

# **EXB-IP Ethernet and EXB-FI Fiber**

## **Network Extender Module**

**User Guide # S2-61089-105**



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This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. Limits specified in the standards listed below are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

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*This manual covers EXB-IP and EXB-FI units of Revision 200 or higher and EtherPlug software revision 1.00 or higher. The EXB Unit Revision can be found on the rear of the unit following the letter “U”. The EtherPlug software revision can be found on the Help/About screen of the program. If the revision of the product in hand is greater than that shown above, there may be additional features supported by the product that are not covered in this manual.*

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# QUICK-START GUIDE

This Quick Start Guide provides a concise series of steps to get a pair of the EXB-IP or EXB-FI modules “up and running” quickly so that initial operation may be confirmed.

It is highly recommended that a pair of EXB-IP or EXB-FI modules be tested in your application by first connecting them “back-to-back” with the 10Base-T or fiber crossover cable included with this shipment. Once operation is confirmed using this connection scheme, continue by reconfiguring the IP addressing information and connecting the EXB modules to the actual Ethernet communications channel to be used.

**NOTE:** DO NOT connect the EXB-IP or EXB-FI modules to a live IP network until they have been reconfigured with new IP addresses and subnet mask supplied by the network manager. Network-wide problems could arise from connecting devices to a network without coordination of addressing information. See the **Installation** section of this manual for full information.

## Set Option Switches and Make Back-to-Back Connection

For the EXB-IP:

- Set **OPTION** switch positions 1 through 8 on the rear of both EXB units to the UP position.
- Connect the EXB units “back-to-back” via the 10Base-T connector on the rear of each EXB unit using the supplied crossover cable (#S2-60760-100).

For the EXB-FI:

- Set **OPTION** switch positions 1 through 6 on the rear of both EXB units to the UP position and positions 7 and 8 to the DOWN position.
- Connect the external fiber transceiver units to the **AUI** connector on the rear of the EXB units. Secure the transceiver with the slide lock. Verify that the switches on the transceivers are as follows:
  - **SQE Test** is in the OFF or Disabled position.
  - **LinkALERT** is in the OFF or Disabled position. (This switch is not on all transceivers.)
  - **Half Duplex/Full Duplex** is in the Half Duplex position. (This switch is not on all transceivers.)
- Connect the EXB units “back-to-back” by attaching the **XMT** port on one fiber transceiver to the **RCV** port of the other fiber transceiver, and vice-versa.

## Connect MCN Network and Power

Once the above steps are completed:

- Connect other MCN system modules to the “**NETWORK**” connectors of each EXB.
- Connect power to the EXB units via the rear panel “DC IN” connector. The units can be powered-up in any sequence.

Once properly connected and powered, the “ERR” LED will be off on both units and they are now ready for use.

# 1. INTRODUCTION

## WHAT IS AN EXB?

The EXB System Extender Modules are members of the Monitoring and Control Network (MCN™) family of control products. They are used to connect multiple MCN networks together or to extend the length of an MCN network beyond 4000 feet. Therefore, multiple remote comparators can be controlled from a central site.

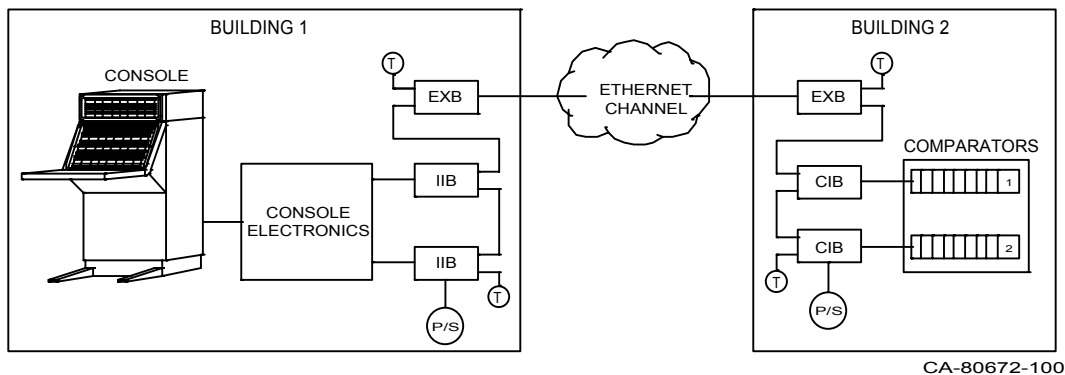
The EXB System Extender Modules allow simultaneous monitoring and control of Master and Slave comparators in wide-area voting systems. Multiple EXB modules can connect multiple MCN networks in real time, spanning distances from a mile to worldwide. Data transfer between distant networks is "live", delayed only by the transit time through the EXB modules and the data rate across the link.

The EXB-IP System Extender Modules use any 10Base-T copper-based Ethernet channel. The EXB-FI System Extender Modules use any 10Base-FL fiber-based Ethernet channel. (Other EXB models are available that utilize other long-distance media, such as analog or digital phone lines and microwave channels.)

Both the EXB-IP and EXB-FI utilize the IP protocol over an Ethernet media and both can coexist on a wide-area IP network with other IP devices such as workstations, servers, and IP routers. Additionally, they can exist on *dedicated* Ethernet IP networks, where the only devices on the network are EXBs and (optionally) physical layer hubs. The most common occurrence of a *dedicated* network is a set of EXB-FIs connected with dedicated fiber.

### Basic Application

Figure 1 shows a comparator system that is located in a different building than the console equipment. Standard MCN CIB modules connect to the comparators and IIB modules connect to the console. The length of the MCN network is normally limited to 4000 feet. As shown in this diagram, a pair of EXB System Extender Modules can greatly extend the MCN network using Ethernet channels.



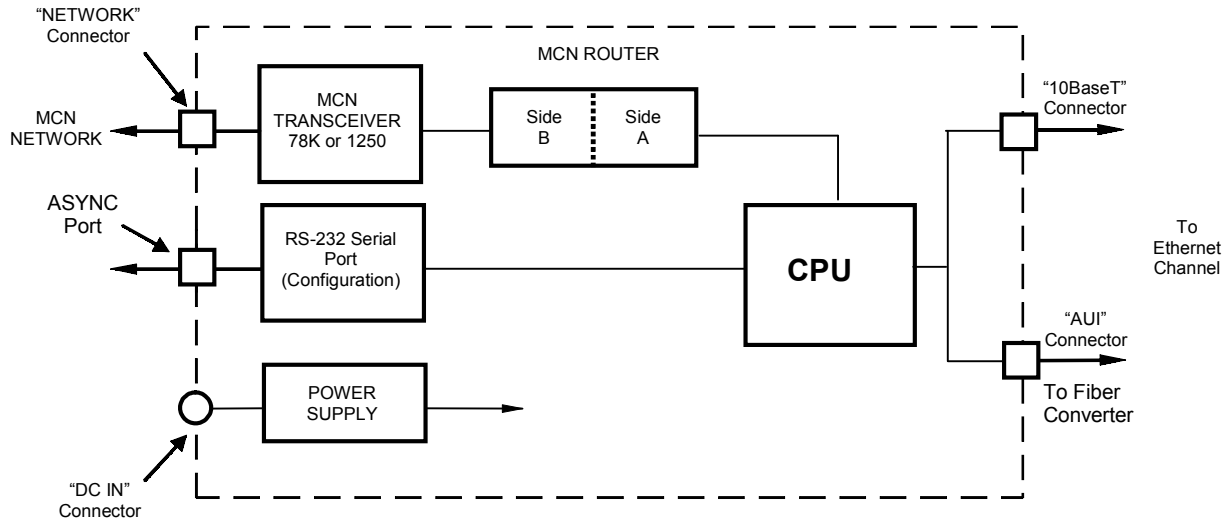
**Figure 1 Extending Comparator Status & Control Signals to a Console with EXB Modules**

For monitoring, the CIB Comparator Interface Modules in Building 2 accept the logic level comparator status indications (*Vote*, *Receive*, *Disable*, and *Fail*) and send status messages over the MCN network. The EXB System Extender Module at Building 2 passes the status messages over the Ethernet channel to the EXB System Extender Module at Building 1. The EXB module at Building 1 passes the status information to the IIB modules over the local MCN Network. The IIB modules then convert the status messages to logic outputs for use by the console.

For controlling, the *Force-Vote* and *Disable* control functions from the console in Building 1 are passed through the IIB modules, through the pair of EXB modules, and to the CIB modules in Building 2. The CIB modules convert the control messages to logic levels to control the comparator.

## Block Diagram

As shown in Figure 2, there are three sources of message packets within the EXB module. The first source is the MCN NETWORK connector on the front of the unit. The second is the Ethernet media connectors on the rear of the unit. (Note that although 10BaseT and AUI connectors exist, only one can be used at a time.) The third source is the Control Neuron Processor. Message packets originating from any of these sources are sent to the other two.



**Figure 2 EXB Network Extender Module Block Diagram**

- The “NETWORK” connector attaches to the local MCN network using a compatible transceiver internal to the EXB module and is associated with *Side B* of the internal router.
- One of the Ethernet connectors attaches to the Ethernet channel, providing communication to additional EXB modules at remote sites. These ports are associated with *Side A* of the internal router.
- The CPU controls the overall operation of the unit.

### MCN Router Function

The internal MCN router in each EXB module may be configured as a repeater, or custom-configured router. The easiest configuration is as a repeater, where all messages which enter the EXB module on the MCN Network or the Ethernet (Or fiber) port are passed to the other port. EXB modules normally ship with the router set up as a repeater unless the system is a Custom Configured system with a Custom Configuration documentation package (KA-8xxxx-xxx)

If the unit is part of a Custom Configured system, there will be a special configuration for each EXB in the system. Typically this is used when there are multiple 78K networks feeding into a 1250 network. The internal routers will be configured to pass the MCN status traffic "upstream" to the PCs on the 1250 network, but not back to the other 78K networks.

