194) will unlock the Drive Control register (#1) and all other writable drive registers. This enables the writing of any drive register that is not designated as read-only.

> **i** **NOTE**
> The factory default password is 225

Writing to Register #49 (Unlock Parameters) with a value equal to the drive's programming password (P194) will unlock all writable drive registers EXCEPT for the Drive Control register (#1). This enables the writing of any drive register that is not designated as read-only, except for Register #1.

Once write access to the drive registers has been unlocked, it will remain unlocked until any of the following conditions occur …

• Register #1 (Drive Control) is written with bit 1 (Lock Security) set

• A network watchdog time-out occurs (see Sections 7.4 and 7.5)

• The TB-13x terminal assigned to NETWORK ENABLE is de-asserted or is assigned to a function other than NETWORK ENABLE.

Writing to Register #1 (Drive Control) with bit 1 (Lock Security) set will lock both Drive Controls and Parameters, disabling the watchdog timer and preventing any further writing to drive registers (other than #48 and #49).

When the Lock Security (bit 1) is set, the drive drops out of NETWORK control and switches to the normal source of control. If P100 = 3 (NETWORK ONLY) and the drive is running, the drive will also be stopped (according to P111).

Drive parameters and status registers can always be read, even when P100=2,5 and/or drive control and parameters are locked.

Stop commands (STOP, QUICK STOP, INHIBIT) will always be accepted, even when network control is not enabled or drive controls are locked.

7.4 Network Watchdog Timer

The drive is equipped with a network communications watchdog timer. If the Modbus Master wishes to control the drive (start, forward, reverse, etc.) it must first Unlock Controls (see Section 7.3). If the watchdog timer is enabled (i.e. P426 is not set to IGNORE) and drive controls have been unlocked, the Master must periodically communicate with the drive or a watchdog time-out will occur. The watchdog timer does not operate unless Controls have been UNLOCKED via Register #48 and a time-out action (other than IGNORE) has been specified using parameter P426.

7.5 Watchdog Timer Controls

7.5.1 Watchdog Time-out Period (P425)

The maximum amount of time that should be allowed to pass between network messages to a specific drive will vary from one network to the next. Therefore, we have made the watchdog time-out period user settable via Drive Programming Parameter P425 (see 4.1 for details).

7.5.2 Watchdog Time-out Action (P426)

The appropriate action to be taken when a watchdog time-out occurs will also vary from one application to the next. Therefore, we have provided five user selectable time-out actions which can be set via Drive Programming Parameter P426 (see 4.1 for details).

If the Watchdog Timer has been disabled (i.e. P426 is set to IGNORE), Controls and/or Parameters must still be unlocked in order to gain write access to the drive control and/or program parameter registers. However, there are no longer any constraints on how often the Master must communicate with the drive.

8 Typical Network Applications

8.1 Controlling the Drive

The following is the sequence of events to start the drive via the network:

1. Unlock the Drive Control register (#1) by writing a 0 (or the drive password) to Register #48.

2. Control drive operation with various commands to Register #1 (Start, Stop, Forward, Reverse, etc.). To start the drive, a value of 0x0008 should be sent to Register #1.

3. If the watchdog timer is enabled, keep it from timing out by assuring that a read command (to any register) is performed within the time specified by P426.

4. Lock Control when drive operations are complete by writing a 0x0002 (i.e. setting the Lock Security bit) to Register #1.

> **i** **NOTE**
> If P100 = 3 (NETWORK ONLY) and the drive is still running when the Lock Security bit is set, it
> will be brought to a stop by the method specified in Drive Programming Parameter P111 (STOP).

5. The drive will return to its normal control mode.

8.2 Changing Drive Parameters

The following is the sequence of events for changing drive parameters:

1. Unlock write access to the drive parameters by writing the drive password (P194) to Register #49. The drive will remain in its normal control mode.

2. Write to all necessary drive configuration or parameters registers.

3. The watchdog timer is not enabled when only the parameters have been unlocked so there is no need to send repeated read commands to prevent it from timing out.

4. Lock Control when drive operations are complete by writing a 0x0002 (i.e. setting the Lock Security bit) to Register #1.

8.3 Controlling Frequency, PID & Torque Setpoints

The following is the sequence of events for changing the drive frequency, PID or torque setpoint:

1. Configure the setpoint reference for NETWORK. The network can be set as the frequency, PID or torque setpoint reference in any of the following ways:

   a) Set P101 (Standard Reference Source) to NETWORK (06) and make sure that no AUTO source has been selected.

   b) Set P121…P123 to AUTO: NETWORK (07) and assert the corresponding TB-13x terminal.

   c) Unlock drive controls and write a value of 0xC000 to Register #1 (see Section 9.2.1).

