

BACnet Manual for Downloadable Ethernet and Serial Configuration

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1. INTRODUCTION

BACnet is a data communication protocol for building automation and control networks.

NOTE: This protocol is supported in the XL4, XL7, EXL6, EXL10, RCC and XL+.

2. CSCAPE INSTALL

Install the standard distribution of Cscape 9.90 - then proceed as follows:

- Copy the Contents of the "Horner" folder included with the BACnet IP 4.00 Beta fileset to the Cscape folder on your hard drive. This will overwrite several DLLs and other files that are required for the BACnet IP 4.00 Beta
- Copy the "BACnetIP server.dll" file included with the BACnet IP 4.00 Beta fileset to the Cscape Ethernet Protocols folder.

3. FIRMWARE INSTALL

Follow the standard procedure to update your OCS Controller (XL4, EXL6, XL7, EXL10) with firmware version 15.22 available from the Horner Automation web site. Remember, it is always recommended to select the "Install Bootloader" button from the OCS screen rather than an Update Firmware button. That eliminates the possibility of creating a mismatch between the bootloader version loaded and the firmware version loaded. After updating to 15.22, proceed as follows:

- Using the same memory card from containing the 15.22 firmware files, copy (overwrite) the main firmware file on the card with the one included in the BACnet IP 4.00 Beta fileset - which is for beta version 15.23.200
 - File "exl6e" for an EXL6
 - File "exl10e" for an EXL10
 - File "xl4e" for an XL4
 - File "xl7e" for at XL7
- Perform another update. After re-boot, verify that the firmware version is now 15.23.200.

4. FILES NEEDED

After Cscape is installed, four files need to be added to the Cscape files. An example path to access the Cscape files is as follows: **C:\Program Files (x86)\Cscape.**

- Move the two BACnetIP Release files, BACnetIP Server.chm and BACnetIP Server.dll, to the **EthernetProtocols** folder.
- Move the two BACnetMSTP, BACnetMSTP server.chm and BACnetMSTP server.dll, to the **Protocols** folder.

5. BACnet SERVER ADDRESS MAPPING

Table 1 - Mandatory Parameters for the Device Object	
Object	Definition
Object Type	An enumerated type "device" with value 8
Object Identifier	As per the BACnet specification $2^{22} + \text{index}$, e.g. 0x02000010 for node ID 16.
Object Name	Model series name, e.g. XL4e
System Status	<p>An enumerated value which can show the following:</p> <ul style="list-style-type: none"> 0 = Operational 1 = Operational Read Only 2 = Download Required 3 = Download in Progress 4 = Non-Operational 5 = Backup Required
Location	A string, "USA," writable from BACnetIP Master.
Vendor Name	Horner APG LLC
Vendor Identifier	The Vendor Identifier allocated to Horner: 600
Model Name	A string, e.g. "XC1E3", the model number of the product.
Firmware Revision	Actual Firmware version in the format "xx.yy"; e.g. 14.22
Application Software Rev.	Internal firmware revision in the format "a.b.c.xxx" ; e.g. "0.8.0.001"
Protocol Services Supported	A bit string with 40 bits (5 bytes) with bits set for: I_Am, I_Have, Who_Has, Who_Is, readProperty, readPropertyMultiple, writeProperty, writePropertyMultiple, 0x00 0xD0, 0x01, 0x06, 0x03.
Protocol Object Types Supported	A bit string with 50 bits, with bits set for Analog Value, Analog Input, Analog Output, Digital Value, Digital Input, Digital Output, and Device
Object List	A BACnet array containing properties of Analog Value, Analog Input, Analog Output, and Device.
MAX APDU length supported	Unsigned, BACnet/IP 1476
Segmentation Supported	3 - NO SEGMENTATION
APDU Timeout	Unsigned, Defaults to 3000. Can be Changed.
APDU Retries	Unsigned. Hardcoded to 3.
Database Revision	0
Device Address Binding	Empty

6. BACnet STACK SERVICES SUPPORTED

The BACnet stack currently implements services listed in the following table. The user can build a BACnet device that meets the standardized profile for a BACnet Smart Sensor, BACnet Smart Actuator, or a BACnet Application Specific Controller.

Table 2 - BACnet Services Supported		
BACnet Service	Initiate	Execute
Who Is	Yes	Yes
I Am	Yes	Yes
Who Has	Yes	Yes
I Have	Yes	Yes
Read Property	Yes	Yes
Write Property	Yes	Yes
Read Property Multiple	Yes	Yes
Write Property Multiple	-	Yes

Table 3 - BACnet Object Supported	
Protocol Object	Definition
Device Object	Device Details
Analog Value	%R
Analog Input	%AI
Analog Output	%AQ
Digital Value	%M
Digital Input	%I
Digital Output	%Q

Table 4 - BACnet Interoperability Building Blocks Supported	
DS-RP-B	Data Sharing Read-Property-B
DS-RPM-B	Data Sharing Read-Property-Multiple-B
DS-WP-B	Data Sharing Write-Property-B
DS-WPM-B	Data Sharing Write-Property-Multiple-B
DM-DDB-B	Device Management Dynamic-Device-Binding-B
DM-DOB-B	Device Management Dynamic-Object-Binding-B

