Cutler-Hammer

BACnet MS/TP Option Board OPTCJ for 9000X Drives

User Manual

August 2006
New Information

August 2006

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.

August 2006

Table of Contents

August 2006

List of Figures

List of Tables

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.

August 2006

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.

August 2006

August 2006

Chapter 1 — General

This manual describes the installation, configuration and use of the OPTCJ BACnet fieldbus adapter from Eaton's electrical business. The OPTCJ is a plug-in board that is compatible with any open or enclosed drive product that uses an SVX or SPX processor module (including the HVX9000 or CPX9000 family). The OPTCJ adapter can be used in slots D or E of the processor module.

BACnet is an acronym for "**B**uilding **A**utomation and **C**ontrol **N**etwork". BACnet is a true non-proprietary communication protocol conceived by a consortium of building management and system users. BACnet has been adopted by ASHRAE (American Society of Heating Refrigeration and Air-conditioning Engineers) as its standard network protocol, and is rapidly gaining international acceptance. BACnet is used in building automation, lightning control, air-conditioning and in heating automation. The protocol is suitable for enterprise wide communication in large building automation projects.

The OPTCJ BACnet adapter is an MS/TP (Master-Slave/Token-Passing) device that supports RS-485 physical layer.

⚠ 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.

OPTCJ Board

Table 1-1: BACnet Option Board Technical Data

Category	Description	Specification
Connections	Interface	OPTCJ: Pluggable connector (5.08 mm)
	Data transfer method	RS-485 MS/TP, half-duplex
	Transfer cable	Twisted pair (1 pair and shield)
	Electrical isolation	500V DC
Communications	BACnet MS/TP	As described in ANSI/ASHRAE Standards 135-2004
	Baud rate	9600, 19200 and 38400 baud
	MAC Addresses	1 to 27
Environment	Ambient operating temperature	14° – 131°F (-10° – 55°C)
	Storing temperature	-40° – 140°F (-40° – 60°C)
	Humidity	<95%, No condensation allowed
	Altitude	Max. 3280 ft. (1000m)
	Vibration	0.5 G at 9 – 200 Hz
Safety	—	Fulfills EN 50178 standard

System Software Versions

OPTCJ BACnet option board is supported from system software versions:

- SVX SVX00031V015 or V016.VCN
- SPX SPX00032V011 or V012.VCN

BACnet Fieldbus Board Layout and Connections

The BACnet option board is connected to the fieldbus through either a 5-pin pluggable bus connector (board OPTCJ) or a 9-pin female sub-D-connector (board OPTC8).

The communication with the control board of the drive takes place through the standard Cutler-Hammer® Interface Board Connector.

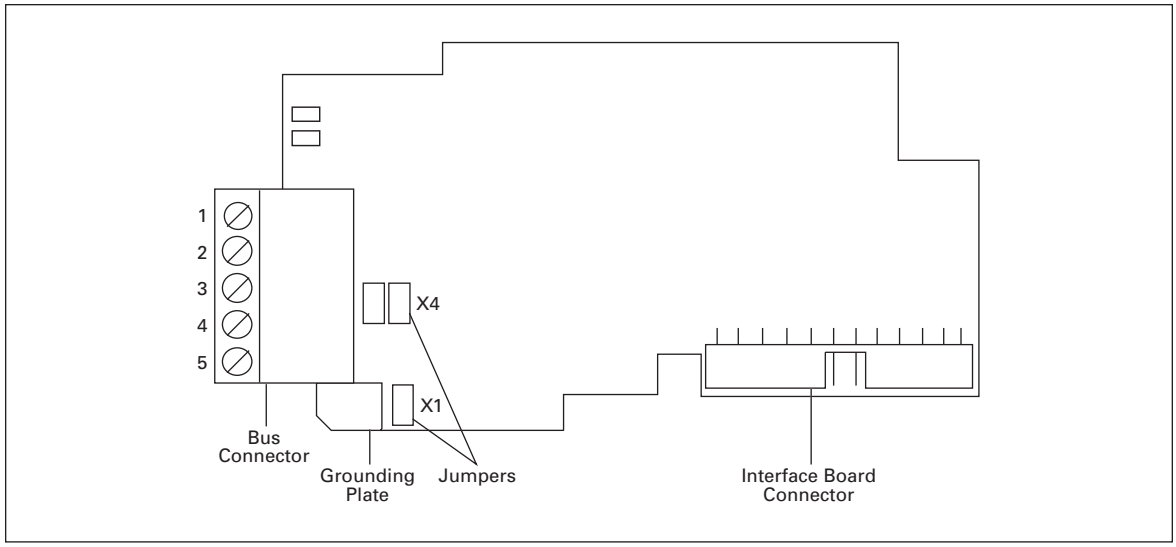


Figure 1-1: Cutler-Hammer BACnet Option Board OPTCJ

Table 1-2: OPTCJ Bus Connector Signals

Signal	Connector	Description
NC*	1 ①	No connection
VP	2	Supply voltage — plug (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)

