



Cutler-Hammer

Modbus/TCP Option Board OPTCi for 9000X Drives

User Manual

October 2005
New Information



October 2005

Important Notice – Please Read

The product discussed in this literature is subject to terms and conditions outlined in Eaton Electrical Inc. selling policies. The sole source governing the rights and remedies of any purchaser of this equipment is the relevant Eaton Electrical Inc. selling policy.

NO WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY, OR WARRANTIES ARISING FROM COURSE OF DEALING OR USAGE OF TRADE, ARE MADE REGARDING THE INFORMATION, RECOMMENDATIONS AND DESCRIPTIONS CONTAINED HEREIN. In no event will Eaton Electrical Inc. be responsible to the purchaser or user in contract, in tort (including negligence), strict liability or otherwise for any special, indirect, incidental or consequential damage or loss whatsoever, including but not limited to damage or loss of use of equipment, plant or power system, cost of capital, loss of power, additional expenses in the use of existing power facilities, or claims against the purchaser or user by its customers resulting from the use of the information, recommendations and descriptions contained herein.

The information contained in this manual is subject to change without notice.

Cover Photo: Cutler-Hammer® 9000X Drives.

Table of Contents

LIST OF FIGURES	iii
LIST OF TABLES	iii
SAFETY	iv
Definitions and Symbols	iv
Hazardous High Voltage	iv
Warnings and Cautions	v
CHAPTER 1 — GENERAL	1-1
OPTCi Board	1-2
EtherNet	1-2
Connections and Wiring	1-4
CHAPTER 2 — INSTALLATION	2-1
Installing the Modbus/TCP Option Board in an SVX/SPX Processor	2-1
Readying Your PC for Use with the OPTCi Fieldbus Adapter	2-3
Using NCIPConfig	2-4
Updating OPTCi Option Board with the NCIPConfig Tool	2-5
CHAPTER 3 — CONFIGURATION	3-1
Modbus/TCP	3-1
Modbus/TCP vs. Modbus/RTU	3-2
EtherNet Option Board's Modbus Address Space	3-2
Coils	3-2
Discrete Inputs	3-5
Holding Registers	3-6
Input Registers	3-11
CHAPTER 4 — OPERATION	4-1
Start-Up Test	4-1
Error Codes and Errors	4-1
APPENDIX A — PROCESS DATA	A-1
Process Data OUT (Slave to Master)	A-1
Process Data IN (Master to Slave)	A-1

October 2005

List of Figures

Figure 1-1: OPTCi Board	1-2
Figure 1-2: Protocol Layer	1-3
Figure 1-3: Typical Example of EtherNet Communications in Control and Operator Interface	1-3
Figure 3-1: Modbus Transaction	3-1
Figure 3-2: IDMap Initialization	3-7

List of Tables

Table 1-1: EtherNet Board Technical Data	1-2
Table 2-1: Installing the EtherNet Option Board	2-1
Table 3-1: Supported Registers	3-2
Table 3-2: Control Word Structure	3-3
Table 3-3: Writing a Single Control Word Bit	3-3
Table 3-4: Counters	3-4
Table 3-5: Force Multiple Coils — Query	3-4
Table 3-6: Status Word Structure	3-5
Table 3-7: Status Word Read — Query	3-5
Table 3-8: Status Word Read — Response	3-6
Table 3-9: Response's Data Block Broken into Bits	3-6
Table 3-10: Holding Registers	3-6
Table 3-11: Parameter IDs	3-7
Table 3-12: Parameter Values in IDMap Read/Write Registers	3-8
Table 3-13: Process Data Out	3-8
Table 3-14: Process Data In	3-9
Table 3-15: Measurement Table	3-10
Table 3-16: Operation Day Counter	3-11
Table 3-17: Resettable Operation Day Counter	3-11
Table 3-18: Energy Counter	3-11
Table 3-19: Resettable Energy Counter	3-12
Table 3-20: Error Coding	3-12
Table 4-1: Error Codes	4-1
Table A-1: Process Data Out Variables	A-1
Table A-2: Basic, Standard, Local/Remote and Multi-Step Speed Applications	A-1
Table A-3: Multipurpose Application	A-1
Table A-4: PID and Pump and Fan Applications	A-2

Safety

Definitions and Symbols

 WARNING

This symbol indicates high voltage. It calls your attention to items or operations that could be dangerous to you and other persons operating this equipment. Read the message and follow the instructions carefully.



This symbol is the "Safety Alert Symbol." It occurs with either of two signal words: CAUTION or WARNING, as described below.

 WARNING

Indicates a potentially hazardous situation which, if not avoided, can result in serious injury or death.

 CAUTION

Indicates a potentially hazardous situation which, if not avoided, can result in minor to moderate injury, or serious damage to the product. The situation described in the CAUTION may, if not avoided, lead to serious results. Important safety measures are described in CAUTION (as well as WARNING).

Hazardous High Voltage

 WARNING

Motor control equipment and electronic controllers are connected to hazardous line voltages. When servicing drives and electronic controllers, there may be exposed components with housings or protrusions at or above line potential. Extreme care should be taken to protect against shock.

Stand on an insulating pad and make it a habit to use only one hand when checking components. Always work with another person in case an emergency occurs. Disconnect power before checking controllers or performing maintenance. Be sure equipment is properly grounded. Wear safety glasses whenever working on electronic controllers or rotating machinery.

October 2005

Warnings and Cautions

 WARNING

Internal components and circuit boards are at high potential when the drive 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.

 CAUTION

Make sure that the drive is switched OFF before an option or fieldbus board is changed or added.

October 2005

Chapter 1 — General

This manual describes the installation, configuration and use of the OPTCi Modbus/TCP fieldbus adapter from Eaton's electrical business. The OPTCi is a plug-in board that is compatible with any open or enclosed drive product that uses an SVX/SPX processor module (any 9000X drive, such as the HVX9000 or CPX9000 family). The OPTCi adapter can only be used in slots D or E of the processor module. The most basic network you can create will require a controller with an EtherNet port, a crossover cable and a drive with a properly installed OPTCi board.

Every device connected to an EtherNet network has two identifiers, a MAC address and an IP address. The MAC address is unique to the device and is hard coded (cannot be changed). The OPTCi board's MAC address can be found on the label attached to the adapter or by using the supplied IP tool software, NCIPConfig.

The OPTCi board comes from the factory with a default IP address of 192.168.0.10. This address is convenient for testing your OPTCi adapter when using the existing EtherNet network in your office.