### Central Processor (CPU)

The CPU controls the overall unit. Ethernet channel parameters can be configured and displayed via the serial port using the EtherPlug program.

### Ethernet Port

The 10BaseT and AUI connectors implement IEEE standard Ethernet at 10 Mbps. OPTION switch positions 7 and 8 are used to select which connector is active. See *Step 6* in the IP CONFIGURATION section.

The EXB-IP and EXB-FI Network Extender Modules utilize IP (Internet Protocol) to implement the link to other EXB modules. Both Unicast/Replicated and Multicast addressing is supported using UDP transport. "APPENDIX F. IP ADDRESSES" provides more detail about IP addressing. The IP "port numbers" used by these EXB modules are 1100 (destination) and 1283 (source).

### **Available Models**

The EXB module is identified by the model number found on the rear panel of the module. The table below shows the model numbers and the type of EXB it represents.

<b>Model Number</b>	<b>EXB Type (WAN Media)</b>	<b>MCN Network Transceiver</b>
S1-60962	EXB-IP (10Base-T copper Ethernet)	78 Kbps
S1-60963	EXB-IP (10Base-T Ethernet)	1.25 Mbps
S1-61138	EXB-FI (Fiber - Multimode)	78 Kbps
S1-61139	EXB-FI (Fiber - Multimode)	1.25 Mbps
S1-61140	EXB-FI (Fiber - Singlemode)	78 Kbps
S1-61141	EXB-FI (Fiber - Singlemode)	1.25 Mbps

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## **REFERENCE DOCUMENTS**

The following additional information is available.

<b>Part Number</b>	<b>Document</b>
S2-60425	Monitoring and Control Network Comparator Display System Manual
S2-60426	CIB Comparator Interface Manual
S2-61043	MCNRCD for Windows Manual

## FRONT PANEL

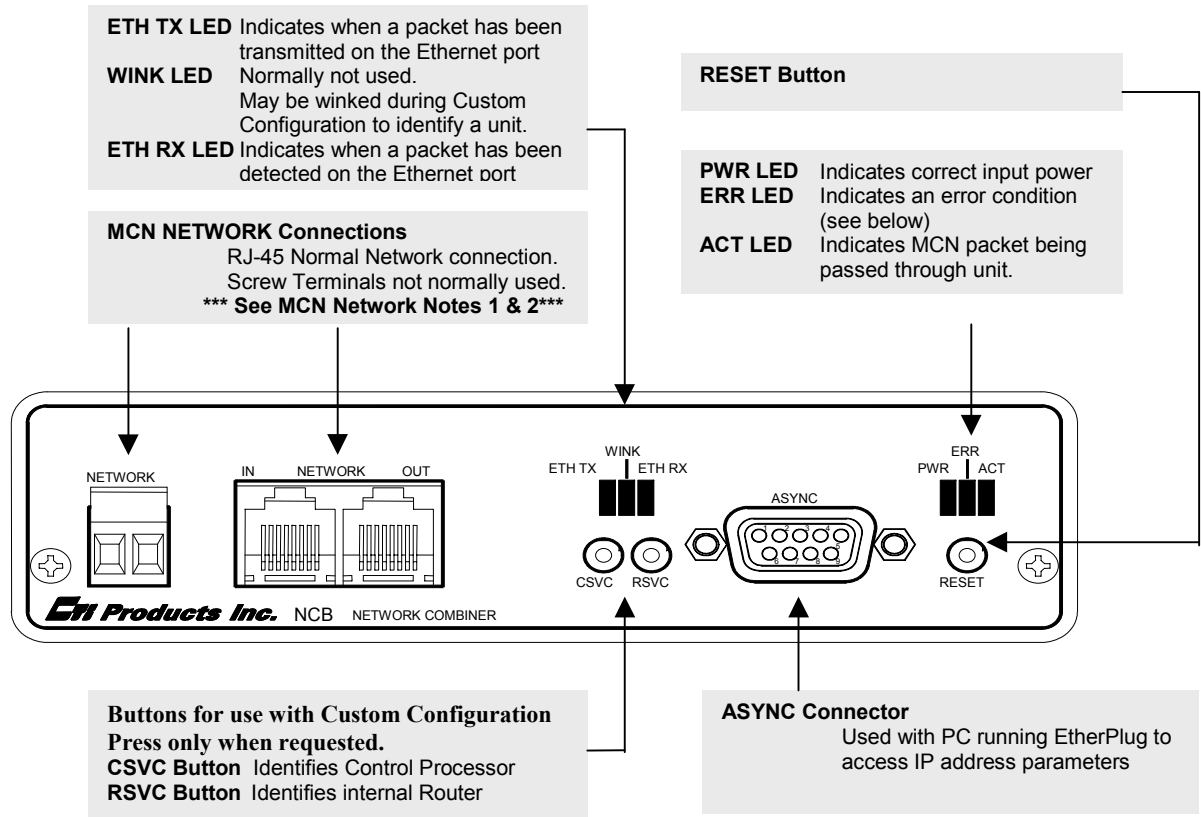


Figure 3 EXB-IP and EXB-FI Front Panel

### MCN Network Note 1

Unlike most other MCN modules, the EXB-IP & EXB-FI units do not inject power into the Network Out connector. They also do not use any DC power from the Network In connector. All 8 pins on the Network In & Out connectors are paralleled, so that any power from other modules will be passed through.

### MCN Network Note 2

Although the MCN Network connectors are RJ-45s, THEY ARE NOT ETHERNET CONNECTORS. Because the MCN network connectors on the front of the units may have DC power on them from other MCN devices, DO NOT CONNECT THE NETWORK IN OR OUT CONNECTORS TO ETHERNET PORTS. THIS CAN DAMAGE THE ETHERNET DEVICE. The Ethernet cable should be connected to the 10BASE-T connector on the rear of the EXB unit.

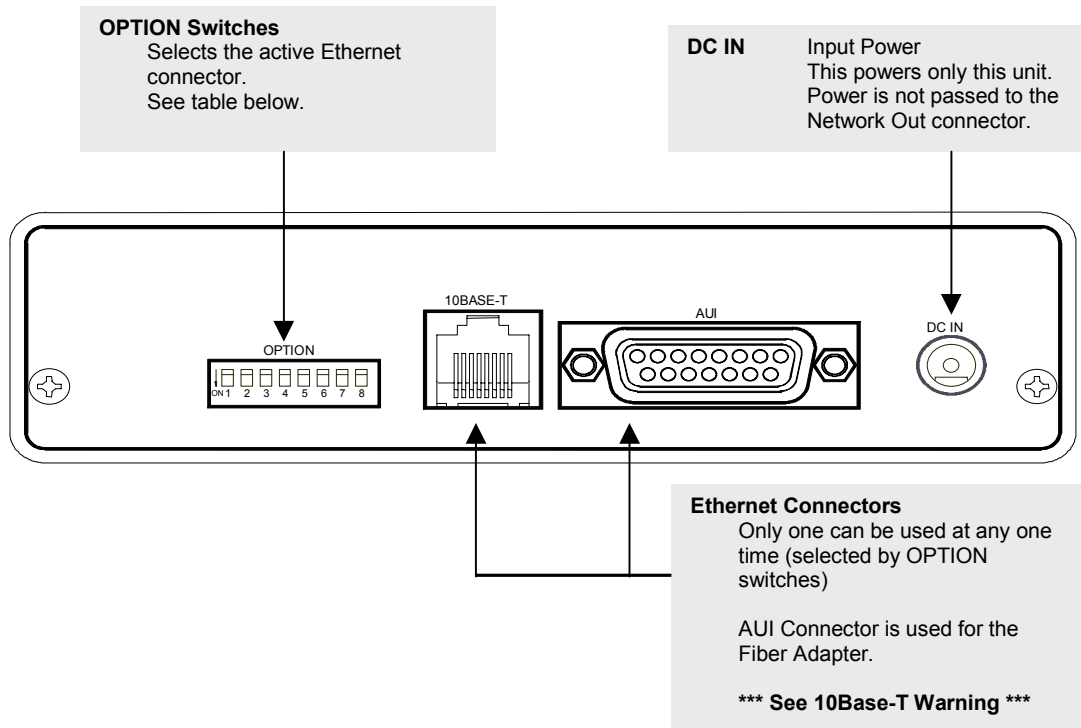
### ***Front Panel Indicators – Additional Information***

**ETH RX** LED (Yellow) – Indicates when a packet has been detected on the Ethernet port. NOTE: Flashing of this LED does NOT necessarily mean that a packet addressed to this EXB module has been received, just that a packet has been detected on the Ethernet network.

**ERR** LED (Red) – Indicates a possible error condition.

- ***Always On:*** A diagnostic error has been detected. Press the “RESET” button. If the “ERR” LED now stays off, the EEPROM contained invalid data and has been reinitialized. Any non-volatile information must be re-entered by using the EtherPlug program. If the LED stays on solid, a hardware problem is indicated. Contact technical support for assistance.
- ***Slow Flash:*** (once per second) Router configuration information is insufficient. Using setrtr.exe, re-program the internal router nodes.
- ***Quick Flash:*** (twice per second) IP address configuration is insufficient. Using EtherPlug, configure the IP addressing parameters.