2. Unlock parameters by writing the drive password (P194) to Register #49. The drive will remain in its normal control mode. The watchdog timer is not enabled when only parameters have been unlocked so there is no need to send repeated read commands to prevent it from timing out.

3. Modify the appropriate NETWORK setpoint register.

   Register #44 - Network Speed Command

   Register #45 - Network PID Setpoint Command

   Register #46 - Network Torque Command

4. Lock Control when drive operations are complete by writing a 0x0002 (i.e. setting the Lock Security bit) to Register #1.

9 Drive Registers

9.1 Data Internal vs. Display Representation

Register data passed across the Modbus communications link is always in INTERNAL units, although the drive itself may show the information in some alternate DISPLAY units.

For register values with 1 or more decimal places, the actual value sent over the Modbus communications will be the value times 10^{DP}, where DP is the number of decimal places.

Example

An actual frequency of 34.3Hz would be sent over the network as 343 ($34.3*10^1$).

If the drive is setup to display the actual frequency in RPM using P178 = 29.17, the actual speed would be displayed on the drive as 1000 (RPM) but would still be sent over the Modbus communications as 343 (or 01 57 hex).

9.2 Drive Control Registers

Table 5 describes the SMV Drive Con trol Registers in ascending order of SMV Register #. Registers #1 through #99 are reserved for configuration and control over the network and cannot be accessed via the drive's local keypad.

Table 5: SMV Drive Control Registers

Reg #	Register Name	Default	Range of Adjustment	Important
1	Drive Control (write only)			See Sections 8.1 and 9.2.1
19	Drive Family			Read only, drive family is 72
21	Drive Size			Read only. See section 9.2.2
23	Drive Status			Read only. See section 9.2.3
24	Command Frequency	0.0 Hz	0.0 … 500.0	Read only.
25	Actual Frequency	0.0 Hz	0.0 … 500.0	Read only.
26	Load (DH) Run Status (DL)			Read only. See section 9.2.4 Read only. See section 9.2.5
27	Actual Direction (DH) Control Mode (DL)			Read only. See section 9.2.6 Read only. See section 9.2.7
28	Speed Source (DH) Auto/Manual (DL)			Read only. See section 9.2.8 Read only. See section 9.2.9
29	Present Fault (DH) Commanded Direction (DL)			Read only. See section 9.2.10 Read only. See section 9.2.11
30	Motor Voltage			Read only. See P506 in drive manual
32	Total kWh (low word)			Read only. See P511 in drive manual
33	Total kWh (high word)			
37	Actual PID setpoint	0.0	-999.0 … 3100.0	Read only. See section 9.2.12
38	PID Setpoint Command	0.0	-999.0 … 3100.0	Read only. See section 9.2.12
39	PID Feedback	0.0	-999.0 … 3100.0	Read only. See section 9.2.12
40	Keypad Speed Command	20.0 Hz	P102 … P103	
41	Keypad PID Setpoint Command	0.0	-999.0 … 3100.0	Read only. See section 9.2.12
42	Keypad Torque Command	100%	0.0 … 400.0	
44	Network Speed Command	0.0 Hz	P102 … P103	See Section 8.3
45	Network PID Setpoint Command	0.0	-999.0 … 3100.0	Read-only See Sections 8.3 and 9.2.12
46	Network Torque Command	0%	0.0 … 400.0	See Sections 8 3
48	Unlock Controls			See Sections 7 3
49	Unlock Parameters			See Sections 7 3
50	Parameter Version			Read only. See section 9.2.13

Reg #	Register Name	Default	Range of Adjustment	Important
60	Total Run Time hours (low word)			Read only. See P540 in drive manual
61	Total Run Time hours (high word)			
64	Total Power-on Hours (low word)			Read only. See P541 in drive manual
65	Total Power-on Hours (high word)			
70	Network Controlled Digital Output (TB14) + Relay			0: de-energized, 1: energized
				bit 9: TB-14 state bit 10: Relay state other bits are not used
				See section 9.2.14
71	Network Controlled Analog Output	0.0%	0.0 … 100.0	See section 9.2.15

9.2.1   Drive Control - Register #1

Table 6 illustrates the Data High Byte and Data Low Byte format of Register #1, Drive Control.

