

**VACON NX**  
AC DRIVES

**OPTC2/C8**  
MODBUS/N2 OPTION BOARD

**USER MANUAL**

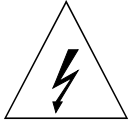
<b>1.</b>	<b>GENERAL .....</b>	<b>3</b>
<b>2.</b>	<b>RS-485 OPTION BOARD TECHNICAL DATA .....</b>	<b>4</b>
2.1	General .....	4
<b>3.</b>	<b>RS-485 FIELDBUS BOARD LAYOUT AND CONNECTIONS .....</b>	<b>5</b>
3.1	RS-485 OPTC2 option board .....	5
3.2	RS-485 OPTC8 option board .....	6
3.3	Grounding .....	7
3.3.1	Grounding by clamping the cable to the converter frame.....	7
3.3.2	Grounding only one point on the net.....	9
3.3.3	Grounding jumper X1 .....	10
3.4	Bus terminal resistors.....	11
3.5	Bus Biasing.....	12
3.6	LED indications .....	13
<b>4.</b>	<b>INSTALLATION OF VACON NX RS-485 BOARD .....</b>	<b>14</b>
<b>5.</b>	<b>COMMISSIONING.....</b>	<b>16</b>
5.1	Fieldbus board parameters .....	16
<b>6.</b>	<b>MODBUS.....</b>	<b>19</b>
6.1	Modbus RTU protocol, introduction.....	19
6.1.1	Supported functions.....	21
6.1.2	Exception responses.....	23
6.2	Modbus interface .....	25
6.2.1	Modbus registers .....	25
6.2.2	Process data .....	25
6.2.3	Process data in .....	26
6.2.4	Process data out .....	27
6.2.5	Parameters .....	30
6.2.6	Actual values.....	30
6.2.7	Example messages .....	31
6.3	Start-up test .....	33
<b>7.</b>	<b>METASYS N2.....</b>	<b>34</b>
7.1	Metasys N2 Protocol Introduction .....	34
7.2	Metasys N2 interface .....	34
7.2.1	Analogue Input (AI) .....	34
7.2.2	Binary Input (BI) .....	34
7.2.3	Analogue Output (AO).....	35
7.2.4	Binary Output (BO) .....	35
7.2.5	Internal Integer (ADI) .....	35
7.3	N2 POINT MAP.....	36
7.3.1	Analogue Inputs (AI).....	36
7.3.2	Binary Inputs (BI) .....	37
7.3.3	Analogue Outputs (AO).....	37
7.3.4	Binary Outputs (BO) .....	38
7.3.5	Internal Integers (ADI) .....	38
<b>8.</b>	<b>FAULT TRACKING.....</b>	<b>39</b>
	APPENDIX 1 .....	40

## 1. GENERAL

Instead of sending and receiving information to and from frequency converters through I/O, you can connect them to a fieldbus.

Vacon NX frequency converters can be connected to the RS-485 bus using a fieldbus board. The converter can then be controlled, monitored and programmed from the host system.

If you purchase your RS-485 Option Board separately, please note that it shall be installed in **slot E** on the control board of the frequency converter.



**WARNING!**

*Internal components and circuit boards are at high potential when the frequency converter is connected to the power source. This voltage is extremely dangerous and may cause death or severe injury if you come into contact with it.*

**NOTE!** You can download the English and French product manuals with applicable safety, warning and caution information from [www.vacon.com/downloads](http://www.vacon.com/downloads).

**REMARQUE** Vous pouvez télécharger les versions anglaise et française des manuels produit contenant l'ensemble des informations de sécurité, avertissements et mises en garde applicables sur le site [www.vacon.com/downloads](http://www.vacon.com/downloads).

## 2. RS-485 OPTION BOARD TECHNICAL DATA

### 2.1 General

<b>Connections</b>	Interface	<b>OPTC2:</b> Pluggable connector (5.08mm) <b>OPTC8:</b> 9-pin DSUB connector (female)
	Data transfer method	RS-485, half-duplex
	Transfer cable	Twisted pair (1 pair and shield)
	Electrical isolation	500 VDC
<b>Communications</b>	Modbus RTU Metasys N2	As described in document "Modicon Modbus Protocol Reference Guide" Find it for example at: <a href="http://public.modicon.com/">http://public.modicon.com/</a> As described in Metasys N2 System Protocol Specification
	Baud rate	300, 600, 1200, 2400, 4800, 9600, 19200 and 38400 kbaud
	Addresses	1 to 247
<b>Environment</b>	Ambient operating temperature	-10°C...55°C
	Storing temperature	-40°C...60°C
	Humidity	<95%, no condensation allowed
	Altitude	Max. 1000 m
	Vibration	0.5 G at 9...200 Hz
<b>Safety</b>		Fulfils EN50178 standard

Table 1. RS-485 technical data

### 3. RS-485 FIELDBUS BOARD LAYOUT AND CONNECTIONS

Vacon RS-485 Fieldbus Board is connected to the fieldbus through either a 5-pin pluggable bus connector (board OPTC2) or a 9-pin female sub-D-connector (board OPTC8).

The communication with the control board of the frequency converter takes place through the standard Vacon Interface Board Connector.

#### 3.1 RS-485 OPTC2 option board

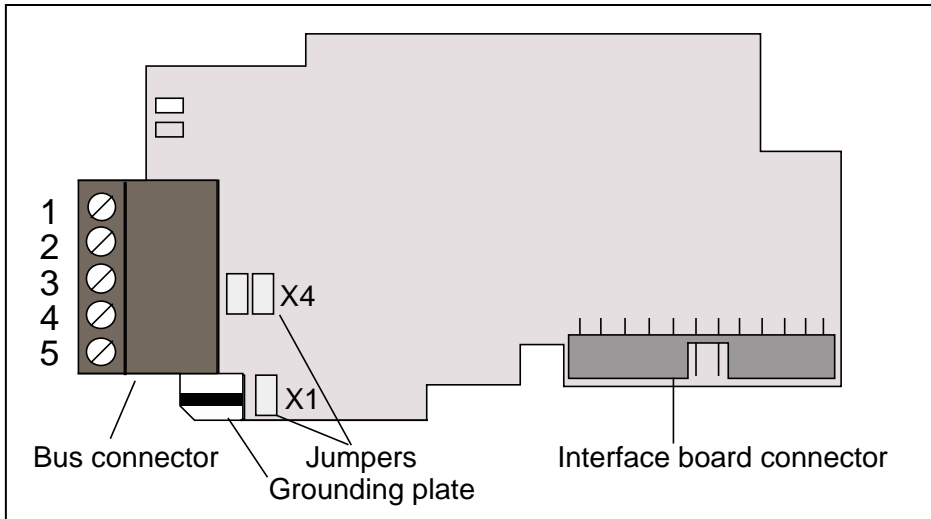


Figure 1. Vacon RS-485 option board OPTC2

Signal	Connector	Description
NC*	1*	No connection
VP	2	Supply voltage – plus (5V)
RxD/TxD –N	3	Receive/Transmit data – A
RxD/TxD –P	4	Receive/Transmit data – B
DGND	5	Data ground (reference potential for VP)

\*You can use this pin (1) to bypass the cable shield to the next slave

Table 2. OPTC2 bus connector signals

### 3.2 RS-485 OPTC8 option board

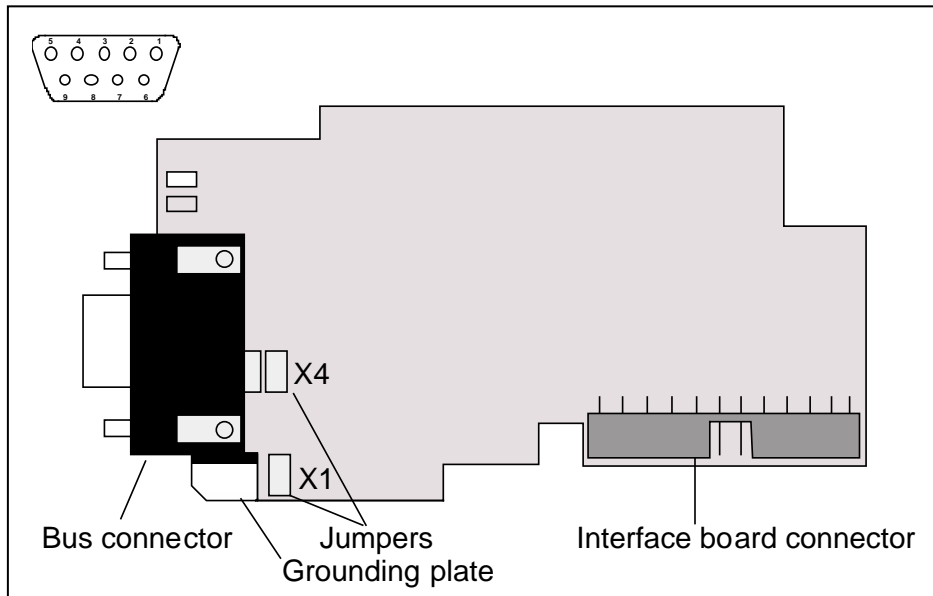


Figure 2. Vacon RS-485 option board OPTC8

Signal	Connector	Description
Shield	1	Cable shield
RxD/TxD-N	3	Receive/ A
DGND	5	Data ground (reference potential for VP)
VP	6	Supply voltage – plus (5V)
RxD/TxD-P	8	Receive/ Transmit data/ B

Table 3. OPTC8 bus connector signals

### 3.3 Grounding

#### 3.3.1 Grounding by clamping the cable to the converter frame

This manner of grounding is the most effective and especially recommended when the distances between the devices are relatively short or if the device is the last device on the net.