Table 5 - Mandatory Parameters for the Analog Objects	
Analog Value Objects	
Object	Definition
Object Identifier	Encoded as per the BACnet specifications $2^{22} + \text{index}$, e.g. 0x02000010 for %R100
Object Name	A string, e.g. %R100
Object Type	An enumerated type 'analog-value' enumerated value 2
Present Value	Value corresponding to %R register encoded as a real number (-32768.0 - 32767.0)
Status Flags	A bit string containing 4 zeroes. Not used currently.
EventState	An enumerated value indicating 'normal' - enumerated value 0.
OutOfService	A Boolean - Always FALSE.
Engineering Units	An enumerated value indicating 'No Units', enumerated value 95.
Description	A string, e.g. "Retentive Register of BACnet Server"
Analog Input Objects	
Object	Definition
Object Identifier	e.g. %A14
Object Name	A string, e.g. %A14
Object Type	An enumerated type 'analog-input' enumerated value 0
Present Value	Value corresponding to %AI register encoded as a real number (-32768.0 - 32767.0)
Status Flags	A bit string containing 4 zeroes. Not used currently.
EventState	An enumerated value indicating 'normal' - enumerated value 0.
OutOfService	A Boolean - Always FALSE.
Engineering Units	An enumerated value indicating 'No Units', enumerated value 95.
Description	A string, e.g. %A14
Analog Output Objects	
Object	Definition
Object Identifier	e.g. %AQ4
Object Name	A string, e.g. %AQ4
Object Type	An enumerated type 'analog-output' enumerated value 1
Present Value	Value corresponding to %AQ register encoded as a real number (-32768.0 - 32767.0)
Status Flags	A bit string containing 4 zeroes. Not used currently.
EventState	An enumerated value indicating 'normal' - enumerated value 0.
OutOfService	A Boolean - Always FALSE.
Engineering Units	An enumerated value indicating 'No Units', enumerated value 95.
Description	A string, e.g. %AQ4

Table 6 - Mandatory Parameters for the Digital Value Objects	
Digital Value Objects	
Object	Definition
Object Identifier	e.g. Object_Binary_Value: 100
Object Name	A string, e.g. %M100
Object Type	An enumerated type 'analog-value' enumerated value 5
Present Value	Value corresponding to %M register Boolean 0 or 1.
Status Flags	A bit string containing 4 zeroes. Not used currently.
EventState	An enumerated value indicating 'normal' - enumerated value 0.
OutOfService	A Boolean - Always FALSE.
Description	A string, e.g. %M100
Digital Input Objects	
Object	Definition
Object Identifier	e.g. Object_Binary_Input
Object Name	A string, e.g. %I100
Object Type	An enumerated type 'digital-input' enumerated value 3
Present Value	The value in the %I Register Boolean 0 or 1.
Status Flags	A bit string containing 4 zeroes. Not used currently.
EventState	An enumerated value indicating 'normal' - enumerated value 0.
OutOfService	A Boolean - Always FALSE.
Description	A string, e.g. %I100
Digital Output Objects	
Object	Definition
Object Identifier	e.g. Object_Binary_Output
Object Name	A string, e.g. %Q100
Object Type	An enumerated type 'digital-output' enumerated value 4
Present Value	The value in the %Q Register Boolean 0 or 1
Status Flags	A bit string containing 4 zeroes. Not used currently.
EventState	An enumerated value indicating 'normal' - enumerated value 0.
OutOfService	A Boolean - Always FALSE.
Description	A string, e.g. %AQ4

7. BACnet IP DOWNLOADABLE ETHERNET PROTOCOL CONFIGURATION

ATTENTION: Refer to [Sections 2-4](#) to install Cscape, firmware, and files needed to perform the following configuration.

Use the following steps to configure BACnet IP Downloadable Protocol:

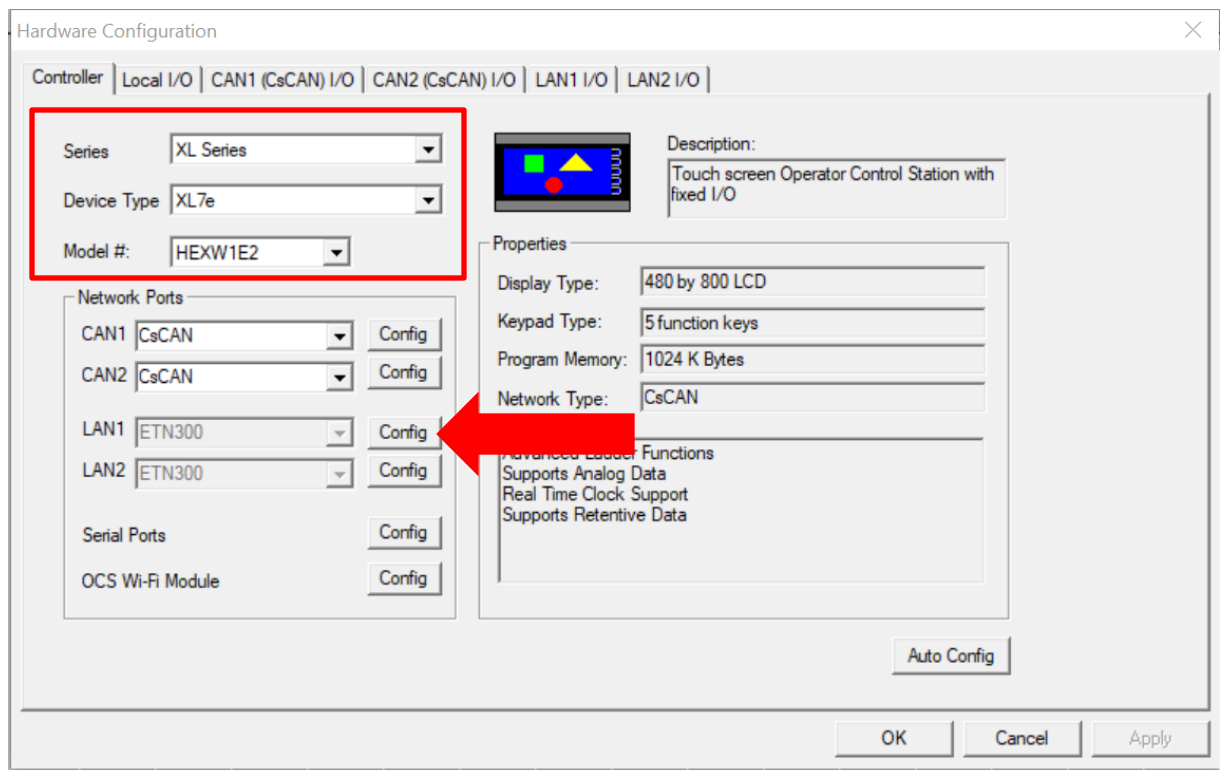


Figure 1 - Hardware Configuration Screen

- From Cscape go to **Controller** → **Hardware Configuration** and verify the controller series and model #. (Figure 1)
- Click on the LAN1 **Config** button. (Figure 1)

LAN1 Configuration ×

Register Usage

Default Settings	Register	Get settings from
IP Address: 192 . 168 . 254 . 128	Name: []	32-BIT Configuration
Net Mask: 255 . 255 . 255 . 0	Name: []	32-BIT Configuration
Gateway: 0 . 0 . 0 . 0	Name: []	32-BIT Configuration
Status: []	Name: []	16-BIT []
Version: []	Name: []	16-BIT []

Use CAN ID for last Octet

Protocol Support

Resident Protocols

- ICMP (Ping)
- EGD (Ethernet Global Data)
- SRTP Slave (90-30 Service Request)
- Modbus Slave
- Ethernet/IP
- FTP (File Server)
- HTTP (Web Server)
- ASCII Over TCP/IP
- NTP Protocol(Obtain clock from web based server)

Configure Selected Protocol

Downloadable Protocols

ETN1/1	BACnetIP server v 4.01	Network	Devices	Scan List
ETN1/2	-- None --	Network	Devices	Scan List

OK Cancel

Figure 2 - LAN1 Configuration

- c) Under **Downloadable Protocols** (LAN1 or LAN2), select **BACnetIP server v4.00**.
- d) Select **Network** button.



Network Config (BacNetIP)

Port Configuration

Minimum Port Id: 1024

Maximum Port Id: 2048

Keep Alive Time: 1000

Retries: 1 (0-255)

Timeout: 1000 mSec

Slave Speed: [dropdown]

Update Scan

Automatic

Update Interval: [] mSec ReacquireTime: [] mSec

Manual

Trigger: [] 1-BIT

ID Select: [] 16-BIT

Master ID / Address

Address: []

Status

Register: [] Name [] 4 x 32-BIT

OK Cancel

Figure 3 - Network Config (BacNetIP)

- e) Assign a Status Register and press **OK**. This will be 4 consecutive 32-bit registers. These status registers correspond to:
- Reserved (UDINT)
 - NoFrame Count (UDINT)
 - BadFrame Count (UDINT)
 - GoodFrame Count (UDINT)

Network Communication Errors: In order to access the Network statistics, a Network status register must be assigned. It occupies eight consecutive registers:

Table 7 - Network Statistics Status Registers			
Number	Statistics	Location	Description
1	Reserved	%Rx	Reserved
2	NoFrameCount	%R(x=2)	This register explains number of times that a device (or devices) did not respond to a transaction. This includes ALL failed transactions, not just those after the retry count is exceeded.
3	BadFrameCount	%R(x=4)	This register explains number of times that a device (or devices) returned an invalid or failed response to a transaction. This includes ALL failed transactions, not just those after the retry count is exceeded.
4	GoodFrameCount	%R(X=6)	This register explains total number of valid responses.

f) Next, select the **Devices** button.