**REAR PANEL**



*Figure 4 EXB-IP and EXB-FI Rear Panel*

**10Base-T Warning**  
Do not connect the 10Base-T connector to an MCN Network connector.  
Damage could result.

**Switch Settings**

1. Must be Up  
2. Must be Up  
3. Not Used – Default Up  
4. Not Used – Default Up  
5. Not Used – Default Up  
6. Not Used – Default Up  
7. > Ethernet Connector  
8. > Ethernet Connector

Modem Mode	Switch:	7	8
10BaseT		UP	UP
AUI (Fiber)		DN	DN
		X = Don't Care	

## 2. IP ADDRESS CONFIGURATION

This section describes the steps necessary to configure the IP address parameters of EXB-IP and EXB-FI modules for an IP network that is shared with other IP devices (such as workstations, servers, etc.).

**NOTE:** *DO NOT connect the EXB-IP or EXB-FI modules to a live IP network until they have been reconfigured with new IP addresses and subnet mask supplied by the network manager. Network-wide problems could arise from connecting devices to a network without coordination of addressing information. For usage with dedicated fiber segments, see the note below.*

IP address configuration will not be required when EXB modules are installed on a dedicated network segment, as the default factory programmed IP address parameters can be used.

Configuration of IP address parameters is performed by using the EtherPlug configuration software supplied with the EXB units. Appendix F of this manual provides an overview of IP addressing concepts.

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### SELECTING THE ADDRESSING MODE

The EXBs can run in two different addressing modes: “Unicast/Replicated” or “Multicast”.

#### ***Unicast/Replicated***

Unicast/Replicated addressing mode allows point-to-point or point-to-multipoint communications in any IP network. It is used in the following configurations:

- Point-to-Point should be used if only two units will be communicating.
- Point-to-Multipoint mode can be used when Multicast is not supported on the IP network (non-preferred)

In multipoint applications, Unicast/Replicated mode uses up more Ethernet channel bandwidth than Multicast mode does. For each MCN data packet received, an EXB-IP unit in Unicast/Replicated mode will send out an Ethernet packet to each remote EXB-IP unit. For example, in a system with 5 EXB-IP units, each unit would generate 4 Ethernet packets for each MCN packet received. (A good portion of this extra traffic can be eliminated in systems that have multiple comparator sites feeding only 1 PC site. In this application, each of the comparator site EXBs can be programmed to send data to only the Central Site EXB.)

#### ***Multicast***

Multicast addressing mode allows efficient point-to-multipoint communications in a network. A single MCN message packet entering any one of the EXB modules results in a **single** multicast IP packet being sent out the Ethernet port of that module to be received by *all* other EXB members configured to the same Multicast IP address. Because only one IP packet is generated for every MCN message packet, multicast addressing mode uses far less network bandwidth than Unicast/Replicated.

Before choosing multicast addressing mode, it is important to determine the following capabilities of the IP network to which the EXB modules will be connected:

- IP routers must be capable of handling IP multicast traffic.
- IP routers must have IP multicast enabled
- IP routers must forward the EXB multicast port numbers of 1100 (destination port) and 1283 (source port).

## IP SETTINGS WORKSHEET

After determining which IP addressing mode will be used (Unicast/Replicated or Multicast), gather the following IP information for the system. IP information must be obtained *for each EXB module to be used* (from the network administrator responsible for the IP network to which the EXB module will be attached):

### System-Wide Parameters (for all EXB's)

Channel Name	
Global Subnet Mask	____.____.____.____
IP Address Mode	<input type="checkbox"/> Unicast Replicated or <input type="checkbox"/> Multicast
A Multicast IP Address (only for Multicast Addressing Mode)	____.____.____.____
Central Site EXB Number (For Unicast Replicated multipoint)	

### Individual EXB Parameters:

EXB Number	1
EXB Location (Member Name)	
EXB IP Address (Host IP Address)	____.____.____.____
Subnet Mask	____.____.____.____ or <input type="checkbox"/> Use Global
Gateway IP Address	____.____.____.____
Target (Other EXBs to talk to)	<input type="checkbox"/> All in Channel or <input type="checkbox"/> Central Site Only

EXB Number	2
EXB Location (Member Name)	
EXB IP Address (Host IP Address)	____.____.____.____
Subnet Mask	____.____.____.____ or <input type="checkbox"/> Use Global
Gateway IP Address	____.____.____.____
Target (Other EXBs to talk to)	<input type="checkbox"/> All in Channel or <input type="checkbox"/> Central Site Only

EXB Number	3
EXB Location (Member Name)	
EXB IP Address (Host IP Address)	____.____.____.____
Subnet Mask	____.____.____.____ or <input type="checkbox"/> Use Global
Gateway IP Address	____.____.____.____
Target (Other EXBs to talk to)	<input type="checkbox"/> All in Channel or <input type="checkbox"/> Central Site Only

EXB Number	4
EXB Location (Member Name)	
EXB IP Address (Host IP Address)	____.____.____.____
Subnet Mask	____.____.____.____ or <input type="checkbox"/> Use Global
Gateway IP Address	____.____.____.____
Target (Other EXBs to talk to)	<input type="checkbox"/> All in Channel or <input type="checkbox"/> Central Site Only

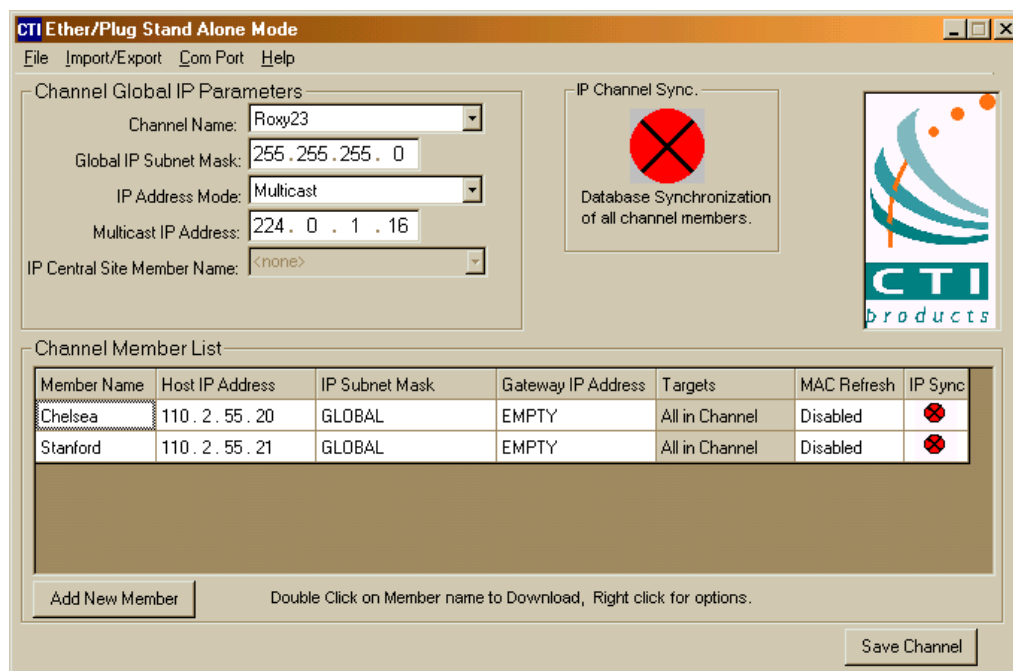
## STEP 1. INSTALL ETHERPLUG CONFIGURATION SOFTWARE

The EtherPlug configuration software will be used to configure IP address parameters of EXB modules, and is included on the CDROM shipped with units. EtherPlug is a Windows application compatible with Windows 95/98, NT, 2000, and XP. Use the following steps to install EtherPlug on your PC:

- Insert the EtherPlug CDROM in your CDROM drive.
- Click the Windows **Start** button, choose "Run...", click **Browse...**, select the "Setup.exe" application in the EtherPlug directory on the CDROM, and click **Open**.
- Follow the instructions displayed by the "Setup" application.

## STEP 2. START ETHERPLUG

The EtherPlug configuration software provides access to IP address parameters for EXB-IP and EXB-FI modules. The main window for EtherPlug is shown in *Figure 5*.



*Figure 5 EtherPlug main window*

### Field Descriptions

#### Channel Name

A Channel is defined as a collection of EXB-IP units and their interconnecting IP network. Each system will have its own Channel. Each MCN system could have multiple Channels (if, for instance, there were multiple IP networks or if the system was broken down into multiple sub-systems.) EtherPlug saves all the information in a file using the Channel Name and an extension of .elp. For the system shown above, the configuration file would be named "Roxy23.elp".

#### Global IP Subnet Mask

A global IP Subnet Mask is entered if all units (or most of the units) use the same subnet mask. You can use the Global IP Subnet Mask for individual units so you don't have to type the subnet mask for each unit.

**IP Address Mode**

Unicast/Replicated or Multicast. (See Selecting the Addressing Mode above.)

**Multicast IP Address**

The IP address used in Multicast systems. The first number must be between 224 & 239.

**IP Central Site Member Name**

If you have a system in which a number of remote EXBs at comparator sites talk to one central EXB at the PC site, select the name of the EXB at the PC site.

**Member Name**

Name for each EXB. Typically a site name or location.

**Host IP Address**

This is the IP address for each EXB-IP or EXB-FI unit.

**IP Subnet Mask**

This is the individual Subnet Mask for each EXB-IP or EXB-FI unit. If all the IP Subnet Masks are the same, you can enter it once in the Global IP Subnet Mask and select "Global" in this field.

**Gateway IP Address**

When an EXB-IP or EXB-FI unit must communicate with a unit on a different IP subnet, it must talk through a Gateway. Enter the IP address for the Gateway. It must be on the same IP subnet as the EXB Host IP Address.