Table 6: Drive Control - Register #1

Byte	Bit	Status
Data Low Byte	0	Quick Stop
	1	Lock Security
	2	STOP drive (P111)
	3	Start drive
	4	Inhibit
	5	Network Reference Off
	6	Set Reverse
	7	Set Forward
Data High Byte	8	Stop Forcing Manual Reference
	9	Force Manual Reference (P101)
	10	DC Braking ON
	11	DC Braking OFF
	12	Network Reference (enumeration):
	13	0 Network Reference OFF (used only when bit 5 is set) 1 AUTO: Keypad
	14	2 AUTO: 0-10VDC
	15	3 AUTO: 4-20mA 4…10 AUTO: Presets 1-7 11 AUTO: MOP 12 AUTO: Network

Drive Controls must be unlocked in order to write to this register (refer to section 7.3).

The appropriate bit for the desired action should be set to 1. For example, to stop the drive according to P111, bit 2 should be set (i.e. send 0004h). To start the drive, bit 3 should be set (i.e. send 0008h). Locking security (i.e. setting bit 1) disables network drive control and the communications watchdog timer and prevents any further writing to control or parameter registers.

NOTE
During each write to Register #1 only one action can be performed at one time. This means that either a single bit (0-11) is set to perform a specific action OR the network reference is set using bits 12-15. The drive will respond to INHIBIT, QUICK STOP and STOP bits even if more than 1 bit is set. But, if more than 1 bit is set and none of them is either an INHIBIT, QUICK STOP or STOP bit, all bits will be ignored and the drive will respond with exception 04.

9.2.2 Drive Size - Register #21

This register returns an index value that is associated with the voltage and power rating of the drive as shown in Table 7.

Table 7: Drive Size - Register #21

Index	Input Voltage	Power Rating
8	240 VAC, Single-Phase	0.33 HP (0.25 kW)
12	240 VAC Single or Three-Phase	1.5 HP (1.1 kW)
13		2 HP (1.5 kW)
14		3 HP (2.2 kW)
21	240 VAC Three-Phase	0.5 HP (0.37 kW)
23		1 HP (0.75 kW)
24		1.5 HP (1.1 kW)
25		2 HP (1.5 kW)
26		3 HP (2.2 kW)
28		5 HP (4 kW)
29		7.5 HP (5.5 kW)
30		10 HP (7.5 kW)
42	480 VAC Three-Phase	0.5 HP (0.37 kW)
44		1 HP (0.75 kW)
45		1.5 HP (1.1 kW)
46		2 HP (1.5 kW)
47		3 HP (2.2 kW)
49		5 HP (4 kW)
50		7.5 HP (5.5 kW)
51		10 HP (7.5 kW)
69	600 VAC Three-Phase	1 HP (0.75 kW)
71		2 HP (1.5 kW)
72		3 HP (2.2 kW)
74		5 HP (4 kW)
75		7.5 HP (5.5 kW)
76		10 HP (7.5 kW)
91	120 or 240 VAC Single-Phase	0.33 HP (0.25 kW)
92		0.5 HP (0.37 kW)
94		1 HP (0.75 kW)

All unused Index values are reserved for future use

9.2.3 Drive Status - Register #23

Table 8 lists the status of the bits in Register 23, Drive Status.

Table 8: Drive Status - Register #23

Bit	Status
0	0 = STOP 1 = RUN
1	0 = Quick Stop not active 1 = Quick Stop active
2	0 = Direction Forward 1 = Reverse (commanded direction)
3	0 = Direction Forward 1 = Reverse (actual direction)
4	0 = Network Reference not active 1 = Network Ref., sets active source
5	0 = Network Enable not active 1 = Network Enable active
6	0 = Open Loop (PID off) 1 = Closed Loop (PID on)
7	0 = Manual Source (P101) 1 = AUTO Source
8	Actual set point source:
9	0 = Keypad 1 = 0-10VDC
10	2 = 4-20 mA
11	3 = Preset #1 4 = Preset #2 5 = Preset #3 6 = Preset #4 7 = Preset #5 8 = Preset #6 9 = Preset #7 10 = MOP 11 = Network
12	Control: 0 = Keypad
13	1 = Terminal 2 = Remote Keypad 3 = Network
14	0 = Network Control DISABLED 1 = Network control ENABLED
15	0 = DC Braking not active 1 = DC Braking active

9.2.4 Load - Register #26

The high byte (DH) of register 26 provides the load as a percentage of the drives output current rating. **Example:** This byte is 64 (one byte in hex) equivalent to 100 (decimal) = 100% drive load.