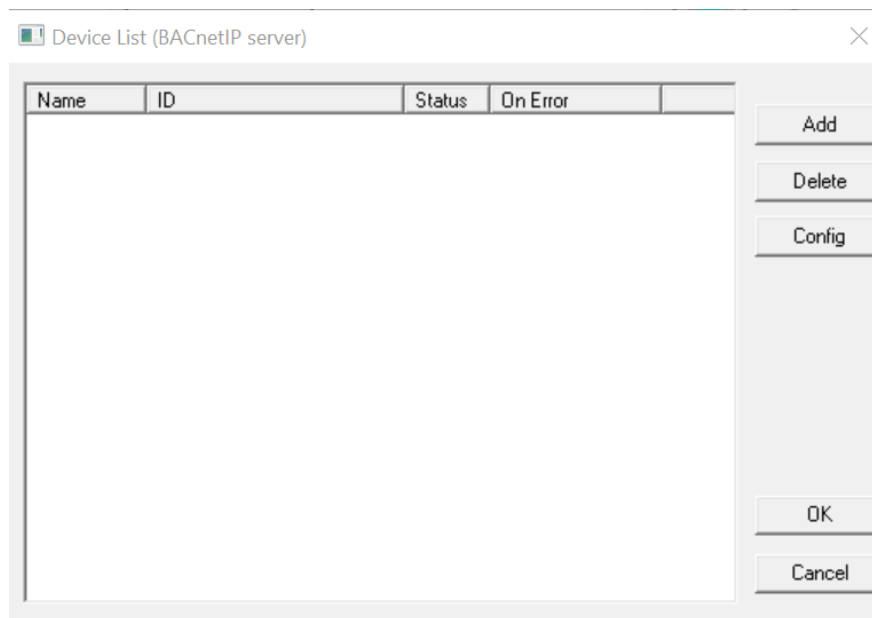
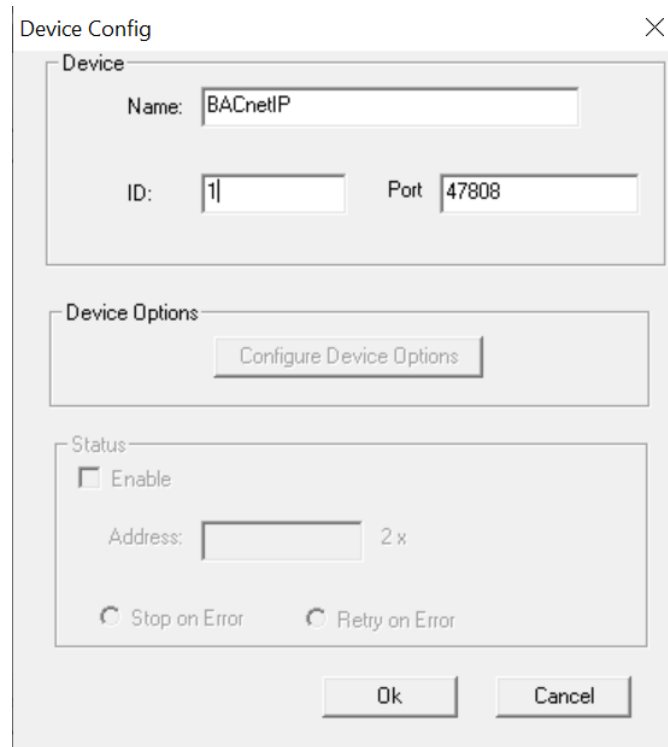


Figure 4 - Device List (BACnetIP server)

g) Press the **Add** button.



Device Config

Device

Name: BACnetIP

ID: 1 Port: 47808

Device Options

Configure Device Options

Status

Enable

Address: 2 x

Stop on Error Retry on Error

Ok Cancel

Figure 5 - Device Config

- h) Assign a name for convenience purposes. It has no BACnet meaning.
- i) The BACnet IP Port number is set to 47808 by default. It may be changed if desired. This is a new feature for version 4.00.
- j) The APDU Timeout has a default of 3000. It can be changed by pressing the **Configure Device Options** button if desired.
- k) Press **OK** when finished setting the Name, Port Number and APDU Timeout. Press **OK** again to return to the LAN1 Configuration page.

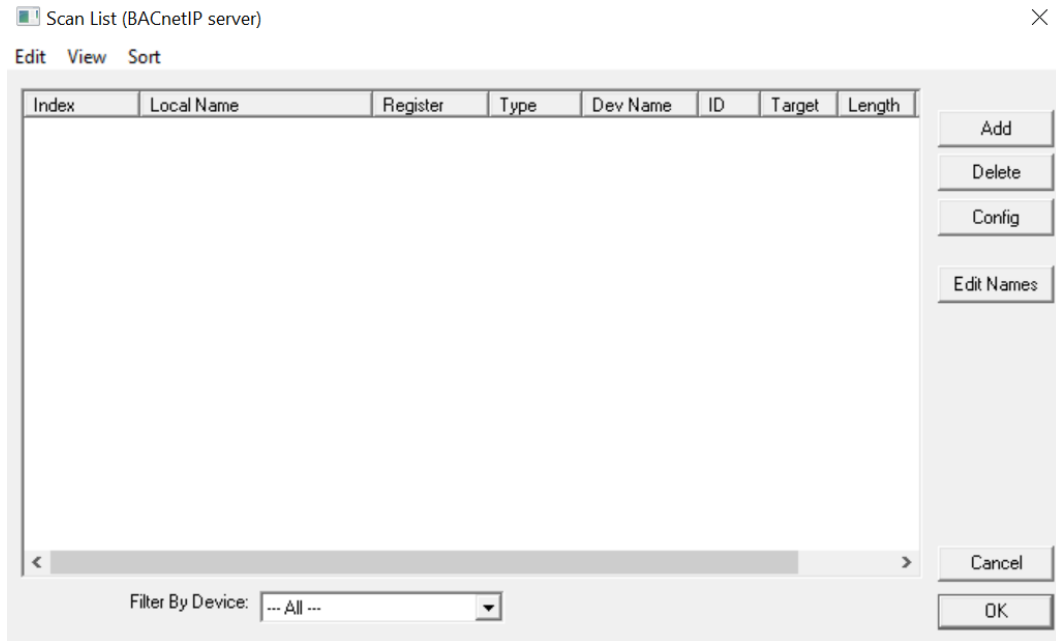
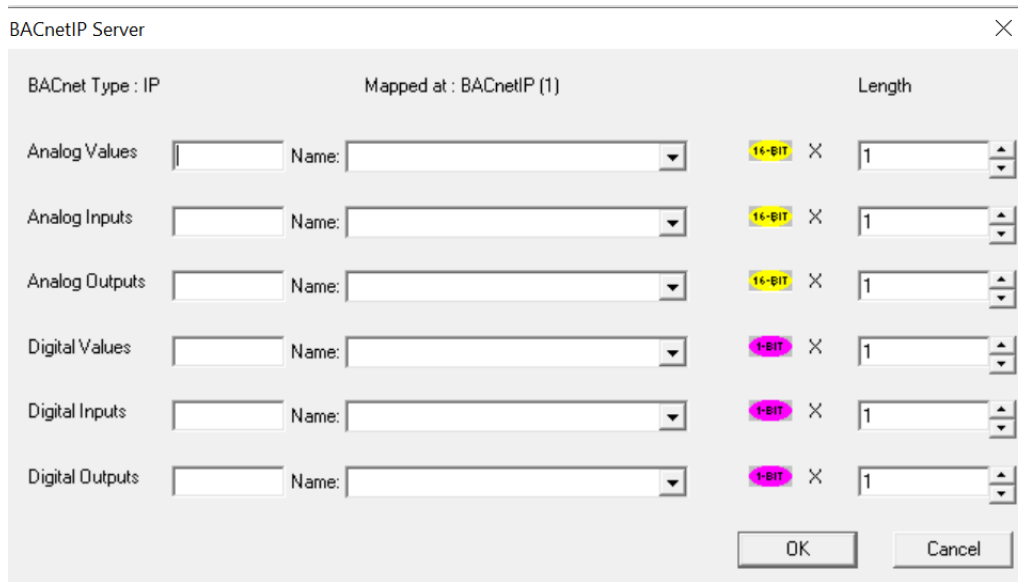