For example:

Global IP Subnet Mask:	255.255.0.0		
EXB #1	Host IP Address: 192.180.0.5	Gateway IP Address:	192.180.0.1
EXB #2	Host IP Address: 192.200.0.7	Gateway IP Address:	192.200.0.1

Since the Host IP Addresses for the two EXBs are different in the first two octets (192.180 versus 192.200), they are on different subnets.

**Targets**

This indicates which other EXB units that this unit will send messages to. There are two choices:

- All in Channel or
- Central Site only

**MAC Refresh**

This tells the EXB unit to send periodic refresh messages for Ethernet switches and routers that need them.

**IP Sync**

This indicates whether the IP data in the EXB unit matches (green check mark) or does not match (red X) the data on the screen.

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## STEP 3. EDIT IP ADDRESS PARAMETERS

The IP information that was gathered from the IP Network Administrator, as described at the beginning of Section 2 of this manual, must be entered into the EtherPlug program as follows:

### A) Specify the Channel Global IP Parameters:

- If you wish to change the “Channel Name”, choose *File – New Channel*, enter an appropriate name, then click **OK**.
- Click on the “Global IP Subnet Mask” textbox, then enter the *Subnet Mask* assigned the EXB units by the IP Network Administrator.
  - If different subnet masks are specified for different groups of EXB units, enter the subnet mask that is common to most of the EXB units in the group.
  - If a different subnet mask is assigned to every EXB unit, leave this field with its default value.
- After reviewing the information concerning *IP Addressing Modes* in Appendix F, choose either “Unicast/Replicated” or “Multicast” from the “IP Address Mode” drop-down list.
- If “Multicast” was selected above, click on the “Multicast IP Address” box and enter the *Multicast IP Address* that the IP Network Administrator has assigned to this group of EXBs.

### B) Specify the “Channel Member List” parameters:

Use the *Add New Member* button to add a line in the *Channel Member List* and enter the name for each EXB unit connected to the Ethernet channel.

Enter the following information for each EXB unit in the *Channel Member List* :

- Host IP Address
- IP Subnet Mask (if different than the “Global IP Subnet Mask”). With IP Subnet Mask set to GLOBAL, the value set in the Global IP Subnet Mask field is used as this member’s IP Subnet Mask
- Gateway IP Address
- Leave the **Targets** field set to *All in Channel* unless *Central Site* mode is to be used, see the bullet below for a description of this mode.
- Leave the **MAC Refresh** field to *Disabled* unless the EXB is connected to an Ethernet MAC layer switch or intelligent hub. See the bullet below for further information.

### C) Save the Channel Information:

Use the *File – Save As* or the *File – Save* (same as the *Save Channel* button on the main screen) to save the channel information entered.

## Special Cases

Several special cases should be considered, as discussed below:

- **Central Site Mode:** If *Unicast/Replicated* IP Addressing mode is being used and the system application using these EXB units requires message packets to pass *only between devices connected to a single EXB unit at the host computer and devices connected to EXB units at remote locations*, **Central Site** mode can be used to reduce network traffic. To restate, if the system being constructed *does not require message packets to flow between devices at different remote sites, but only between a remote site and a single central site*, use **Central Site** mode. If message packets must flow between remote sites and the Central site *and also from one remote site to another remote site*, **do not** use Central Site mode.

To use Central Site mode :

- Set IP Central Site Member Name to the name of the EXB unit with its NETWORK port connected to the MCN network at the Host Computer site.
- For all remote EXB units that need to exchange message packets with only the Central Site EXB, set its **Targets** selection to *Central Site*.
- **MAC Refresh:** If the Ethernet port of an EXB is connected to an IP MAC layer switch, specify a MAC Refresh value other than Disabled for that member to cause the EXB to periodically notify that switch of its existence on the network. This is useful following a reset of the MAC layer switch, as the forwarding table of MAC addresses in the switch is emptied and may not know to forward an incoming message to an EXB. When the notification is sent from the EXB, the MAC layer switch forwarding table is updated, allowing the successful forwarding of an incoming message packet. A MAC Refresh can be enabled by specifying a value from 1 to 255 seconds. The MAC Refresh can be disabled by specifying a value of 0. Edit this field by double-clicking it.

---

## STEP 4. DOWNLOAD IP ADDRESS PARAMETERS TO EXBs VIA SERIAL PORT

When first installing EXB units to a network, the IP Address parameters entered into EtherPlug in step 3 must be downloaded to each EXB via a serial COM port on the PC. After all EXB units are configured and properly installed on the Ethernet and MCN networks as detailed in Step 5 below, changes in IP Address Parameters can be made via the MCN network without the need to access each EXB directly for a serial port connection.

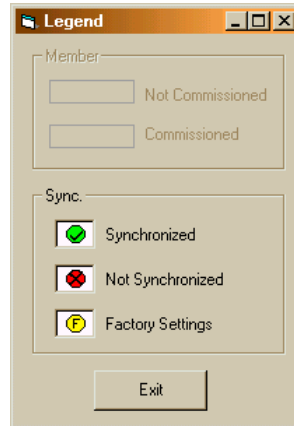
### A) Select the serial communications port that will be used for downloading IP address parameters:

- Click the “**COM Port**” menu item, and the “*Com Select*” window will be displayed.
- Choose an available serial port on the PC from the drop-down list, then click **Select**.

### B) Download IP address parameters to EXB:

- Double-click on the first “Member” name in the Channel Member List. The “*Download*” window will be displayed.
- Select :
  - *Database* from the Download drop-down list
  - *Channel* from the To ... Members drop-down list
  - *Serial* from the Via the ... Port drop-down list
- Click **Load**.
- The “*Instructions*” window will prompt to connect the selected COM port to the indicated EXB Member. A 9 pin to 9 pin “null modem” cable (supplied with EXB units) is required. Click **OK** after the cable has been connected. The “*Downloading*” window will be displayed. When downloading has completed successfully, the “*Sync*” field will change to a green ‘✓’.
- The “*Instructions*” window will prompt to connect the selected COM port to the next EXB Member. Click **OK** after the cable has been connected. Continue this process for all EXB units.
- When downloading is complete to all EXB members, the “*Channel Sync*” indicator will change to a green ‘✓’.

Synchronization of IP Address parameters between the database and each physical EXB are indicated with color coding of the **Member Name** fields and the *IP Sync* (individual members) and *IP Channel Sync* (all EXB members in the channel collectively) “dots”. Use the *Help – Display Status Legend* function for color definitions. The window in Figure 1 will be displayed.



**Figure 6 Display Status Legend window**

A red 'X' in the “Sync” field indicates the IP address parameters on-screen are not the same as stored in the device. A green '✓' indicates the IP address parameters on-screen are the same as stored in the device. A yellow 'F' indicates that factory default parameters are stored in the device.

**C) Exit EtherPlug:**

- From the **File** menu, select **Exit**.

*NOTE: EtherPlug uses an external data file with the extension “.elp” to store all data. The name given to the channel is used as the root portion of the file name. To select the path used to save the .elp datafile for the channel to be created, select the File – Set Project Directory function. Any existing .elp files in this directory are shown in the Channels box.*

---

## ETHERPLUG ADDITIONAL FUNCTIONS

### ***Printing Information from EtherPlug***

The *File – Print* and *File – Print to File* functions can be used to print Channel information (from the main window) or detailed member information (from the View Details window) either directly to a printer, or to the default Windows editor.

### ***Updating Firmware in the EXB Unit***

The *File – Flash Loader* function is used to update the firmware in the EXB-IP or EXB-FI unit. This is possible on EXB units of revision 200 or greater. Contact CTI Products technical support should the firmware need upgrading.

### ***Importing/Exporting EtherPlug Configuration Data***

The *Import/Export – Export File* function is not used with EXB modules.

### ***Other Right-Click Member Functions***

Other functions available on the menu presented after right-clicking on a member name are as follows:

- *View Details* : Shows the Ethernet/IP data as stored in the EXB unit compared to that in the database for that unit.
- *Rename Member & Delete Member* : Renaming and deleting members is accomplished with this function.
- *Wink, Pulse Router Service Pin, Soft Reboot* : Not used with EXB modules.
- *Ping* : See *Using the “Ping” Function* on Page 18.

# 3. INSTALLATION

## PHYSICALLY INSTALL EXBs INTO THE IP NETWORK

### A) Select an Ethernet connector:

- OPTION switches are used to select the active Ethernet connector. Use the 10Base-T setting for the EXB-IP and the AUI setting for the EXB-FL. The position of the OPTION switches are read by the EXB module at power-up or after pressing the “RESET” button on the front panel.

1. Must be Up  
 2. Must be Up  
 3. Not Used – Default Up  
 4. Not Used – Default Up  
 5. Not Used – Default Up  
 6. Not Used – Default Up  
 7. > Ethernet Connector  
 8. > Ethernet Connector

Connector	Switch:	7	8
10BaseT (NCB-EL)		UP	UP
AUI (NCB-FL, Fiber)		DN	DN
		X = Don't Care	

### B) Mount the EXB units (See Appendix B for Mounting Option details):

#### *Desk, Wall, or Rack Mounting*

- Non-slip rubber feet are included on all EXB modules to allow them to conveniently rest on any horizontal surface. Four 6-32 threaded holes are also available on the bottom of the module to allow bolting of the module in any convenient orientation. **WARNING: Care should be taken to limit protrusion of the screw into the module to no more than 0.125 inch from the module bottom surface!**
- Mounting kits are available as options to allow wall or rack (19” EIA) mounting of the EXB modules.

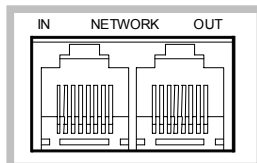
### C) Make electrical connections (See Appendix C for connector details):

#### *Grounding*

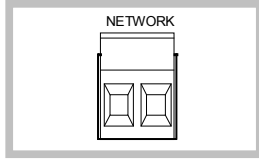
- When wall or rack mounting the EXB, a suitable safety and protective earth ground should be provided to the metal enclosure. The protective earth ground provides a path to ground for electrostatic discharge (ESD) energy. This connection is most conveniently made directly to the wall mount bracket or rack plate.