9.2.5 Run Status - Register #26

The low byte (DL) of register 26 provides the Operational Status as listed in Table 9.

Table 9: Operational Status - Register #26 DL

Value	Description
0	Fault Lockout
1	Fault
2	Start Pending
3	IDE not done
4	Inhibit
5	STOP
6	Lower Transistors switching on
7	Run IDE
8	Run
9	Accel
10	Decel
11	Decel Override
12	DC Brake
13	Flying Restart
14	Slow Current Limit
15	Fast Current Limit
16	Sleep

9.2.6 Actual Direction - Register #27

The high byte (DH) of register 27 provides the actual rotational direction of the motor.

Table 10: Actual Rotational Direction - Register #27 DH

Setting	Direction
0	Forward
1	Reverse

9.2.7 Control Mode - Register #27

The low byte (DL) of register 27 provides the Control Mode as listed in Table 11.

Table 11: Control Mode - Register #27 DL

Value	Control Mode	Description
0	Local	Start commands from drive keypad (P100 = 0 or 4)
1	Terminal	Start commands from control wiring on drive terminal Strip (P100 = 1, 4 or 5)
2	Remote Keypad Only	Start commands from optional remote keypad (P100 = 2 or 5)
3	Network Only	Start commands from Network, but Network control is not active (P100 = 3)
4	Network Control	Start commands from Network and Network control is active (P100 = 0, 1, 3 or 4)

9.2.8   Speed Source - Register #28

The high byte (DH) of register 28 provides the Speed Command Source as listed in Table 12.

Table 12: Speed Source - Register #28 DH

Value	Command Source
0	Keypad
1	0-10 VDC
2	4-20 mA
3	Preset #1
4	Preset #2
5	Preset #3
6	Preset #4
7	Preset #5
8	Preset #6
9	Preset #7
10	MOP
11	Network
12	JOG

9.2.9   Auto/Manual Reference - Register #28

The low byte (DL) of register 28 provides the Auto/Manual Reference as shown in Table 13.

Table 13: Auto/Manual Reference - Register #28 DL

Setting	Reference
0	Manual
1	Auto

9.2.10 Present Fault - Register #29

The high byte (DH) of register 29 provides the active Fault Message as listed in Table 14.

Table 14: Present Fault

Value	Fault	Display		Value	Fault	Display
0	No Fault			19	Internal Fault 3	F_F3
1	TMP Output Fault			20	Internal Fault 5	F_F5
2	Output (Transistor) Fault	F_OF		21	Internal Fault 5	F_F5
3	Ground Fault	F_OF1		22	Internal Fault 6	F_F6
4	High Drive Temperature	F_AF		23	Internal Fault 7	F_F7
5	Flying Start Fault	F_rF		24	Internal Fault 8	F_F8
6	High DC Bus Voltage	F_HF		25	Internal Fault 9	F_F9
7	Low DC Bus Voltage	F_LF		26	Personality Fault	F_bF
8	Thermal Overload	F_PF		27	AD Offset Fault	F_F12
9	OEM Fault	F_GF		28	Remote Keypad Lost	F_JF
10	Illegal Setup	F_IL		29	Assertion Level Fault	F_AL
11	Dynamic Brake Over Temperature	F_dbF		30	Internal Fault 4	F_F4
12	Single Phase Fault	F_SF		31	Internal Fault 0	F_F0
13	External Fault	F_EF		32	Follower Lost	F_FoL
14	Control Fault	F_CF		33	ISO Comm Fault	F_F11
15	Start Error	F_UF		34	SPI Time-out	F_ntF
16	Incompatibility Fault	F_cF		35	Invalid Message Received	F_Fnr
17	Internal Fault 1 (EPM)	F_F1		36	Network Time-out	F_nF1
18	Internal Fault 2	F_F2				

9.2.11 Commanded Direction - Register #29

The low byte (DL) of register 29 provides the Commanded Rotation Direction (Table 15).

Table 15: Commanded Rotation Direction - Register #29 DL

Setting	Direction
0	Foward
1	Reverse

9.2.12 PID Registers

Registers 37, 38, 39, 41 and 45 are associated with the PID function and are sent over the modbus communication network in signed internal units.

Example: An Actual PID setpoint value of 999.0 would be transmitted as 9990 (27 06 hex) where an actual PID setpoint value of -999.0 would be transmitted as -9990 (D8 FA hex).