Figure 6 - Scan List (BACnetIP server)

- l) Press the **Scan List** button. This is where Object support is added for Analog Inputs, Analog Outputs, Analog Values, Binary Inputs, Binary Outputs, and Binary Values. Only those Objects which are desired need to be added. By default, these Objects are mapped to the following OCS references types:

Table 8 - Limitations for Data Types	
Data Type	Limitation
Analog Value	5000
Analog Input	256
Analog Output	256
Digital Values	1000
Digital Input	256
Digital Output	256

m) From the **Scan List**, select **Add**.



BACnet Type : IP	Mapped at : BACnetIP (1)	Length
Analog Values	Name: []	16-BIT x 1
Analog Inputs	Name: []	16-BIT x 1
Analog Outputs	Name: []	16-BIT x 1
Digital Values	Name: []	1-BIT x 1
Digital Inputs	Name: []	1-BIT x 1
Digital Outputs	Name: []	1-BIT x 1

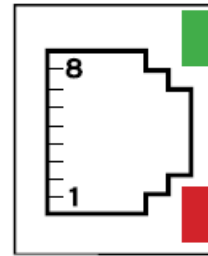
Figure 7 - BACnetIP Server

- n) Fill in the Length refer to Table 8. These will be in words for analog objects and bits for binary objects. For example, configure 100 Analog Values, enter the length of 100.
- o) Fill in the Register. This will be the starting point for that object type in OCS reference memory. For example, to configure Analog Values starting at %R1001, enter a Register of %R1001.
- p) If additional Objects are desired, add them to the scan list (up to a maximum of 6 entries), which would correspond to one each of Analog Inputs, Analog Outputs, Analog Values, Binary Inputs, Binary Outputs, and Binary Values.
- q) Once all the desired objects are mapped, press **OK** on the **Scan List** dialog; **OK** on the **LAN1 Configuration** dialog, and **OK** on the **Hardware Configuration** dialog.
- r) Save the program. When ready to perform a download to the OCS controller to test the program.

Hardware Connections:

1. Cable Specification: Shielded and non-shielded twisted pair 10/100 BASE-T cables with RJ45 connectors.
2. Maximum length between two stations - 100m (323 ft.)
3. Ethernet Connection: The Ethernet connector, Channel 1, is a RJ45 1//00 BASE-T connector. Refer to the pin-out table below.

Table 9 - Pin-outs	
Pin	Pin Name
1	Tx+
2	Tx-
3	Rx+
4	Not used by 10/100 Base-T
5	Not used by 10/100 Base-T
6	Rx-
7	Not used by 10/100 Base-T
8	Not used by 10/100 Base-T


 Link
Indicator

 Activity
Indicator

9. THE BACnet MS/TP SERIAL CONFIGURATION

ATTENTION: Refer to [Sections 2-4](#) to install Cscape, firmware, and files needed to perform the following configuration.

Use the following steps to configure BACnet MS/TP Serial Protocol:

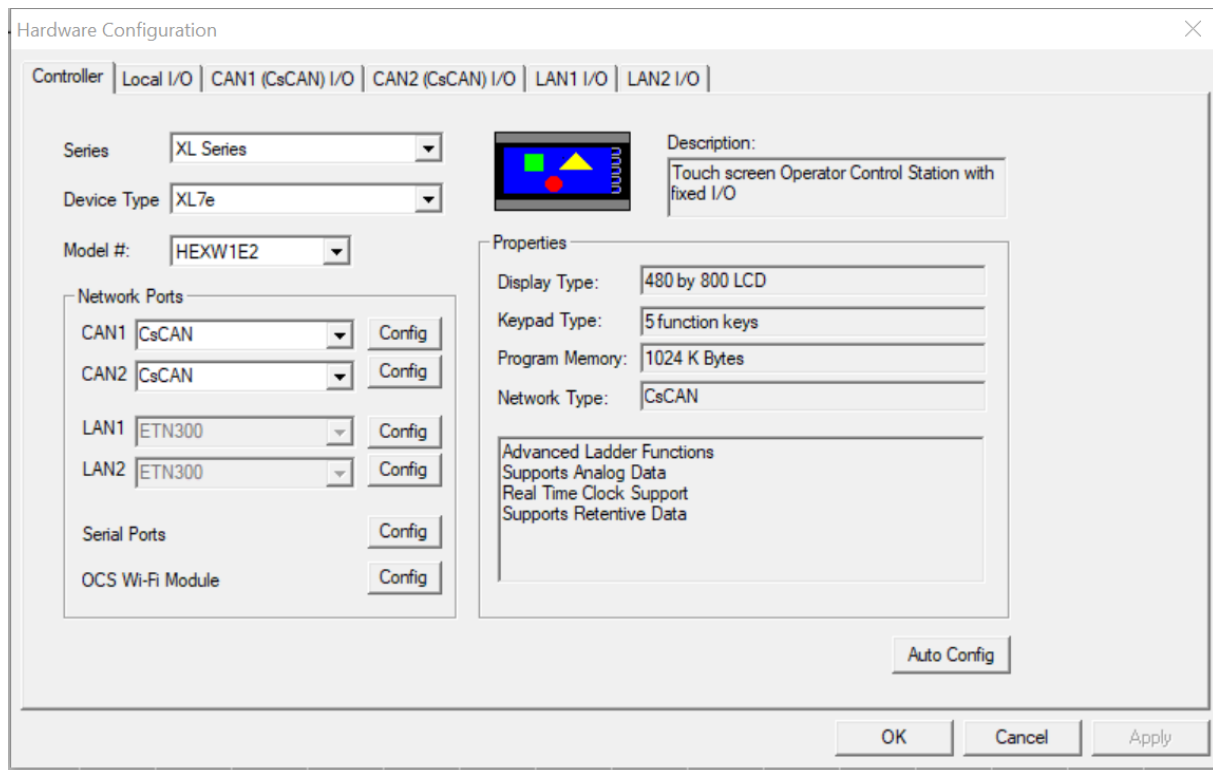


Figure 8 - Hardware Configuration Screen

- From Cscape go to **Controller** → **Hardware Configuration** and verify the controller series and model #. (Figure 1)
- Select **OK**.
- Select **Program** → **Protocol Configuration** in the toolbar to configure the Serial Protocol. See below.

Protocol Config ✕

Serial Protocols

MJ1	-- None --	Network	Devices	Scan List
MJ2	BACnetMSTP server v 4.01	Network	Devices	Scan List
COM	-- None --	Network	Devices	Scan List
MJ3	-- None --	Network	Devices	Scan List

Swap Serial Port Settings

Ethernet

ETN1/1	BACnetIP server v 4.01	Network	Devices	Scan List
ETN1/2	-- None --	Network	Devices	Scan List
ETN2/1	-- None --	Network	Devices	Scan List
ETN2/2	-- None --	Network	Devices	Scan List
Wi-Fi1	-- None --	Network	Devices	Scan List
Wi-Fi2	-- None --	Network	Devices	Scan List

OK **Cancel**

Figure 9 - Protocol Config

- d) Select **Network** to configure serial Port Configuration and Status Register. Refer to Table 10 below for Device Status Register States. Also, refer to Table 11 for Network Status Register

Network Config (BACnetMSTP server) ✕

Port Configuration

Baud Rate: Protocol:

Parity: Mode:

Data Bits: Retries: (0-255)

Stop Bits: Timeout: mSec

Handshake:

Update Scan

Automatic
 Update Interval: mSec ReacquireTime: mSec

Manual
 Trigger: Name: 1-BIT

ID Select: Name: 16-BIT

Master ID / Address

Address:

Status

Register: Name: 4 x 32-BIT

Figure 10 - Network Config (BACnetMSTP server)

Table 10 - Device Status Registers		
Register	Register Name	Definition
%R	GoodDataCount	32-Bit - Good Data Frame sent Count
%R(x+2)	DEV_ID	16-Bit - Local Device ID
%R(X+3)	MASTER_Station_ID	16-Bit - Station ID of data previously sent to MASTER DATA request.

Network Communication Errors - In order to access the Network Statistics, the user must assign the Network Status Register found in the Network Config menu. It occupies 16 consecutive registers.

Table 11 - Network Status Registers			
Number	Statistic	Location	Description
1	Reserved	%Rx	Reserved
2	NoFrameCount	%R(x+2)	Explains the number of times that device(s) did not respond to a transaction. Includes ALL failed transactions, not just those after retry count is exceeded
3	BadFrameCount	%R(x+4)	Explains the number of times that device(s) returned to an invalid or failed response to a transaction, not just those after retry count is exceeded.
4	GoodFrameCount	%R(x+6)	Explains the total number of valid responses
5	TotalTokenPassed	%R(x+8)	Counts total Token Passed to another Node
6	ErrorCode	%R(x+10)	Displays Last Error Code Encountered by last BAD Frame: 0=ERR_NO, 1=ERR_BAD_CRC, 2=ERR_BAD INDEX, 3=ERR_FRAME_TIMEOUT, 4=ERR_FRAME_ERROR
7	This_Station	%R(x+12)	Indicates MAC_ID of BACnet Server.
8	Next_Station	%R(x+14)	Indicates MAC_ID of the next node in the network to which the BACnet Server Passed the token.

e) Select **Devices** → **Add**.