#### *MCN Network Connection*

- The local MCN network must be attached to the EXB module via the “NETWORK” connector following standard guidelines as to cable type, cable length, and termination appropriate for the selected transceiver.



The dual RJ45 **NETWORK** connector allows a daisy-chained network connection method, as the network pins of the two RJ45 connectors are directly paralleled. The EXB does not inject DC power on the network cable. It does not use any DC power from the cable.

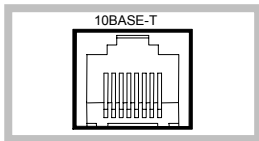


The 2 pin removable terminal strip is wired in parallel with the network connections on the dual RJ45 connector. This connector is normally not used.

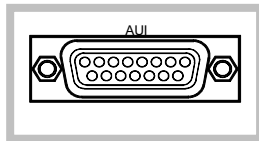
### Ethernet Connection

- The Ethernet network must be attached to the EXB module via one of the Ethernet connectors. Be sure to set the OPTION switch positions 7 and 8 as shown in *Step 6A* to match the type of Ethernet physical media being used.

**WARNING:** DO NOT connect the EXB modules to a live Ethernet network until they have been reconfigured with IP parameters supplied by the Network Administrator. Network-wide problems could arise from connecting devices to a network without coordination of addressing information.

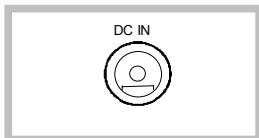


The **10BaseT** port utilizes a standard RJ45 connector. Level 5 unshielded twisted pair cable should be used between the EXB-IP module and the hub. The length of this cable should be less than 100 meters (328 feet).



The **AUI** port accepts standard Ethernet MAUs (Media Attachment Units) for 10Base-FL (fiber).

### DC Power Connection

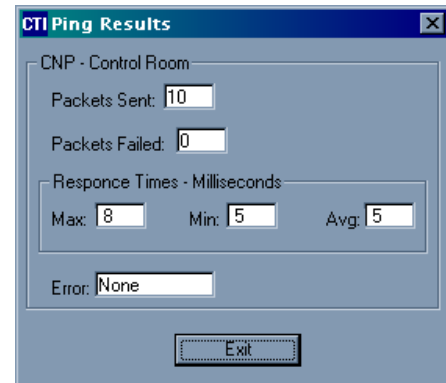
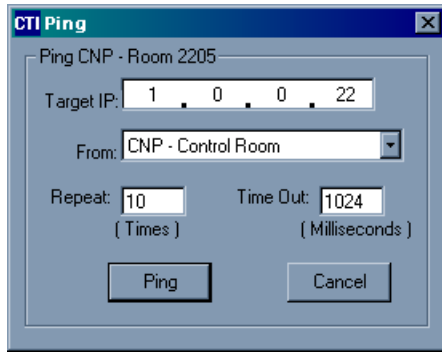


DC power must be attached to the EXB module via the **DC IN** connector. **Apply DC power to the EXB module only after all other connections have been made.** A wall plug-in style power supply designed for the EXB module is an available option.

**The installation of the EXB units is now complete.**

## USING THE “PING” FUNCTION

The “Ping” function can be used as a diagnostic tool to determine if a particular IP address can be “seen” by a host PC. From EtherPlug, right-click on a **Member Name** in the Channel Member List, then choose “**Ping**” from the selection. The “**Ping**” request window will be displayed as shown below (left). Next, click **Ping** to cause the ping to be initiated, and the “**Ping Results**” window (shown below right) will be displayed.



## INSTALLING ADDITIONAL EXB UNITS AFTER INITIAL INSTALLATION

If additional EXB-IP or EXB-FI units need to be installed after the initial installation has been completed, use one of the two following sequences:

### **If using Multicast IP Address Mode:**

1. Start EtherPlug and edit the IP Parameters for the new EXB units per **Step 2** and **Step 3** starting on Page 10.
2. Download IP Parameters to **all** new EXB units via the serial port per **Step 4** on Page 13.
3. Physically install all new EXB units into the IP Network per this INSTALLATION section starting on Page 15.

### **If using Unicast/Replicated IP Address Mode:**

1. Start EtherPlug and edit the IP Parameters for the all **new** EXB units per **Step 2** and **Step 3** starting on Page 10.
2. Download IP Parameters to all **new** EXB units via the serial port per **Step 4** on Page 13.
3. Per **Step 4**, and using the Serial Port, re-download IP Parameters to the existing Central Site EXB unit.
4. Physically install the new EXB units into the IP network per this INSTALLATION section starting on Page 15.
5. Restart EtherPlug and, per **Step 4** on Page 13, re-download *Database* parameters to existing *Channel* members via the MCN network. This will put all EXB units in sync with the newly edited database from Step 1 above.

# APPENDIX

## APPENDIX A. FACTORY DEFAULT CONFIGURATION

### **Control Processor**

#### Restoring Factory Default Communication Parameters

If the Control Processor or router module communication parameters are overwritten by a network management tool, they can be restored as follows:

- Press the “RESET” button on the front of the EXB unit
- After the “ERR” LED goes off, press the “RESET” button a second time.

The Control Processor communication parameters are now restored to factory defaults.

#### IP Address Parameters

The units are factory programmed as follows:

- IP Address: Unique address based on MAC address of module
- IP Address Mode: Multicast
- IP Multicast Address: 224.0.1.16
- Subnet Mask: 255.255.255.0

### **Router**

The router portion of the EXB module may be configured for various operational characteristics. The factory default configuration is as a **repeater**, where all messages entering the EXB module via the MCN Network or the Ethernet network are simply passed through. Other configurations may be set in Custom Configured systems. If so, that information will be provided with those systems.

#### Using SETRTR.EXE to Query or Change Router Configuration

The SETRTR.EXE DOS utility provided with each EXB can be used to query the router for its current configuration, force the router to certain default states, or force the router to *unconfigured* mode. If the router will be installed with the *configured* router algorithm, it is highly recommended that the router module is set to *unconfigured* mode before being installed into the system (this step is mandatory if redundant routers are to be configured).

The SETRTR program requires a network interface to be connected to the host PC with a PCLTA interface. Network interface driver software must be loaded in the host PC and configured with a device name (typically "LON $n$ " where  $n$  is a number). Documentation that is provided with the network interface device details how to install the unit and driver software. The network interface device must contain a network transceiver compatible with the network transceiver in the EXB module to be controlled (78K or 1250).

After the network interface and its software driver are properly configured on the host PC, connect its network port to the front panel “NETWORK” connector on the EXB.

#### **Querying an EXB's Router for its Current Configuration**

Start the SETRTR program with the following command line:

```
SETRTR [-ddevicename] -L <cr>
```

where *devicename* is the name assigned to the network interface on the command line of the device driver (typically "LON1" or "LON2"). If this parameter is omitted, the default name of LON1 is used.

The -L parameter instructs SETRTR to List the current configuration of the router module.

After the signon message appears, press the “RSVC” button on the front of the connected EXB module. SETRTR will report the current router configuration to the screen.

**Returning an EXB’s Router to Factory Default Configuration**

Start the SETRTR program with the following command line:

```
SETRTR [-ddevicename] -F <cr>
```

where *devicename* is the name assigned to the network interface on the command line of the device driver (typically "LON1" or "LON2"). If this parameter is omitted, the default name of LON1 is used.

The -F parameter instructs SETRTR to set the EXB's router to Factory defaults.

After the signon message appears, press the “RSVC” button on the front of the connected EXB module. SETRTR will send the required messages to the router and exit. Press the “RESET” button on the front of the EXB module to complete the reconfiguration.

Note: If you are using a Custom Configured EXB, you will need to reconfigure the EXB as described in the Custom Configuration data shipped with the system.

**Setting an EXB’s Router to Unconfigured Mode**

Start the SETRTR program with the following command line:

```
SETRTR [-ddevicename] -U <cr>
```

The -U parameter instructs SETRTR to set both sides of the EXB’s router to Unconfigured mode.