**Note:** Normally, the option board has already been installed in slot D or slot E of the control board. It is not necessary to detach the whole board for the grounding of the bus cable shield. Just detach the terminal block.

- 1 Strip about 5 cm of the cable and cut off the grey cable shield. Remember to do this for both bus cables (except for the last device). See pictures below.
- 2 Leave no more than 1 cm of the cable outside the terminal block and strip the data cables at about 0.5 cm to fit in the terminals. See pictures below.  
**Note:** Do this for both bus cables.

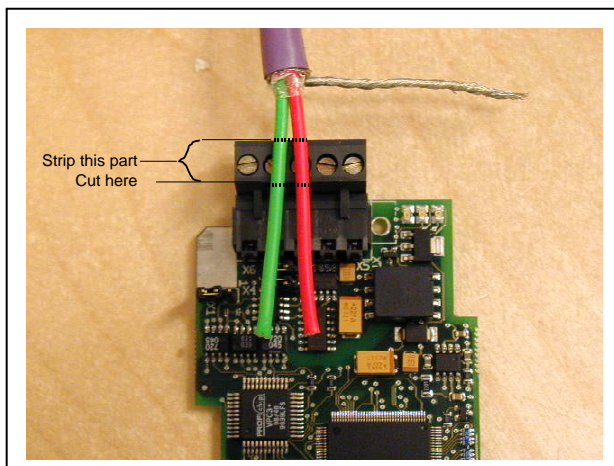


Figure 3.

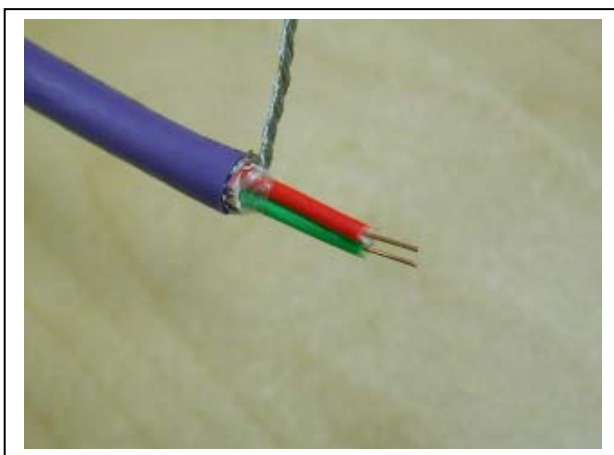
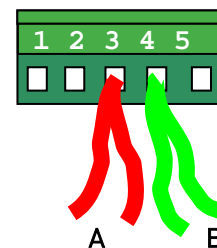


Figure 4.



- 3 Insert the data cables of **both cables** into terminals #3 (Line B) and #4 (Line A).
- 4 Strip the cable at such a distance from the terminal that you can fix it to the frame with the grounding clamp. See

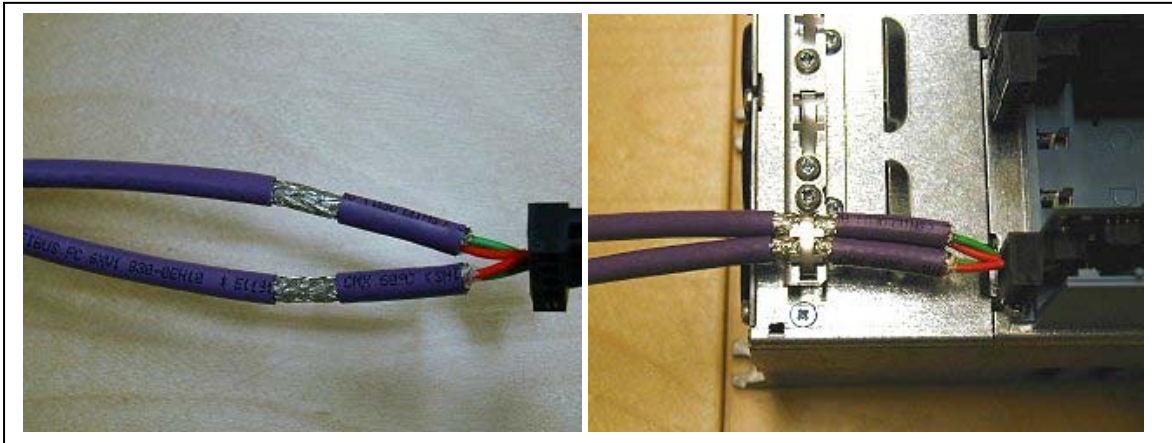


Figure 5.



### 3.3.2 Grounding only one point on the net

In this manner of grounding, the shield is connected to ground only at the last device on the net in the same way as described in chapter 3.3.1. Other devices of the net just pass the shield.

We recommend you to use an Abico connector to fit the shields into the terminal.

- 1 Strip about 5 cm of the cable and cut off the grey cable shield. Remember to do this for both bus cables (except for the last device).
- 2 Leave no more than 1 cm of the cable outside the terminal block and strip the data cables at about 0.5 cm to fit in the terminals. See Figure 6.

**Note:** Do this for both bus cables.

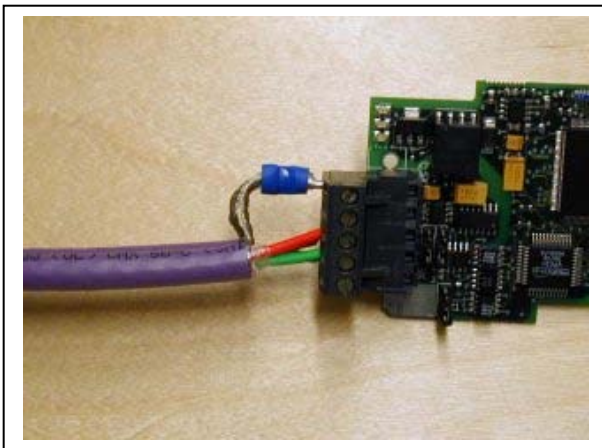
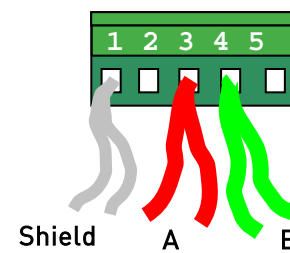


Figure 6.



- 3 Fix both the cables on the frame with the clamp. See Figure 7.

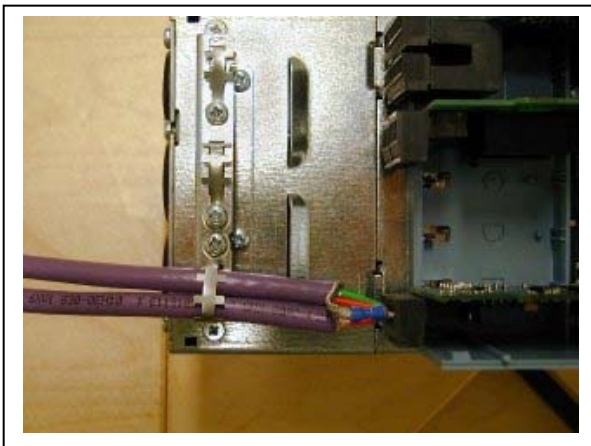


Figure 7.

**3.3.3 Grounding jumper X1**

The Grounding jumper X1 on the OPTC8 is used for grounding selection. If position ON is selected it means that the D-sub connector PIN1 is connected directly to ground. Selection of position OFF means that PIN1 is connected to ground via an RC-filter. Jumper X1 has no effect on OPTC2.

