

Motoman NX100 Controller

EtherNet/IP Card Instructions Manual

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Revision: 5



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Chapter 1

Introduction

This manual provides instructions for the Motoman EtherNet/IP PCI Interface cards (P/N 154310-1). The application of this board allows the transmission of NX100's general-purpose I/O data with other devices connected to EtherNet/IP.

EtherNet/IP is an open low-level network that provides connections between simple industrial devices (such as sensors and actuators) and higher-level devices (such as robot controllers and computers). The EtherNet/IP (EtherNet Industrial Protocol) communication protocol uses CIP (Control and Information Protocol), TCP/IP and Ethernet. CIP is common to the EtherNet protocol and ControlNet protocol and uses TCP for transporting message data and UDP for transporting input/output data.

EtherNet/IP is managed by the ODVA (Open DeviceNet Vendors Association). You can obtain specifications for this protocol at the following address: <http://www.odva.org>.

1.1 System Configuration

The EtherNet/IP card interfaces with the NX100 controller, and does not require an I/O expansion rack. The 154446-1 single-channel card can be configured either as a Master or Slave (server or adapter) interface. One free PCI slot is required.



Note: The EtherNet/IP card is only available for the NX100. This card is not compatible with the NXC100.

The EtherNet/IP card supports the FTP function, an extended application of the data transmission function (Ethernet), as a server or a client. Please refer to the FTP Function Manual (154311-1) for details.

1.1.1 Functionality of the AppliconIO[®] EtherNet/IP Master

- Connector Type: RJ45
- Speeds Supported:
 - Automatic
 - 10 Mbits (half and full duplex)
 - 100 Mbits (half and full duplex)
- TCP/IP Configuration:
 - Static
 - DHCP or BOOTP
- Devices Supported:
 - Maximum 8 devices
 - Device Type: “Generic EtherNet/IP”
 - One input/output data connection with configuration data
 - One status data connection (optional)
- Name of supported host (“Hostname” via DNS server)
- EtherNet/IP functionality: Level 4 (I/O Messages - Client/Originator + Server/Target)
- Input/Output Scanner
- Class 1 I/O Connection - Implicit Messaging
- Automatic organization of input/output memories
- Total size of inputs/outputs: 127 bytes maximum

1.1.2 Functionality of the AppliconIO[®] EtherNet/IP Slave

- Supported Connections:
 - Cyclic type input/output connections
 - Input size: from 1 to 127 bytes
 - Output Size: from 1 to 127 bytes
 - Configuration size: from 0 words

1.2 About This Document

This manual provides system information for the EtherNet/IP PCI interface card and contains the following sections:

SECTION 1 - INTRODUCTION

Provides general information about the structure of this manual, a list of reference documents, and customer service information.

SECTION 2 - SAFETY

This section provides information regarding the safe use and operation of Motoman products.

SECTION 3 - ETHERNET/IP CARD INSTRUCTIONS

Provides detailed instructions for EtherNet/IP Card, including installation, specifications, and operation.

1.3 Reference to Other Documentation

For additional information refer to the following:

- NX100 Controller Manual (P/N 149201-1)
- Concurrent I/O Manual (P/N 149230-1)
- Operator's Manual for your application
- Vendor manuals for system components not manufactured by Motoman

1.4 Customer Service Information

If you are in need of technical assistance, contact the Motoman service staff at (937) 847-3200. Please have the following information ready before you call:

- Product (EtherNet/IP Card serial number)
- Robot Type (EA1900N, HP5, etc.)
- Application Type (arcwelding, spot welding, handling, general)
- Robot Serial Number (located on back side of robot arm)
- Robot Sales Order Number (located on back of controller)

NOTES

Chapter 2

Safety

2.1 Introduction

It is the purchaser's responsibility to ensure that all local, county, state, and national codes, regulations, rules, or laws relating to safety and safe operating conditions for each installation are met and followed.

We suggest that you obtain and review a copy of the ANSI/RIA National Safety Standard for Industrial Robots and Robot Systems. This information can be obtained from the Robotic Industries Association by requesting ANSI/RIA R15.06-1999. The address is as follows:

Robotic Industries Association
900 Victors Way
P.O. Box 3724
Ann Arbor, Michigan 48106
TEL: (734) 994-6088
FAX: (734) 994-3338
INTERNET: www.roboticsonline.com

Ultimately, the best safeguard is trained personnel. The user is responsible for providing personnel who are adequately trained to operate, program, and maintain the robot cell. **The robot must not be operated by personnel who have not been trained!**

We recommend that all personnel who intend to operate, program, repair, or use the robot system be trained in an approved Motoman training course and become familiar with the proper operation of the system.

This safety section addresses the following:

- Standard Conventions (Section 2.2)
- General Safeguarding Tips (Section 2.3)
- Mechanical Safety Devices (Section 2.4)
- Installation Safety (Section 2.5)
- Programming, Operation, and Maintenance Safety (Section 2.6)

2.2 Standard Conventions

This manual includes the following alerts – in descending order of severity – that are essential to the safety of personnel and equipment. As you read this manual, pay close attention to these alerts to insure safety when installing, operating, programming, and maintaining this equipment.



DANGER!

Information appearing in a **DANGER** concerns the protection of personnel from the immediate and imminent hazards that, if not avoided, will result in immediate, serious personal injury or loss of life in addition to equipment damage.



WARNING!

Information appearing in a **WARNING** concerns the protection of personnel and equipment from potential hazards that can result in personal injury or loss of life in addition to equipment damage.



CAUTION!

Information appearing in a **CAUTION** concerns the protection of personnel and equipment, software, and data from hazards that can result in minor personal injury or equipment damage.



Note: Information appearing in a Note provides additional information which is helpful in understanding the item being explained.

2.3 General Safeguarding Tips

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. All personnel involved with the operation of the equipment must understand potential dangers of operation. General safeguarding tips are as follows:

- Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation of this robot, the operator's manuals, the system equipment, and options and accessories should be permitted to operate this robot system.
- Do not enter the robot cell while it is in automatic operation. Programmers must have the teach pendant when they enter the robot cell.
- Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).
- The robot must be placed in Emergency Stop (E-STOP) mode whenever it is not in use.
- In accordance with ANSI/RIA R15.06-1999, section 4.2.5, Sources of Energy, use lockout/tagout procedures during equipment maintenance. Refer also to Section 1910.147 (29CFR, Part 1910), Occupational Safety and Health Standards for General Industry (OSHA).

2.4 Mechanical Safety Devices

The safe operation of the robot, positioner, auxiliary equipment, and system is ultimately the user's responsibility. The conditions under which the equipment will be operated safely should be reviewed by the user. The user must be aware of the various national codes, ANSI/RIA R15.06-1999 safety standards, and other local codes that may pertain to the installation and use of industrial equipment. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. The following safety equipment is provided as standard:

- Safety fences and barriers
- Light curtains and/or safety mats
- Door interlocks
- Emergency stop palm buttons located on operator station, robot controller, and programming pendant

Check all safety equipment frequently for proper operation. Repair or replace any non-functioning safety equipment immediately.

2.5 Installation Safety

Safe installation is essential for protection of people and equipment. The following suggestions are intended to supplement, but not replace, existing federal, local, and state laws and regulations. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. Installation tips are as follows:

- Be sure that only qualified personnel familiar with national codes, local codes, and ANSI/RIA R15.06-1999 safety standards are permitted to install the equipment.
- Identify the work envelope of each robot with floor markings, signs, and barriers.
- Position all controllers outside the robot work envelope.
- Whenever possible, install safety fences to protect against unauthorized entry into the work envelope.
- Eliminate areas where personnel might get trapped between a moving robot and other equipment (pinch points).
- Provide sufficient room inside the workcell to permit safe teaching and maintenance procedures.

2.6 Programming, Operation, and Maintenance Safety

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation, manuals, electrical design, and equipment interconnections of this robot should be permitted to program, operate, and maintain the system. All personnel involved with the operation of the equipment must understand potential dangers of operation.

- Inspect the robot and work envelope to be sure no potentially hazardous conditions exist. Be sure the area is clean and free of water, oil, debris, etc.
- Be sure that all safeguards are in place. Check all safety equipment for proper operation. Repair or replace any non-functioning safety equipment immediately.
- Do not enter the robot cell while it is in automatic operation. Be sure that only the person holding the programming pendant enters the workcell.
- Check the E-STOP button on the programming pendant for proper operation before programming. The robot must be placed in Emergency Stop (E-STOP) mode whenever it is not in use.
- Back up all programs and jobs onto suitable media before program changes are made. To avoid loss of information, programs, or jobs, a backup must always be made before any service procedures are done and before any changes are made to options, accessories, or equipment.

- Any modifications to PART 1, System Section, of the robot controller concurrent I/O program can cause severe personal injury or death, as well as damage to the robot! Do not make any modifications to PART 1, System Section. Making any changes without the written permission of Motoman will VOID YOUR WARRANTY!
- Some operations require standard passwords and some require special passwords. Special passwords are for Motoman use only. YOUR WARRANTY WILL BE VOID if you use these special passwords.
- The robot controller allows modifications of PART 2, User Section, of the concurrent I/O program and modifications to controller parameters for maximum robot performance. Great care must be taken when making these modifications. All modifications made to the controller will change the way the robot operates and can cause severe personal injury or death, as well as damage the robot and other parts of the system. Double-check all modifications under every mode of robot operation to ensure that you have not created hazards or dangerous situations.
- Check and test any new or modified program at low speed for at least one full cycle.
- This equipment has multiple sources of electrical supply. Electrical interconnections are made between the controller and other equipment. Disconnect and lockout/tagout all electrical circuits before making any modifications or connections.
- Do not perform any maintenance procedures before reading and understanding the proper procedures in the appropriate manual.
- Use proper replacement parts.
- Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).