Successful use of the OPTCi board will require careful design of network architecture, and may require consulting with your corporate IT administrator. The selection of IP addresses will impact how the OPTCi board interacts with other devices, such as switches or routers.

A demonstration version of KEPWARE's KEPSERVEREX is included on the software support CD and provides an excellent tool for testing EtherNet communications and becoming familiar with the Modbus registers available in the drive. The only items you will need to test are a PC equipped with an EtherNet port and an EtherNet crossover cable. Eaton has also included a sample project file for KEPSERVEREX that contains tags for commonly used SVX parameters. Using this tool, you can have the drive up and running on EtherNet in minutes.

WARNING

Internal components and circuit boards are at high potential when the drive 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.

OPTCi Board

Table 1-1: EtherNet Board Technical Data

Category	Description	Specification
General	Card Name	OPTCi
EtherNet connections	Interface	RJ-45 Connector
Communications	Transfer cable	Foiled CAT-5e
	Speed	10/100 Mb
	Duplex	Half/Full
	Default IP-address	192.168.0.10
Protocols	Modbus / TCP	
Environment	Ambient operating temperature	14° – 122°F (-10° – 50°C)
	Storing temperature	-40° – 158°F (-40° – 70°C)
	Humidity	<95%, No condensation allowed
	Altitude	Max. 3280 ft. (1000m)
	Vibration	0.5 G at 9 – 200 Hz
Safety	—	Fulfills EN 50178 standard



Figure 1-1: OPTCi Board

EtherNet

Background

EtherNet-based communications networks have become increasingly popular in industrial control and building automation. This popularity is due to a number of factors: (1) speed; (2) a broad range of physical media and support hardware, such as optical fiber and wireless; and (3) a well designed, layered software architecture known as a communications stack.

October 2005

This stack is known as the OSI/ISO seven-layer architecture and appears in **Figure 1-2**. This layered architecture makes it relatively easy for manufacturers to adapt their communications protocol to EtherNet.

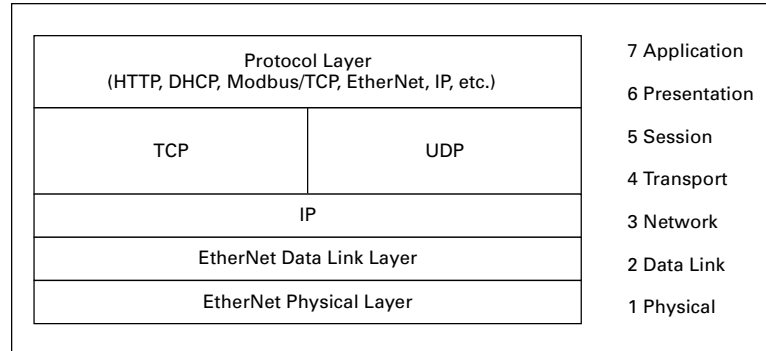


Figure 1-2: Protocol Layer

Applications

Common applications of EtherNet communications are operator interface and control interface. **Figure 1-3** shows an example of how EtherNet can be applied to a control scheme. The OPTCi adapter supports 10 and 100 Mbps communication speeds, making it ideally suited for real time control. An added value of EtherNet-based communication is its ability to reside on the Internet. There are also a number of third-party vendors who provide wireless EtherNet modems, making remote machine control or process monitoring practical.

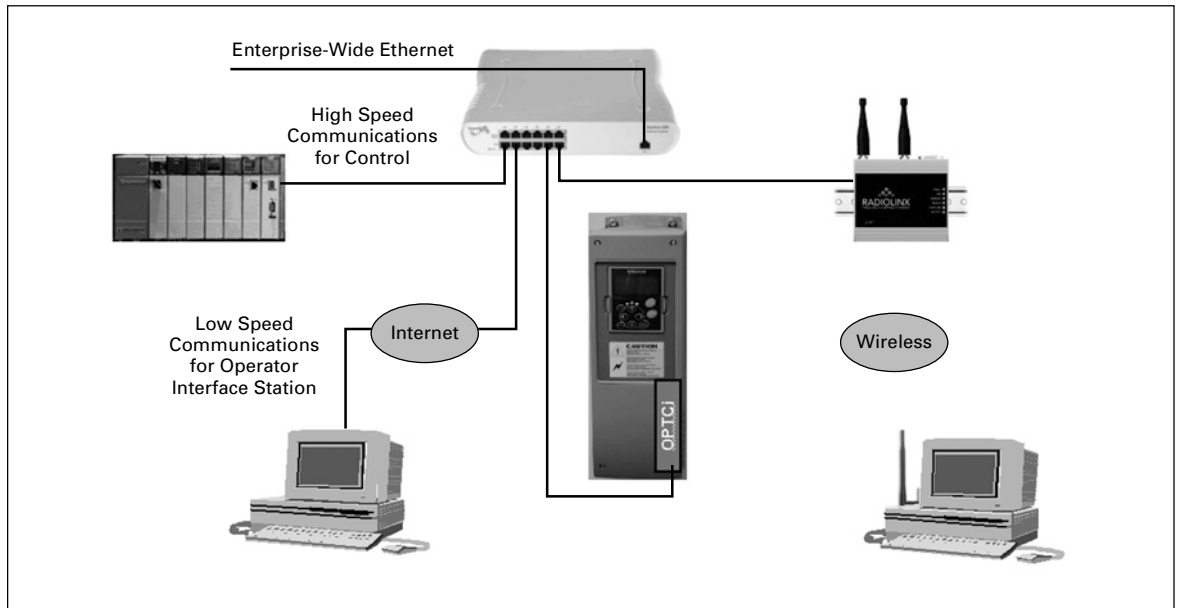


Figure 1-3: Typical Example of EtherNet Communications in Control and Operator Interface

Connections and Wiring

The OPTCi board supports 10 and 100 Mbps speeds in both full- and half-duplex modes. The OPTCi adapter must be connected to the EtherNet network with a shielded CAT-5e cable. Use a crossover cable if you want to connect the EtherNet option board directly to the master device. Use only industry standard components in your network, and avoid complex structures to maximize performance.

October 2005

Chapter 2 — Installation

Installing the Modbus/TCP Option Board in an SVX/SPX Processor

⚠ CAUTION

Make sure that the drive is switched OFF before an option or fieldbus board is changed or added.