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

Chapter 2 — Installation

Grounding Cable Shield

Grounding by Clamping the Cable to the Converter Frame (Recommended)

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 gray cable shield. Remember to do this for both bus cables (except for the last device). See **Figures 2-1** and **2-2**.
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.

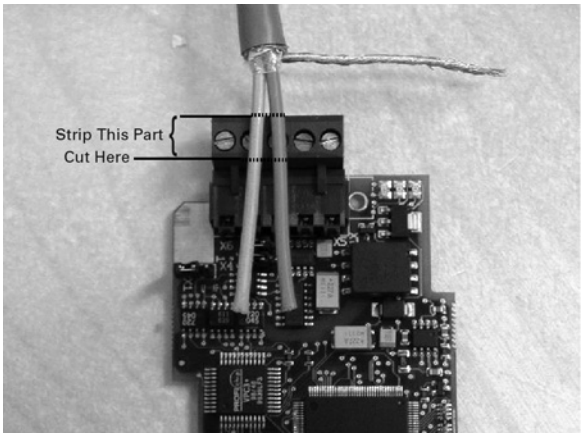


Figure 2-1: Bus Cables

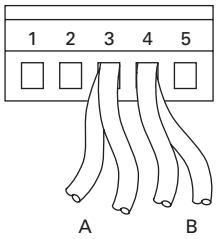


Figure 2-2: Stripped Cable

3. Insert the data conductors **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 **Figures 2-3** and **2-4**:

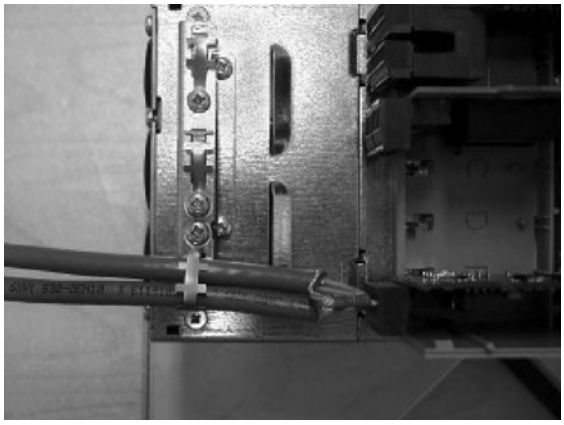


Figure 2-3: Locate Grounding Clamp

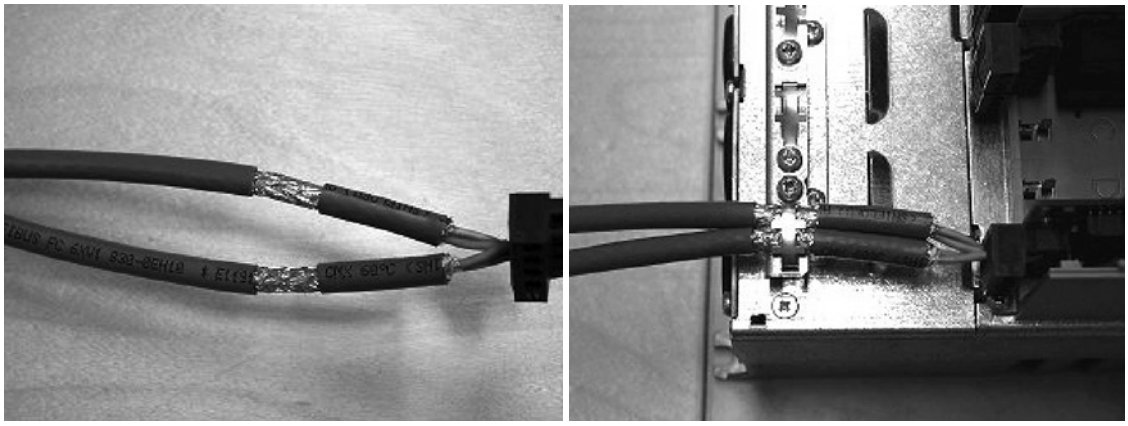


Figure 2-4: Strip at Correct Distance

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 on **Pages 2-1** and **2-2**. Other devices of the net just pass the shield. The use of a ferule to will allow the cable shielding to easily be inserted into the terminal block.