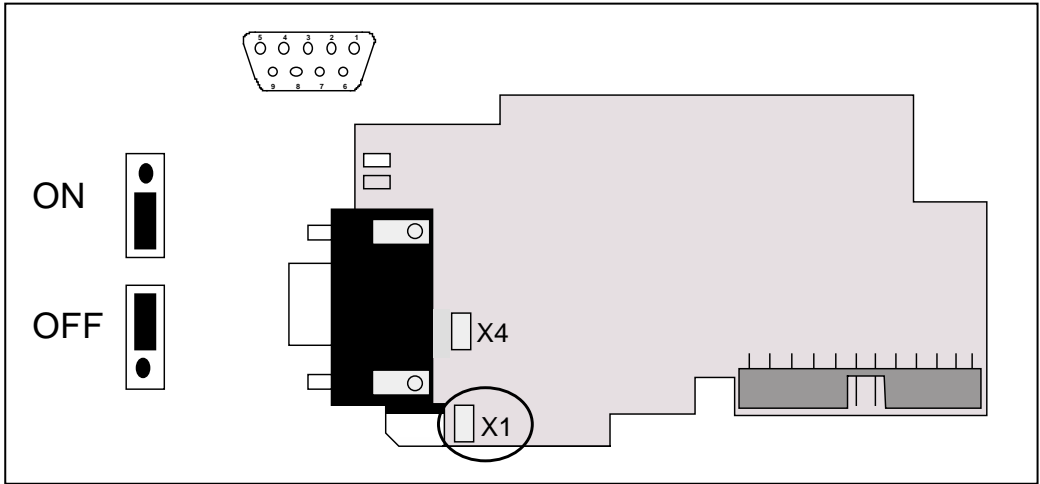


Figure 8. Grounding jumper X1

### 3.4 Bus terminal resistors

If Vacon is the last device of the fieldbus line the bus termination must be set. Use jumper X4 (ON position) or external termination resistors (e.g. in DSUB-9 connector). See Figure 9.

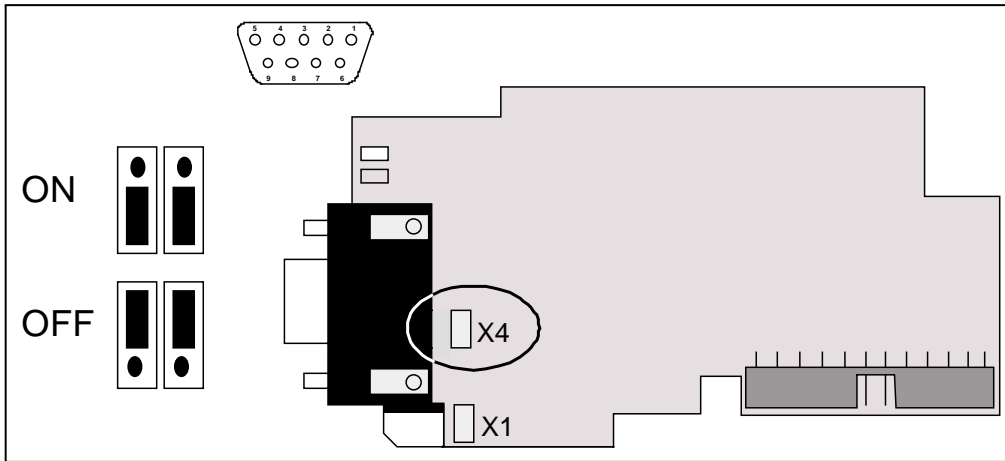


Figure 9. Using jumper X4 to set the bus termination.

### 3.5 Bus Biasing

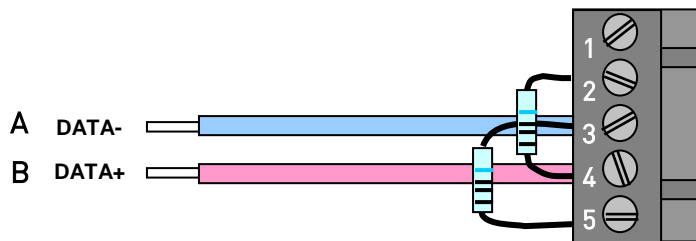
Bus biasing is required to ensure faultless communication between devices at RS-485 bus. Bus biasing makes sure that the bus state is at proper potential when no device is transmitting. Without biasing, faulty messages can be detected when the bus is in idle state. RS-485 bus state should be neither +0,200..+7V or -0,200..-7V. Illegal bus state is <200mV..-200mV.

Number of nodes	Bias resistance
2-5	1.8 kohm
5-10	2.7 kohm
11-20	12 kohm
21-30	18 kohm
31-40	27 kohm

Table 4. Bias resistor size vs number of node

#### Fail safe *biasing* in OPTC2 option board

Connect resistor biasing resistors between pins #2 and #4 as well as pins #3 and #5 as shown in picture.



Matters related to this are discussed in the application note *Failsafe Biasing of Differential Buses* (an-847.pdf) published by National Semiconductor ([www.national.com](http://www.national.com)).

### 3.6 LED indications

The two LED indications next to the connector show the present statuses of the RS-485 board (yellow) and the Fieldbus Module (green).

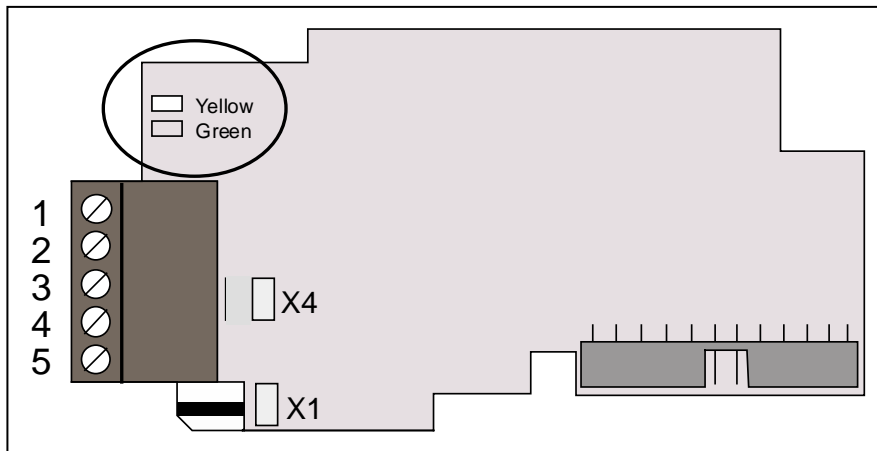


Figure 10. LED indications on the RS-485 board




#### **RS-485 board status LED (BS) YELLOW**

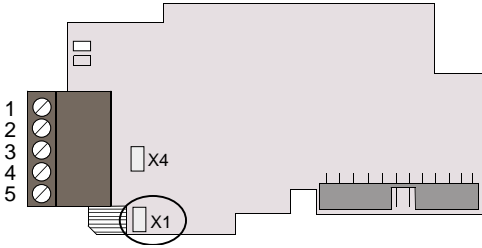
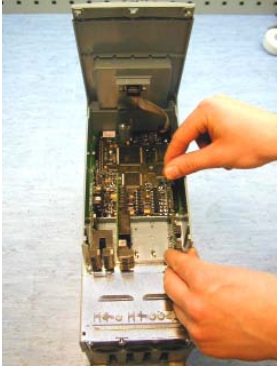
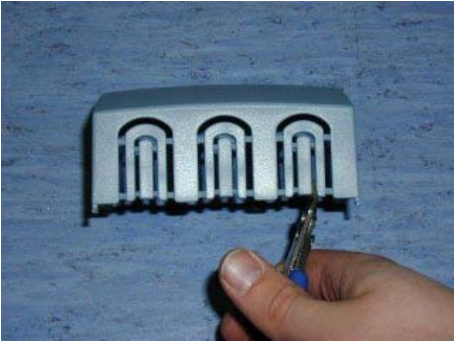

LED is:	Meaning:
OFF	Option board not activated
ON	Option board in initialisation state waiting for activation command from the frequency converter
Blinking fast (once/sec)	Option board is activated and in RUN state <ul style="list-style-type: none"> <li>Option board is ready for external communication</li> </ul>
Blinking slow (once/5 secs)	Option board is activated and in FAULT state <ul style="list-style-type: none"> <li>Internal fault of option board</li> </ul>

#### **Fieldbus status LED (FS) GREEN**

LED is:	Meaning:
OFF	Fieldbus module is waiting for parameters from the frequency converter <ul style="list-style-type: none"> <li>No external communication</li> </ul>
ON	Fieldbus module is activated <ul style="list-style-type: none"> <li>Parameters received and module activated</li> <li>Module is waiting for messages from the bus</li> </ul>
Blinking fast (once/sec)	Module is activated and receiving messages from the bus
Blinking slow (once/5 secs)	Module is in FAULT state <ul style="list-style-type: none"> <li>No messages from Master within the watchdog time</li> <li>Bus broken, cable loose or Master off line</li> </ul>

4. INSTALLATION OF VACON NX RS-485 BOARD

<p><b>A</b></p>	<p>Vacon NX frequency converter</p>	
<p><b>B</b></p>	<p>Remove the cable cover.</p>	
<p><b>C</b></p>	<p>Open the cover of the control unit.</p>	

<p><b>D</b></p>	<p>Install RS-485 option board in slot E on the control board of the frequency converter. Make sure that the grounding plate (see below) fits tightly in the clamp.</p>  
<p><b>E</b></p>	<p>Make a sufficiently wide opening for your cable by cutting the grid as wide as necessary.</p> 
<p><b>F</b></p>	<p>Close the cover of the control unit and the cable cover.</p> 

## 5. COMMISSIONING

READ FIRST CHAPTER 8 'COMMISSIONING' IN VACON NX USER'S MANUAL (Document nr. ud00701, please visit <http://www.vacon.com/925.html>).