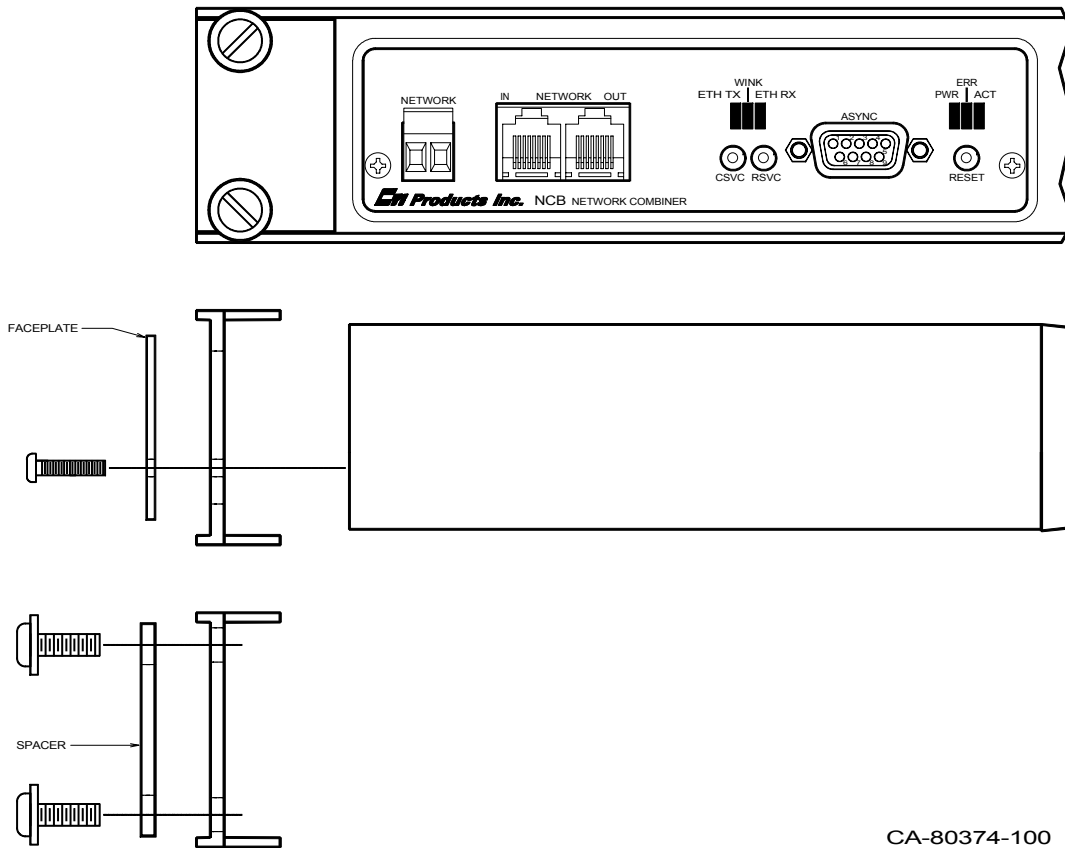
After the signon message appears, press the “RSVC” button on the front of the connected EXB module. SETRTR will send the required messages to the router and exit.

## APPENDIX B. MOUNTING OPTIONS

Wall mount and EIA 19" rack mount kits are available as options for the EXB from CTI Products, Inc. The wall mount kit includes brackets to allow a single EXB module to be mounted to any flat surface. The rack mount kit includes an adapter allowing up to three EXB modules to be mounted in a single rack unit height.

### Rack Mount Option

The rack mount option allows up to three EXB modules to be mounted in a one rack unit height (1.75 inches) of a standard 19 inch rack. The modules are mounted in the rack plate by removing its' front bezel and remounting the module into the rack plate. Figure 7 shows an exploded view of the rack mount installation. The top diagram shows the front view of the bracket with one module installed. The bottom two diagrams show a side view of the module installation into the rack adapter and rack adapter installation into the rack, respectively.



CA-80374-100

Figure 7 EXB Module Rack Mounting

To attach a module to the rack adapter, and then mount the rack adapter into the rack, follow the steps below.

### WARNING

Do not allow the PC board to slide out of the housing when the front panel is removed. If it does, **DO NOT** slide the PC board back into the housing from the front of the module. Doing so may damage the unit, causing the unit to malfunction when powered on. Doing so will void the unit's warranty. Return the PC board to the housing by sliding it only from the rear. (See instructions below.)

### Rack Mounting Instructions

Step	Operation
1	Remove the front panel from the module, including the bezel, by removing the two Philips head screws in the faceplate. The bezel is not used when rack mounting the module.
2	Position the module behind the rack adapter, lining up the holes in the rack adapter with the front panel screw holes on the module.
3	Position the front panel in front of the rack adapter, lining up the front panel with the module.
4	Fasten the front panel and module to the rack adapter with the Philips head screws that were previously removed.
5	Position the rack adapter into your rack, lining up the four mounting holes of the rack adapter with mounting holes in the rack frame.
6	Position the two spacers in the front of the rack adapter, aligning the cutouts in the spacers with the holes of the adapter.
7	Install mounting screws (customer provided) into the rack.

When the module's front panel is removed, do not allow the PC board to slide out of the housing. If the PC board does slide out of the housing, you must follow the steps below to replace the PC board in the housing. **DO NOT RE-INSTALL THE PC BOARD FROM THE FRONT OF THE HOUSING !**

### Re-Installing a PC Board in its housing

Step	Operation
1	From the front of the module, slide the PC board out of the housing.
2	Remove the back panel of the module.
3	Attach either bezel and front panel or rack kit and front panel to the housing with two Philips head screws.
3	From the rear of the module, slide the PC board back into the housing (there are markings on the PC board to indicate which edge to insert into the rear of the housing first).
4	Attach bezel and rear panel to the housing with two Philips head screws.

### Wall Mount Option

The wall mount option allows an EXB module to be mounted to any flat surface. The EXB module has four screw holes on the bottom. Simply attach the two mounting plates to the bottom of the module using the four flat-head screws provided with the wall mount kit. This assembly is then attached to the flat surface with user-provided fasteners. Figure 8 shows a dimensioned view of the wall mount installation.

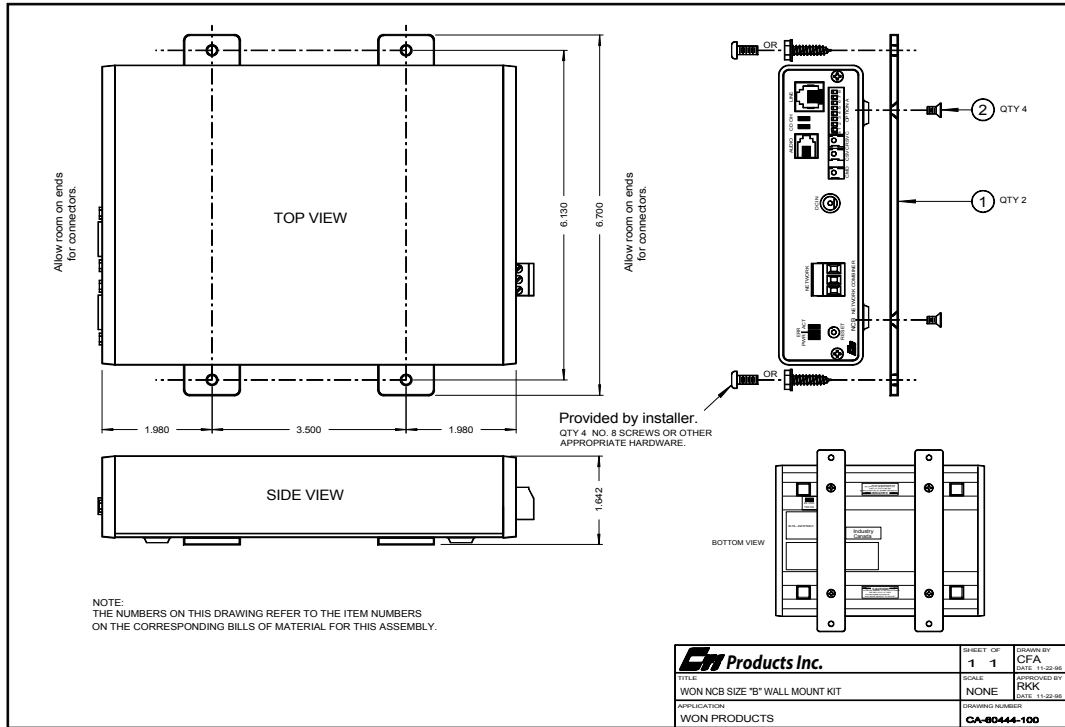


Figure 8 EXB Module Wall Mounting

#### CAUTION

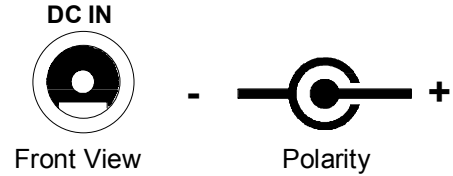
Be sure to use the flat head screws provided with the wall mount kit. If you are not using the wall mount kit from CTI Products, Inc., make sure that the screws do not protrude into the enclosure more than 0.125 inches from the bottom surface of the module.

Using a longer screw that touches the PC board inside the module may damage the module. Doing so will void the unit's warranty.

**APPENDIX C. CONNECTOR DETAILS**

**DC IN Connector**

Connector type: 2.5 x 5.5 mm coaxial  
 Mating Connector: Switchcraft 760 or equivalent  
 Connector pinout: CTI Products, Inc. standard power supply is wired with center pin positive, EXB module can accept either pin positive, polarity routing is provided internal.

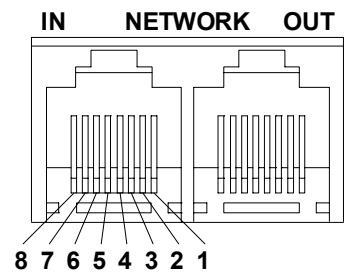


**NETWORK Connectors**

**RJ45 Connectors:**

Pins 1 and 2 of both RJ45 connectors as well as the screw-terminal connector are all wired in parallel.

Connector Type: Standard RJ45 telephone connector, 8 position 8 contact.



Pin	Function	Notes
1	Network	Network connection is NOT polarity sensitive
2	Network	Pins 1,2 of IN and OUT connectors tied parallel
3	No Connection Note 1	Pin 3 of IN and OUT connectors tied together
4	No Connection	Pin 4 of IN and OUT connectors tied together
5	No Connection	Pin 5 of IN and OUT connectors tied together
6	No Connection Note 2	Pin 6 of IN and OUT connectors tied together
7	No Connection Note 2	Pin 7 of IN and OUT connectors tied together
8	No Connection Note 1	Pin 8 of IN and OUT connectors tied together

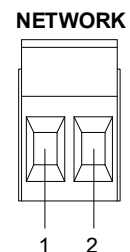
Note 1: May have + DC power on this pin from other MCN modules.

Note 2: May have - DC power on this pin from other MCN modules.