1. Strip about 5 cm of the cable and cut off the gray 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 cable at about 0.5 cm to fit in the terminals. See **Figure 2-5**.

Note: Do this for both cables.

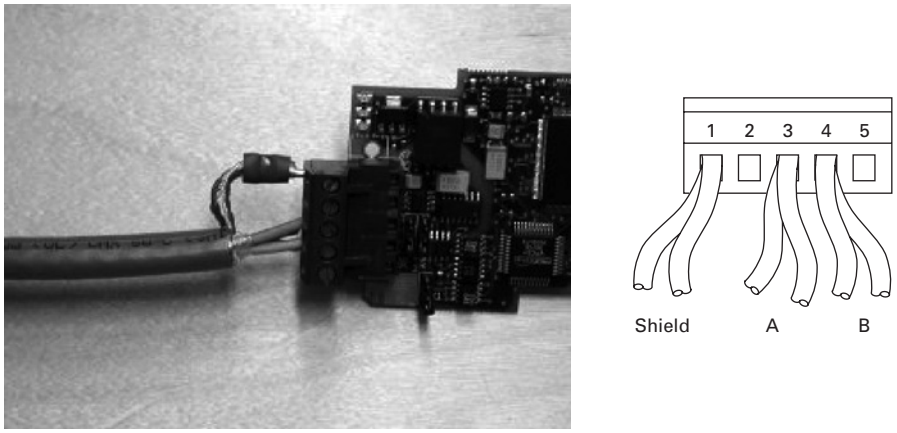


Figure 2-5: Both Cables on One Clamp

3. Fix both the cables on the frame with the clamp. See **Figure 2-5**.

Bus Terminal Resistors

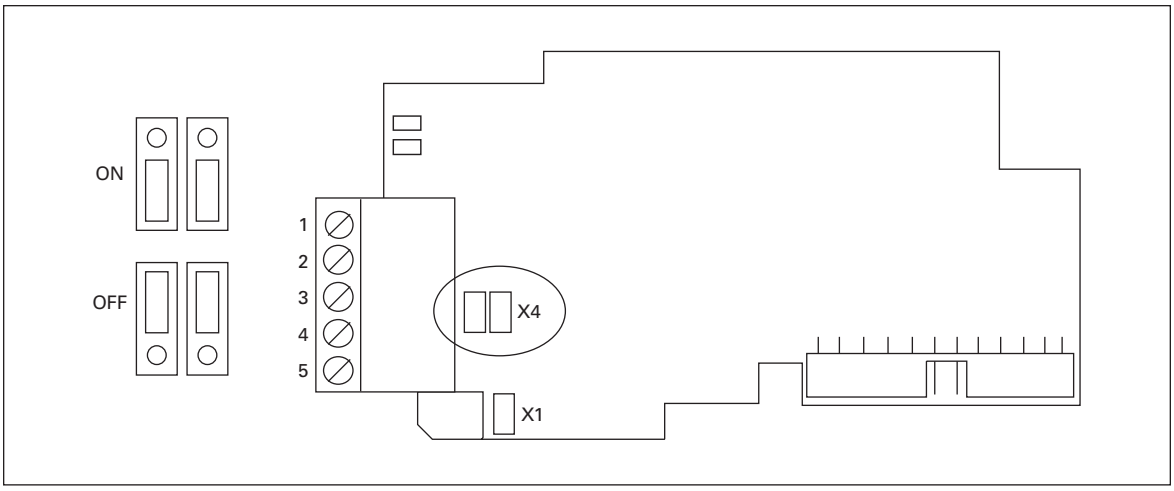


Figure 2-6: Using Jumper X4 to Set the Bus Termination

If the drive is the last device of the fieldbus line, the bus termination must be set. Use jumper X4 (ON position). See **Figure 2-6**.

Bus Biasing

Bus biasing is recommended to ensure fault free communication between all of the devices on RS-485. Bus biasing ensures that the bus is at the 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 within +200 mV to +7V or -200 mV to -7V. Illegal bus state is from -200 mV to +200 mV.

Table 2-1: Bias Resistor Size vs. Number of Node

Number of Nodes	Bias Resistance
2 – 5	1.8K ohm
5 – 10	2.7K ohm
11 – 20	12K ohm
21 – 30	18K ohm
31 – 40	27K ohm

Fail Safe Biasing in OPTCJ Option Board

Connect biasing resistors between pins #2 and #4 as well as pins #3 and #5 as shown in **Figure 2-7**.