NOTES

Chapter 3

Hardware Specifications

When the card is configured in the controller, the first byte of data from each channel is a status byte. The information defined in each byte is outlined in the chart below:

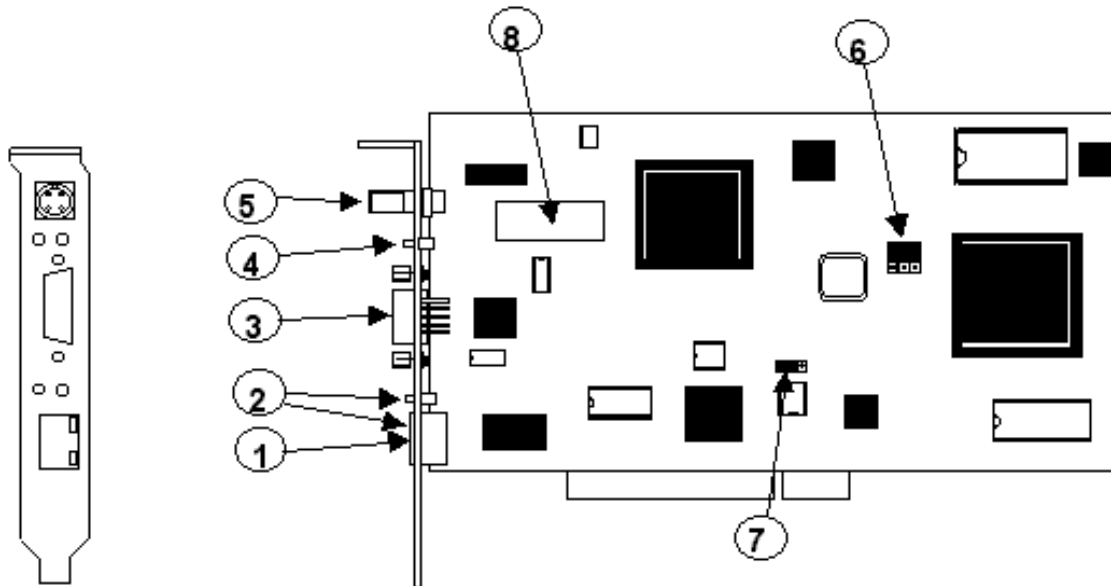
Signal	Description
2xxx0 2xxx3 (bit 0 to 3)	Reserved
2xxx4 (bit 4)	Not used, always set to zero
2xxx5 (bit 5)	Master or Slave mode 0: Communication to all nodes normal 1: Unlinked node exists
2xxx6 (bit 6)	EtherNet/IP Communication Status 0: Normal, 1: Error
2xxx7 (bit 7)	EtherNet/IP board status 0: Normal, 1: Error



Note: Not all PLC systems are capable of passing 128 bytes of data. Consult the PLC owner's manual to determine system maximum I/O capability.

3.1 Card Components

3.1.1 PCU-ETHIO Board



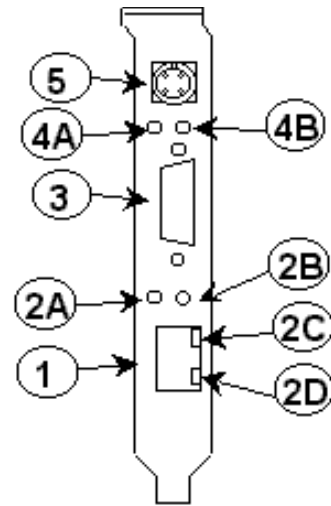
1. RJ45 connector for connection to the Ethernet network
2. Ethernet transmission indicator lamps
3. Male SubD 9-pin connector for configuration by RS232 serial link
4. Configuration RS232 port transmission indicator lamps
5. Connector providing access to a discrete input and output through the ApplicomIO functions IO_SetWatchDog and IO_GetDigitalInput (Not used by Motoman functions)
6. Board number configuration jumpers (1 to 8)
Default configuration: board 1
7. PCI configuration jumper (reserved for Applicom international use)
8. Socket for required 5RS232 module if configuration port is used

Miscellaneous Characteristics

- Size of the PCU ETHIO board: 174 x 106 mm (excluding connectors and rear panel)
- Consumption: 5.5 W (5V)
- Operating temperature: 0 to +65° C
- Dielectric strength (galvanic isolation): 500 Volts
- MTBF: 100,000 hours

3.1.2 PCU-ETHIO Cabling and Indicators

1. RJ45 connector for connection to Ethernet network
2. Indicator lamps of the Ethernet channel (EtherNet/IP protocol)
 - 2A: Network Status
 - OFF - IP Address not received
 - Blinking Green - IP address received, no CIP connection established
 - ON - Connected
 - Blinking Red - At least one CIP connection is timed out
 - 2B: Module Status
 - OFF - Not powered or card not initialized
 - Blinking Green - Card not configured
 - ON (green)- Card operational
 - Blinking Red - Minor fault
 - Red - Major Fault
 - 2C: Ethernet Link OK
 - 2D: Transmission Speed
 - ON - 100 Mb/s
 - OFF - 10 Mb/s
2. Indicator lamps of the Ethernet channel (other protocols)
 - 2A: Transmission
 - 2B: Reception
 - 2C: Ethernet Link OK
 - 2D: Transmission Speed
 - ON - 100 Mb/s
 - OFF - 10 Mb/s
3. Female SubD 9-pin connector not used
4. Configuration port indicator lamps
 - 4A. Transmission
 - 4B. Reception
5. Connector providing access to a discrete input and output through the functions IO_SetWatchDog and IO_GetDigitalInput.



Notes

Chapter 4

Installation

The following procedures outline how to configure the EtherNet/IP card (P/N 151164-2). The settings below should only be used if the end-user has not specified the card configuration.

4.1 Materials

- Single Channel EtherNet/IP Card (P/N 151164-2)
Includes EtherNet/IP Card and ApplicomIO PC Network Interface software on CD

4.1.1 Board Settings

No changes in board settings are required.

4.1.2 Card Installation



DANGER!

Remove all power from the controller before installing the EtherNet/IP Card! Failure to remove power may result in injury or death!



WARNING!

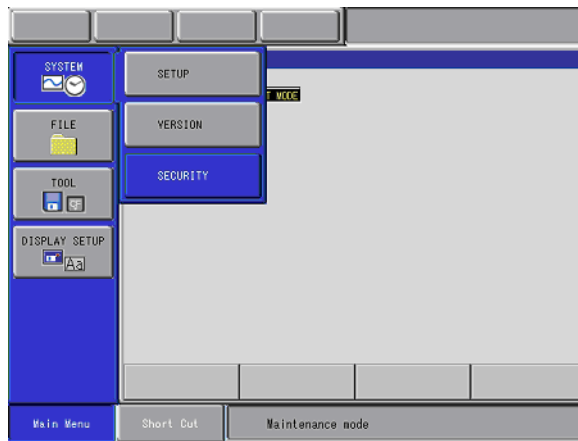
Follow all Electrical Static Discharge procedures, including use of anti-static straps, to avoid damage to the board. Never touch the mounting surfaces of the board parts directly with fingers.

1. Remove PCI card from static shielding bag.
2. Insert card in the NX100's CPU rack slot: CPU OPTION 1.
3. Secure card with M3 x 10 screw.

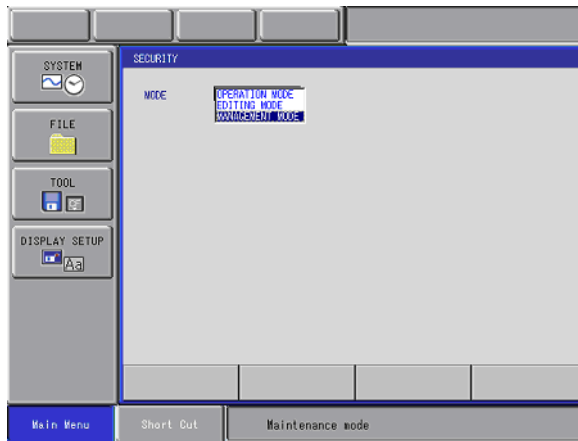
4.2 NX100 Configuration

The NX100 controller must be properly configured to use the EtherNet/IP Card. The following modifications require the user to be in Maintenance Mode with Management Mode selected. Make certain EtherNet/IP Card is correctly mounted inside NX100 controller and NX100 main power supply is OFF before proceeding.

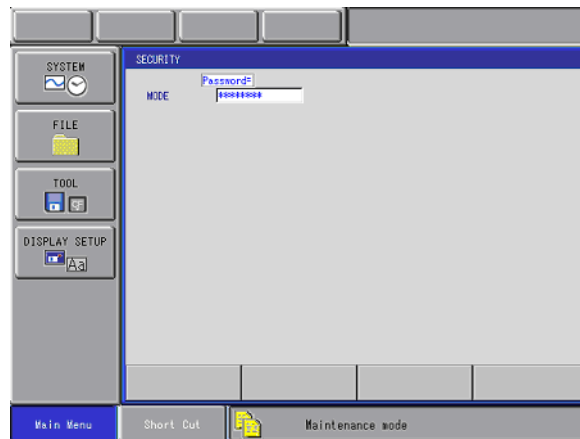
1. Turn ON main power to NX100 while simultaneously pressing the Main Menu button on the programming pendant. The Main Menu appears.
2. From the Main Menu select System > Security.



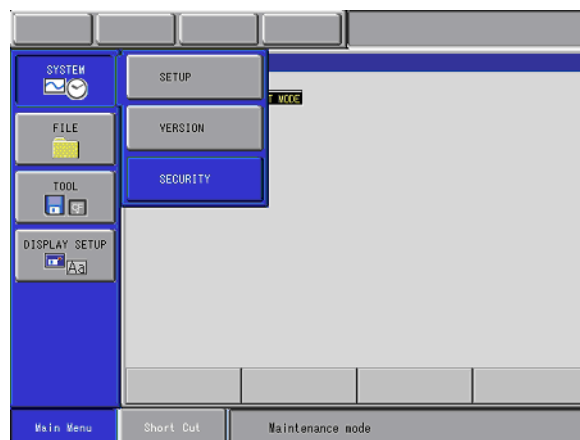
3. Select Management Mode.



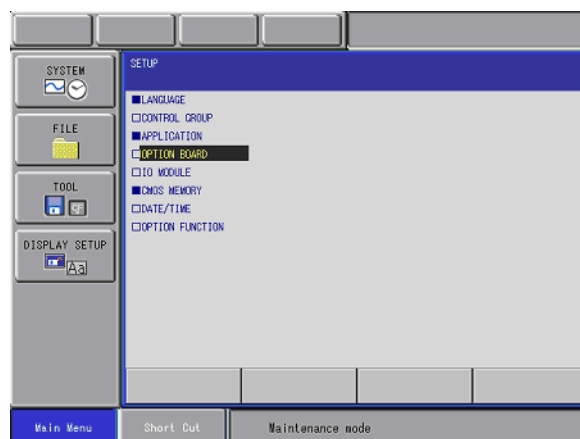
4. Enter password 99999999 (default).