Table 2-1: Installing the EtherNet Option Board



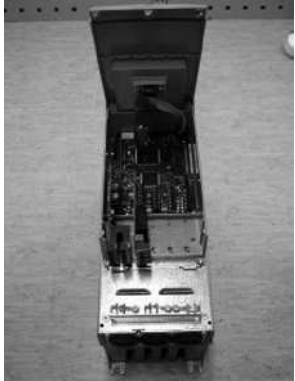
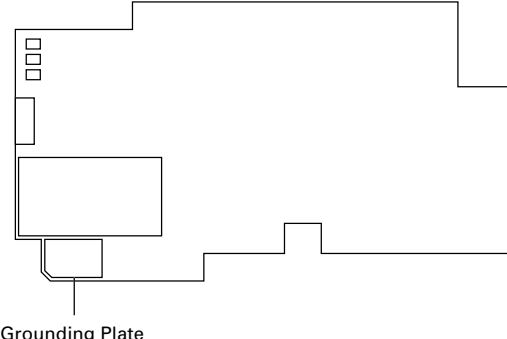
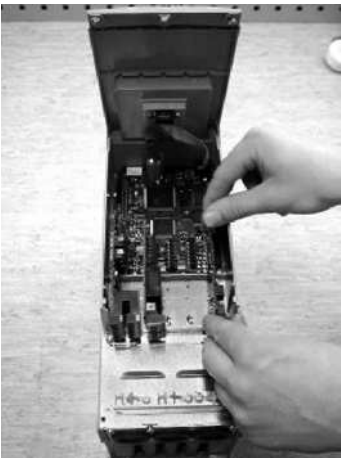
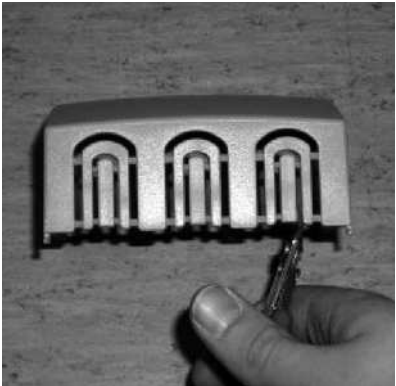

Item	Description	
A	Locate the 9000X drive.	
B	Remove the cable cover.	
C	Open the cover of the control unit.	

Table 2-1: Installing the Modbus/TCP Option Board (Continued)

Item	Description	
<p>D</p>	<p>Install the OPTCi adapter in slot D or E on the control board of the drive. Make sure the grounding plate (shown below) fits tightly in the clamp.</p>  <p style="text-align: center;">Grounding Plate</p>	
<p>E</p>	<p>Make a sufficiently wide opening for your cable by cutting the grid as wide as necessary.</p>	
<p>F</p>	<p>Close the cover of the control unit and the cable cover.</p>	

October 2005

Readying Your PC for Use with the OPTCi Fieldbus Adapter

The factory default IP address of the OPTCi adapter is 192.168.0.10. The final address you select must be compatible with your existing network architecture. You should carefully examine the range of IP addresses used in your network, and make sure they are not used by any other device. You should also make sure that if your network uses DHCP to assign IP addresses, the IP address you use is never re-assigned by the DHCP server.

Use of NCIPConfig will require a PC with an EtherNet port and connection to the OPTCi board via an EtherNet cable. If you use a direct connection from your PC to the OPTCi board, you will need a crossover cable. If the PC you are using to configure the OPTCi board is already part of an office LAN, you will most likely need to: (1) disable DHCP in your network settings, and (2) set a static IP address and subnet mask. If you do not take these steps, the PC will be unable to connect to the OPTCi interface. We recommend using the following settings for your PC's network properties on the General tab of the Internet Protocol (TCP/IP) Properties menu.

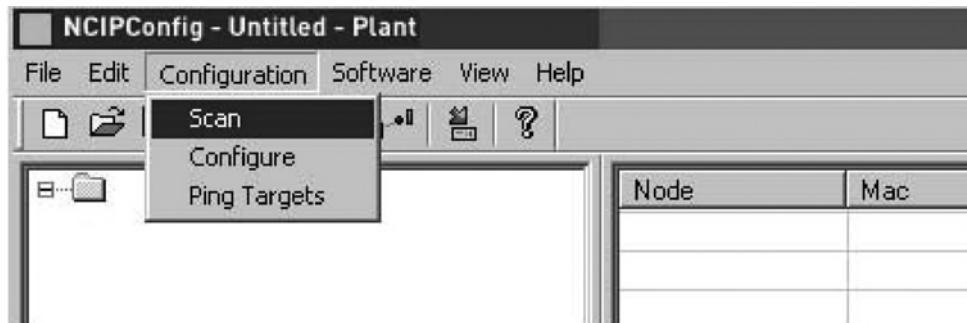
When you are finished experimenting with the OPTCi interface, remember to change the adapter back to DHCP before you re-connect your PC to the office LAN.

Using NCIPConfig

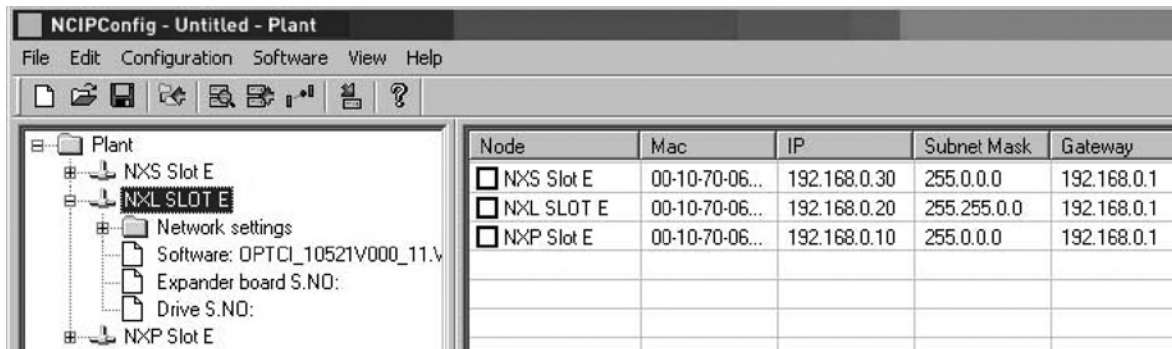
Before using the OPTCi interface board, you must set its IP address. The supplied software application NCIPConfig is used to configure the OPTCi's IP address and update the adapter's firmware. To install the NCIPConfig application, double click the NCIPConfig icon and follow the following installation instructions. Once the application is installed, it can be launched from the Windows® "Start" menu.