**Note!** You must select Fieldbus as the active control place, if you wish to control the frequency converter through fieldbus. See Vacon NX User's Manual, Chapter 7.3.3.1.

### 5.1 Fieldbus board parameters

The Vacon RS-485 board is commissioned with the control keypad by giving values to appropriate parameters in menu **M7** (for locating the expander board menu see Vacon NX User's Manual, Chapter 7).

#### Expander board menu (M7)

The *Expander board menu* makes it possible for the user 1) to see what expander boards are connected to the control board and 2) to reach and edit the parameters associated with the expander board.

Enter the following menu level (**G#**) with the *Menu button right*. At this level, you can browse through slots A to E with the *Browser buttons* to see what expander boards are connected. On the lowermost line of the display you also see the number of parameter groups associated with the board.

If you still press the *Menu button right* once you will reach the parameter group level where there are two groups: Editable parameters and Monitored values. A further press on the *Menu button right* takes you to either of these groups.

#### RS-485 parameters

To commission the RS-485 board, enter the level P7.5.1.# from the *Parameters* group (G7.5.1). Give desired values to all RS-485 parameters (see Figure 11 and Table 5).

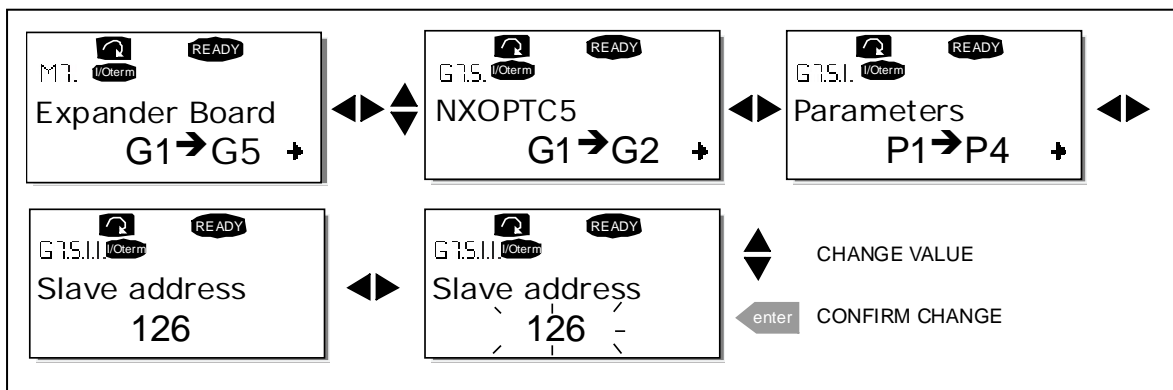


Figure 11. Changing the RS-485 board commissioning parameter values



#	Name	Default	Range	Description
1	COMMUNICATION PROTOCOL	1	1 - Modbus RTU 2 - N2	Protocol
2	SLAVE ADDRESS	1	1...247	
3	BAUD RATE	6	1 - 300 baud 2 - 600 baud 3 - 1200 baud 4 - 2400 baud 5 - 4800 baud 6 - 9600 baud 7 - 19200 baud 8 - 38400 baud	Communication speed When N2 protocol is used <i>Baudrate</i> must be set to 9600.
4	PARITY TYPE	0	0 - None 1 - Even 2 - Odd	Describes what kind of parity checking is used. When N2-protocol is used <i>Parity type</i> must be set to 0 = None
5	COMMUNICATION TIMEOUT	20	0 - OFF 1 - 300 s	See chapter Communication timeout below
6	OPERATE MODE	1	1 - Normal	Reserved for later use

Table 5. RS-485 parameters

The parameters of every device must be set before connecting to the bus. Especially the parameters *Communication Protocol*, *Slave Address* and *Baud Rate* must be the same as in the master configuration.

**Communication timeout**

The RS-485 board initiates a communication error if communication is broken for as long as defined by the *Communication Timeout*. *Communication Timeout* is disabled when given the value 0.

**Communication status**

To see the present status of the RS-485 fieldbus, enter the *Comm.Status* page from *Monitor menu* (G7.5.2). See Figure 12 and Table 6 below.

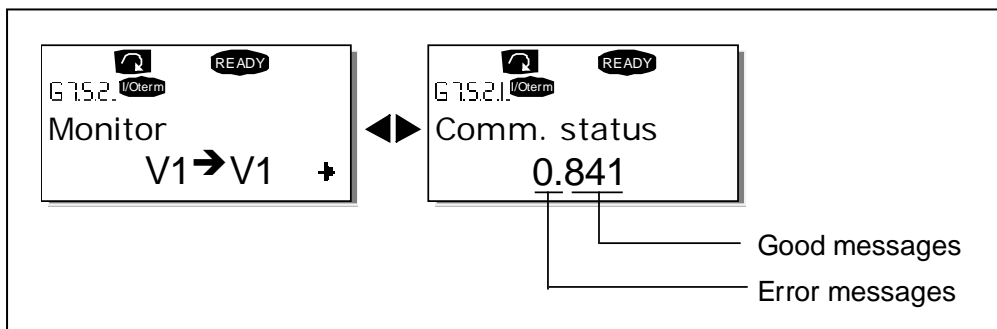


Figure 12. Communication status

<b>Good messages</b>	
0...999	Number of messages received without communication errors
<b>Error messages</b>	
0...64	Number of messages received with CRC or parity errors

*Table 6. RS-485 message indications*

## 6. MODBUS

### 6.1 Modbus RTU protocol, introduction

The MODBUS protocol is an industrial communications and distributed control system to integrate PLCs, computers, terminals, and other monitoring, sensing, and control devices. MODBUS is a Master-Slave communications protocol. The Master controls all serial activity by selectively polling one or more slave devices. The protocol provides for one master device and up to 247 slave devices on a common line. Each device is assigned an address to distinguish it from all other connected devices.

The MODBUS protocol uses the master-slave technique, in which only one device (the master) can initiate a transaction. The other devices (the slaves) respond by supplying the request data to the master, or by taking the action requested in the query. The master can address individual slaves or initiate a broadcast message to all slaves. Slaves return a message ('response') to queries that are addressed to them individually. Responses are not returned to broadcast queries from the master.

A transaction comprises a single query and single response frame or a single broadcast frame. The transaction frames are defined below.