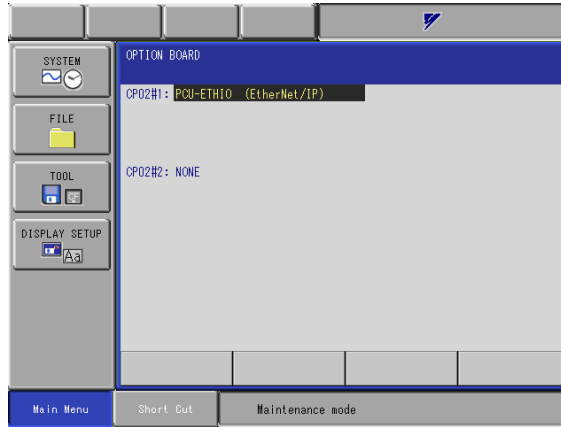
5. Select System > Setup.



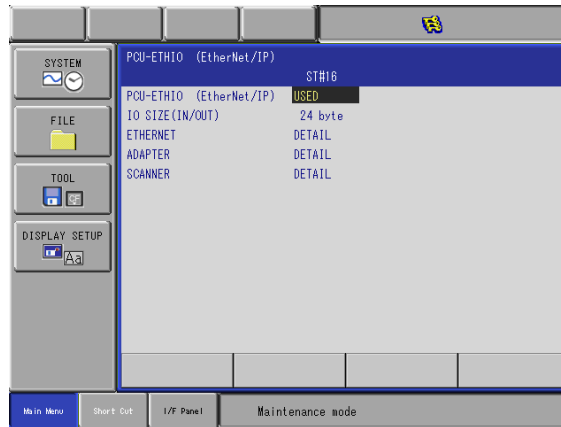
6. Select Option Board.



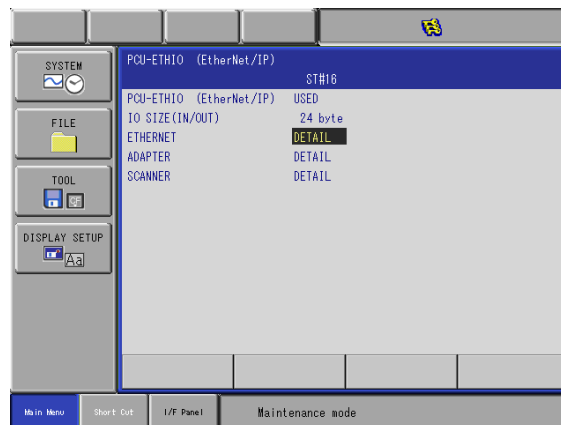
7. Verify EtherNet/IP board is detected as PCU-ETHIO. Board should be identified in slot CP02#1.



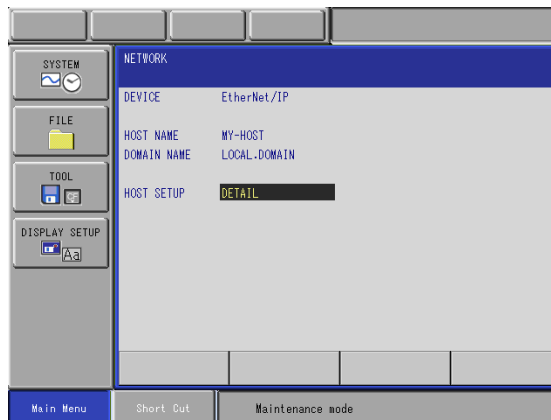
8. Press Select. PCU-ETHIO(CH1) and Device Information list should be displayed. Select PCU-ETHIO(CH1).



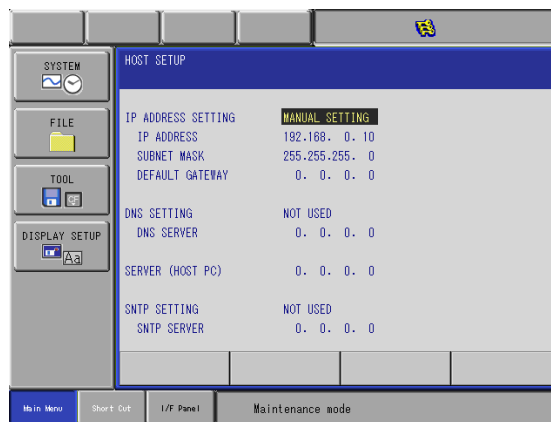
9. Set IO SIZE (IN/OUT).
10. Select ETHERNET DETAIL and press SELECT.



- At the NETWORK screen, select HOST SETUP: DETAIL.



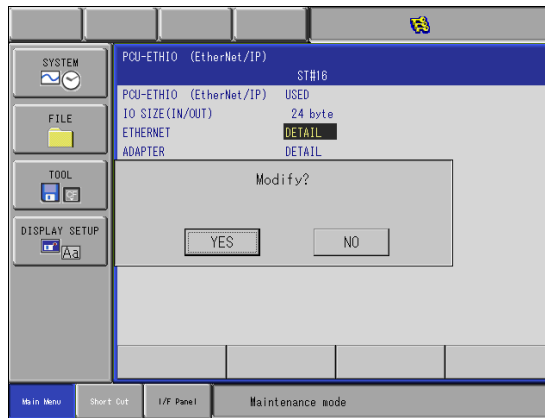
- Enter data in the HOST SETUP screen as specified below.



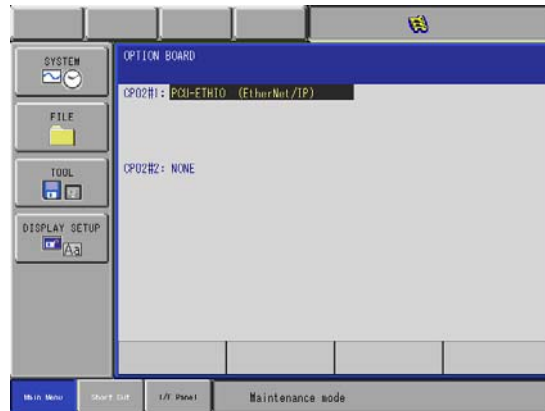
Suggested Default Settings:

- IP Address Setting: Manual
 - IP Address: 192.168.0.10
 - Subnet Mask: 255.255.255.0
 - Default Gateway: 0.0.0.0
 - DNS Settings: Not Used
 - DNS Server: 0.0.0.0
 - Server (Host PC): 0.0.0.0
 - Sntp Setting: Not Used
- After setting values press the ENTER key to go to the NETWORK screen.
 - Press ENTER again to return to the "PCU-ETHIO" screen. Press ENTER a final time to receive the Modify prompt. Select YES.
 - See Sections 4.3.3 and 4.3.4 to set up the card as Master/Slave (Scanner/Adapter).

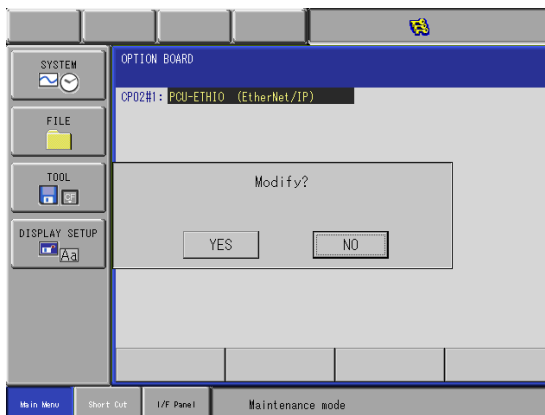
16. Press ENTER. The Modify prompt appears. Select YES.



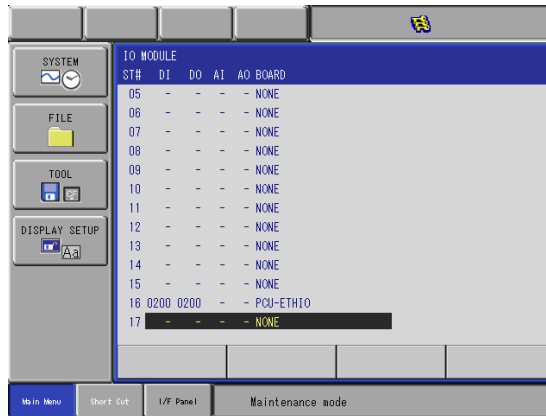
17. After an auditory beep the "OPTION BOARD" menu is again displayed.



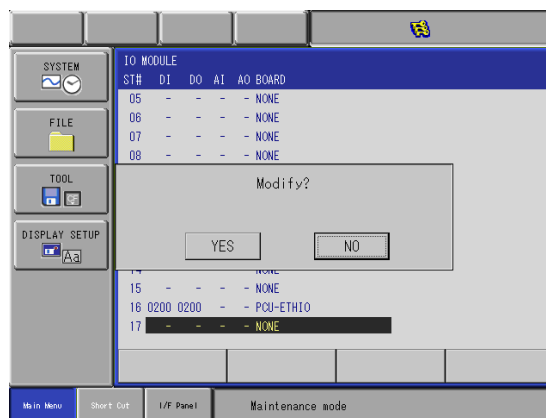
18. Press ENTER. Another Modify prompt appears. Press YES.



- At the IO Module Screen, press ENTER once. Verify that PCU-ETHIO is registered as Station #16 with appropriate IO Count.



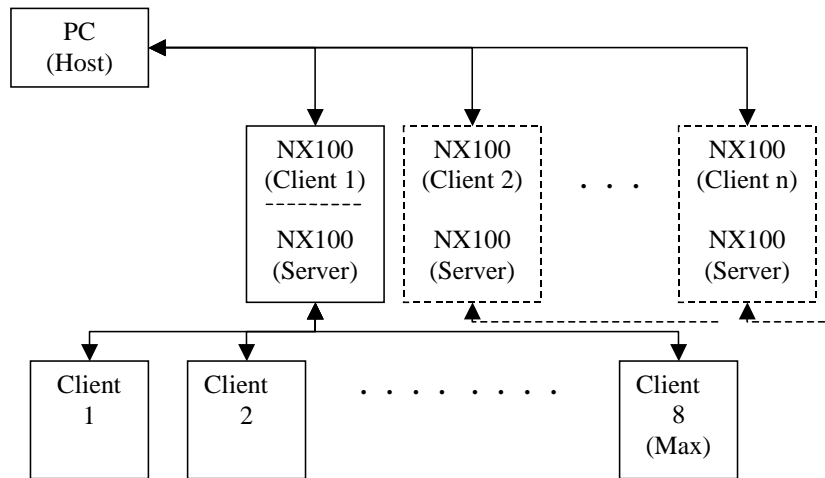
- Press ENTER again. At the Modify prompt select Yes.