Step 1. Scan network nodes. Select **Configuration > Scan** and wait until the devices connected to the bus in the tree structure are displayed on the left of the screen.

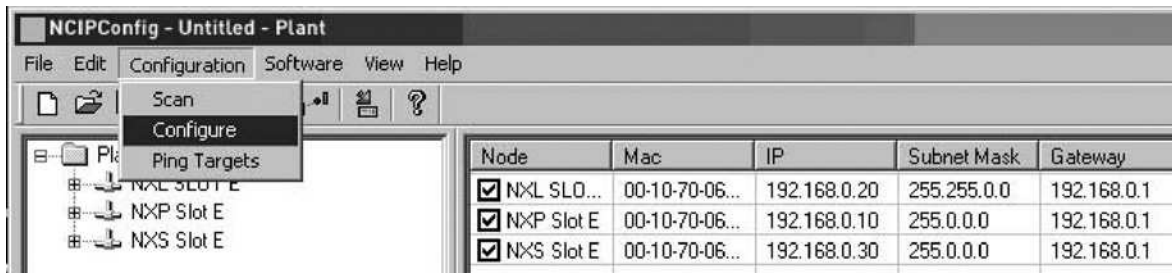
Note: Some network switches may block broadcast messages. In that case, each network node must be scanned separately.



Step 2. Set IP addresses. Change the node's IP settings in accordance with the network IP settings. The program will report conflicts with a red color in a table cell.



Step 3. Upload configuration to board. In the table view, check the boxes for boards whose configuration you want to upload and select **Configuration > Configure**. Your changes are sent to the network and will be valid immediately.



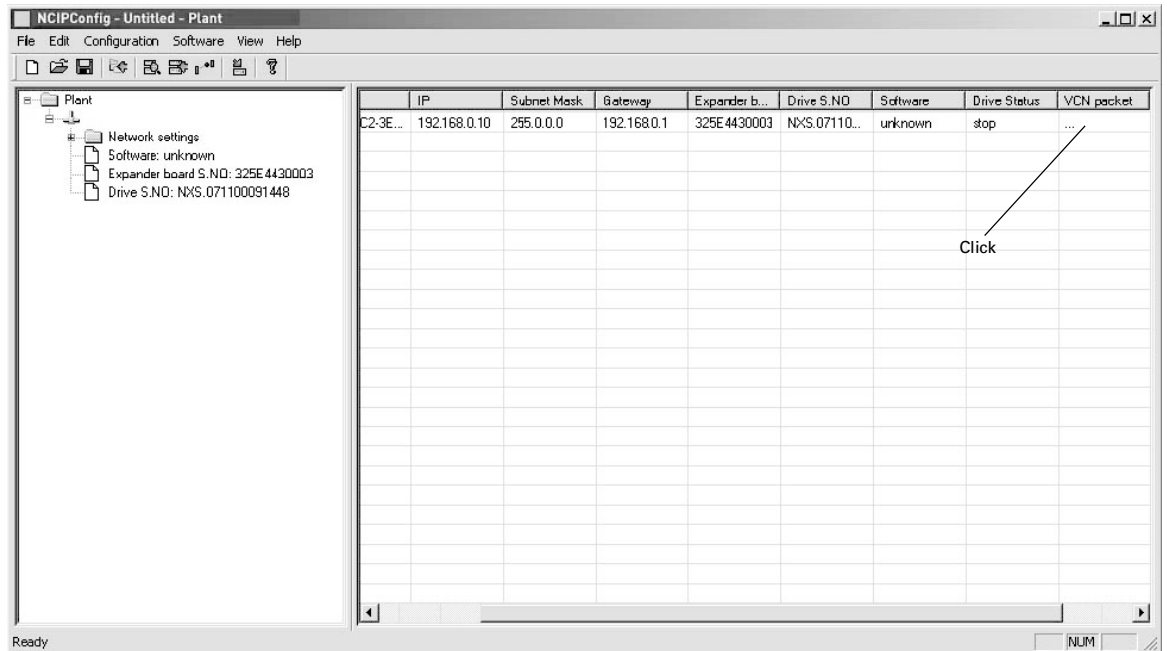
October 2005

Updating OPTCi Option Board with the NCIPConfig Tool

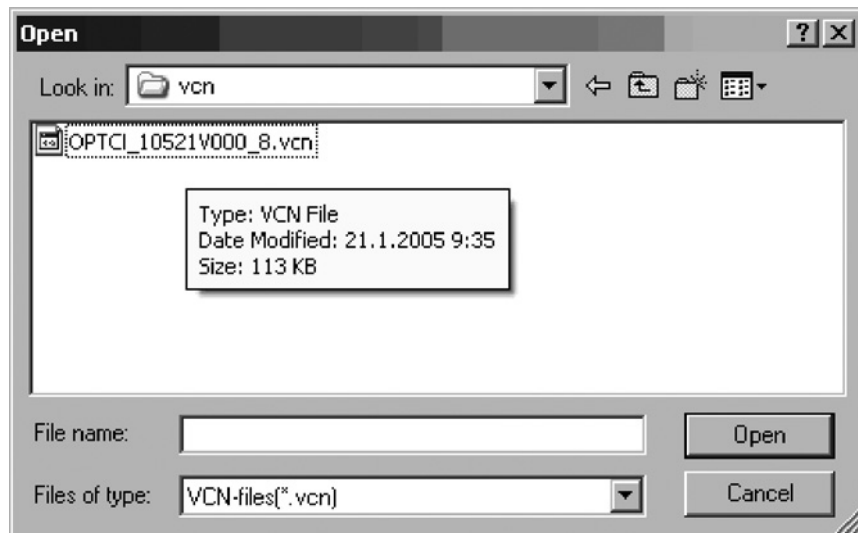
In some cases, it may be necessary to update the option board’s firmware. Unlike other option boards, the OPTCi option board’s firmware is updated with the NCIPConfig software, and the data transfer occurs via the EtherNet connection, not the standard SVDRIVE cable.