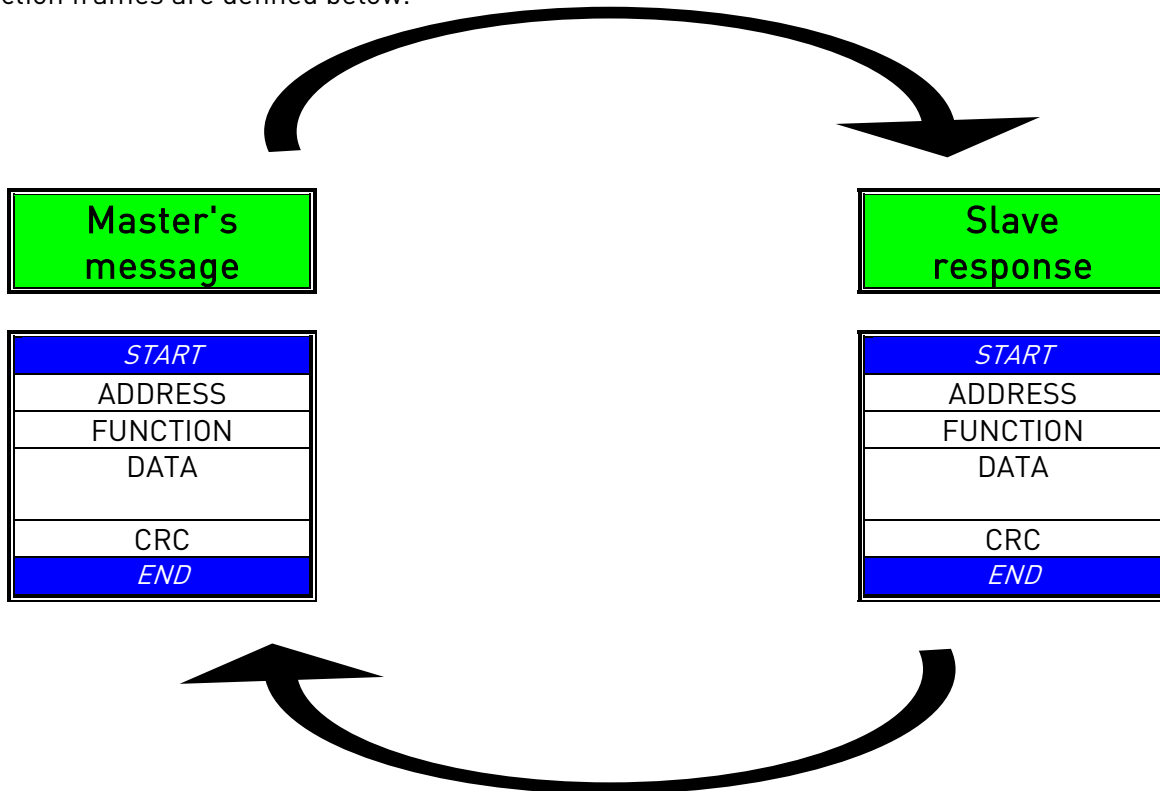


Figure 13. The basic structure of a Modbus frame

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. 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 of the response to let the master know which slave is responding.

The function code field of a message frame contains two characters (ASCII) or eight bits (RTU). Valid codes are in the range of 1 ... 255 decimal. 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. Examples are to read the ON / OFF states of a group of discrete coils or inputs; to read the data contents of a group of registers; to

read the diagnostic status of the slave; to write to designated coils or registers; or to allow loading, recording, or verifying the program within the slave.

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 a logic 1.

The data field is constructed using sets of two hexadecimal digits, in the range of 00 to FF hexadecimal. These can be made from a pair of ASCII characters, or from one RTU character, according to the network's serial transmission mode.

The data field of messages sent from a master to slave devices contains additional information which the slave must use to take the action defined by the function code. This can include items like discrete and register addresses, the quantity of items to be handled, and the count of actual data bytes in the field.

If no error occurs, the data field of a response from a slave to a master contains the data requested. If an error occurs, the field contains an exception code that the master application can use to determine the next action to be taken.

Two kinds of checksum are used for standard Modbus networks. The error checking field contents depend upon the transmission method that is being used.

6.1.1 Supported functions

Function Code	Description	Address range
03	Read Holding Registers	Applies to all addresses
04	Read Input Registers	Applies to all addresses
06	Write Single Register	Applies to all addresses
16	Write Multiple Registers	Applies to all addresses
Note: Broadcasting can be used with codes 06 and 16		

Table 7. Supported messages

6.1.1.1 Read Holding Registers

The query message specifies the starting register and the quantity of registers to be read. Registers are addressed starting with zero, i.e. registers 1 to 16 are addressed as 0 to 15.

Example of a request to read registers 42001-42003 from Slave device 1:

ADDRESS		01 hex	Slave address 1 hex (= 1)
FUNCTION		03 hex	Function 03 hex (= 3)
DATA	Starting address HI	07 hex	Starting address 07d0 hex (= 2000)
	Starting address LO	D0 hex	
	No. of points HI	00 hex	Number of registers 0003 hex (= 3)
	No. of points LO	03 hex	
ERROR	CRC HI	05 hex	CRC field 0546 hex (= 1350)
CHECK	CRC LO	46 hex	

6.1.1.2 Read Input Registers

The query message specifies the starting register and the quantity of registers to be read. Registers are addressed starting with zero, i.e. registers 1 to 16 are addressed as 0 to 15.

Example of a request to read registers 32001 from Slave device 1:

ADDRESS		01 hex	Slave address 1 hex (= 1)
FUNCTION		04 hex	Function 04 hex (= 4)
DATA	Starting address HI	07 hex	Starting address 07d0 hex (= 2000)
	Starting address LO	D0 hex	
	No. of points HI	00 hex	Number of registers 0003 hex (= 3)
	No. of points LO	01 hex	
ERROR	CRC HI	31 hex	CRC field 3147 hex (= 12615)
CHECK	CRC LO	47 hex	

6.1.1.3 Preset Single Register

The query message specifies the register reference to be preset. Registers are addressed starting with zero, i.e. register 1 is addressed as 0.

Example of a request to preset register 42001 to 00001hex in Slave device 1:

ADDRESS		01 hex	Slave address 1 hex (= 1)
FUNCTION		06 hex	Function 04 hex (= 4)
DATA	Starting address HI	07 hex	Starting address 07d0 hex (= 2000)
	Starting address LO	D0 hex	
	Data HI	00 hex	Data = 0001 hex (= 1)
	Data LO	01 hex	
ERROR	CRC HI	48 hex	CRC field 4887 hex (= 18567)
CHECK	CRC LO	87 hex	

#### 6.1.1.4 Preset Multiple Registers

The query message specifies the register references to be preset. Registers are addressed starting with zero, i.e. register 1 is addressed as 0.

Example of a request to preset two registers starting at 42001 to 0001hex and 0010hex in Slave device 1:

ADDRESS		01 hex	Slave address 1 hex (= 1)
FUNCTION		10 hex	Function 10 hex (= 16)
DATA	Starting address HI	07 hex	Starting address 07d0 hex (= 2000)
	Starting address LO	D0 hex	
	No. of registers HI	00 hex	Number of registers 0002 hex (= 2)
	No. of registers LO	02 hex	
	Byte count	04 hex	Byte count 04 hex (= 4)
	Data HI	00 hex	Data 1 = 0001 hex (= 1)
	Data LO	01 hex	
	Data HI	00 hex	Data 2 = 0010 hex (= 16)
	Data LO	10 hex	
ERROR	CRC HI	88 hex	CRC field 88CF hex (= 35023)
CHECK	CRC LO	CF hex	

**6.1.2 Exception responses**

Error response is given when the Slave receives a message without communication errors, but cannot handle it. Examples of such messages are an incorrect register address, data value or unsupported message. No answer is given if a CRC or parity error occurs or the message is a broadcast message.

Code	Function	Description
01	ILLEGAL FUNCTION	The message function requested is not recognized by the slave.
02	ILLEGAL DATA ADDRESS	The received data address is not an allowable address for the slave
03	ILLEGAL DATA VALUE	The received data value is not an allowable value for the slave.
06	SLAVE DEVICE BUSY	The message was received without error but the slave was engaged in processing a long duration program command.

Table 8. Exception response codes

**Example of an exception response**

In an exception response, the Slave sets the most-significant bit (MSB) of the function code to 1. The Slave returns an exception code in the data field.

Command Master – Slave:

ADDRESS		01 hex	Slave address 1 hex (= 1)
FUNCTION		04 hex	Function 4 hex (= 4)
DATA	Starting address HI	17 hex	Starting address 1770 hex (= 6000)
	Starting address LO	70 hex	
	No. of registers HI	00 hex	Invalid number of registers 0005 hex (= 5)
	No. of registers LO	05 hex	
ERROR	CRC HI	34 hex	
CHECK	CRC LO	66 hex	CRC field 3466 hex (= 13414)

Message frame:

01	04	17	70	00	05	34	66
----	----	----	----	----	----	----	----

Exception response.

Answer Slave – Master:

ADDRESS	01 hex	Slave address 1 hex (= 1)
FUNCTION	14 hex	Most significant bit set to 1
ERROR CODE	02 hex	Error code 02 => Illegal Data Address
ERROR CRC HI	AE hex	CRC field AEC1 hex (= 44737)
CHECK CRC LO	C1 hex	

Reply frame:

01	14	02	AE	C1
----	----	----	----	----



## 6.2 Modbus interface

Features of the Modbus-Vacon NX interface:

- Direct control of Vacon NX ( e.g. Run, Stop, Direction, Speed reference, Fault reset)
- Full access to all Vacon NX parameters
- Monitor Vacon NX status (e.g. Output frequency, Output current, Fault code)

### 6.2.1 Modbus registers

The Vacon variables and fault codes as well as the parameters can be read and written from Modbus. The parameter addresses are determined in the application. Every parameter and actual value have been given an ID number in the application. The ID numbering of the parameter as well as the parameter ranges and steps can be found in the application manual in question. The parameter value shall be given without decimals. If several parameters/actual values are read with one message, the addresses of the parameters/actual values must be consecutive.