- This completes the software setup in Maintenance Mode. Cycle power to the controller and restart normally.

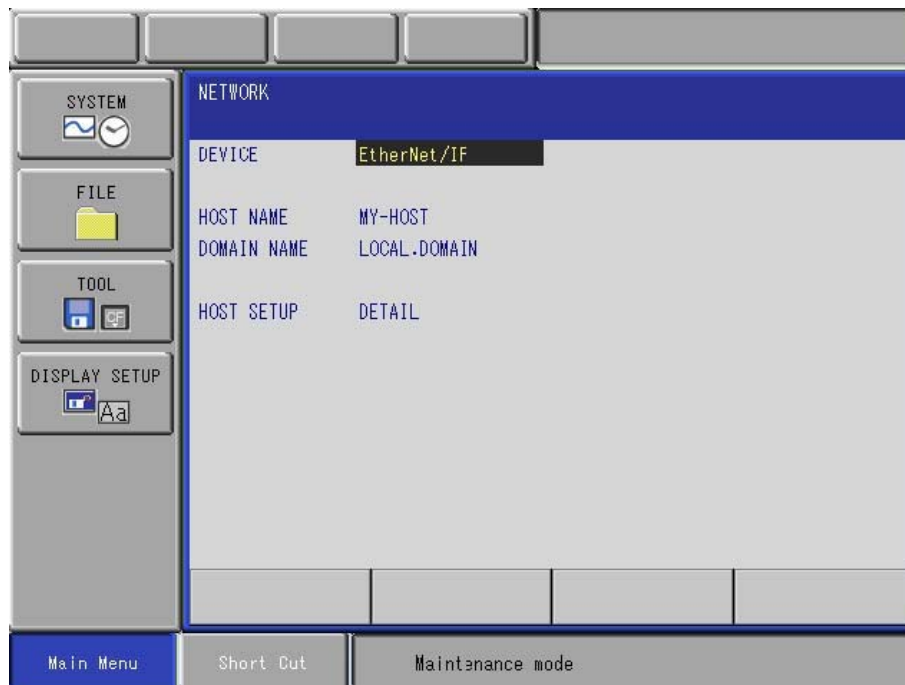
4.3 Configuration

Sample Network



4.3.1 Definition of Terms and Screenshots

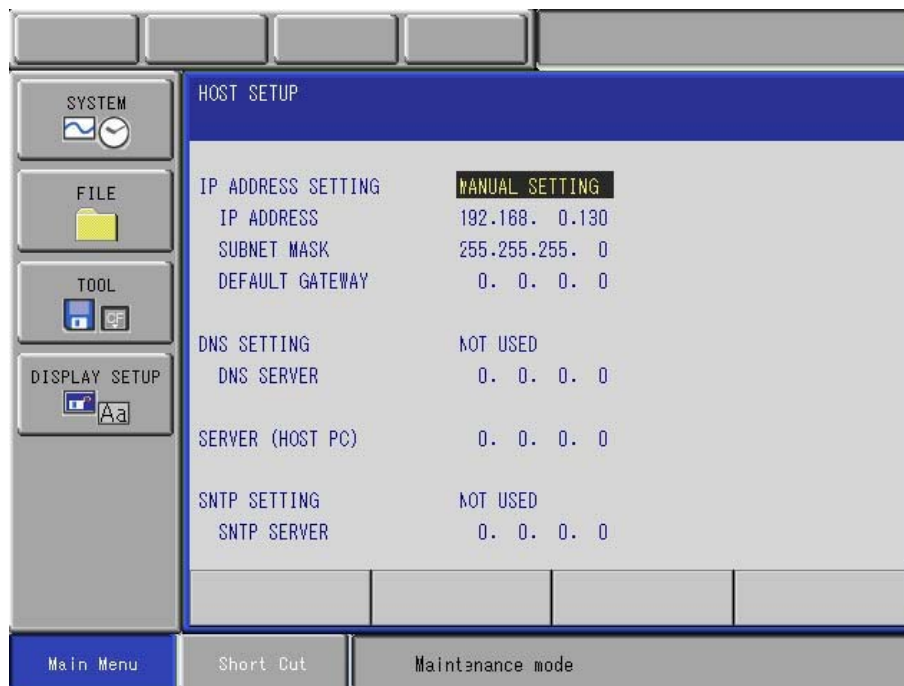
Network Screen:



HOST NAME: The computer system that is accessed by a robot controller.

DOMAIN NAME: A Domain Name is the text name corresponding to the numeric IP address of a computer on the network. A domain name must be unique.

HOST SETUP Screen



IP Address: An identifier for a computer or device on a TCP/IP network. Networks using the TCP/IP protocol route messages based on the IP address of the destination.

SUBNET MASK: Subnet enables the network administrator to divide the host part of the address into two or more subnets.

DEFAULT GATEWAY: A node on a computer network that serves as an access point to another network.

DNS SERVER: Short for Domain Name System (or Service or Server), an Internet service that translates domain names into IP addresses.

SERVER (HOST PC): A computer that delivers information and software to other computers linked by a network.

HOST SETUP Screen (Continued / Farther down)



SNTP SERVER: Simple Network Time Protocol, which is an adaptation of the Network Time Protocol (NTP) used to synchronize computer clocks in the Internet.

4.3.2 Setup with DHCP

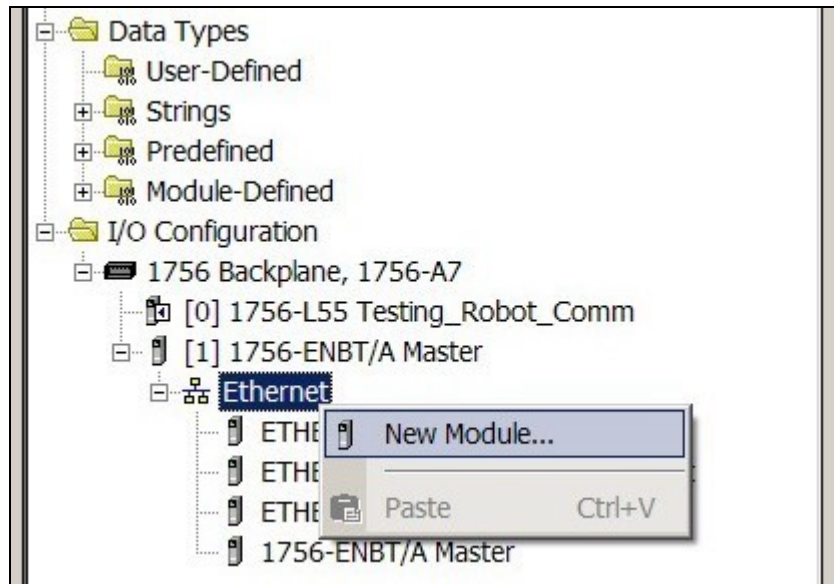
DHCP: Dynamic Host Configuration Protocol is a protocol for assigning dynamic IP addresses to devices on a network. With dynamic addressing, a device can have a different IP address every time it connects to the network. In some systems, the device's IP address can even change while it is still connected. DHCP also supports a mix of static and dynamic IP addresses.

Dynamic addressing simplifies network administration because the software keeps track of IP addresses rather than requiring an administrator to manage the task. This means that a new computer can be added to a network without the hassle of manually assigning it a unique IP address.

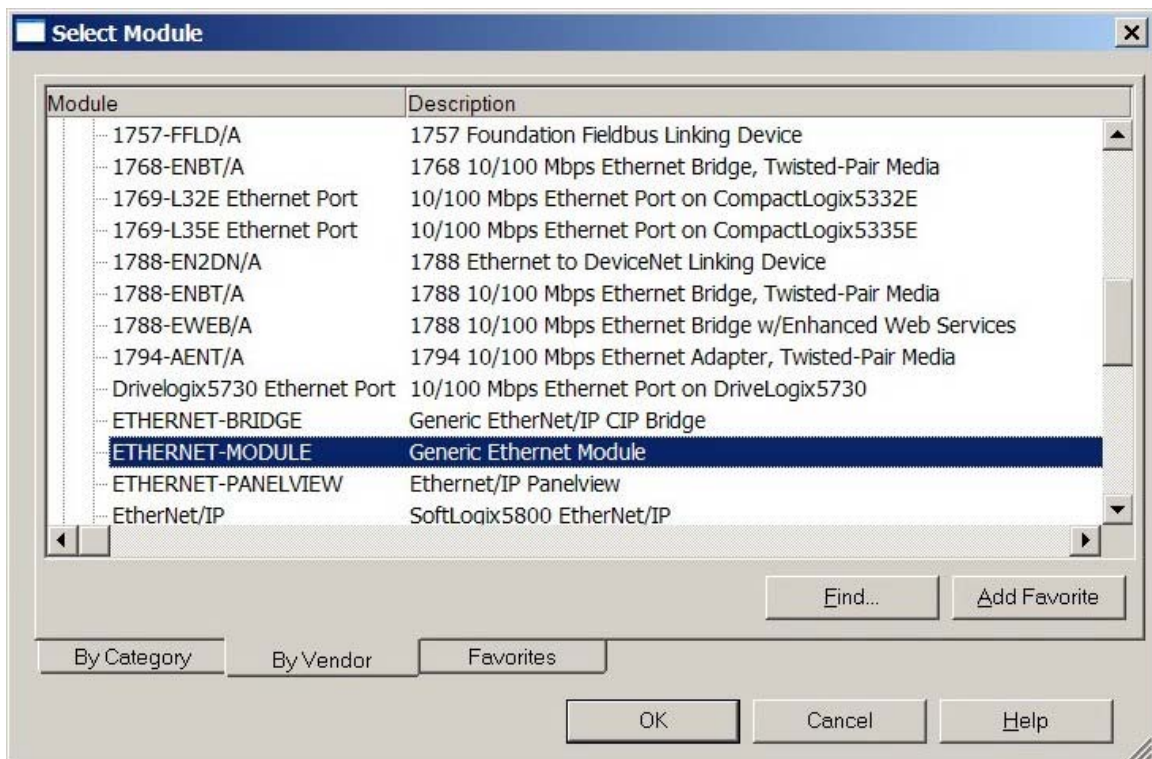
4.3.3 Configuration Example #1 - Robot as Slave to ControlLogix PLC