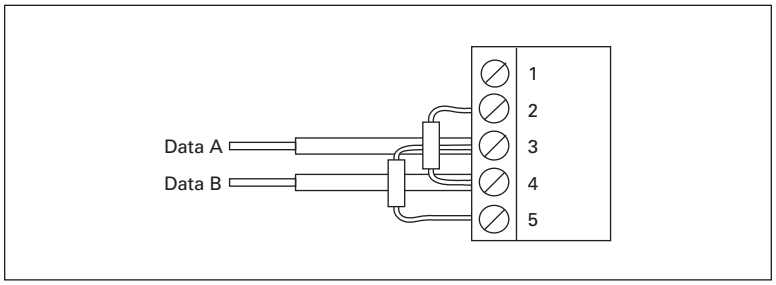


Figure 2-7: Biasing Resistor Connections

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).

LED Indications

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

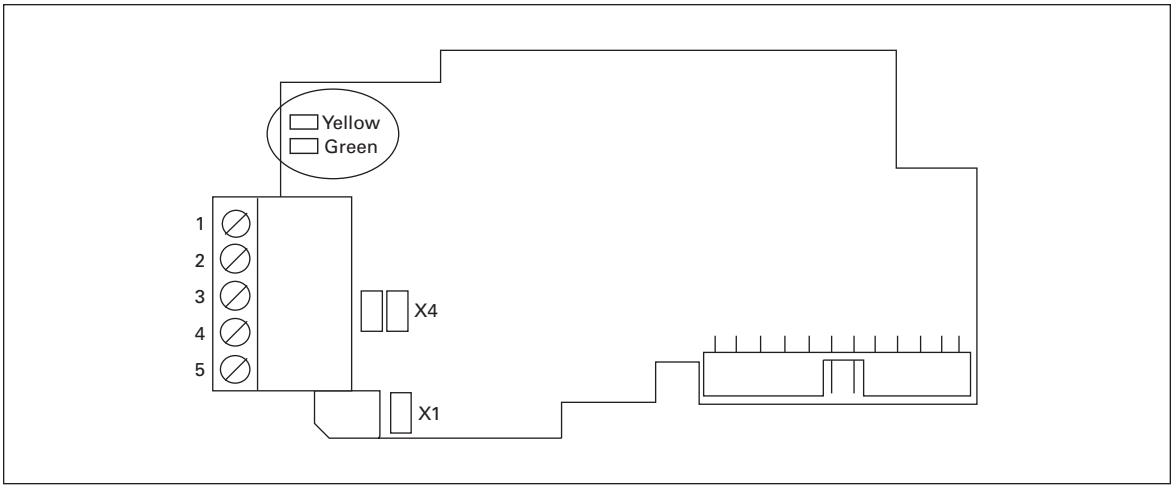


Figure 2-8: LED Indications on the BACnet Board

Table 2-2: BACnet Board Status LED (BS) YELLOW

LED is:	Meaning
OFF	Option board not activated.
ON	Option board in initialization state waiting for activation command from the drive.
Blinking fast (once/sec)	Option board is activated and in RUN state. Option board is ready for external communication.
Blinking slow (once/5 secs)	Option board is activated and in FAULT state. Internal fault of option board.

Table 2-3: Fieldbus Status LED (FS) GREEN

LED is:	Meaning
OFF	Fieldbus module is waiting for parameters from the drive. • No external communication
ON	Fieldbus module is activated. • Parameters received and module activated • Module is waiting for messages from the bus
Blinking fast (once/sec)	Module is activated and receiving messages from the bus.
Blinking slow (once/5 secs)	Module is in FAULT state. • No messages from Master within the watchdog time • Bus broken, cable loose or Master off line

