# Cutler-Hammer

## Modbus/TCP Option Board OPTCi for 9000X Drives

User Manual

October 2005
New Information

October 2005

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Cover Photo: Cutler-Hammer® 9000X Drives.

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# 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.

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## 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.

# 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.

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.

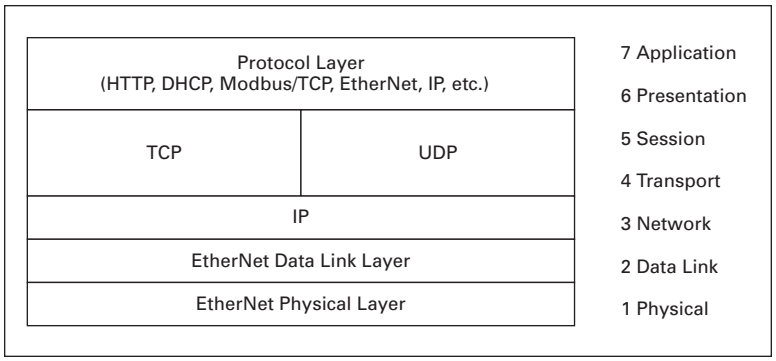



**Figure 1-2: Protocol Layer**

### *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.

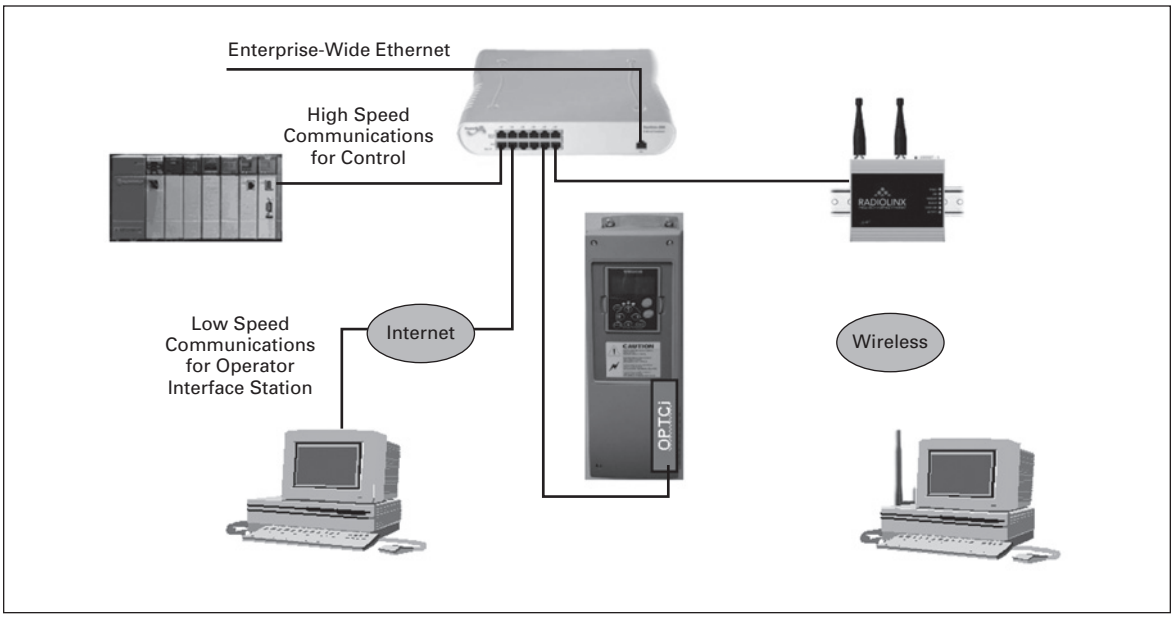



**Figure 1-3: Typical Example of EtherNet Communications in Control and Operator Interface**

## Connections and Wiring

The OPTCi board supports 10 and 100 Mpbs 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.