RSLogix 5000 Setup:

1. Add Robot to the Ethernet network through the project explorer on the left hand side:



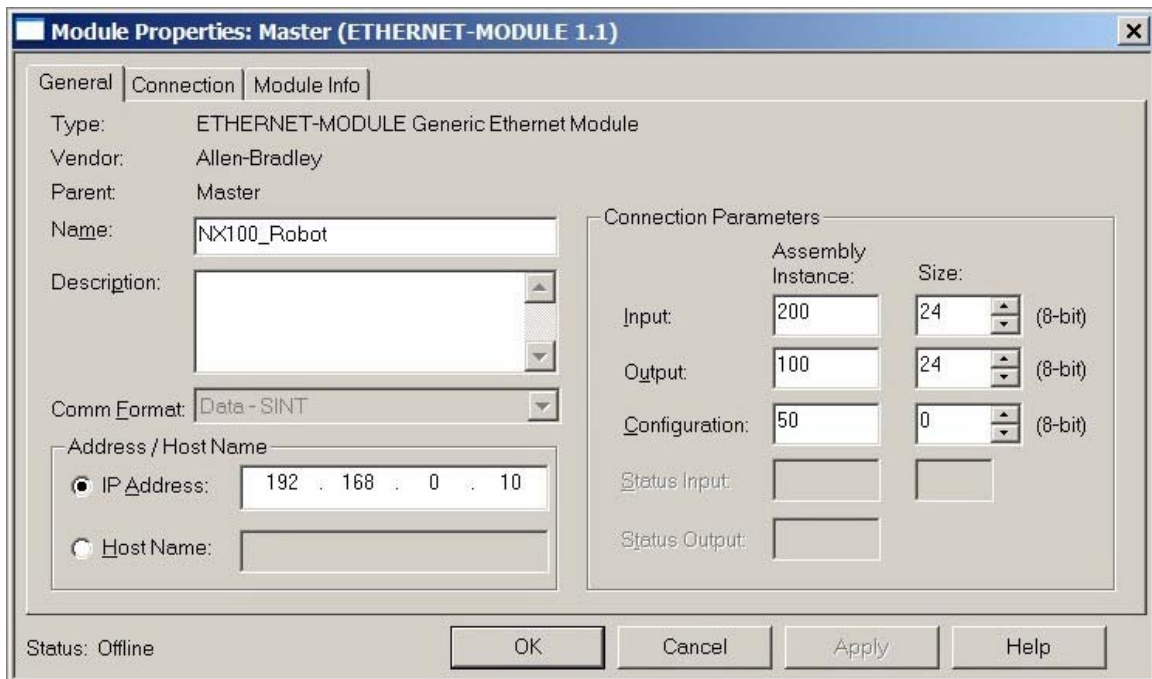
2. Select the ETHERNET-MODULE from the module list.



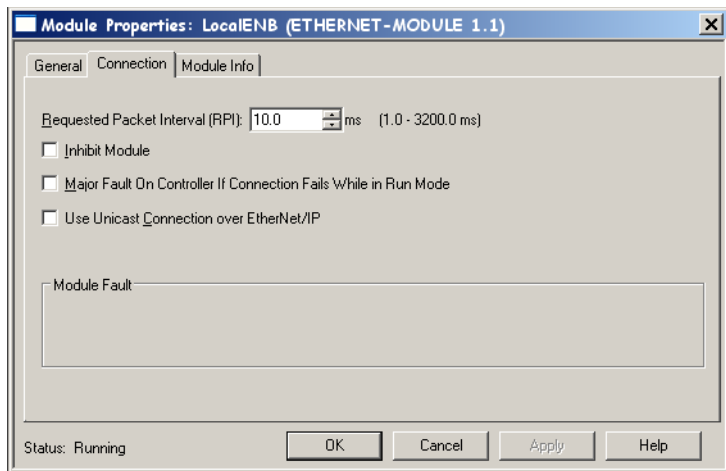
3. Setup the modules properties to match the properties setup in the robot controller.



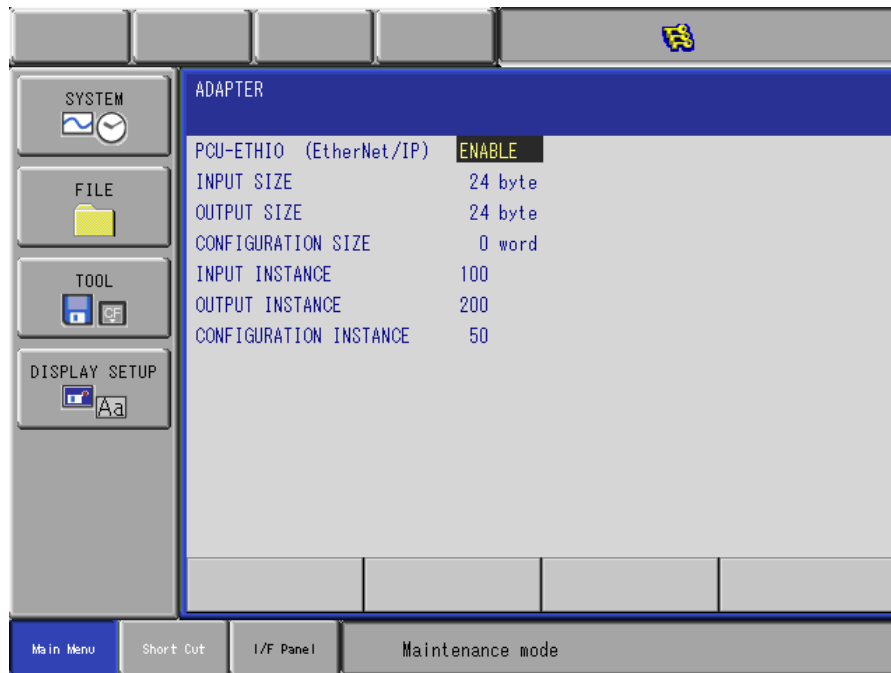
*Note: Input Instance ID in PLC = Output Instance ID in Robot
Output Instance ID in PLC = Input Instance ID in Robot*



4. If using RSLogix version 18.00.00 or greater, uncheck the setting "Use Unicast Connection over EtherNet/IP". This setting is not available in earlier versions of RSLogix and can be ignored.

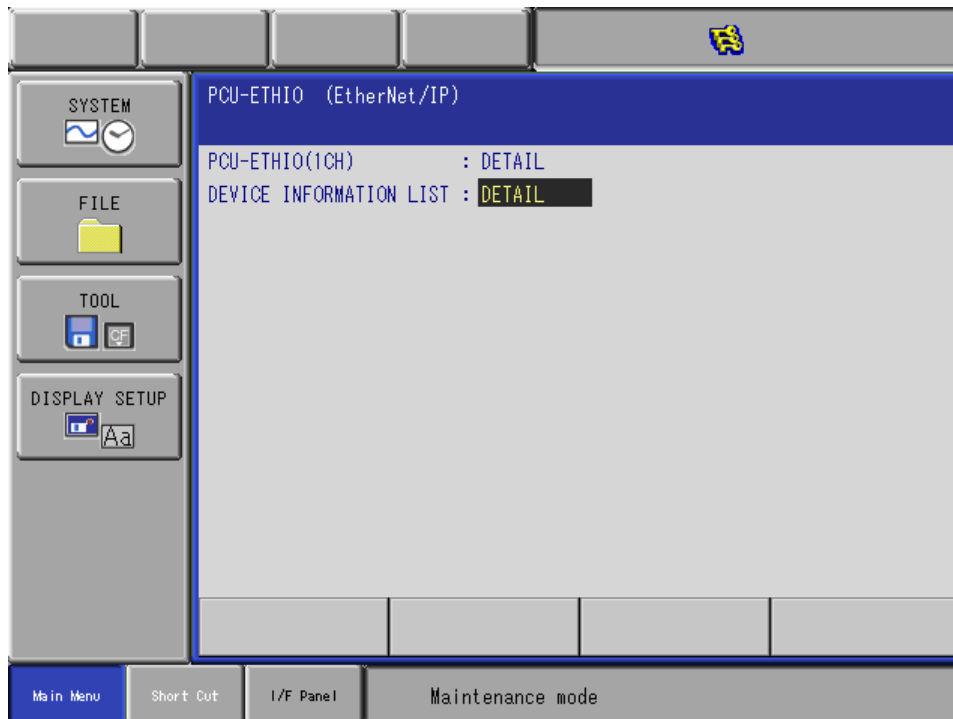


Robot Setup:

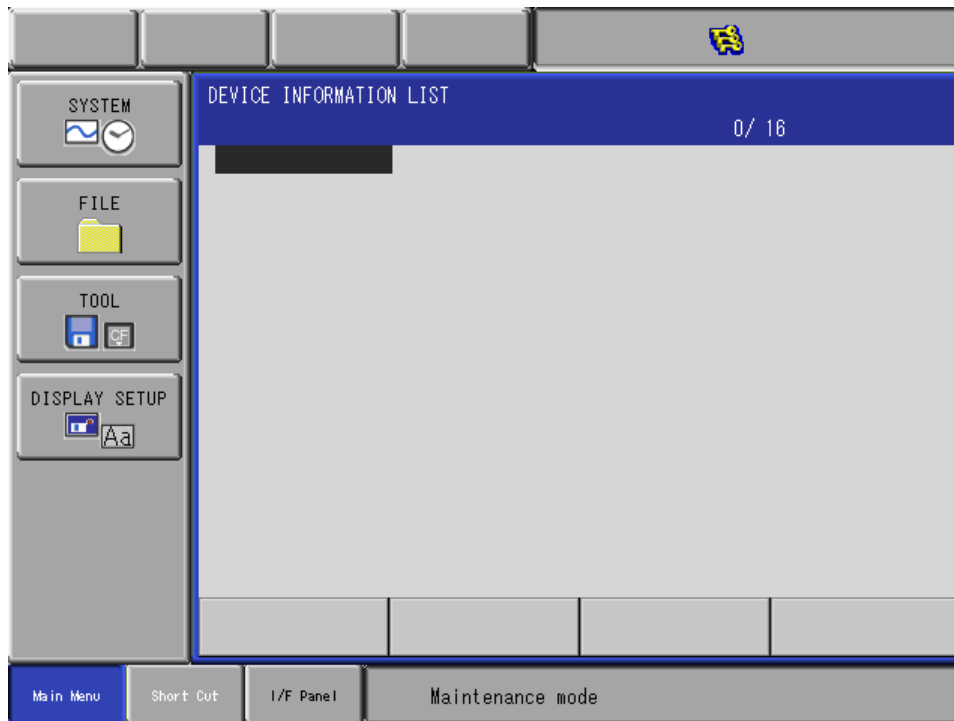


4.3.4 Configuration Example #2 - Robot as Master on Ethernet/IP Network

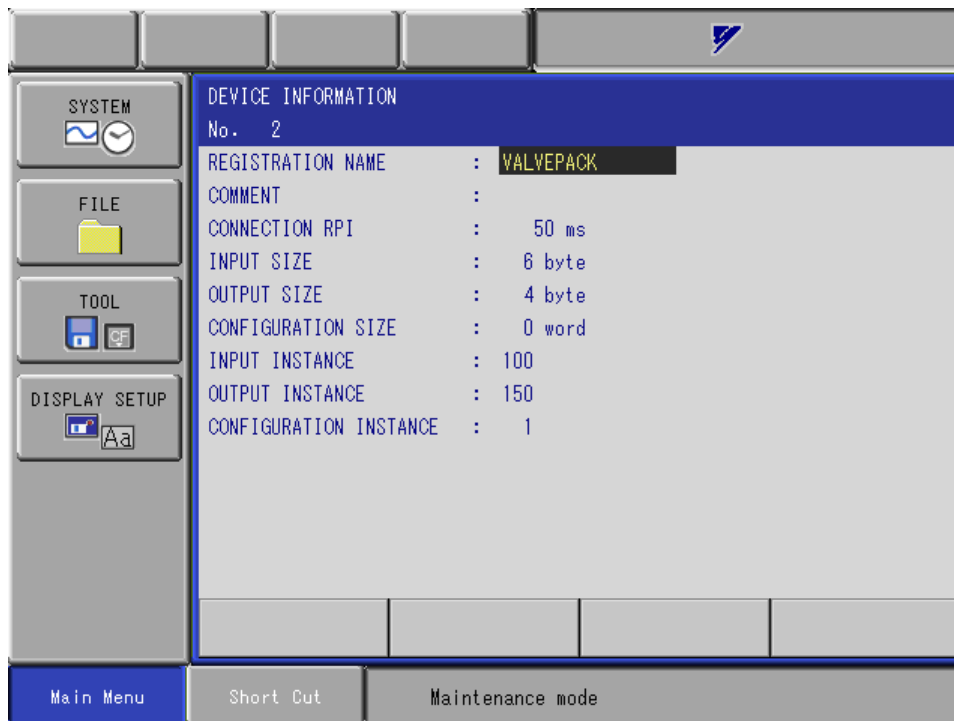
1. Enter the Device Information List setup:



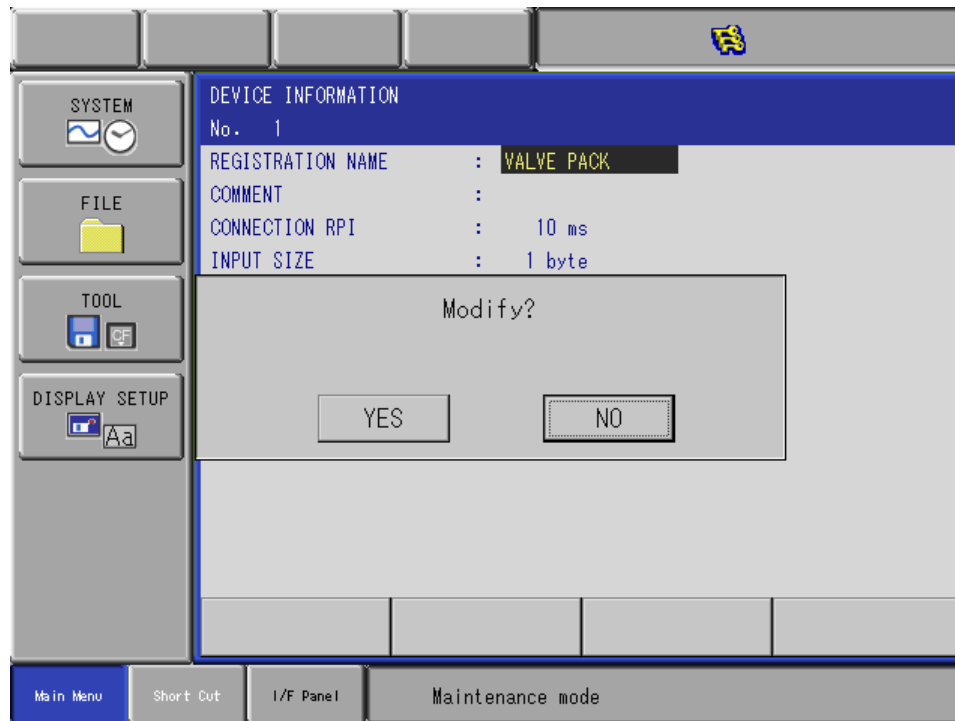
- The following screen appears. Select a blank definition and press SELECT to add a new device.



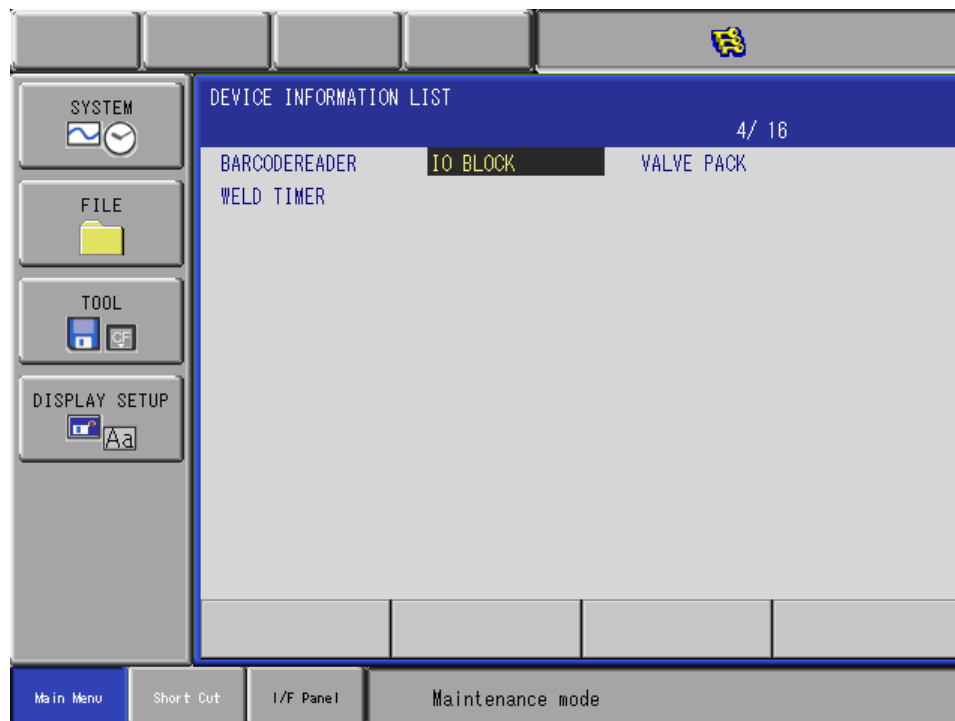
- Enter information for each specific device. Press ENTER when complete.



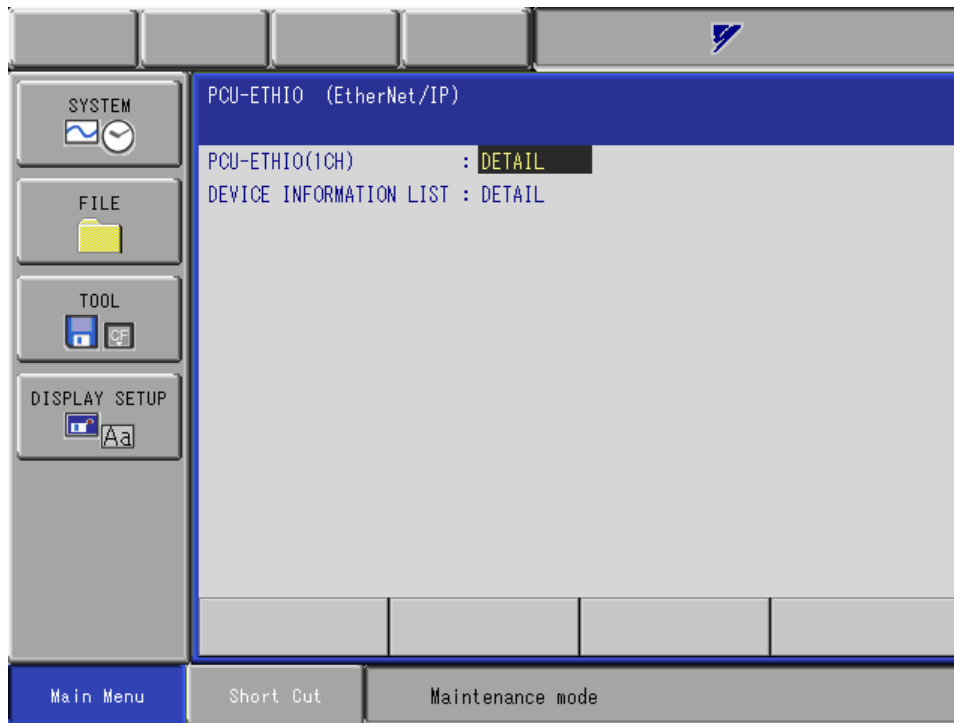
- At Modify prompt, select YES to save device configuration.