All values can be read with function codes 3 and 4 (all registers are 3X and 4X reference). Modbus registers are mapped to drive ID's as follows:

ID	Modbus register	Group	R/W
1 ... 98	40001...40098 (30001...30098)	Actual Values	30/1
99	40099 (30099)	Fault Code	30/1
101... 1999	40101...41999 (30101...31999)	Parameters	30/1
2001...2099	42001...42099 (32001...32099)	Process Data In	20/20
2101...2199	42101...42199 (32101...32199)	Process Data Out	20/20

Table 9. Index table

### 6.2.2 Process data

The process data fields are used to control the drive (e.g. Run, Stop , Reference, Fault Reset) and to quickly read actual values (e.g. Output frequency, Output current, Fault code). The fields are structured as follows:

*Process Data Slave -> Master(max 22 bytes)*

ID	Modbus register	Name	Range/Type
2101	32101, 42101	FB Status Word	Binary coded
2102	32102, 42102	FB General Status Word	Binary coded
2103	32103, 42103	FB Actual Speed	0...10000 %
2104	32104, 42104	FB Process Data Out 1	See appendix 1
2105	32105, 42105	FB Process Data Out 2	See appendix 1
2106	32106, 42106	FB Process Data Out 3	See appendix 1
2107	32107, 42107	FB Process Data Out 4	See appendix 1
2108	32108, 42108	FB Process Data Out 5	See appendix 1
2109	32109, 42109	FB Process Data Out 6	See appendix 1
2110	32110, 42110	FB Process Data Out 7	See appendix 1
2111	32111, 42111	FB Process Data Out 8	See appendix 1

Table 10.

*Process Data Master -> Slave (max 22 bytes)*

ID	Modbus register	Name	Range/Type
2001	32001, 42001	FB Control Word	Binary coded
2002	32002, 42002	FB General Control Word	Binary coded
2003	32003, 42003	FB Speed Reference	0...10000 %
2004	32004, 42004	FB Process Data In 1	Integer 16
2005	32005, 42005	FB Process Data In 2	Integer 16
2006	32006, 42006	FB Process Data In 3	Integer 16
2007	32007, 42007	FB Process Data In 4	Integer 16
2008	32008, 42008	FB Process Data In 5	Integer 16
2009	32009, 42009	FB Process Data In 6	Integer 16
2010	32010, 42010	FB Process Data In 7	Integer 16
2011	32011, 42011	FB Process Data In 8	Integer 16

Table 11.

The use of process data depends on the application. In a typical situation, the device is started and stopped with the ControlWord (CW) written by the Master and the Rotating speed is set with Reference (REF). With PD1...PD8 the device can be given other reference values (e.g. Torque reference). With the StatusWord (SW) read by the Master, the status of the device can be seen. Actual Value (ACT) and PD1...PD8 show the other actual values.

### 6.2.3 Process data in

This register range is reserved for the control of the frequency converter. *Process data in* is located in range ID 2001...2099. The registers are updated every 10 ms. See Table 12.

ID	Modbus register	Name	Range/Type
2001	32001, 42001	FB Control Word	Binary coded
2002	32002, 42002	FB General Control Word	Binary coded
2003	32003, 42003	FB Speed Reference	0...10000 %
2004	32004, 42004	FB Process Data In 1	Integer 16
2005	32005, 42005	FB Process Data In 2	Integer 16
2006	32006, 42006	FB Process Data In 3	Integer 16
2007	32007, 42007	FB Process Data In 4	Integer 16
2008	32008, 42008	FB Process Data In 5	Integer 16
2009	32009, 42009	FB Process Data In 6	Integer 16
2010	32010, 42010	FB Process Data In 7	Integer 16
2011	32011, 42011	FB Process Data In 8	Integer 16

Table 12. Fieldbus basic input table

6.2.3.1 *Control word*

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
-	-	-	-	-	-	-	-	-	-	-	-	-	RST	DIR	RUN

In Vacon applications, the three first bits of the control word are used to control the frequency converter. However, you can customise the content of the control word for your own applications because the control word is sent to the frequency converter as such.

Bit	Description	
	Value = 0	Value = 1
0	Stop	Run
1	Clockwise	Counterclockwise
2	Rising edge of this bit will reset active fault	
3...15	Not in use	Not in use

Table 13. Control word bit descriptions

6.2.3.2 *Speed reference*

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MSB															LSB

This is the Reference 1 to the frequency converter. Used normally as Speed reference. The allowed scaling is -10000...10000. In the application, the value is scaled in percentage of the frequency area between the set minimum and maximum frequencies.

6.2.3.3 *Process data in 1 to 8*

Process Data In values 1 to 8 can be used in applications for various purposes. Update rate is 10 ms for all values. See Vacon NX Application Manual for usage of these data values.

6.2.4 *Process data out*

This register range is normally used to fast monitoring of the frequency converter. *Process data out* is located in range ID 2101...2199. See Table 14.

ID	Modbus register	Name	Range/Type
2101	32101, 42101	FB Status Word	Binary coded
2102	32102, 42102	FB General Status Word	Binary coded
2103	32103, 42103	FB Actual Speed	0...10000 %
2104	32104, 42104	FB Process Data Out1	See appendix 1
2105	32105, 42105	FB Process Data Out2	See appendix 1
2106	32106, 42106	FB Process Data Out3	See appendix 1
2107	32107, 42107	FB Process Data Out4	See appendix 1
2108	32108, 42108	FB Process Data Out5	See appendix 1
2109	32109, 42109	FB Process Data Out6	See appendix 1
2110	32110, 42110	FB Process Data Out7	See appendix 1
2111	32111, 42111	FB Process Data Out8	See appendix 1

Table 14. Fieldbus basic output table

### 6.2.4.1 *Status word*

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
-	-	-	-	-	UVFS	DDI R	TCSPDL	FR	Z	ARE F	W	FLT	DIR	RUN	RDY

Information about the status of the device and messages is indicated in the *Status word*. The *Status word* is composed of 16 bits that have the following meanings:

Bit	Description	
	<i>Value = 0</i>	<i>Value = 1</i>
0	Not Ready	Ready
1	STOP	RUN
2	Clockwise	Counterclockwise
3	-	Faulted
4	-	Warning
5	Ref. frequency not reached	Ref. Frequency reached
6	-	Motor is running at zero speed
7	Flux Not Ready	Flux Ready
8	TC Speed Limit Active	TC Speed Limit Not Active
9	Detected Encoder Direction Clockwise	Encoder Direction Counterclockwise
10	UV Fast Stop Active	UV Fast Stop Not Active
11...15	Not In use	Not In use

Table 15. Status word bit descriptions

### 6.2.4.2 *General status word*

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
I/O	PANEL	FB	-	-	-	-	-	-	-	-	-	-	-	-	-

Bit	Description
0...12	Not in use
13	Fieldbus control, (1 = FB control active)
14	Panel control, (1 = Panel control active)
15	I/O Control, (1 = I/O control active)

Table 16. General status word bit descriptions

6.2.4.3 *Actual speed*

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MSB															LSB

This is the reference 1 to the frequency converter. Used normally as Speed reference. The allowed scaling is -10000...10000. In the application, the value is scaled in percentage of the frequency area between set minimum and maximum frequency.

6.2.4.4 *Process data out 1 to 8*

Process Data Out values 1 to 8 can be used in application for various purposes. Update rate is 10ms for all values. See APPENDIX 1 for usage of these values.

### 6.2.5 Parameters

The parameter addresses are determined in the application. Every parameter has been given an ID number in the application. The ID numbering of the parameter as well as the parameter ranges and steps can be found in the application manual in question. The parameter value shall be given without decimals. The following functions can be activated with parameters:

Function code	Function	Modbus Address	Parameter ID's
03	Read Holding Registers	30101...31999	101-1999
04	Read Input Registers	40101...41999	101-1999
06	Preset Single Register	40101...41999	101-1999
16	Preset Multiple Registers	40101...41999	101-1999

Table 17. Parameters

### 6.2.6 Actual values

The actual values as well as parameter addresses are determined in the application. Every actual value has been given an ID number in the application. The ID numbering of the actual values as well as the value ranges and steps can be found in the application manual in question. The following functions can be activated with parameters:

Function code	Function	Actual values
03	Read Holding Registers	30001-30098
04	Read Input Registers	40001-40098

Table 18. Actual values

6.2.7 Example messages

Example 1

Write the process data 42001...42003 with command 16 (Preset Multiple Registers).