# Chapter 2 — Installation

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

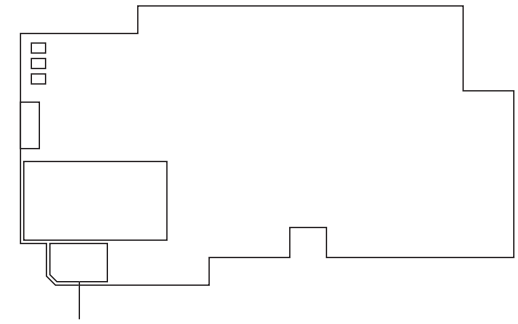
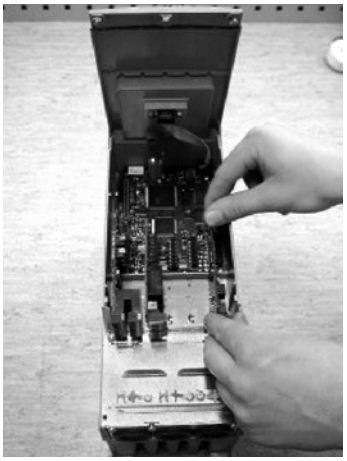
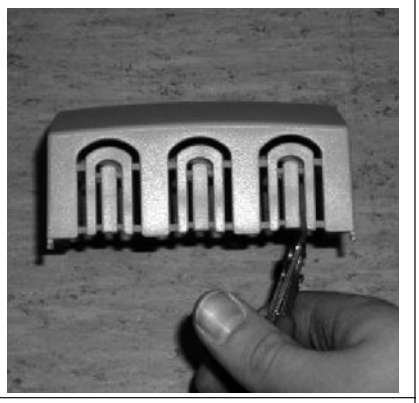
**⚠ CAUTION**

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. |  |

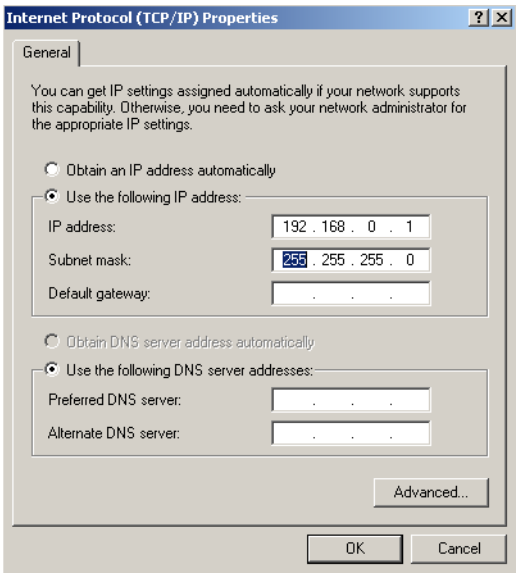
**Table 2-1: Installing the Modbus/TCP Option Board (Continued)**

| Item | Description | |
|---|---|---|
| **D** | Install the OPTCi apadpter in slot D or E on the control board of the drive. Make sure the grounding plate (shown below) fits tightly in the clamp.<br>  <br>Grounding Plate |  |
| **E** | Make a sufficiently wide opening for your cable by cutting the grid as wide as necessary. |  |
| **F** | Close the cover of the control unit and the cable cover. |  |

## 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.



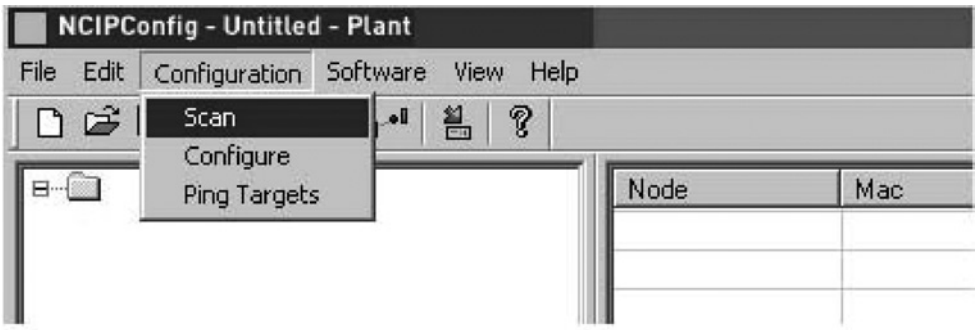

When you are finished experimenting with the OPTCi interface, remember to change the adapter back to DHCP before you re-connect your PC to the office LAN.