9.2.13 Parameter Version - Register #50

The Parameter Version identifies the parameter set for the current version of software. If the Parameter version is different between two drives, it could indicate that a register has been added or deleted, a register's min/max limits have changed, a register's function has been changed, or a register's default value has been changed.

9.2.14 Network Controlled Digital Output - Register #70

To control the state of the relay or digital output (TB14), Drive Programming Parameter P140 and/or P142 must be set to 25 (Network Controlled).

9.2.15 Network Controlled Analog Output - Register #71

To control the state of the analog output (TB30), Drive Programming Parameter P150 must be set to 09 (Network Controlled).

10   Programming Parameters

Registers #100-399 are programming parameters used to set up the drive for a specific application. For details regarding these registers, refer to the SMV Operating Instructions (SV01) that accompanied the drive.

Registers #400-499 are communication specific programming parameters and will vary depending on which, if any, of the optional communication modules is installed in the drive. Refer to Section 4.1 for details regarding the communication registers associated with the RS-485 communication module.

Registers #500-599 are read-only drive diagnostic parameters, the details of which can also be found in the drive's operating instructions.

There is a direct correspondence between the Drive Programming Parameter numbers and the register numbers used in the Modbus messages. For example, if you want to read Drive Programming Parameter P103 (Maximum Frequency) over the Modbus network, you would read register #103.

10.1   Negative Number Transmission

Drive parameters P160, P161, P204, P205, P214, P215, P231, P232, P233, P522, and P523 are signed integer values and could be negative (refer to the SMV Operating Instructions, SV01, for details on these parameters).

These registers are sent over the modbus communications in signed internal units. For example: A preset PID setpoint value of 500.0 would be transmitted as 5000 (13 88 hex). A preset PID setpoint value of -500.0 would be transmitted as -5000 (EC 78 hex).

10.2   Terminal and Protection Status (P530)

When a read command is issued over the Modbus network to Programming Parameter P530 (register #530), the Terminal and Protection Status data returned is shown in Table 16.

Table 16: Terminal Status

Byte	Bit	Status
Data Low Byte	0	Unused
	1	Unused
	2	Protection Status
	3	Fast Current Limit Status
	4	Input TB-1 Status
	5	Unused
	6	TB-13A Input Status
	7	TB-13B Input Status
Data High Byte	8	TB-13C Input Status
	9	TB-14 Output Status
	10	Relay Output Status
	11	Charge Relay State
	12	Assertion Level Switch State
	13	Unused
	14	Unused
	15	Unused

10.3   Keypad Status (P531)

When a read command is issued over the Modbus network to Programming Parameter P531 (register #531), the Keypad Status data returned is shown in Table 17.

Table 17: Keypad Status

Byte	Bit	Status
Data Low Byte	0	UP Push-button State
	1	DOWN Push-button State
	2	MODE Push-button State
	3	FWD/REV Push-button State
	4	STOP Push-button State
	5	START Push-button State
	6	Unused
	7	Unused
Data High Byte	8	Unused
	9	Unused
	10	Unused
	11	Unused
	12	Unused
	13	Unused
	14	Unused
	15	Unused

11 Troubleshooting and Fault Elimination

11.1 Faults

Table 18 lists faults relating to Modbus communication. Refer to section 9.2.10, Present Fault, for a list of drive faults.

Table 18: Communication Faults

Display	Status	Cause	Remedy
F_ntF	Module to Drive communication time out	Connection between drive and module is not made.	Check cable and connection between module and drive
F_nF1	Network Time-out Fault	Drive under NETWORK control and network communications have been lost.	See parameters P425, P426

11.2 Troubleshooting

Table 19 lists common communication errors and suggests methods to verify and correct the problem.

Table 19: Communication Errors

Symptom	Possible Cause	Remedy
No communication from the drive	Module is not initialized properly	• Verify the module connection • Check P400 and P402
	Incorrect Modbus settings	• Use P403 to reset Modbus parameters. • Verify P410 and P411, P412
	Improper wiring	• Check wiring between the Modbus Network and communication module. • Ensure that terminal block is properly seated. • Check connection between module and drive.
Modbus write commands are ignored or return exceptions.	"Network Enabled terminal is either open or not configured.	Configure one of the input terminals (P121, P122, or P123) to "Network Enabled" function (selection 9) and close the corresponding contact.
Drive stops without obvious reason	Modbus message monitoring time-out occurred. The timeout reaction is set to STOP, Quick stop or Inhibit..	Modify the setting of time-out time (P425) or the reaction to the time-out (P426).