To start the firmware update:

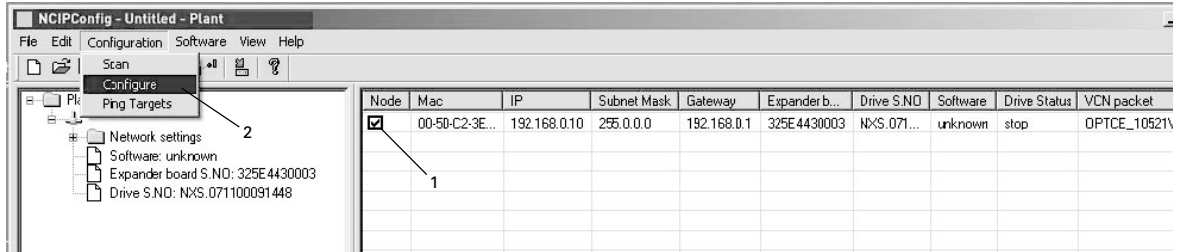
1. Scan the nodes in the network according to the instructions in Step 1 on **Page 2-4**.
2. Once you can see all nodes in NCIPConfig’s table view, you can update the new firmware by clicking the **VCN packet** field on the far right of the NCIPConfig’s table view.



3. After clicking the VCN Packet field, a file window opens where you can choose a new firmware packet from the **Look in** file drop down menu.



4. Upload the new firmware to the option board by clicking the **Node** box for each **VCN packet** field in the right table view. After selecting all the nodes to be updated, you can simultaneously send the new firmware to all the OPTCi boards by selecting **Configuration > Configure**.



October 2005

Chapter 3 — Configuration

Modbus/TCP

The Modbus/TCP is a variant of the Modbus family. It is a manufacturer-independent protocol for monitoring and controlling automatic devices.

The Modbus/TCP is a client server protocol. The client makes queries to the server by sending "request" messages to the server's TCP port 502. The server answers client queries with "response" messages.

The term "client" can refer to a master device that runs queries. Correspondingly, the term "server" refers to a slave device that serves the master device by answering its queries.

Both the request and response messages are composed as follows:

- Byte 0: Transaction ID
- Byte 1: Transaction ID
- Byte 2: Protocol ID
- Byte 3: Protocol ID
- Byte 4: Length field, upper byte
- Byte 5: Length field, lower byte
- Byte 6: Unit identifier
- Byte 7: Modbus function code
- Byte 8: Data (of variable length)

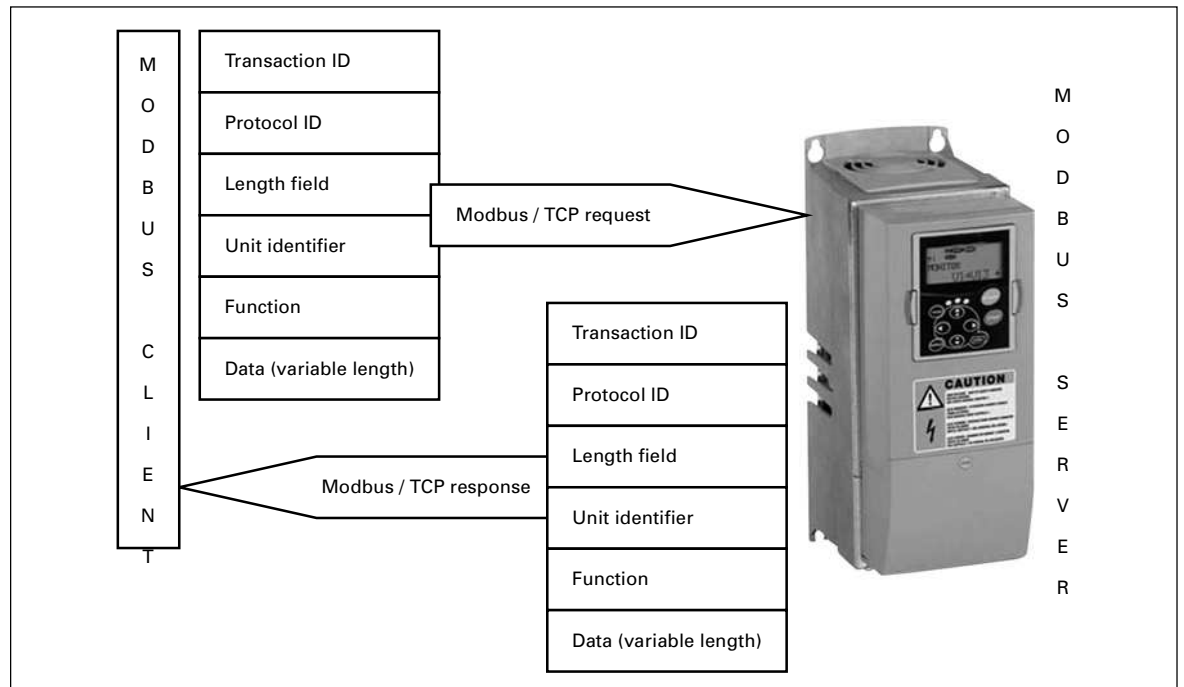


Figure 3-1: Modbus Transaction

Modbus/TCP vs. Modbus/RTU

The Modbus/TCP differs from the Modbus/RTU in its method of error checking. Transfer Control Protocol (TCP) already includes efficient error checking, so the Modbus/TCP does not include a separate CRC (error-checking) field. TCP also contains provisions for resending bad packets and fragmentation of long messages for proper fit in communication frames.

The slave address field of Modbus/RTU is the unit identifier field in Modbus/TCP, and it is used when one IP address acts as a common connection point, such as with a gateway, for several devices.

EtherNet Option Board's Modbus Address Space

Class 1 Modbus/TCP functionality has been implemented in the OPTCi board. **Table 3-1** lists supported Modbus registers.

Table 3-1: Supported Registers

Name	Size	Modbus Address	Type
Input Registers	16 Bit	30001-3FFFF	Read
Holding Register	16 Bit	40001-4FFFF	Read / Write
Coils	1 Bit	00001-0FFFF	Read / Write
Discrete Inputs	1 Bit	10001-1FFFF	Read

Coils

Coil registers represent data in a binary format. Each coil can only be in an ON (1) or OFF (0) state. Coil registers can be written using the Modbus function **Write Coil (5)** or **Force Multiple Coils (16)**. The following tables include examples of both functions.