**2-Position Screw-Terminal:**

Mating Connector: Weidmuller 128176

Pin	Function
1	Network
2	Network



## Ethernet Connectors

### 10BaseT Connector:

Connector type: Standard RJ45 female.

Pin	Function
1	Ethernet TX
2	Ethernet TX
3	Ethernet RX
4	N/C
5	N/C
6	Ethernet RX
7	N/C
8	N/C

### AUI Connector:

Connector type: Standard D-Subminiature 15 pin female.

Pin	Function
1	Chassis Ground
2	Collision
3	Ethernet TX
4	Chassis Ground
5	Ethernet RX
6	Signal Ground
7	N/C
8	N/C
9	Collision
10	Ethernet TX
11	Chassis Ground
12	Ethernet RX
13	+12V
14	Chassis Ground
15	N/C

## ASYNCR Connector

When this port is connected to a PC's serial port, the EtherPlug program can be used to configure the IP address parameters.

Connector type: Standard D-Subminiature 9 pin male. DTE (Like IBM PC 9 pin)  
Null Modem cable (CTI # 89-11314) required for connection to PC.

Pin	Function
1	Data Carrier Detect
2	RX
3	TX
4	Data Terminal Ready
5	Signal Ground
6	Data Set Ready
7	Clear to Send
8	Request to Send
9	N/C

## APPENDIX D. TROUBLESHOOTING

Table D1

If the PWR LED . . .	REASON	CORRECTIVE ACTION
Is always illuminated.	Normal operation indicating that EXB unit is receiving proper DC input power.	Go to next Table.
Does not illuminate.	EXB unit is not receiving DC input power.	Check for proper voltage at “DC IN” connector (10-32VDC).

Table D2

If the ERR LED . . .	REASON	CORRECTIVE ACTION
Is always off.	Normal operation indicating no error condition was detected.	Go to next Table.
Occasionally blinks on, then off.	Normal operation when “CSVC” button or “RSVC” button is pressed.	Go to next Table.
Flashes slowly, at a rate of once every 2 seconds.	The Router Neurons are unconfigured.	Use LonScript or NODEUTIL to change the mode/state to ‘Configured’ and ‘On-line’, or Use SETRTR –F to configure the router to Factory default conditions (Repeater Mode).
Flashes quickly, at a rate of once every second.	The Control Neuron Processor detects missing IP address information.	Use EtherPlug to update the IP address parameters. (See Installation section for instructions.)
Is always illuminated.	Router module, or Control Neuron Processor, or Microprocessor is not functioning.	Call CTI Products, Customer Support (+1-513-595-5900), to arrange to return unit for evaluation/repair.

Table D3

If the ETH TX LED (on local EXB) . . .	REASON	CORRECTIVE ACTION
Occasionally blinks on, then off.	Normal operation indicating a message packet has been transmitted from the Ethernet port.	Go to next Table.
Does not illuminate when “RSVC” button on local EXB is pressed.	Ethernet port is not terminated correctly to the IP network.	<ol style="list-style-type: none"> <li>Verify that OPTION switch positions 7 and 8 are set correctly for the Ethernet connector being used. See INSTALLATION section.</li> <li>Verify that the cable from EXB Ethernet port is terminated correctly to IP network. Check the ‘connection’ LED that is found near each port on most IP interconnect devices.</li> <li>Verify that the correct cross or straight-through cable is being used. See “Appendix F. IP Addresses”.</li> </ol>

Table D4

If the ETH RX LED (on local EXB) . . .	REASON	CORRECTIVE ACTION
Occasionally blinks on, then off.	Normal operation indicating a message packet has been detected on the IP network.	Go to next Table.
Does not illuminate when "RSVC" button on <b>remote</b> EXB is pressed.	<ol style="list-style-type: none"> <li>1. Ethernet port is not terminated correctly to the IP network.</li> <li>2. If Unicast/Replicated addressing mode is being used, IP addresses for local and remote EXB are not compatible.</li> <li>3. If Multicast addressing mode is being used, IP network routers or switches are not configured properly.</li> </ol>	<ol style="list-style-type: none"> <li>1a. Verify that OPTION switch positions 7 and 8 are set correctly for the Ethernet connector being used. See INSTALLATION section.</li> <li>b. Verify that the cable from EXB Ethernet port is terminated correctly to IP network. Check the 'connection' LED that is found near each port on most IP interconnect devices.</li> <li>c. Verify that the correct cross or straight-through cable is being used. See "Appendix F. IP Addresses".</li> <li>2a. Verify that portion of IP addresses identified by Subnet Mask for both local and remote EXBs are identical.</li> <li>3a. Verify that IP routers and switches have Multicast mode enabled.</li> <li>b. Verify that IP routers are programmed to pass the IP multicast address of the EXB module.</li> <li>c. Verify that IP routers are programmed to pass the EXB multicast port numbers of 1100 (destination port) and 1283 (source port).</li> </ol>

Table D5

If the ACT LED (on local EXB) . . .	REASON	CORRECTIVE ACTION
Occasionally blinks on, then off.	Normal operation indicating a message packet has passed through the router module of the EXB.	Go to next Table.
Does not illuminate when “RSVC” button on <b>remote</b> EXB is pressed.	<ol style="list-style-type: none"> <li>1. Router Service Pin message from <b>remote</b> EXB is not reaching the <b>local</b> EXB.</li> <li>2. Router Service Pin message from <b>remote</b> EXB is not passing through the <b>local</b> router module.</li> </ol>	<ol style="list-style-type: none"> <li>1a. Verify that “ACT” and “ERR” LED’s on <b>remote</b> EXB flash once. If not, return remote unit for evaluation/repair.</li> <li>b. Verify that “ETH TX” LED flashes on the remote EXB and that “ETH RX” LED flashes on the local EXB.</li> <li>2a. Place the <b>remote</b> router in Repeater mode and verify that the <b>local</b> “ACT” LED illuminates when “RSVC” button on <b>remote</b> EXB is pressed.</li> <li>b. If ‘2a’ is ok, re-program the router in the <b>local</b> EXB.</li> <li>c. If ‘2a’ is not ok, swap either the local or remote EXB with a known-good-unit to determine the faulty unit.</li> </ol>
Does not illuminate when other modules on the <b>local</b> MCN network are transmitting messages.	1. Message packets from modules on the <b>local</b> MCN network are not passing through the router in the <b>local</b> EXB.	<ol style="list-style-type: none"> <li>1a. Verify the connection between the <b>local</b> EXB and other modules on the MCN network.</li> <li>b. Place the router in the <b>local</b> EXB in Repeater mode and verify that its “ACT” LED illuminates when modules on the local MCN network are transmitting messages.</li> <li>c. If ‘1b’ is ok, re-program the router in the <b>local</b> EXB.</li> <li>d. If ‘1b’ is not ok, return the <b>local</b> EXB unit for evaluation/repair.</li> </ol>
Does not illuminate when modules on a <b>remote</b> MCN network are transmitting messages.	<ol style="list-style-type: none"> <li>1. Message packets from modules on a <b>remote</b> MCN network are not passing through the router in the <b>remote</b> EXB.</li> <li>2. Message packets from modules on a <b>remote</b> MCN network are not reaching the local EXB.</li> <li>3. Message packets from modules on <b>remote</b> MCN network are not passing through the router in the <b>local</b> EXB.</li> </ol>	<ol style="list-style-type: none"> <li>1a. Verify the connection between the <b>remote</b> EXB and other modules on the <b>remote</b> MCN network.</li> <li>b. Verify that “ACT” LED on <b>remote</b> EXB illuminates when other modules on the <b>remote</b> MCN network are transmitting messages.</li> <li>c. Place the router in the <b>remote</b> EXB in Repeater mode and verify that its “ACT” LED illuminates when modules on its <b>remote</b> MCN network are transmitting messages.</li> <li>d. If ‘1c’ is ok, re-program the router in the <b>remote</b> EXB.</li> <li>e. If ‘1c’ is not ok, return unit for evaluation/repair.</li> <li>2. See this Table above and verify step “ACT LED... Does not illuminate when RSVC button on <b>remote</b> EXB is pressed”.</li> <li>3. See this Table above and verify step “ACT LED... Does not illuminate”. when “RSVC” button on <b>remote</b> EXB is pressed”.</li> </ol>

Table D6

<b>Miscellaneous:</b>	<b>REASON</b>	<b>CORRECTIVE ACTION</b>
Cannot communicate with Control Neuron Processor of <b>local</b> EXB when using NODEUTIL.	<ol style="list-style-type: none"> <li>1. In Bridge or Configured modes, router neurons and network interface are not in the same domain.</li> <li>2. In Repeater mode, the network interface may be defective.</li> </ol>	<ol style="list-style-type: none"> <li>1. Verify that NODEUTIL can communicate with other MCN modules.</li> <li>2a. Place the local router in Repeater mode and verify that communications is possible, or               <ol style="list-style-type: none"> <li>b. Use NODEUTIL to change the network interface Domain to match the router neurons' domains.</li> </ol> </li> </ol>
Cannot communicate with the Control Neuron Processor of local EXB.	<ol style="list-style-type: none"> <li>1. In Bridge or Configured modes, the Control Neuron, the router neurons, and the network interface are not all in the same domain.</li> <li>2. In Repeater mode, the Control Neuron and network interface are not in the same domain.</li> </ol>	<ol style="list-style-type: none"> <li>1. Place the router neurons for the <b>local</b> EXB in Repeater mode.</li> <li>2. Change the network interface Domain to match the Control Neuron domain.</li> </ol>

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## APPENDIX E. SPECIFICATIONS

### ***EXB-IP and EXB-FI***

<i>DC Power Input:</i>	10 to 32 VDC, unregulated (10BaseT) 15 to 32 VDC unregulated (AUI - Fiber) 5 watts maximum without SMX transceiver 10 watts maximum with SMX power line transceiver
<i>Size:</i>	7.5" D x 5.6" W x 1.6" H
<i>Operating Temperature:</i>	0 to 60 °C
<i>Humidity:</i>	10-95% non-condensing
<i>Mounting:</i>	Desktop with integral non-slip feet Wallmount or 19" rack mount with optional adapters
<i>Configuration:</i>	
<i>Integral Router</i>	Factory default router mode is set to Repeater. Configured or Bridge mode can be also be programmed.
<i>Ethernet IP Parameters</i>	Using supplied EtherPlug
<i>Transceivers Supported:</i>	
<i>MCN</i>	78K or 1250, depending on model
<i>Ethernet</i>	10BaseT (EXB-IP), Fiber (10BaseFL Multimode or Singlemode for EXB-FI, depending on model.)
<i>IP Addressing Modes:</i>	Unicast/Replicated, Multicast
<i>IP Transport:</i>	UDP
<i>IP Ports:</i>	1100 (destination) and 1283 (source).