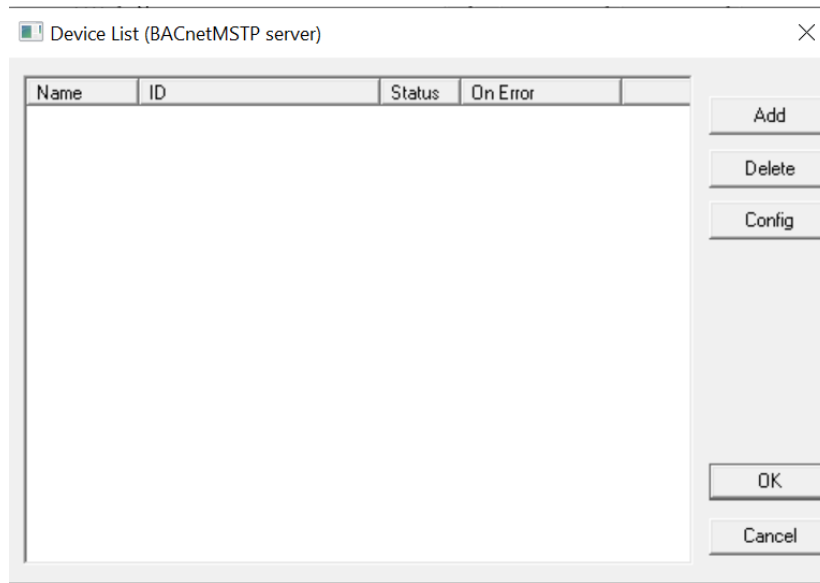


Figure 11 - Device List (BACnetMSTP server)

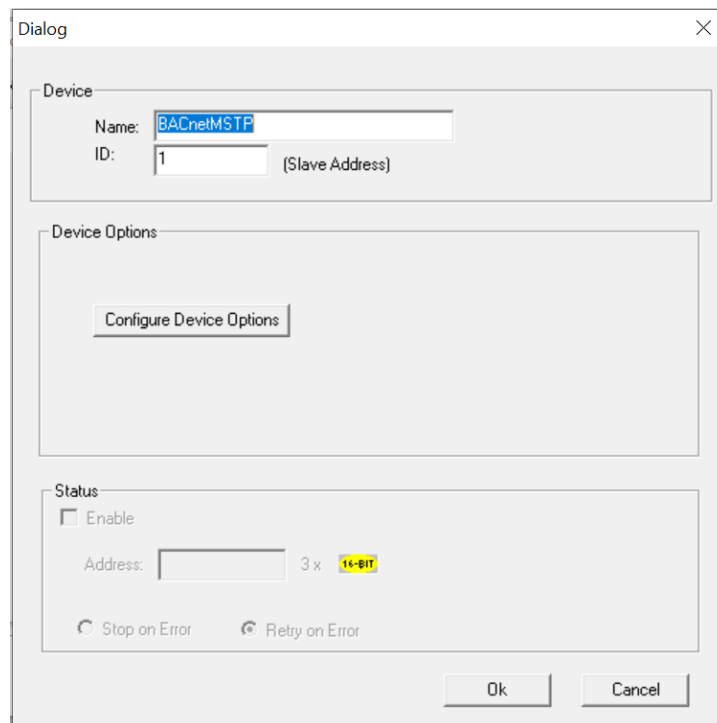
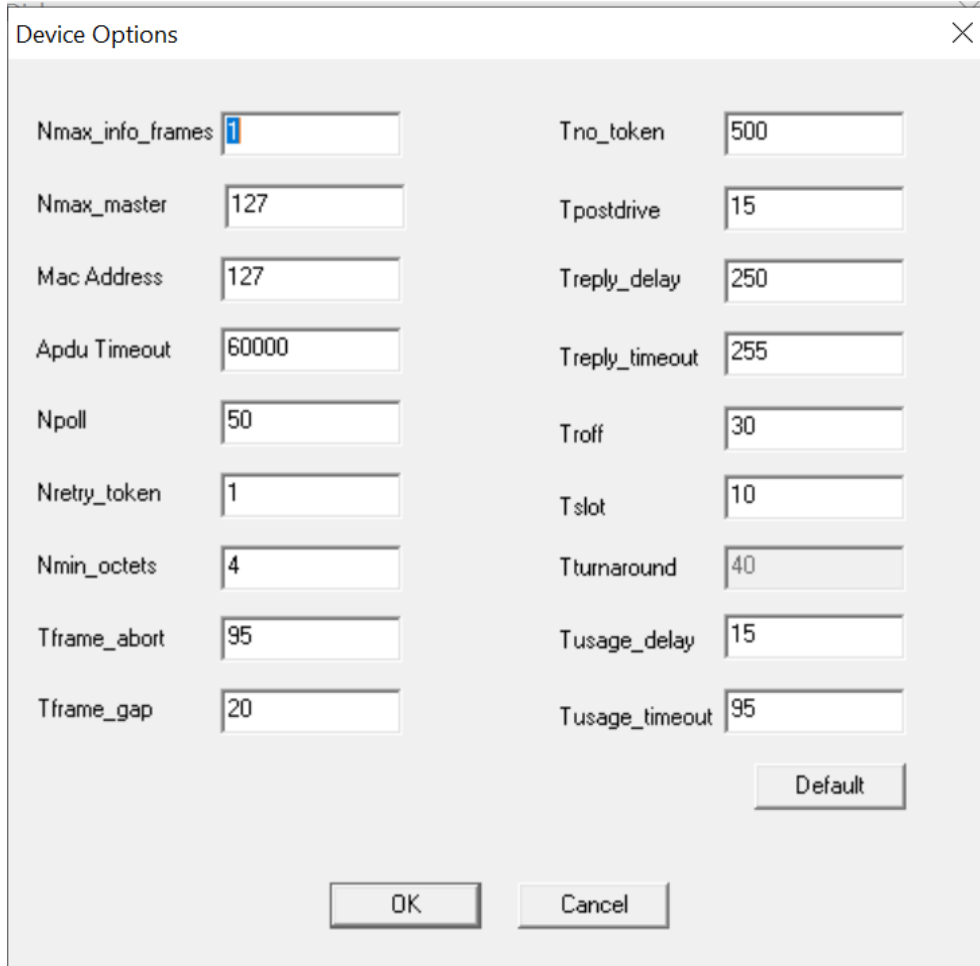


Figure 12 - Dialog

- f) Select **Configure Device Options** to set Timeout and BACnet device settings. See Table 12 for BACnet Device Options.