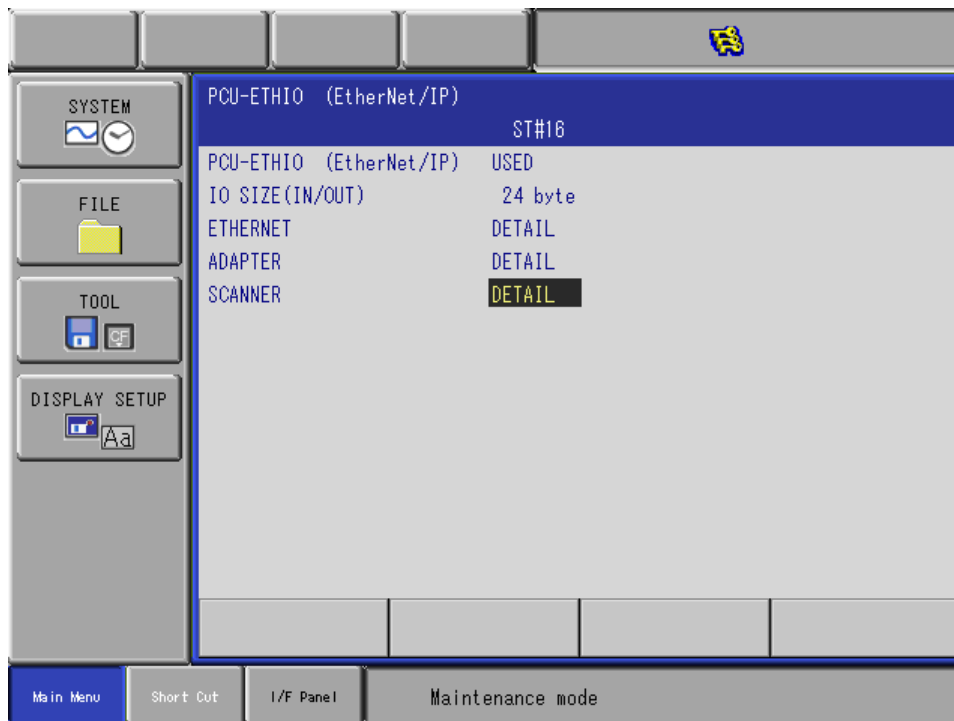
- Continue to add devices to the list until all devices for the network have been defined. Press ENTER to return to the initial screen.



- Press SELECT while PCU-ETHIO DETAIL is selected.



- Press SELECT on SCANNER DETAIL to define the network setup.



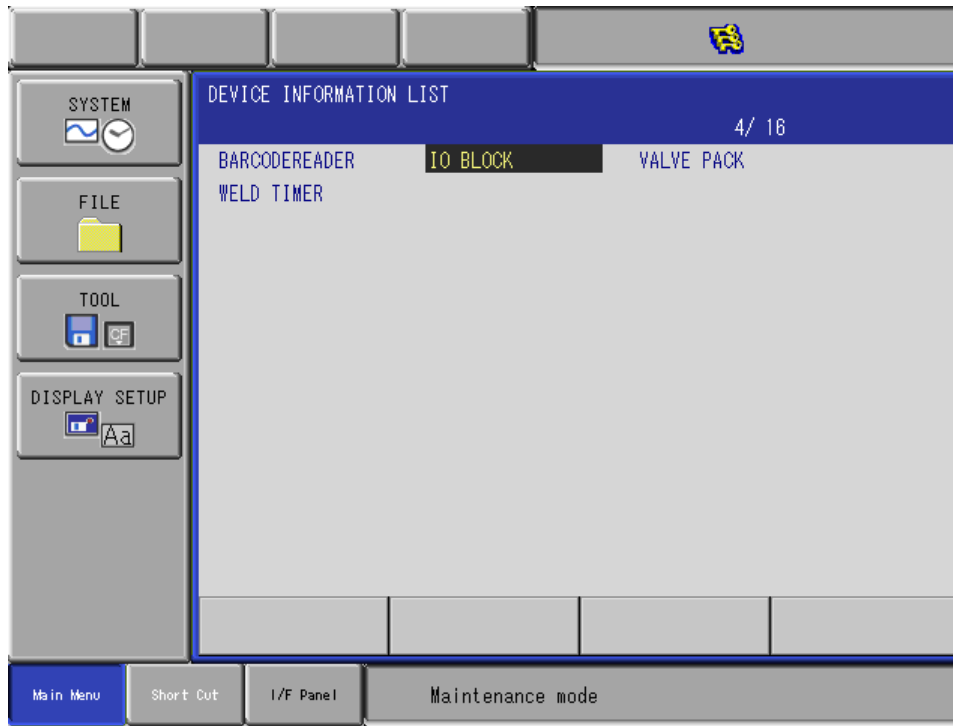
- The Scanner network is initially blank.



- Select the first item and press SELECT. MODIFY is the only option, press ENTER.



10. Select the device to be used from the list of previously configured adapters.



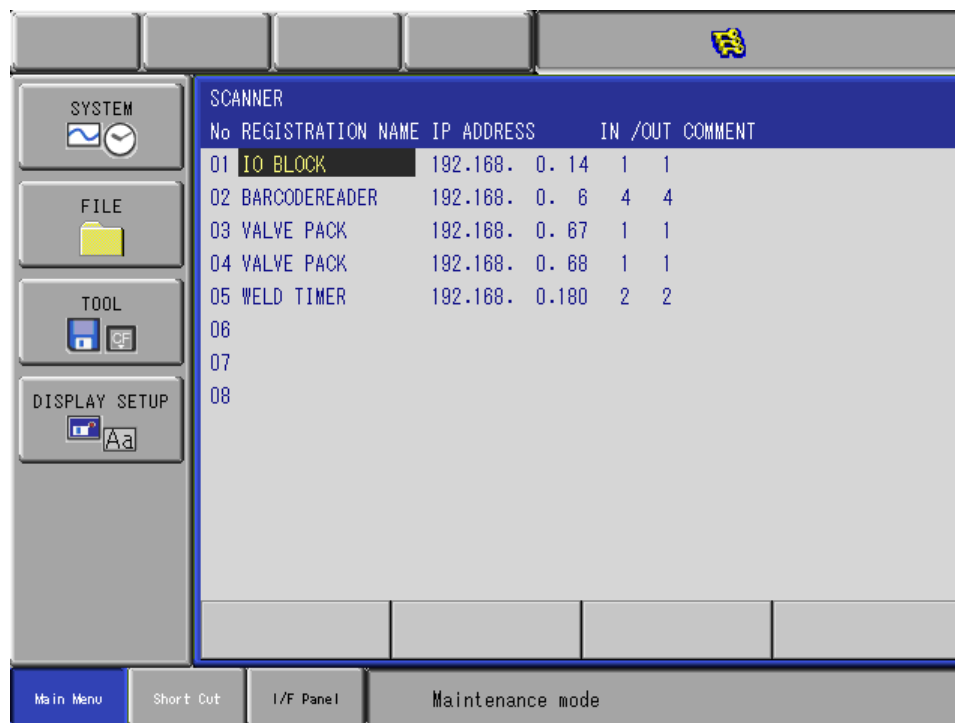
11. The device appears in the list. The ID number of the device or order of the devices in the list is not important.



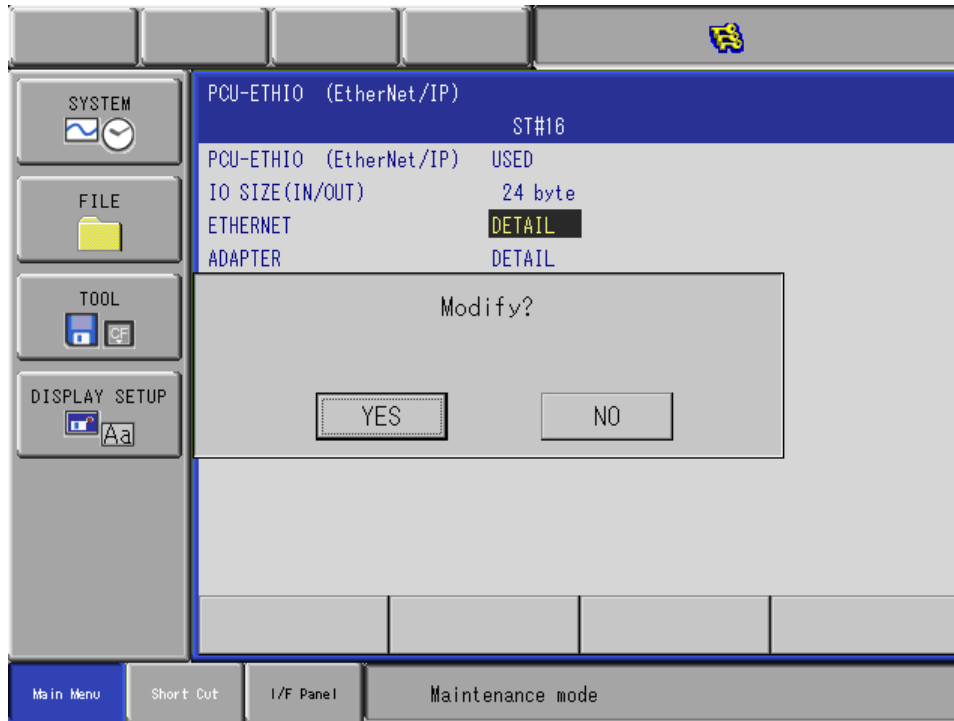
- Set the IP address for this device.



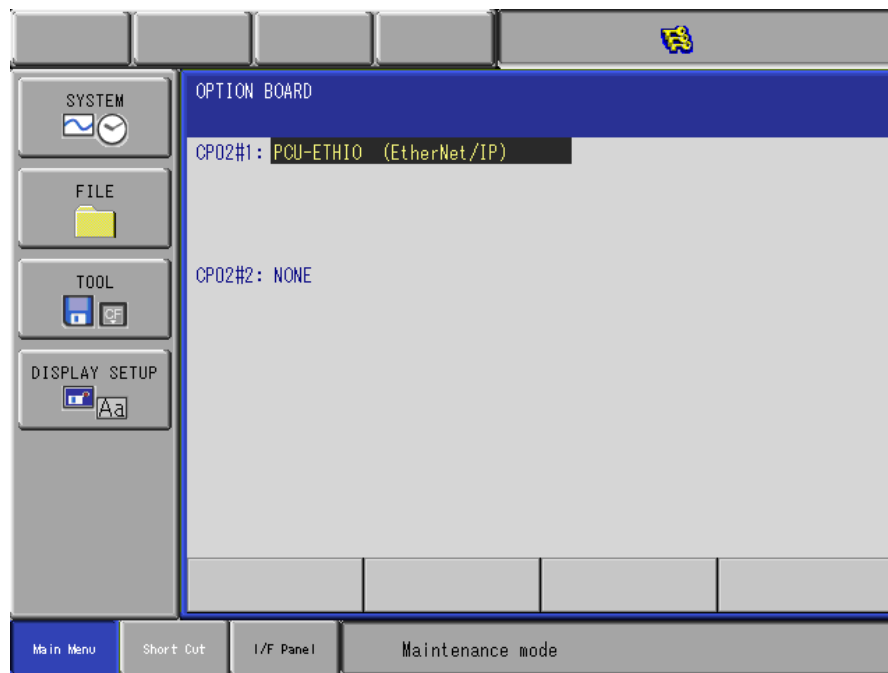
- Add remaining devices following the same steps.