## APPENDIX F. IP ADDRESSING

### Conventions

Any node connected to an IP (Internet Protocol) network must be identified with a unique 32-bit address. These 32-bit addresses are commonly written *in dotted decimal* notation as four decimal numbers (referred to as octets because each decimal number represents 8 bits) separated by decimal points. Each octet can be a number from 1 to 255. For example, 131.9.1.2 is a valid IP address. The IP address assigned to a network device is commonly called the *Host IP Address*. By having unique addresses on a network, individual stations (also called hosts or nodes) can be identified on the network.

The EXB-IP and EXB-FI modules are provided from the factory with default addressing to allow simple “quickstart” testing by connecting them back-to-back. See “APPENDIX A. FACTORY DEFAULT CONFIGURATION”.

### IP Address Classes

There are five types of IP addresses. Three are associated with networks – Class A, B, and C.

- **Class A** addresses are for networks that have a large number of hosts, up to a maximum of 16,777,216 on a single IP network. The first octet is between 1 and 126. (127 is reserved for loopback and is used for internal testing on the local machine.)
- **Class B** addresses are for medium-sized networks. The first octet is between 128 and 191.
- **Class C** addresses are for small networks, up to 255 hosts. The first octet is between 192 and 223.
- **Class D** addresses are reserved for multicasting and the first octet is between 224 and 239.
- **Class E** addresses (240 to 255) are reserved and should not be used.

An IP address consists of two parts – one part identifies the network, and one part identifies the host (or node). The NetID portion of the IP address identifies the physical network segment. The HostID portion of the IP address identifies the node within the network segment. The following table lists the capacities of each IP address and the bits used as NetID and HostID.

IP Class	Net ID (Beginning Bits)	# of Networks	Host ID (Ending Bits)	# of Hosts or Subnets	1 <sup>st</sup> byte Range
A	8	126	24	16.7 million	1-126
B	16	16,000	16	65,000	128-191
C	24	2 million	8	254	192-293

### Subnetting using Subnet Masks

A portion of the host bits can be used to “subnet the network”. The subnet mask identifies the “NetID” and “HostID” portions of the IP address in a bitwise fashion. The mask is constructed by placing a “1” in any bit that is part of a subnetwork address. So subnet mask bits that are SET define the NetID, and CLEARED subnet mask bits define the HostID.

A subnet mask of 255.255.255.0 defines the NetID as the first three octets, and the HostID as the last octet. For example, for the address 192.47.73.111 and the subnet mask of 255.255.255.0, the subnetwork can be identified as 192.47.73.0.

### Summary of Important Networking Details

- A specific “NetID” can exist on only ONE port of ONE IP router.
- The “NetID” portion of the Host Address and the Gateway Address **MUST BE THE SAME**.
- If a functional router (such as an EXB-IP or EXB-FI) is moved to a different location, its Host IP Address and Default Gateway IP Address **MUST BE CHANGED** to match the “NetID” at the new location.

## **IP Addressing modes**

### **Unicast/Replicated**

Unicast/Replicated addressing mode allows point-to-point or point-to-multipoint communications in any IP network. A table of *Target IP Addresses* is configured into each of the EXB-IP modules. The table in each EXB contains the IP addresses of the other modules in the group. The maximum number of EXBs that can be configured into one Unicast/Replicated group is 96.

Each EXB is programmed with a *Host IP Address*, a list of *Target IP Addresses*, and optionally, a *Default Gateway IP Address*. The *Default Gateway IP Address* is the address of the IP router to which the respective EXB is attached and allows for IP routers or gateways that may exist between EXB units.

Using Unicast/Replicated mode, a single MCN message packet entering any of the EXB modules of the group will be sent out the Ethernet port of that module as multiple Unicast IP messages, one to each of the other EXB modules in the group.

### **Multicast**

Multicast addressing mode allows efficient point-to-multipoint communications in a network. Each EXB is assigned a *Host IP Address*, a *multicast Target IP Address*, and optionally, a *Default Gateway IP Address*. A single *multicast Target IP Address* is assigned to all EXBs in the network within the range 224.0.1.0 through 239.255.255.255.

A single MCN message packet entering any one of the EXB modules results in a **single** multicast IP packet being sent out the Ethernet port of that module to be received by *all* other EXB members configured to the same Multicast IP address.

Multicast addressing mode can be used with a very large number of EXB modules. Because only one IP packet is generated for every MCN message packet, multicast addressing mode uses far less network bandwidth than Unicast/Replicated.

Before choosing multicast addressing mode, it is important to determine the following capabilities of the IP network to which the EXB modules will be connected:

- IP routers must be capable of handling IP multicast traffic.
- IP routers must have IP multicast enabled
- IP routers must forward the EXB multicast port numbers of 1100 (destination port) and 1283 (source port).

### **MAC Addresses**

Whereas IP uses Logical Addresses to identify a host (node), other protocols use Hardware Addresses called Media Access Control addresses, or MAC addresses. MAC addresses are set at the factory at time of manufacture and cannot be changed. (IP addresses can be changed at any time.) A MAC address consists of six octets, in hexadecimal notation, separated by colons. An example would be: 00:10:EE:00:02:34.

The first three octets in a MAC address identify the manufacturer. In the above example, 00:10:EE identifies CTI Products as the manufacturer of this device. The last three octets are sequentially assigned by the manufacturer to form a type of serial number. In this way, no two devices have the same MAC address.

Multicast addressing is also possible using MAC addresses, just as in IP addressing. MAC addresses reserved for broadcast messages start at: 00:01:5E:00:00:00.

### **Address Resolution Protocol (ARP)**

Since IP uses Logical Addresses at the OSI Network Layer (Layer 3) and Ethernet uses MAC addresses at the OSI Data Link Layer (Layer 2), Address Resolution Protocol is used whenever IP is used over the Ethernet. ARP is needed to convert an IP address to a MAC address. The client then stores this resolved address for a period of time in its ARP cache. An ARP cache is a lookup table, typically in a router, that will store a quantity of resolved addresses for devices that it must communicate with.

When a message is destined for an IP address whose MAC address has not yet been resolved, an ARP REQUEST is sent from the local host as a broadcast message, asking for MAC identification. A remote host with the IP address in question generates an ARP RESPONSE. This ARP RESPONSE contains the requested MAC address. The local host receives the message, and places the IP Address and the matching MAC Address in its ARP Cache. The original message is then sent using the MAC Address found previously. Any additional messages to this remote IP address will be sent using the MAC address found in the local host's ARP cache.

### **Ethernet 10BaseT Cables**

When connecting two IP devices together, either a straight-through cable or a crossover cable may be required.

If interconnecting similar devices, then a crossover cable is needed. Examples would be interconnecting two EXB routers, or two IP routers, or two hubs, or two computers. Generally, if the two devices are both Layer 3 devices, then a crossover cable is required. Routers operate at Layer 3. Similarly, if the two devices are Layer 1 or 2 devices, they would also require a crossover cable. Bridges, switches, and Network Interface Cards (NIC) operate at Layer 2, and hubs, repeaters, and concentrators operate at Layer 1.

If interconnecting dissimilar devices, then a straight-through cable is needed. Dissimilar devices would involve one Layer 3 device and a Layer 1 or Layer 2 device.

The following table summarizes devices in each layer.

Layer 3	Layer 2	Layer 1
IP Router	Bridge	Hub
EXB Router	Switch	Repeater
	NIC	Concentrator

The following table lists the connections for a straight-through cable.

Standard End				Standard End		
Signal Name	Wire Color	Pin		Pin	Wire Color	Signal Name
TD+	White/Orange	1	↔	1	White/Orange	TD+
TD-	Orange	2	↔	2	Orange	TD-
RD+	White/Green	3	↔	3	White/Green	RD+
Not used	Blue	4	↔	4	Blue	Not used
Not used	White/Blue	5	↔	5	White/Blue	Not used
RD-	Green	6	↔	6	Green	RD-
Not used	White/Brown	7	↔	7	White/Brown	Not used
Not used	Brown	8	↔	8	Brown	Not used

The following table lists the connections for a crossover cable.

Standard End				Crossover End		
Signal Name	Wire Color	Pin		Pin	Wire Color	Signal Name
TD+	White/Orange	1	↔	3	White/Green	RD+
TD-	Orange	2	↔	6	Green	RD-
RD+	White/Green	3	↔	1	White/Orange	TD+
Not used	Blue	4	↔	5	Blue	Not used
Not used	White/Blue	5	↔	4	White/Blue	Not used
RD-	Green	6	↔	2	Orange	TD-
Not used	White/Brown	7	↔	8	White/Brown	Not used
Not used	Brown	8	↔	7	Brown	Not used





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