Command Master – Slave:

ADDRESS		01 hex	Slave address 1 hex (= 1)
FUNCTION		10 hex	Function 10 hex (= 16)
DATA	Starting address HI	07 hex	Starting address 07d0 hex (= 2000)
	Starting address LO	D0 hex	
	No. of registers HI	00 hex	Number of registers 0003 hex (= 3)
	No. of registers LO	03 hex	
	Byte count	06 hex	Byte count 06 hex (= 6)
	Data HI	00 hex	Data 1 = 0001 hex (= 1). Setting control word run bit to 1.
	Data LO	01 hex	
	Data HI	00 hex	Data 2 = 0000 hex (= 0). General control word 0.
	Data LO	00 hex	
	Data HI	13 hex	Data 3 = 1388 hex (= 5000), Speed Reference to
	Data LO	88 hex	50.00%
ERROR	CRC HI	C8 hex	CRC field C8CB hex (= 51403)
CHECK	CRC LO	CB hex	

Message frame:

01	10	07	D0	00	03	06	00	01	00	00	13	88	C8	CB
----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

The reply to Preset Multiple Registers message is the echo of 6 first bytes.

Answer Slave – Master:

ADDRESS		01 hex	Slave address 1 hex (= 1)
FUNCTION		10 hex	Function 10 hex (= 16)
DATA	Starting address HI	07 hex	Starting address 07d0 hex (= 2000)
	Starting address LO	D0 hex	
	No. of registers HI	00 hex	Number of registers 0003 hex (= 3)
	No. of registers LO	03 hex	
ERROR	CRC HI	F1 hex	CRC F101 hex (= 61697)
CHECK	CRC LO	01 hex	

Reply frame:

01	10	07	D0	00	03	F1	01
----	----	----	----	----	----	----	----

**Example 2**

Read the Process Data 42103...42104 with command 4 (Read Input Registers).

Command Master – Slave:

ADDRESS		01 hex	Slave address 1 hex (= 1)
FUNCTION		04 hex	Function 4 hex (= 4)
DATA	Starting address HI	08 hex	Starting address 0836 hex (= 2102)
	Starting address LO	36 hex	
	No. of registers HI	00 hex	Number of registers 0002 hex (= 2)
	No. of registers LO	02 hex	
ERROR	CRC HI	93 hex	
CHECK	CRC LO	A5 hex	CRC field B321 hex (= 45857)

Message frame:

01	04	08	36	00	02	93	A5
----	----	----	----	----	----	----	----

The reply to the Read Input Registers message contains the values of the read registers.

Answer Slave – Master:

ADDRESS		01 hex	Slave address 1 hex (= 1)
FUNCTION		04 hex	Function 4 hex (= 4)
DATA	Byte count	02 hex	Byte count 4 hex (= 4)
	Data HI	13 hex	Speed reference = 1388 hex (=5000 => 50.00%)
	Data LO	88 hex	
	Data HI	09 hex	Output Frequency = 09C4 hex (=2500 =>25.00Hz)
	Data LO	C4 hex	
ERROR	CRC HI	F0 hex	CRC field B321 hex (= 45857)
CHECK	CRC LO	E9 hex	

Reply frame:

01	04	02	13	88	09	C4	F0	E9
----	----	----	----	----	----	----	----	----



### 6.3 Start-up test

#### *Frequency converter application*

Choose Fieldbus (Bus/Comm) as the active control place (see Vacon NX User's Manual, Chapter 7.3.3).

#### *Master software*

1. Set *FB Control Word* (MBaddr 42001) value to **1hex**.
2. Frequency converter status is RUN.
3. Set *FB Speed Reference* (MBaddr 42003) value to **5000** (=50,00%).
4. The Actual value is 5000 and the frequency converter output frequency is 25,00 Hz.
5. Set *FB Control Word* (MBaddr 42001) value to **0hex**.
6. Frequency converter status is STOP.

*If FB Status Word (Addr 42101) bit 3 = 1 Status of frequency converter is FAULT.*

## 7. METASYS N2

### 7.1 Metasys N2 Protocol Introduction

The N2 communications protocol is used by Johnson Controls and others to connect terminal unit controllers to supervisory controllers. It is open to any manufacturer and based upon a simple ASCII protocol widely used in the process control industry.

The physical characteristics of the N2 bus are three wire RS-485 with a maximum of 100 devices over a 4,000 foot distance running at 9,600 bps. Logically, the N2 is a master-slave protocol, the supervisory controller normally being the master. Data is partitioned into common HVAC control objects, such as analogue input, analogue output, binary input and binary output. N2 messaging supports the reading, writing and overriding of these points. Additionally, there are messages defined to perform uploads and downloads of devices as well as direct memory reads and writes.

### 7.2 Metasys N2 interface

Features of the N2 Interface:

- Direct control of Drive ( e.g. Run, Stop, Direction, Speed reference, Fault reset)
- Full access to necessary parameters
- Monitor Drive status (e.g. Output frequency, Output current, Fault code )
- In standalone operation, or should the polling stop, the overridden values are released after a specified period (about 10 minutes).

#### 7.2.1 Analogue Input (AI)

All Analogue Input (AI) points have the following features:

- Support Change of State (COS) reporting based on high and low warning limits.
- Support Change of State (COS) reporting based on high and low alarm limits.
- Support Change of State (COS) reporting based on override status.
- Always considered reliable and never out of range.
- Writing of alarm and warning limit values beyond the range that can be held by the drive's internal variable will result in having that limit replaced by the "Invalid Float" value even though the message is acknowledged. The net result will be the inactivation of the alarm or warning (the same as if the original out of range value was used).
- Overriding is supported from the standpoint that the "Override Active" bit will be set and the value reported to the N2 network will be the overridden value. However, the value in the drive remains unchanged. Therefore, the N2 system should be set up to disallow overriding AI points or have an alarm condition activated when an AI point is overridden.
- Overriding an AI point with a value beyond the limit allowed by the drive's internal variable will result in an "Invalid Data" error response and the override status and value will remain unchanged.

#### 7.2.2 Binary Input (BI)

All Binary Input (BI) points have the following features:

- Support Change of State (COS) reporting based on current state.
- Support Change of State (COS) reporting based on alarm condition.
- Support Change of State (COS) reporting based on override status.
- Always considered reliable.

Overriding is supported from the standpoint that the "Override Active" bit will be set and the value reported to the N2 network will be the overridden value. However, the value in the drive remains un-

changed. Therefore, the N2 system should be set up to disallow overriding BI points or have an alarm condition activated when a BI point is overridden.

### 7.2.3 *Analogue Output (AO)*

All Analogue Output (AO) points have the following features:

- Support Change of State (COS) reporting based on override status.
- Always considered reliable.
- Overriding of the AO points is the method used to change a value. Overriding an AO point with a value beyond the limit allowed by the drive's internal variable will result in an "Invalid Data" error response and the override status and value will remain unchanged. If the overridden value is beyond the drive's parameter limit but within the range that will fit in the variable, an acknowledge response is given and the value will be internally clamped to its limit.
- An AO point override copies the override value to the corresponding drive parameter. This is the same as changing the value on the keypad. The value is non-volatile and will remain in effect when the drive is turned off and back on. It also remains at this value when the N2 network "releases" the point. The N2 system always reads the current parameter value.

Note:

On some N2 systems, the system will not poll the AO point when it is being overridden. In this case, the N2 system will not notice a change in value if the change is made with the keypad. To avoid this, set the point up as a "local control" type and release it once it has been overridden. In this way, the N2 system will monitor the value when not being overridden.

### 7.2.4 *Binary Output (BO)*

All Binary Output (BO) points have the following features:

- Support Change of State (COS) reporting based on override status.
- Always considered reliable.
- Overriding BO points control the drive. These points are input commands to the drive. When released, the drive's internal value remains at its last overridden value.

### 7.2.5 *Internal Integer (ADI)*

All Internal Integer (ADI) points have the following features:

- Do not support Change of State (COS) reporting.
- Can be overridden and the "Override Active" bit will be set. However, the Internal value is unchanged (Read Only).