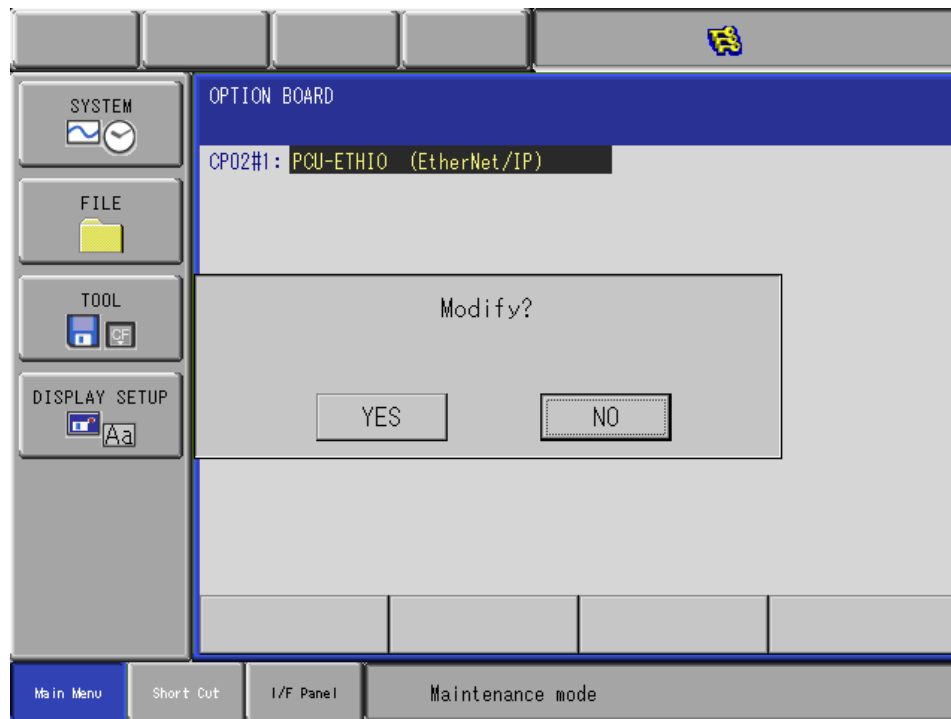
- When list is completely populated press ENTER to return to the PCU-ETHIO menu. Press ENTER at this menu to receive a Modify prompt, select Yes.



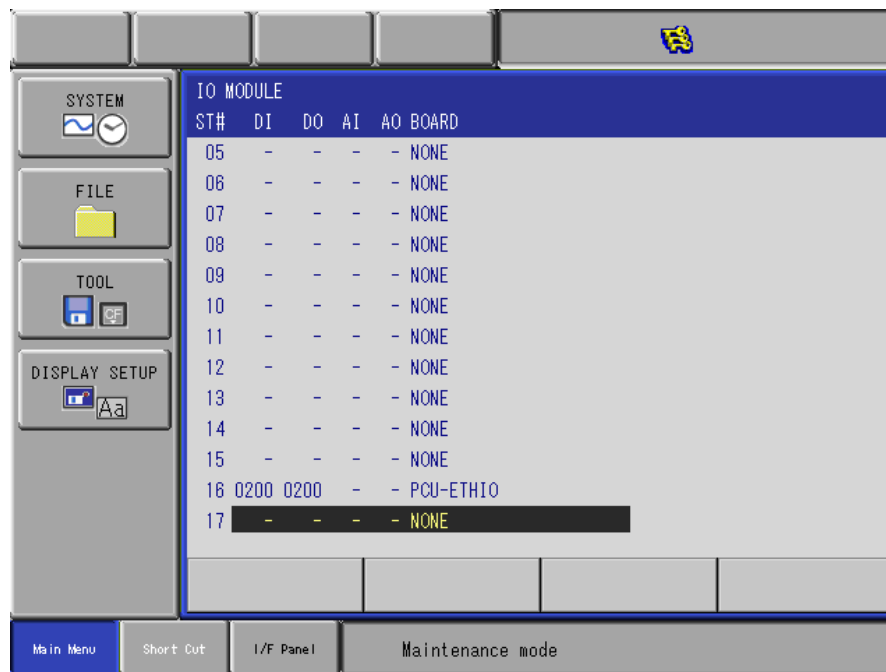
- After the auditory tone, the "OPTION BOARD" menu is again displayed.



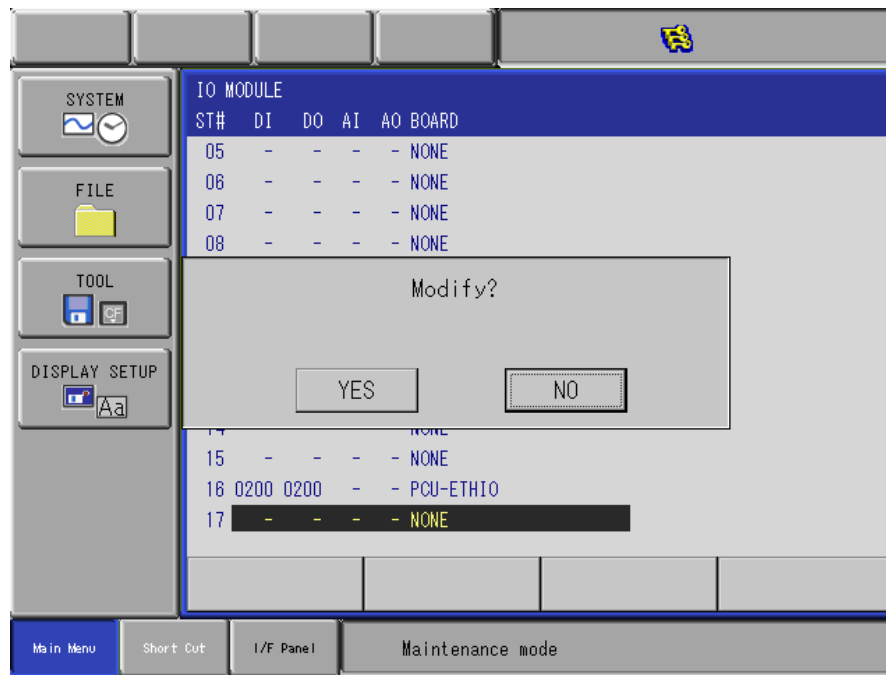
16. Press ENTER to receive another Modify prompt. Press YES.



17. At the IO Module Screen, press ENTER once. Verify that PCU-ETHIO is registered as Station #16 with the appropriate IO Count.



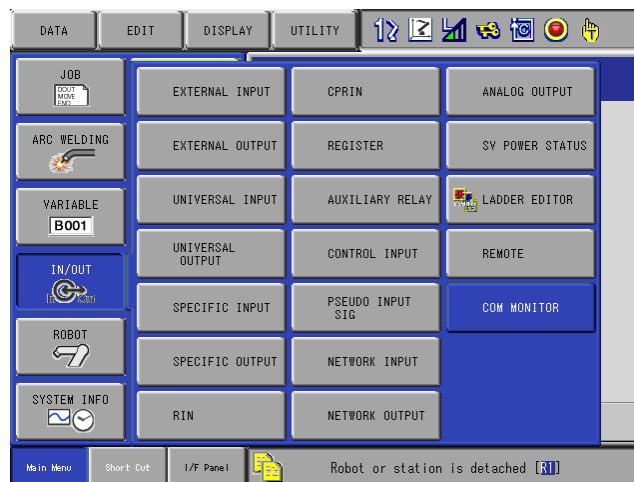
- Press ENTER again. At the Modify prompt select Yes.



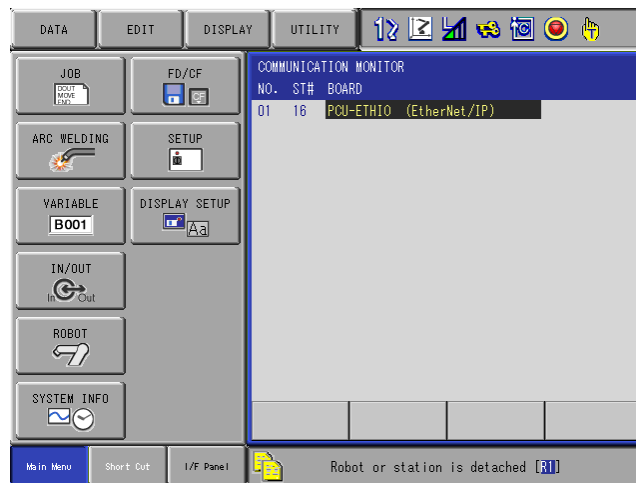
- To complete installation, contact Motoman Service at at (937) 847-3200.

4.3.5 Monitoring the Network Status through the NX100 Teach Pendant:

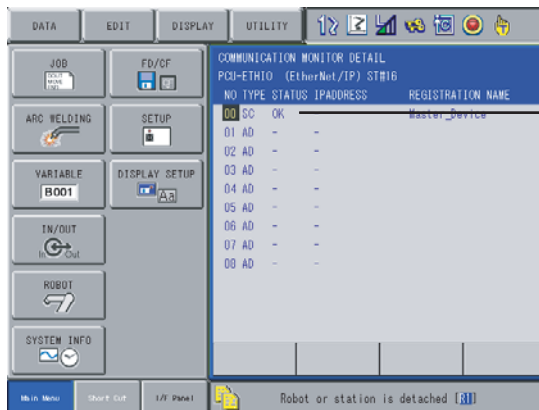
- To monitor the EtherNet/IP Network, select COM MONITOR from the IN/OUT menu.



- Select the I/O Board to be monitored.



- View network status.



SC STATUS:
OK - Network is functional
NG - Not Good. Network is not
configured properly

This screen shows the card configured as an adapter.

Notes

Chapter 5

Network Configurations and Connections

For information on network configurations and connections for EtherNet/IP communications, please refer to the ODVA EtherNet/IP Infrastructure Guidelines (Pub 35) located at www.odva.org.

Notes

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