Installing the BACnet MS/TP Option Board in an 9000X Drive

⚠ CAUTION

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

Table 2-4: Installing the BACnet Option Board

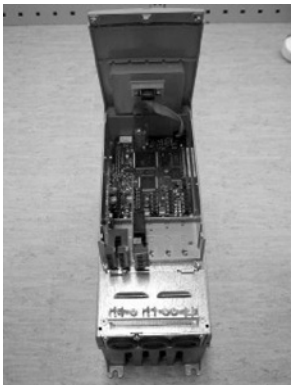
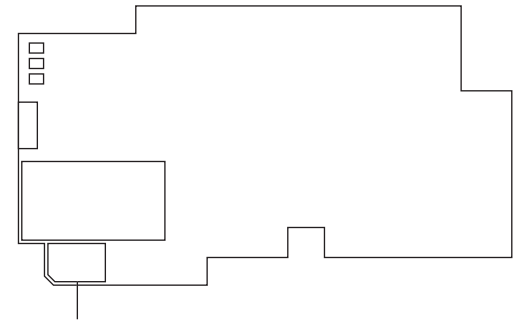
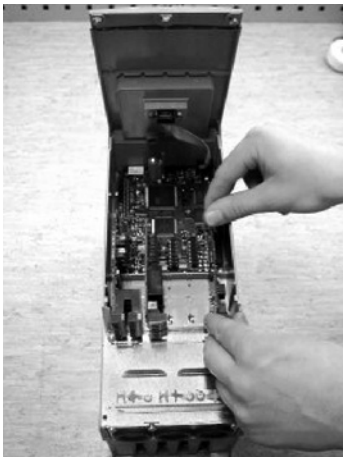
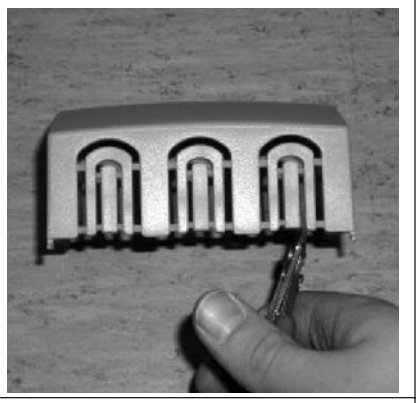
Item	Description	
A	Locate the 9000X drive.	
B	Remove the cable cover.	
C	Open the cover of the control unit.	

Table 2-4: Installing the BACnet Option Board (Continued)

Item	Description	
D	Install the BACnet option board in slot E on the control board of the drive. Make sure the grounding plate (shown below) fits tightly in the clamp.  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.	

Chapter 3 — Configuration

IMPORTANT

First read the Menu Information Chapter in your 9000X drive user manual.

Note: You must select Fieldbus as the active control place, if you wish to control the drive through fieldbus.

Fieldbus Board Parameters

The CH BACnet board is commissioned with the control keypad by giving values to appropriate parameters in menu **M6** (for locating the expander board menu see your 9000X drive user manual).

Expander Board Menu (M6)

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 press the *Menu button right* again, you will reach the parameter group level where there are two groups: Editable parameters and Monitored values. Another press on the *Menu button right* takes you to either of these groups.

BACnet Parameters

To commission the RS-485 board, enter the level P6.5.1.# from the Parameters group (G6.5.1). Give desired values to all RS-485 parameters (see **Figure 3-1** and **Table 3-1**).

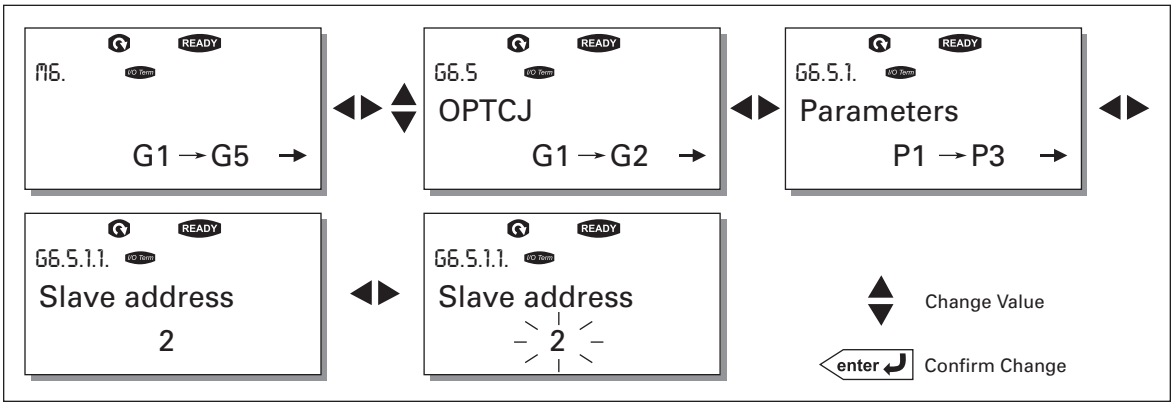


Figure 3-1: Changing the BACnet Board Commissioning Parameter Values

Table 3-1: BACnet Option Board Parameters

No.	Name	Default	Range	Description
1	MAC ADDRESS	1	1 – 127	
2	INDEX NUMBER	0	0-65535	Unique system identifier
3	BAUD RATE	1	1 – 9600 baud 2 – 19200 baud 3 – 38400 baud	Communication speed

Required MS/TP Parameters

Before the OPTCJ is connected to a network, there are three parameters that must be set in order for it to operate correctly, these are the MACID (Medium Access Control Identifier), Index Number, and the BAUD rate.