## Using NCIPConfig

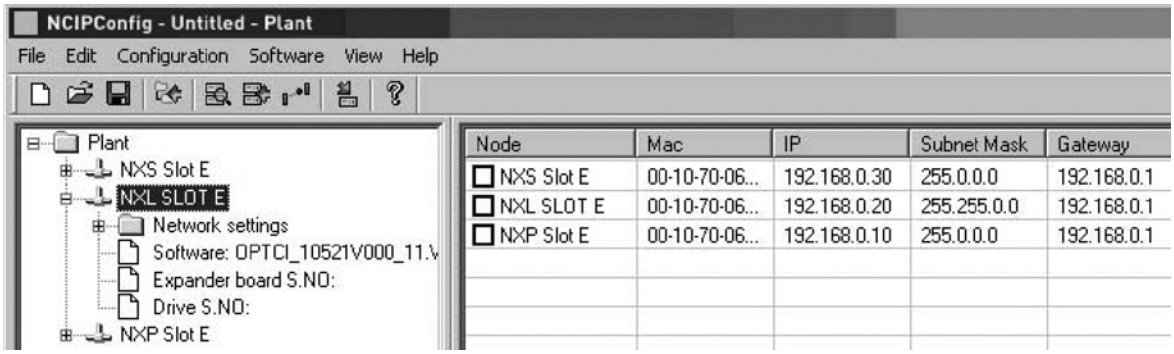
Before using the OPTCi interface board, you must set its IP address. The supplied software application NCIPConfig is used to configure the OPTCi's IP address and update the adapter's firmware. To install the NCIPConfig application, double click the NCIPConfig icon and follow the following installation 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.

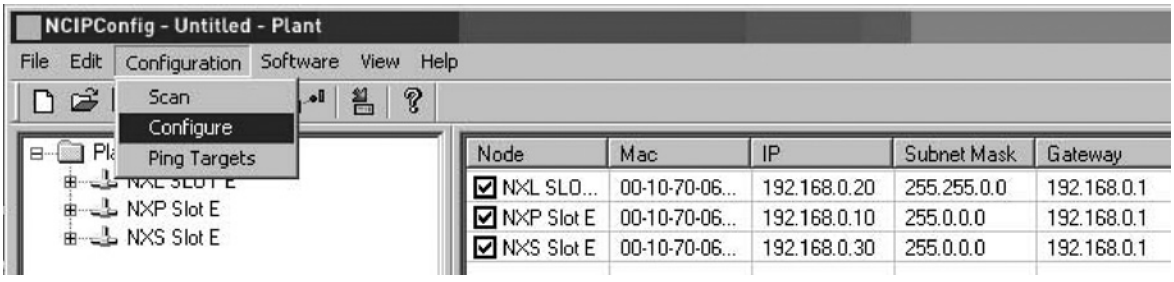
**Note:** Some network switches may block broadcast messages. In that case, each network node must be scanned separately.