October 2005

Discrete Coils (0001 – 0016), Control Word (Read/Write)

Table 3-2: Control Word Structure

Address	Function	Purpose
0001	RUN/STOP	Control Word, Bit 1
0002	DIRECTION	Control Word, Bit 2
0003	Fault reset	Control Word, Bit 3
0004	FBDIN1	Control Word, Bit 4
0005	FBDIN2	Control Word, Bit 5
0006	FBDIN3	Control Word, Bit 6
0007	FBDIN4	Control Word, Bit 7
0008	FBDIN5	Control Word, Bit 8
0009	BusCtrl	Control Word, Bit 9
0010	BusRef	Control Word, Bit 10
0011	FBDIN6	Control Word, Bit 11
0012	FBDIN7	Control Word, Bit 12
0013	FBDIN8	Control Word, Bit 13
0014	FBDIN9	Control Word, Bit 14
0015	FBDIN10	Control Word, Bit 15
0016	FBFaultIN	Control Word, Bit 16

The following table shows a Modbus query that changes the motor’s rotation direction by entering a value of “1” for Control Word, Bit 2. This example uses the “**Write Coil**” Modbus function. Note that the Control Word is application-specific, and use of bits may vary depending on the control word used.

Query:

0x00, 0x00, 0x00, 0x00, 0x00, 0x06, 0x01, 0x05, 0x00, 0x02, 0xFF, 0x00

Table 3-3: Writing a Single Control Word Bit

Data	Purpose
0x00	Transaction ID
0x00	Transaction ID
0x00	Protocol ID
0x00	Protocol ID
0x00	Length
0x06	Length
0x01	Unit Identifier
0x05	Write Coil
0x00	Reference Number
0x01	Reference Number
0xFF	Data
0x00	Padding

Discrete Coils (0017 – 0018), Reset Counters (Read/Write)

The drive's Days of Operation and Energy Usage counters can be reset by sending a value of "1" in a coil request. When a value of "1" is received, the device resets the counter. Note that the actual coil value does not change after reset, but maintains a value of "0".

Table 3-4: Counters

Address	Function	Purpose
0017	ClearOpDay	Clears Days of Operation Counter
0018	ClearMWh	Clears MWh Counter

The following table represents a Modbus query that resets both counters simultaneously. This example applies the "Force Multiple Coils" function. The reference number indicates the address after which the amount of data defined by the **Bit Count** is written. This data is the last block in the Modbus/TCP message.

Query:

0x00, 0x00, 0x00, 0x00, 0x00, 0x08, 0x01, 0x0F, 0x00, 0x10, 0x00, 0x02, 0x01, 0x03

Table 3-5: Force Multiple Coils

Data	Purpose
0x00	Transaction ID
0x00	Transaction ID
0x00	Protocol ID
0x00	Protocol ID
0x00	Length
0x08	Length
0x01	Unit Identifier
0x0F	Force Multiple Coils
0x00	Reference Number
0x10	Reference Number
0x00	Bit Count
0x02	Bit Count
0x01	Byte Count
0x03	Data

October 2005

Discrete Inputs

Both the **Discrete Coils** and **Discrete Inputs** contain binary data. However, the Input register's data can only be read while discrete coils can be read and written. The EtherNet board's Modbus/TCP implementation uses the following Discrete Input addresses.

Discrete Input (10001 – 10008), Status Word (Read Only)

Table 3-6: Status Word Structure

Address	Name	Purpose
10001	Ready	Status Word, Bit 0
10002	Run	Status Word, Bit 1
10003	Direction	Status Word, Bit 2
10004	Fault	Status Word, Bit 3
10005	Warning	Status Word, Bit 4
10006	AtReference	Status Word, Bit 5
10007	ZeroSpeed	Status Word, Bit 6
10008	FluxReady	Status Word, Bit 7
10009	Manufacturer reserved	

The following tables show a Modbus query that reads the entire status word (8 input discrete) and the query response.

Query:

0x00, 0x00, 0x00, 0x00, 0x00, 0x06, 0x01, 0x02, 0x00, 0x00, 0x00, 0x08

Table 3-7: Status Word Read — Query

Data	Purpose
0x00	Transaction ID
0x00	Transaction ID
0x00	Protocol ID
0x00	Protocol ID
0x00	Length
0x06	Length
0x01	Unit Identifier
0x02	Read Discrete Input
0x00	Reference Number
0x00	Reference Number
0x00	Bit Count
0x08	Bit Count

Response:

0x00, 0x00, 0x00, 0x00, 0x00, 0x06, 0x01, 0x02, 0x01, 0x41

Table 3-8: Status Word Read — Response

Data	Purpose
0x00	Transaction ID
0x00	Transaction ID
0x00	Protocol ID
0x00	Protocol ID
0x00	Length
0x04	Length
0x01	Unit Identifier
0x02	Read Input Discrete
0x01	Byte Count
0x41	Data

In the response's data field, you can read the value (0x41) that corresponds to the read discrete status after offsetting by the value of the query's reference number field (0x00, 0x00).

Table 3-9: Response's Data Block Broken into Bits

LSB 0x1				MSB 0x4			
0	1	2	3	4	5	6	7
1	0	0	0	0	0	1	0

In this example, the drive is in the ready mode because bit 0 is set. The motor does not run because bit 6 is set, indicating a fault condition.

Holding Registers

You can both read and write data from the Modbus Holding registers. The EtherNet board's Modbus/TCP implementation uses the following address map.

Table 3-10: Holding Registers

Address Range	Purpose
0001 – 2000	Application IDs
2001 – 2099	FB Process Data In
2101 – 2199	FB Process Data Out
2200 – 10000	Application IDs
10001 – 10033	IndexMap
10101 – 10133	Index Map, Read / Write
10301 – 10333	Measure Table
10501 – 10533	ID Map
10601 – 10633	ID Map Read / Write
10634 – 65535	Not Used

October 2005

Holding Registers (400001 – 402000 and 402200 – 410000), Application ID (Read Only)

Application IDs are parameters that depend on the drive’s application. These parameters can be read and written by pointing the corresponding memory range directly or by using a so-called ID map (more information below). It is easiest to use a straight address if you want to read a single parameter value or parameters with consecutive ID numbers.

Table 3-11: Parameter IDs

Address Range	Purpose	ID
0001 – 2000	Application Parameters	1 – 2000
2200 – 10000	Application Parameters	2200 – 10000

Holding Registers (410501 – 410533 and 410601 – 410633), ID Map (Read/Write)

Using the ID map, you can read consecutive memory locations that contain parameters whose IDs are not in consecutive order. The address range 410501 – 410533 is called “IDMap,” and is used as an address map in which you can write your parameter IDs in any order. The address range 410601 – 410633 is called “IDMap Read/Write,” and it includes values for parameters written in the IDMap. As soon as one ID number has been written in the map cell 410501, the corresponding parameter value can be read and written in the address 410601, and so on.