The MACID must be unique on the network to which it is connected. The same MAC address may be used on a device on another subnet. MACIDs 128 – 254 are reserved for slave devices. MACIDs 1 – 127 are valid for both masters and slaves. The portion of the address space that is actually used for masters in a particular installation is determined by the value of the Max_Master property of the Device object.

It is recommended that MAC address 0 be reserved for use by the MS/TP router and 255 is reserved for broadcasts.

The Index Number is used by BACnet networks to uniquely identify BACnet nodes over the entire network (including subnets). The number may be programmed manually from the keypad to any in the range of 0 – 65535. The number zero is a special case that will instruct the OPTCJ adapter to create a unique index number by reading information from the drive's power unit.

The baud rate for each device must also be set, and must match all the other devices on the network for communication to work. The default BAUD rate is 9600.

Communication Status

To see the present status of the RS-485 fieldbus, enter the Comm.Status page from Monitor menu (G6.5.2) (see **Figure 3-2** and **Table 3-2**).

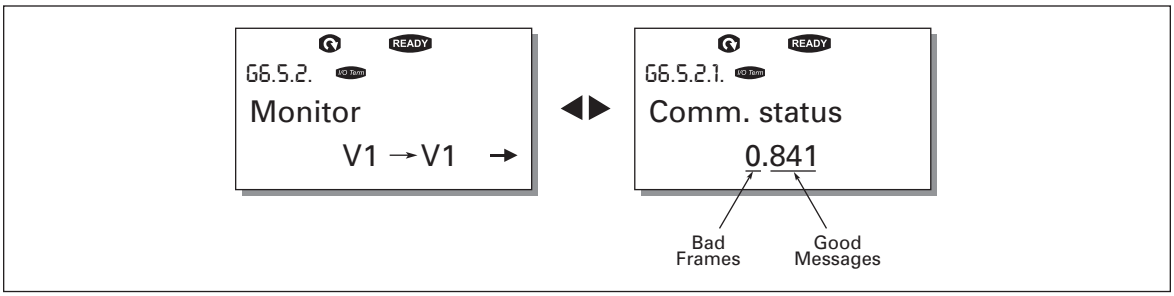


Figure 3-2: Communication Status

Table 3-2: BACnet Message Indications

Good Messages	
0 – 999	Number of messages received without communication errors
Bad Frames	
0 – 64	Number of messages received with CRC or parity errors

Annex — Protocol Implementation Conformance Statement (Normative)

(This annex is part of this Standard and is required for its use.)

BACnet Protocol Implementation Conformance Statement

Date: May 31, 2005
Vendor Name: Eaton Cutler-Hammer
Product Name: BACnet Option Board
Product Model Number: OPTCJ
Applications Software Version: 10522 **Firmware Revision:** 1 **BACnet Protocol Revision:** 4

Product Description:
BACnet Option board is designed for CH SVX family devices.

BACnet Standardized Device Profile (Annex L):
BACnet Application Specific Controller (B-ASC)

List all BACnet Interoperability Building Blocks Supported (Annex K):
DS-RP-B, DS-WP-B, DM-DDB-B, DM-DOB-B.

Segmentation Capability:
☐ Segmented requests supported Window Size _____
☐ Segmented responses supported Window Size _____

Standard Object Types Supported:

An object type is supported if it may be present in the device. For each standard Object Type supported provide the following data:

1. Whether objects of this type are dynamically creatable using the CreateObject service
2. Whether objects of this type are dynamically deletable using the DeleteObject service
3. List of the optional properties supported
4. List of all properties that are writable where not otherwise required by this standard
5. List of proprietary properties and for each its property identifier, datatype, and meaning
6. List of any property range restrictions

Data Link Layer Options:
MS/TP master (Clause 9), baud rate(s): 9600, 19200, 34800

Device Address Binding:
Is static device binding supported? (This is currently necessary for two-way communication with MS/TP slaves and certain other devices.) ☐ Yes ☐ No

Networking Options:
☐ Router, Clause 6 — List all routing configurations, e.g., ARCNET-Ethernet, Ethernet-MS/TP, etc.
☐ Annex H, BACnet Tunneling Router over IP
☐ BACnet/IP Broadcast Management Device (BBMD)

Does the BBMD support registrations by Foreign Devices? ☐ Yes ☐ No

Character Sets Supported:

Indicating support for multiple character sets does not imply that they can all be supported simultaneously.