**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.

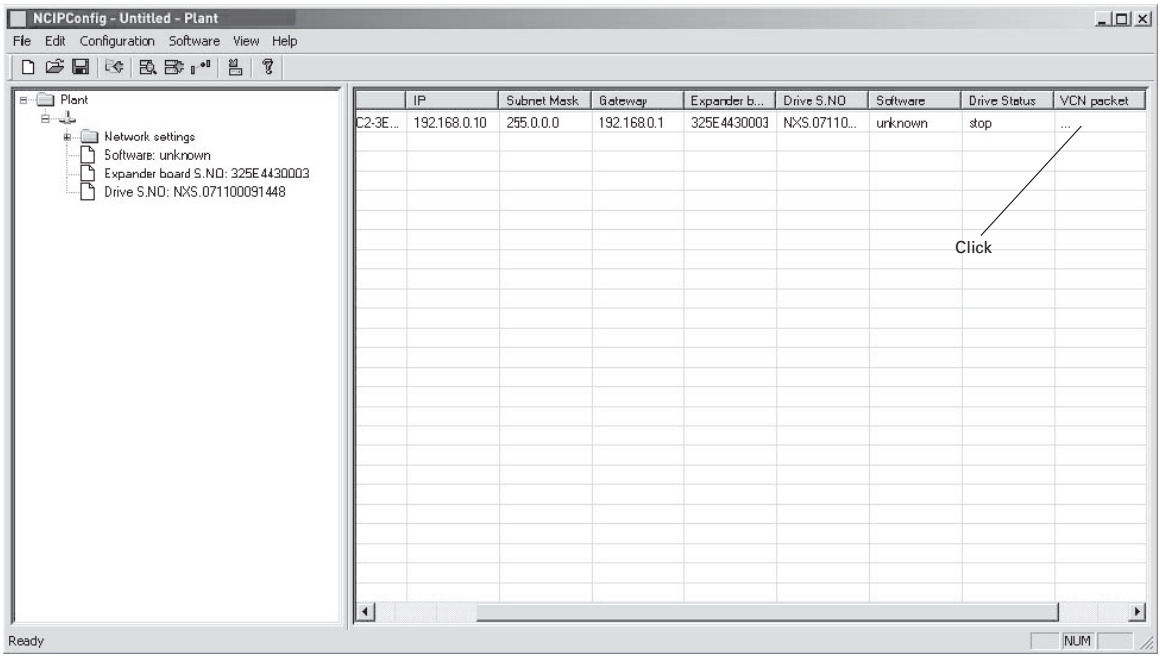


## Updating OPTCi Option Board with the NCIPConfig Tool

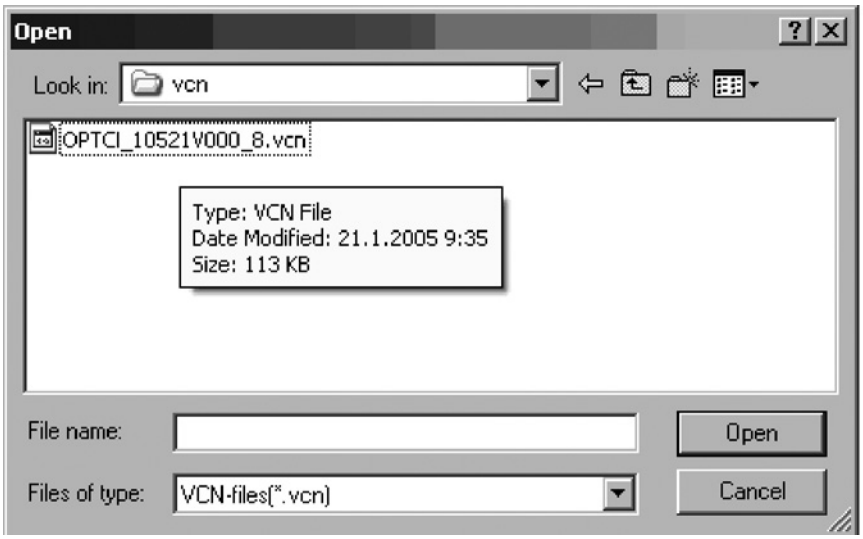
In some cases, it may be necessary to update the option board's firmware. Unlike other option boards, the OPTCi option board's firmware is updated with the NCIPConfig software, and the data transfer occurs via the EtherNet connection, not the standard SVDRIVE cable.

To start the firmware update:

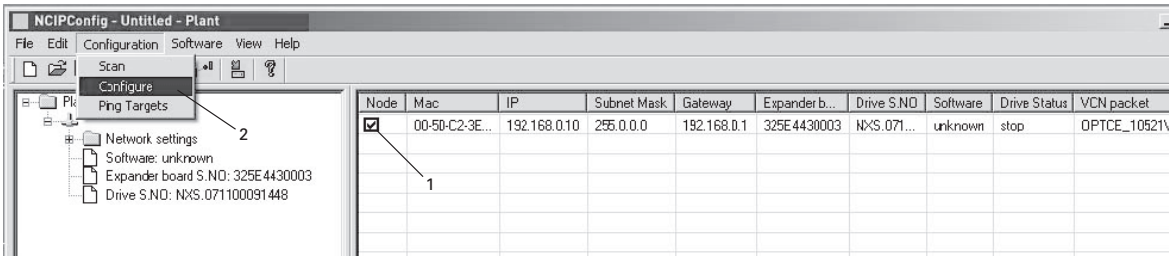
1. Scan the nodes in the network according to the instructions in Step 1 on **Page 2-4**.
2. Once you can see all nodes in NCIPConfig's table view, you can update the new firmware by clicking the **VCN packet** field on the far right of the NCIPConfig's table view.




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**.