## 7.3 N2 POINT MAP

### 7.3.1 Analogue Inputs (AI)

NPT	NPA	Description	Units	Note
AI	1	Speed Setpoint	Hz	2 decimals
AI	2	Output Speed	Hz	2 decimals
AI	3	Motor Speed	Rpm	0 decimal
AI	4	Load (power)	%	1 decimal
AI	5	Megawatt Hours	MWh	Total Counter
AI	6	Motor Current	A	2 decimal
AI	7	Bus Voltage	V	0 decimal
AI	8	Motor Volts	V	1 decimal
AI	9	Heatsink Temperature	° C	0 decimal
AI	10	Motor Torque	%	1 decimal
AI	11	Operating Days (trip)	Day	0 decimal
AI	12	Operating Hours (trip)	Hour	0 decimal
AI	13	Kilowatt Hours (trip)	kWh	Trip Counter
AI	14	Torque Reference <sup>1)</sup>	%	1 decimal
AI	15	Motor Temperature Rise <sup>1)</sup>	%	1 decimal
AI	16	FBProcessDataOut1 <sup>2)</sup>	-32768 to +32767	0 decimal
AI	17	FBProcessDataOut2 <sup>2)</sup>	-32768 to +32767	0 decimal
AI	18	FBProcessDataOut3 <sup>2)</sup>	-32768 to +32767	0 decimal
AI	19	FBProcessDataOut4 <sup>2)</sup>	-32768 to +32767	0 decimal
AI	20	FBProcessDataOut5 <sup>2)</sup>	-32768 to +32767	0 decimal
AI	21	FBProcessDataOut6 <sup>2)</sup>	-32768 to +32767	0 decimal
AI	22	FBProcessDataOut7 <sup>2)</sup>	-32768 to +32767	0 decimal
AI	23	FBProcessDataOut8 <sup>2)</sup>	-32768 to +32767	0 decimal

Table 19.

<sup>1)</sup> Torque Reference (AI-14) and Motor Temperature Rise (AI-15) **NOT** supported in **NXL**

<sup>2)</sup> These analogue inputs are application specific.

**7.3.2 Binary Inputs (BI)**

NPT	NPA	Description	0 =	1 =
BI	1	Ready	Not Ready	Ready
BI	2	Run	Stop	Run
BI	3	Direction	Clockwise	Counterclockwise
BI	4	Faulted	Not Faulted	Faulted
BI	5	Warning	Not Warning	Warning
BI	6	Ref. Frequency reached	False	True
BI	7	Motor running zero speed	False	True
BI	8	General 0 <sup>3)</sup>	0	1
BI	9	General 1 <sup>3)</sup>	0	1
BI	10	General 2 <sup>3)</sup>	0	1
BI	11	General 3 <sup>3)</sup>	0	1
BI	12	General 4 <sup>3)</sup>	0	1
BI	13	General 5 <sup>3)</sup>	0	1
BI	14	General 6 <sup>3)</sup>	0	1
BI	15	General 7 <sup>3)</sup>	0	1

Table 20.

<sup>3)</sup> These binary inputs are application specific. They are read from the drives General Status Word.

**7.3.3 Analogue Outputs (AO)**

NPT	NPA	Description	Units	Note
AO	1	Comms Speed	%	2 decimals
AO	2	Current Limit	A	2 decimals
AO	3	Minimum Speed	Hz	2 decimals
AO	4	Maximum Speed	Hz	2 decimals
AO	5	Accel Time	s	1 decimal
AO	6	Decel Time	s	1 decimal
AO	7	FBProcessDataIN 1 <sup>4)</sup>	-32768 to +32767	2 decimals
AO	8	FBProcessDataIN 2 <sup>4)</sup>	-32768 to +32767	2 decimals
AO	9	FBProcessDataIN 3 <sup>4)</sup>	-32768 to +32767	2 decimals
AO	10	FBProcessDataIN 4 <sup>4)</sup>	-32768 to +32767	2 decimals

Table 21.

<sup>4)</sup> These Analogue Outputs are application specific.

### 7.3.4 Binary Outputs (BO)

NPT	NPA	Description	0 =	1 =
B0	1	Comms Start/Stop	Stop	Start
B0	2	Comms Forward/Reverse	Forward	Reverse
B0	3	Reset Fault	N/A	Reset
B0	4	FBFixedControlWord Bit_3 <sup>5)</sup>	-	-
B0	5	FBFixedControlWord Bit_4 <sup>5)</sup>	-	-
B0	6	FBFixedControlWord Bit_5 <sup>5)</sup>	-	-
B0	7	FBFixedControlWord Bit_6 <sup>5)</sup>	-	-
B0	8	FBFixedControlWord Bit_7 <sup>5)</sup>	-	-
B0	9	FBFixedControlWord Bit_8 <sup>5)</sup>	-	-
B0	10	FBFixedControlWord Bit_9 <sup>5)</sup>	-	-
B0	11	FBFixedControlWord Bit_10 <sup>5)</sup>	-	-
B0	12	FBFixedControlWord Bit_11 <sup>5)</sup>	-	-
B0	13	FBFixedControlWord Bit_12 <sup>5)</sup>	-	-
B0	14	FBFixedControlWord Bit_13 <sup>5)</sup>	-	-
B0	15	FBFixedControlWord Bit_14 <sup>5)</sup>	-	-
B0	16	FBFixedControlWord Bit_15 <sup>5)</sup>	-	-

Table 22.

<sup>5)</sup> These Binary Outputs are application specific.

### 7.3.5 Internal Integers (ADI)

NPT	NPA	Description	Units
ADI	1	Active Fault Code	-

Table 23.

## 8. FAULT TRACKING

The table below presents the faults related to the RS-485 option board. For more information, see also Vacon NX User's Manual, Chapter 9.

The **RS-485 option board status LEDs** have been described in more detail in Chapter 3.6.

Fault code	Fault	Possible cause	Correcting measures
37	Device change	Option board changed.	Reset
38	Device added	Option board added.	Reset
39	Device removed	Option board removed.	Reset
40	Device unknown	Unknown option board.	
53	Fieldbus fault	The data connection between the Modbus/N2 Master and the RS-485 option board is broken	Check the installation. If installation is correct contact the nearest Vacon distributor.
54	Slot fault	Defective option board or slot	Check the board and slot. Contact the nearest Vacon distributor.

Table 24. RS-485 option board faults

You can define with parameters how the frequency converter shall react to certain faults:

Code	Parameter	Min	Max	Unit	Step	Default	ID	Note
P2.7.22	Response to fieldbus fault	0	3		1	0	733	0=No response 1=Warning 2=Fault, stop acc. to 2.4.7 3=Fault, stop by coasting
P2.7.23	Response to slot fault	0	3		1	0	734	0=No response 1=Warning 2=Fault, stop acc. to 2.4.7 3=Fault, stop by coasting

Table 25. Frequency converter responses to faults

## APPENDIX 1

### *Process Data OUT (Slave to Master)*

The Fieldbus Master can read the frequency converter's actual values using process data variables. *Basic, Standard, Local/Remote Control, Multi-Step Speed Control, PID control and Pump and fan control* applications use process data as follows:

ID	Data	Value	Unit	Scale
2104	Process data OUT 1	Output Frequency	Hz	0,01 Hz
2105	Process data OUT 2	Motor Speed	rpm	1 rpm
2106	Process data OUT 3	Motor Current	A	0,1 A
2107	Process data OUT 4	Motor Torque	%	0,1 %
2108	Process data OUT 5	Motor Power	%	0,1 %
2109	Process data OUT 6	Motor Voltage	V	0,1 V
2110	Process data OUT 7	DC link voltage	V	1 V
2111	Process data OUT 8	Active Fault Code	-	-

Table 26. Process data OUT variables

The *Multipurpose Control application* has a selector parameter for every Process Data. The monitoring values and drive parameters can be selected using the ID number (see NX All in One Application Manual, Tables for monitoring values and parameters). Default selections are as in the table above.

### *Process Data IN (Master to Slave)*

ControlWord, Reference and Process Data are used with All-inOne applications as follows:

*Basic, Standard, Local/Remote Control and Multi-Step Speed Control applications*

ID	Data	Value	Unit	Scale
2003	Reference	Speed Reference	%	0.01%
2001	ControlWord	Start/Stop Command Fault reset Command	-	-
2004–2011	PD1 – PD8	Not used	-	-

Table 27.



*Multipurpose Control application*

ID	Data	Value	Unit	Scale
2003	Reference	Speed Reference	%	0.01%
2001	ControlWord	Start/Stop Command Fault reset Command	-	-
2004	Process Data IN1	Torque Reference	%	0.1%
2005	Process Data IN2	Free Analogia INPUT	%	0.01%
2006–2011	PD3 – PD8	Not Used	-	-

*Table 28.**PID control and Pump and fan control applications*

ID	Data	Value	Unit	Scale
2003	Reference	Speed Reference	%	0.01%
2001	ControlWord	Start/Stop Command Fault reset Command	-	-
2004	Process Data IN1	Reference for PID controller	%	0.01%
2005	Process Data IN2	Actual Value 1 to PID controller	%	0.01%
2006	Process Data IN3	Actual Value 2 to PID controller	%	0.01%
2007–2011	PD4–PD8	Not Used	-	-

*Table 29*

# VACON

DRIVEN BY DRIVES

Find your nearest Vacon office  
on the Internet at:

[www.vacon.com](http://www.vacon.com)

Manual authoring:  
[documentation@vacon.com](mailto:documentation@vacon.com)

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