☐ ANSI X3.4 ☐ IBM™/Microsoft™ DBCS ☐ ISO 8859-1
☐ ISO 10646 (UCS-2) ☐ ISO 10646 (UCS-4) ☐ JIS C 6226

If this product is a communication gateway, describe the types of non-BACnet equipment/networks(s) that the gateway supports: _____

Object Map

Table 3-3: Object Types and Properties Supported

Property	Object Type		
	Device	**Binary Value**	**Analog Value**
Object Identifier	X	X	X
Object Name	X	X	X
Object Type	X	X	X
System Status	X		
Vendor Name	X		
Vendor Identifier	X		
Model Name	X		
Firmware Revision	X		
Appl Software revision	X		
Protocol Version	X		
Protocol Revision	X		
Services Supported	X		
Object Types Supported	X		
Object List	X		
Max APDU Length	X		
Segmentation Support	X		
APDU Timeout	X		
Number APDU Retries	X		
Max Master	X		
Max Info Frames	X		
Device Address Binding	X		
Database Revision	X		
Preset Value		X	X
Status Flags		X	X
Event State		X	X
Out-of-Service		X	X
Units			X
Priority Array		X ①	X ①
Relinquish Default		X ①	X ①
Polarity			
Active Text		X	
Inactive Text		X	

① Only with commandable values.

Table 3-4: Binary Value Object

Instance ID	Object Name	Description	Inactive / Active	Present Value Access Type
BV0	Ready State	Indicates whether the drive is ready or not	Not Ready / Ready	R
BV1	Run/Stop State	Indicates whether the drive is running or stopped	Stop / Run	R
BV2	Fwd/Rev State	Indicates the rotation direction of the motor	Fwd / Rev	R
BV3	Fault State	Indicates if a fault is active	OK / Fault	R
BV4	Warning State	Indicates if a warning is active	OK / Warning	R
BV5	At Setpoint	Ref. Frequency reached	False / True	R
BV6	At Zero Speed	Motor Running at zero speed	False / True	R
BV7	General 0	Application specific bit from drives General Status Word	0 / 1	R
BV8	General 1	Application specific bit from drives General Status Word	0 / 1	R
BV9	General 2	Application specific bit from drives General Status Word	0 / 1	R
BV10	General 3	Application specific bit from drives General Status Word	0 / 1	R
BV11	General 4	Application specific bit from drives General Status Word	0 / 1	R
BV12	General 5	Application specific bit from drives General Status Word	0 / 1	R
BV13	General 6	Application specific bit from drives General Status Word	0 / 1	R
BV14	General 7	Application specific bit from drives General Status Word	0 / 1	R
BV15	Run/Stop CMD	Command to start drive (FB control is active)	Stop / Run	C
BV16	Fwd/Rev CMD	Command to change rotational direction (FB control is active)	Fwd / Rev	C
BV17	Reset Fault	Command to reset Active Fault from drive	0 / Reset	C
BV18	FBFixedControlWord Bit_3	Application Specific bit from the Fixed Control Word	0 / 1	C
BV19	FBFixedControlWord Bit_4	Application Specific bit from the Fixed Control Word	0 / 1	C
BV20	FBFixedControlWord Bit_5	Application Specific bit from the Fixed Control Word	0 / 1	C
BV21	FBFixedControlWord Bit_6	Application Specific bit from the Fixed Control Word	0 / 1	C
BV22	FBFixedControlWord Bit_7	Application Specific bit from the Fixed Control Word	0 / 1	C
BV23	FBFixedControlWord Bit_8	Application Specific bit from the Fixed Control Word	0 / 1	C

Table 3-4: Binary Value Object (Continued)

Instance ID	Object Name	Description	Inactive/Active	Present Value Access Type
BV24	FBFixedControlWord Bit_9	Application Specific bit from the Fixed Control Word	0 / 1	C
BV25	FBFixedControlWord Bit_10	Application Specific bit from the Fixed Control Word	0 / 1	C
BV26	FBFixedControlWord Bit_11	Application Specific bit from the Fixed Control Word	0 / 1	C
BV27	FBFixedControlWord Bit_12	Application Specific bit from the Fixed Control Word	0 / 1	C
BV28	FBFixedControlWord Bit_13	Application Specific bit from the Fixed Control Word	0 / 1	C
BV29	FBFixedControlWord Bit_14	Application Specific bit from the Fixed Control Word	0 / 1	C
BV30	FBFixedControlWord Bit_15	Application Specific bit from the Fixed Control Word	0 / 1	C

Note: For Present Value Access Types, R = Read-only, W = Writable, C = Commandable. Commandable values support priority arrays and relinquish defaults.