The screenshot shows a dialog box titled "Device Options" with a close button (X) in the top right corner. The dialog contains two columns of text input fields for various BACnet parameters. At the bottom right, there is a "Default" button, and at the bottom center, there are "OK" and "Cancel" buttons.

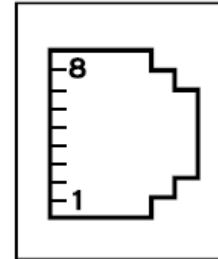
Parameter	Value
Nmax_info_frames	1
Nmax_master	127
Mac Address	127
Apdu Timeout	60000
Npoll	50
Nretry_token	1
Nmin_octets	4
Tframe_abort	95
Tframe_gap	20
Tno_token	500
Tpostdrive	15
Treply_delay	250
Treply_timeout	255
Troff	30
Tslot	10
Tturnaround	40
Tusage_delay	15
Tusage_timeout	95

Figure 13 - Device Options

Table 12 - BACnet Device Options	
Option	Definition
Nmax_info_frames	Represents the value of the Max_Info_Frames property of the node's Device Object. Specifies the max number of information frames the node can send before it must pass the token. May be used to allocate more or less of the available bandwidth. Default should be set to 1
Nmax_master	Represents the value of the Max_Master property of the node's Device Object. Specifies the highest allowable address for master nodes. Should be less than or equal to 127. Default: 127
Mac Address	MAC for master nodes; can be 0-127
Apdu Timeout	Indicates the amount of time in milliseconds between retransmissions of and APDU requiring acknowledgment that passes. Suggested default for applicable devices is: 60,000 milliseconds.
Npoll	The number of tokens received or used before a poll for Master Cycle is used.
Nretry_token	The number of retries on sending Token.
Nmin_octets	The minimum number of DataAvailable or ReceiveError events that must be seen by a receiving node in order to declare line "active."
Tframe_abort	The minimum time without a DataAvailable or ReceiveError event before a receiving node may discard the frame: 60 bit times. May be larger, but not to exceed 100 ms.
Tframe_gap	Maximum idle time a sending node may allow between octets of a frame that the node is transmitting (<i>n</i> bit times).
Tno_token	The time without a DataAvailable or ReceiveError event before declaration of loss of token: 500ms
Tpostdrive	Max time after the end of a transmitted frame's stop bit on final octet transmitted before node must display its driver: 15 bit times.
Treply_delay	Max time a node may wait after reception of a frame that expects reply before sending the first octet of a reply or Reply Postponed frame: 250ms
Treply_timeout:	Minimum time without a DataAvailable or Receive Error Event that a node must wait for a station to begin replying to a confirmed request.
Troff	Repeater turnoff delay. The duration of a continuous logical state at the active input port on MSTP repeater after which the repeater will enter the Idle state: 29 bit times < Troff < 40 bit times.
Tslot	Width of the time slot within which a node may generate a token: 10ms
Tturnaround	Min time after the end of the stop bit of the received frame's final octet before a node may enable its driver: 40 bit times
Tusage_delay	Max time a node may wait after receiving a token or a Poll For Master frame before sending the first octet of a frame: 15ms
Tusage_timeout	The min time without a DataAvailable or ReceiveError event that a node must wait for a remote node to begin using a token or replying to a Poll For Master frame: 20ms

Hardware Connections:

Table 13 - Serial Port Connection Details		
Signal	MJ2	MJ3
RX+	-	1
RX-	-	2
TX+	-	3
TX-	-	4
TX/RX+	1	-
TX/RX-	2	-
CTS	-	-
RTS	-	-
+5V @ 60mA	5	5
0V	6	6
RXD	-	7
TXD	-	8
GND(SG)	-	-


NOTE:

- Do NOT connect unlisted pins.
- Recommended cable: Beldon 9503, twisted pair, screened.
- Connect the screens together at the shield/ Earth pin of the PLC.
- One pair Tx data, one pair Rx data, one pair 0V.

10. TECHNICAL SUPPORT

North America:

Tel: 1-877-665-5666

Fax: 317 639-4279

 Web: <https://hornerautomation.com>

 Email: techsppt@heapg.com
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Tel: +353-21-4321266

Fax: +353-21-4321826

 Web: <http://www.hornerautomation.eu>

 Email: technical.support@horner-apg.com

11. CHANGE LOG

Change Log			
Date	Rev #	Description of Revision	Location in Doc
3/6/2020	R2	1. Added steps to download files to Cscape. 2. Cscape Install Step 3. Firmware Install Step 4. Added new information from New Cscape Helpfile. 5. Rearranged Rev1. 6. Added updated Cscape screenshots.	1. Files Needed 2. Cscape Install 3. Firmware Install 4. Throughout 5. Throughout 6. Throughout
3/12/2020		7. Table 3 - BACnet Object Supported updated	7. BACnet Object Supported Table 3