# 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)

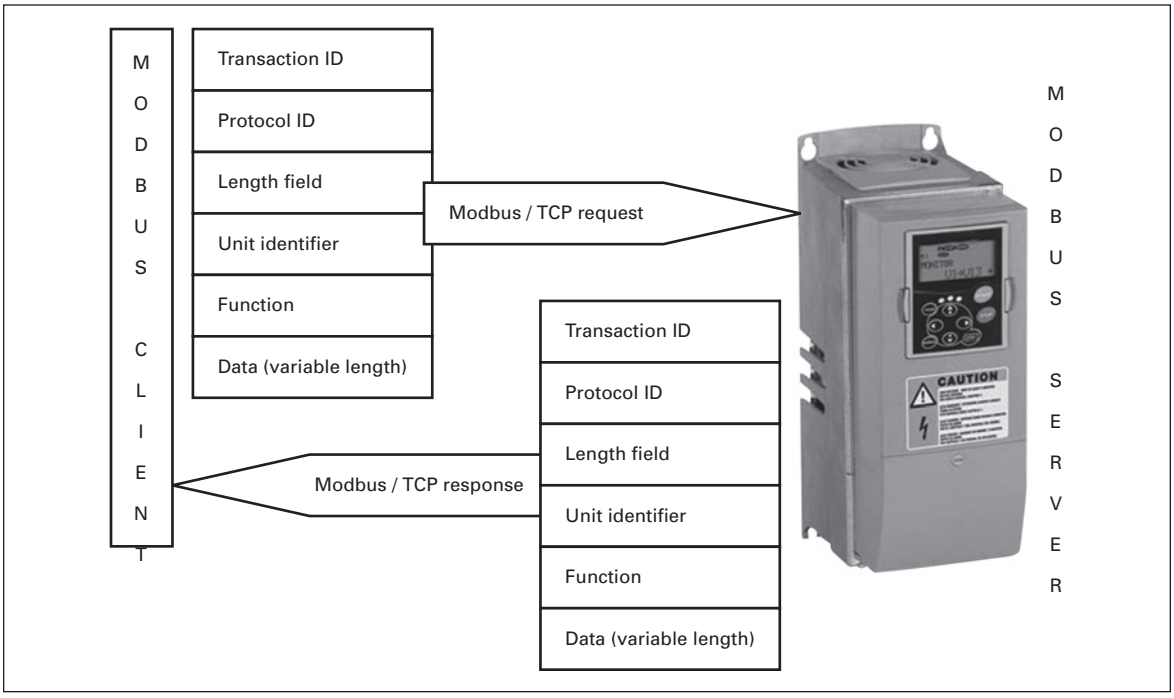



**Figure 3-1: Modbus Transaction**

## 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.

### *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 |

## 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 |

### *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.

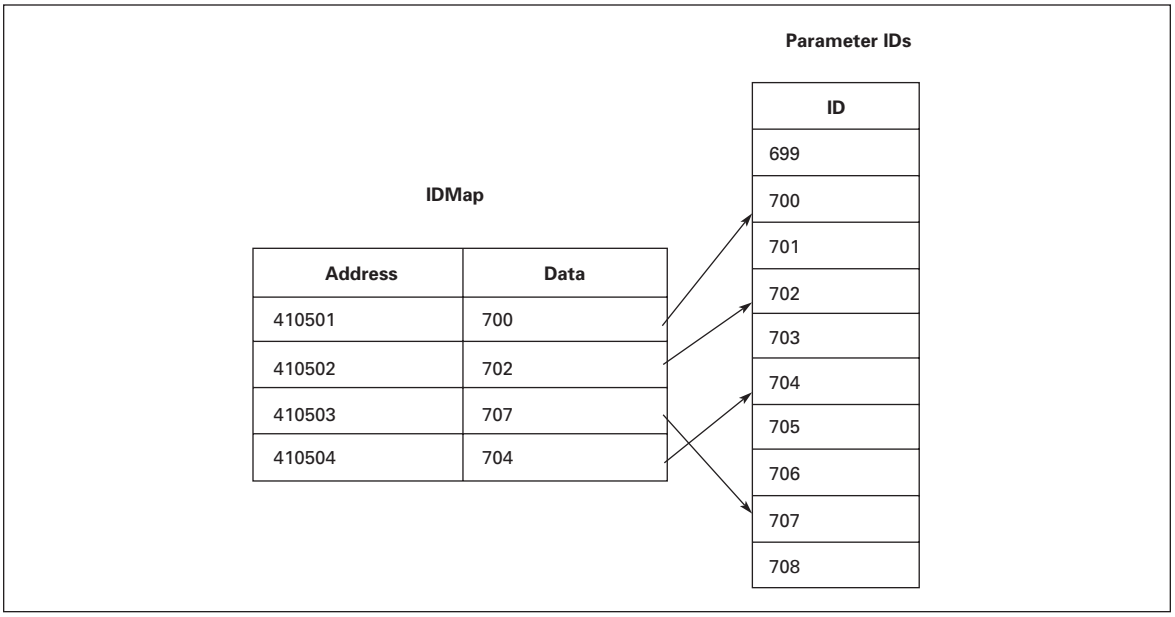



**Figure 3-2: IDMap Initialization**

**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**. |

### *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 |

## 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<br>1 = kWh<br>2 = MWh<br>3 = GWh<br>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<br>1 = kWh<br>2 = MWh<br>3 = GWh<br>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.

# 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<br>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<br>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<br>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 | — | — |

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