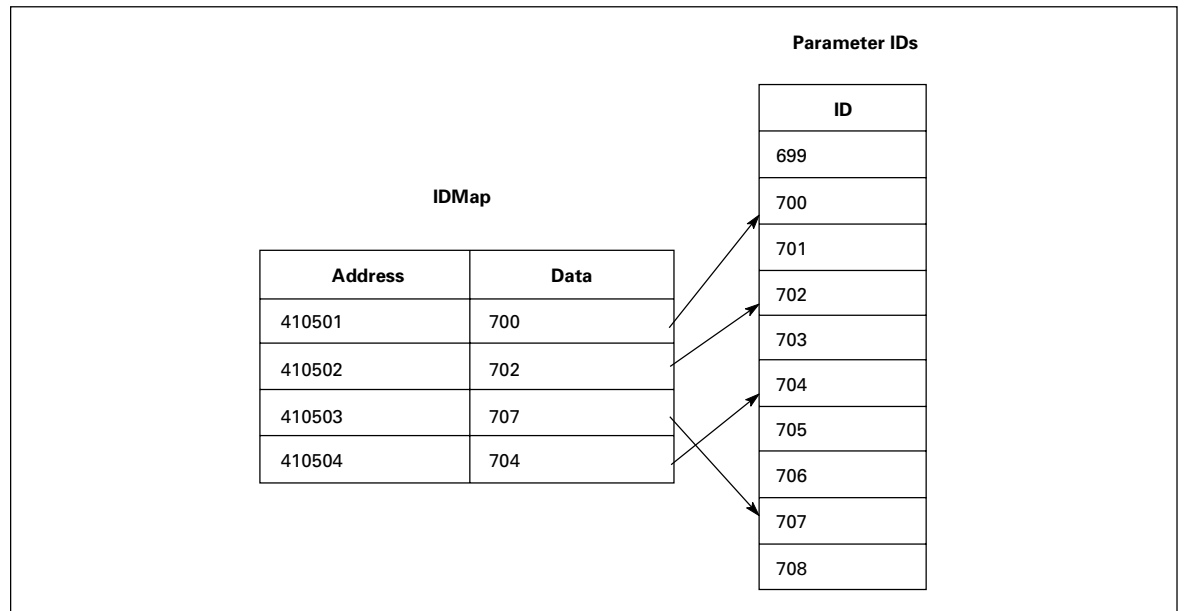


Figure 3-2: IDMap Initialization

Table 3-12: Parameter Values in IDMap Read/Write Registers

Address	Purpose
410601	Data included in the parameter ID 700
410602	Data included in the parameter ID 702
410603	Data included in the parameter ID 707
410604	Data included in the parameter ID 704

If the IDMap table has not been initialized, all fields show the index "0". If the IDMap has been initialized, the parameter IDs included in the table are stored in the OPTCi board's FLASH memory.

Holding Registers (410001 – 410033 and 410101 – 410133), Index Map

The IndexMap functions almost entirely the same way as the IDMap. The difference between them is that the IndexMap is used to handle indexes instead of parameters. The address range 410001 – 410033 is called "IndexMap," and you can write your index number in it. Correspondingly, the value of the written index can be read in the Address Range 410101 – 410133, called the "IndexMap Read/Write." The data contained in the "IndexMap" Address Range is stored in the OPTCi board's FLASH memory. IndexMap data has a default value of 0.

Holding Registers (402101 – 402111), FB Process Data Out (Read Only),

The Process Data Out registers are mainly used for controlling drives. You can read temporary values such as frequency, voltage and moment, using the process data. The table values are updated every 10 mS.

Table 3-13: Process Data Out

Address	Purpose	Range Type
402101	FB Status Word	See Table 3-6.
402102	FB General Status Word	See Table 3-2.
402103	FB Actual Speed	0 – 10 000
402104	FB Process Data Out 1	See Table A-1.
402105	FB Process Data Out 2	See Table A-1.
402106	FB Process Data Out 3	See Table A-1.
402107	FB Process Data Out 4	See Table A-1.
402108	FB Process Data Out 5	See Table A-1.
402109	FB Process Data Out 6	See Table A-1.
402110	FB Process Data Out 7	See Table A-1.
402111	FB Process Data Out 8	See Table A-1.

October 2005

Holding Registers (402001 – 402011), FB Process Data In (Read/Write)

The use of process data depends on the application. Typically, the motor is started and stopped using the “Control Word,” and the speed is set by writing a “Reference” value. Through using other process data fields, the device can give other required information to the Master device, depending on the application.

Table 3-14: Process Data In

Address	Purpose	Range Type
402001	FB Control Word	See Table 3-6 .
402002	FB General Control Word	See Table 3-2 .
402003	FB Speed Reference	0 – 10 000
402004	FB Process Data In 1	See Tables A-2 – A-4 .
402005	FB Process Data In 2	See Tables A-2 – A-4 .
402006	FB Process Data In 3	See Tables A-2 – A-4 .
402007	FB Process Data In 4	See Tables A-2 – A-4 .
402008	FB Process Data In 5	See Tables A-2 – A-4 .
402009	FB Process Data In 6	See Tables A-2 – A-4 .
402010	FB Process Data In 7	See Tables A-2 – A-4 .
402011	FB Process Data In 8	See Tables A-2 – A-4 .

Holding Registers (410301 – 410325), Measurement Table (Read Only)

The measurement table provides 25 readable values as listed in **Table 3-15**. The table values are updated every 100 mS.