Table 3-5: Analog Value Object

Instance ID	Object Name	Description	Units	Present Value Access Type
AV0	Frequency Setpoint	Frequency Setpoint	Hz	R
AV1	Output Frequency	Output Frequency	Hz	R
AV2	Motor Speed	Motor Speed	Rpm	R
AV3	Load (power)	Motor Shaft Power	Percent	R
AV4	Kilowatt Hours total	Megawatt Hour Counter (Total)	kWh	R
AV5	Motor Current	Motor Current	Amps	R
AV6	DC link Voltage	DC link Voltage	Volts	R
AV7	Motor Voltage	Motor Voltage	Volts	R
AV8	Unit Temperature	Heatsink Temperature NOT IN SLX -series	° C	R
AV9	Motor Torque	In % of motor nominal Torque	Percent	R
AV10	Operating Days	Operating Days (resettable)	Day	R
AV11	Operating Hours	Operating Hours (resettable)	Hour	R
AV12	Kilowatt Hours	Kilowatt Hours (resettable)	kWh	R
AV13	Torque Reference	Torque Reference NOT IN SLX -series	Percent	R
AV14	Temperature Rise	Calculated motor temperature 100,0% = nominal temperature of motor NOT IN SLX -series	Percent	R
AV15	FBProcessDataOut1	Application specific	-32768.0 to +32767.0 resolution 1.0	R

Table 3-5: Analog Value Object (Continued)

Instance ID	Object Name	Description	Units	Present Value Access Type
AV16	FBProcessDataOut2	Application specific	-32768.0 to +32767.0 resolution 1.0	R
AV17	FBProcessDataOut3	Application specific	-32768.0 to +32767.0 resolution 1.0	R
AV18	FBProcessDataOut4	Application specific	-32768.0 to +32767.0 resolution 1.0	R
AV19	FBProcessDataOut5	Application specific	-32768.0 to +32767.0 resolution 1.0	R
AV20	FBProcessDataOut6	Application specific	-32768.0 to +32767.0 resolution 1.0	R
AV21	FBProcessDataOut7	Application specific	-32768.0 to +32767.0 resolution 1.0	R
AV22	FBProcessDataOut8	Application specific	-32768.0 to +32767.0 resolution 1.0	R
AV23	Active Fault Code	Active Fault Code	—	R
AV24	Speed Reference	Speed Reference, percentage of nominal speed	Percentage	C
AV25	Current Limit	Current Limit	Amps	W
AV26	Min Frequency	Minimum Frequency	Hz	W
AV27	Maximum Frequency	Maximum Frequency	Hz	W
AV28	Accel Time	Acceleration Time	seconds	W
AV29	Decel Time	Deceleration Time	seconds	W
AV30	FBProcessDataIN 1	Application specific	-32768.0 to +32767.0 resolution 1.0	C
AV31	FBProcessDataIN 2	Application specific	-32768.0 to +32767.0 resolution 1.0	C
AV32	FBProcessDataIN 3	Application specific	-32768.0 to +32767.0 resolution 1.0	C
AV33	FBProcessDataIN 4	Application specific	-32768.0 to +32767.0 resolution 1.0	C
AV34	AnyParam ID	ID number that is used in AV35	0.0 to 65535.0 resolution 1.0	W
AV35	AnyParam Value	Value of ID defined by AV34	-32768.0 to +32767.0 resolution	W

Note: For Present Value Access Types, R = Read-only, W = Writable, C = Commandable. Commandable values support priority arrays and relinquish defaults.

Chapter 4 — Fault Tracking

The table below presents the faults related to the BACnet option board. For more information, also see your 9000X drive user manual.

The **BACnet option board status LEDs** have been described in more detail in **Chapter 2 — Installation**.

Table 4-1: RS-485 Option Board Faults

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 board has lost all contact with other devices on the network. • Duplicate MAC ID (Bad Frames in "Comm. status" is incremented every time a frame is received from a device with the same MAC ID on the same segment.)	Check the installation. If installation is correct contact the nearest Eaton representative. Check that MAC ID is unique.
54	Slot fault	Defective option board or slot.	Check the board and slot. Contact the nearest Eaton representative.

You can define with parameters how the drive will react to certain faults:

Table 4-2: Drive Responses to 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

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 2005 sales of $11.1 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 60,000 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

EATON | Cutler-Hammer

Printed in USA
Publication No. MN04012006E/CPG
August 2006