Table 3-15: Measurement Table

Address	Purpose	Range Type
410301	Motor Torque	Integer
410302	Motor Power	Integer
410303	Motor Speed	Integer
410304	Frequency Out	Integer
410305	Frequency Reference	Integer
410306	Remote Indication	Unsigned Short
410307	Motor Control Mode	Unsigned Short
410308	Active Fault	Unsigned Short
410309	Motor Current	Unsigned Integer
410310	Motor Voltage	Unsigned Integer
410311	Frequency Minimum	Unsigned Integer
410312	Frequency Scale	Unsigned Integer
410313	DC Voltage	Unsigned Integer
410314	Motor Nominal Current	Unsigned Integer
410315	Motor Nominal Voltage	Unsigned Integer
410316	Motor Nominal Freq	Unsigned Integer
410317	Motor Nominal Speed	Unsigned Integer
410318	Current Scale	Unsigned Integer
410319	Motor Current Limit	Unsigned Integer
410320	Deceleration Time	Unsigned Integer
410321	Acceleration Time	Unsigned Integer
410322	Frequency Maximum	Unsigned Integer
410323	Pole Pair Number	Unsigned Integer
410324	Ramp Time Scale	Unsigned Integer
410325	Millisecond Counter	Unsigned Integer

October 2005

Input Registers

The Input registers include read-only data. See below for a more specific description of the registers.

Input Registers (30001 – 30005), Operation Day Counter (Read Only)

Table 3-16: Operation Day Counter

Address	Purpose
30001	Years
30002	Days
30003	Hours
30004	Minutes
30005	Seconds

Input Registers (30101 – 30105), Resettable Operation Day Counter (Read Only)

Table 3-17: Resettable Operation Day Counter

Address	Purpose
30101	Years
30102	Days
30103	Hours
30104	Minutes
30105	Seconds

Input Registers (30201 – 30203), Energy Counter (Read Only)

The last number of the "Format" field indicates the decimal point place in the "Energy" field. If the number is larger than 0, move the decimal point to the left by the number indicated.

For example, Energy = 1200, Format = 52, Unit = 1. **Energy = 12.00 kWh**

Table 3-18: Energy Counter

Address	Purpose
30201	Energy
30202	Format
30203	Unit 1 = kWh 2 = MWh 3 = GWh 4 = TWh

Input Registers (30301 – 30303), Resettable Energy Counter (Read Only)**Table 3-19: Resettable Energy Counter**

Address	Purpose
30301	Energy
30302	Format
30303	Unit 1 = kWh 2 = MWh 3 = GWh 4 = TWh

Input Registers (30401 – 30417), Error History (Read Only)

The error history can be viewed by reading from the address 30401 onward. The errors are listed in chronological order with the most recent error mentioned first and the oldest last. The error history can contain 16 errors at any time. The error history contents are represented as follows.

Table 3-20: Error Coding

Error Code	Sub-code
Value as a hexadecimal	Value as a hexadecimal

For example, the IGBT temperature error code 41, sub-code 00: 2900Hex -> 4100Dec. For a complete list of error codes, please see the *SVX9000 AF Drives User Manual*, MN04003002E.

October 2005

Chapter 4 — Operation

Start-Up Test

Once the option board has been installed and configured, its operation can be verified by writing a frequency instruction and giving a run command to the drive via the fieldbus.

Drive Settings

Select the fieldbus as the active control bus. For more information, see the *SVX9000 AF Drives User Manual*, MN04003002E.

Master Unit Programming

1. Write to the register "FB Control Word" (42001) a value of **1**. The drive is now in RUN mode.
2. Write to the register "FB Speed Reference" (42003) a value of **5000** (= 50.00%). The motor is now running at a 50% speed.
3. Write to the register "FB Control Word" (42001) a value of **0**. Due to this, the motor stops.

Error Codes and Errors

Drive Error Codes

The OPTCi board indicates a "**Fieldbus Error 53**" if not properly connected to an EtherNet network and one additional EtherNet node.

For example, if you have connected your PC directly to the OPTCi board but have not used a crossover cable, the "**Fieldbus Error 53**" will be reported.

After the fault causing condition has been remedied, the error can be cleared by pressing the RESET button.

Card Slot Error 54 may be due to a faulty board, a temporary malfunction of the board or a disturbance in the environment.

Modbus/TCP

This section lists the Modbus/TCP error codes used by the OPTCi board and possible causes for such errors.

Table 4-1: Error Codes

Code	Modbus Exception	Possible Cause
0x01	Illegal Function	The device does not support the function.
0x02	Illegal Data Address	Attempt to read the query over the memory range.
0x04	Slave Device Failure	The device or connections are faulty.
0x06	Slave Device Busy	Simultaneous query from two different masters to the same memory range.

Appendix A — Process Data

Process Data OUT (Slave to Master)

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

Table A-1: Process Data Out Variables

ID	Data	Value	Unit	Scale
2104	Process Data OUT 1	Output Frequency	Hz	0.01
2105	Process Data OUT 2	Motor Speed	rpm	1
2106	Process Data OUT 3	Motor Current	A	0.1
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
2110	Process Data OUT 7	DC Link Voltage	V	1
2111	Process Data OUT 8	Active Fault Code	—	—

The Multipurpose control application has a selector parameter for every Process Data register. The monitoring values and drive parameters can be selected using the ID number. (See the *SVX9000 AF Drives User Manual*, MN04003002E, for monitoring values and parameters). Default selections are listed in **Table A-1**.

Process Data IN (Master to Slave)

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

Table A-2: Basic, Standard, Local/Remote and Multi-Step Speed 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 A-3: Multipurpose 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 Analog INPUT	%	0.01
2006 – 2011	PD3 – PD8	Not Used	—	—

Table A-4: PID and Pump and Fan 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	—	—

Company Information

Eaton's electrical business is a global leader in electrical control, power distribution, and industrial automation products and services. Through advanced product development, world-class manufacturing methods, and global engineering services and support, Eaton's electrical business provides customer-driven solutions under brand names such as Cutler-Hammer®, Powerware®, Durant®, Heinemann®, Holec® and MEM®, which globally serve the changing needs of the industrial, utility, light commercial, residential, and OEM markets. For more information, visit www.EatonElectrical.com.

Eaton Corporation is a diversified industrial manufacturer with 2004 sales of \$9.8 billion. Eaton is a global leader in electrical systems and components for power quality, distribution and control; fluid power systems and services for industrial, mobile and aircraft equipment; intelligent truck drivetrain systems for safety and fuel economy; and automotive engine air management systems, powertrain solutions and specialty controls for performance, fuel economy and safety. Eaton has 56,000 employees and sells products to customers in more than 125 countries. For more information, visit www.eaton.com.

Eaton Electrical Inc.
1000 Cherrington Parkway
Moon Township, PA 15108-4312
USA
tel: 1-800-525-2000
www.EatonElectrical.com

EAT•N

Cutler-Hammer

© 2005 Eaton Corporation
All Rights Reserved
Printed in USA
Publication No. MN04012005E/CPG
October 2005