N1 ARCNET® Local Area Network

Introduction

Overview

The N1 Local Area Network (LAN) is a high-performance, local area network over which Metasys® Network Control Units (NCUs) communicate with each other and with Operator Workstations (OWSs). The N1 carries all types of communication, including shared point and control information, database uploads and downloads, commands to field equipment, summaries, and change-of-state messages.

N1 LAN communication can be over coax cable, twisted pair, or optical fiber. The network can be configured as a star, bus, or mixed network. Figure 1 through Figure 3 show these three basic network configurations.

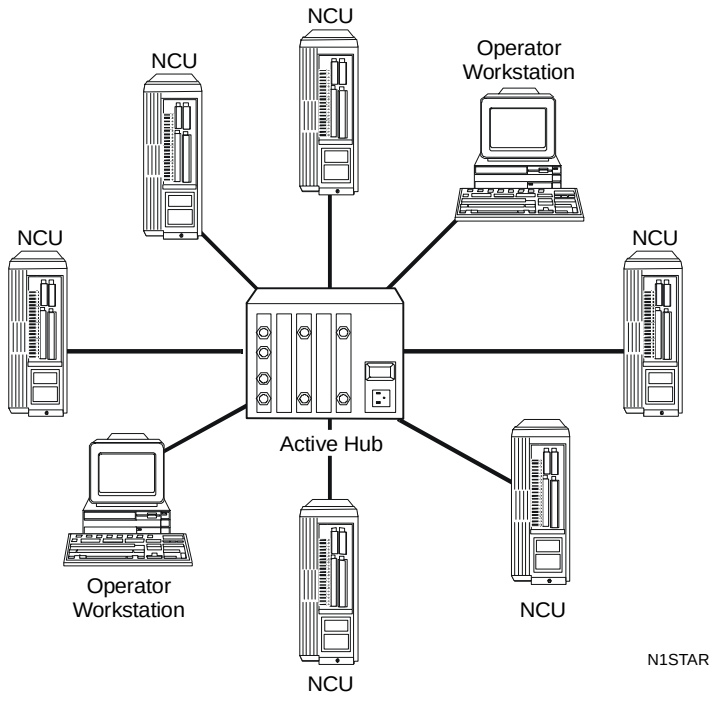


Figure 1: N1 LAN Star Configuration

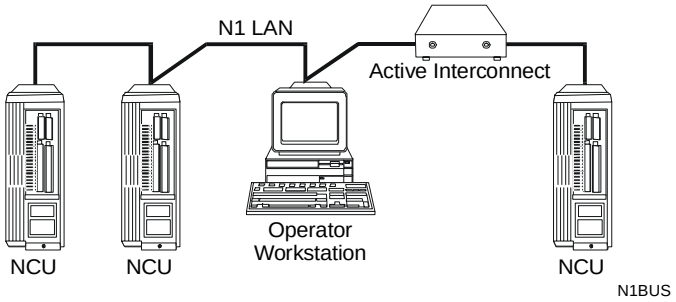


Figure 2: N1 LAN Bus Configuration

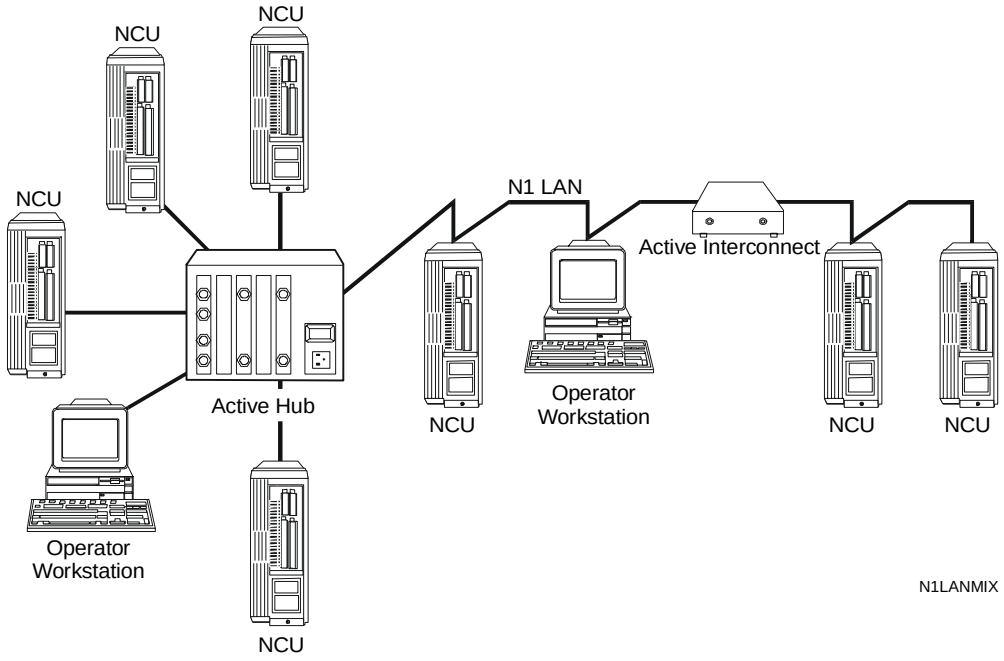


Figure 3: N1 LAN Mixed Configuration

Throughout this document, the term node is used. A node is any addressable device connected to the N1 LAN, which includes Network Control Units and Operator Workstations.

In addition, the term segment means an electrically continuous section of cable that is terminated at both ends (i.e., does not pass through an active hub or active link). See Figure 4.

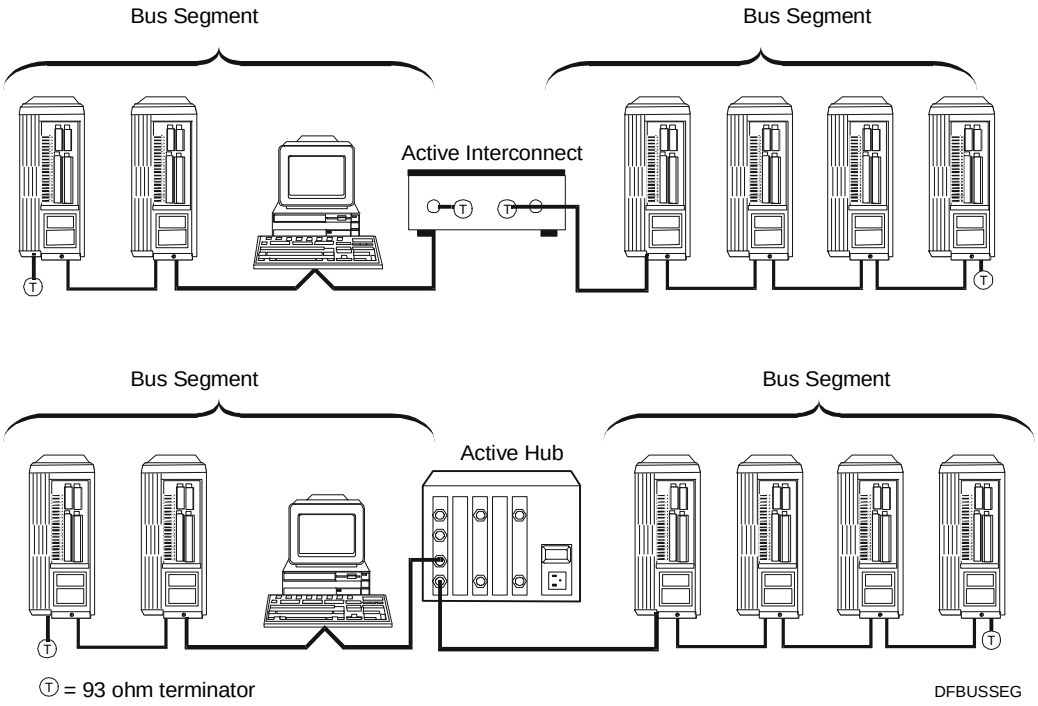


Figure 4: Defining a Bus Segment

Since the N1 LAN uses non Johnson Controls (vendor) products, this document may not contain all the installation, commissioning, and troubleshooting information that you need. In addition, some N1 LAN installation and commissioning is performed at the Operator Workstation, the details of which are in another document. Consult the following documentation for other necessary information:

Table 1: Related Documentation

For Information on:	Refer to:
Installing the Operator Workstation N1 LAN Board	*Operator Workstation Technical Bulletin (LIT-636013)*
Software Commissioning the N1 LAN at the Operator Workstation	*Operator Workstation Technical Bulletin (LIT-636013)*
Troubleshooting Active Hubs and Active Interconnects	Manufacturer's literature
Coax and Optical Fiber Cable Preparation	Manufacturer's literature

Two important factors in engineering, installing, and commissioning the N1 LAN are the maximum number of nodes and maximum length of cable for each N1 LAN segment. This information is covered later. But first, some background information about the ARCNET® system and the N1 LAN is given.

Background

This section provides an orientation on the ARCNET system and the N1 LAN.

Introduction to the ARCNET System

The N1 LAN is ARCNET compatible. The ARCNET system is a local area network developed by Datapoint Corporation of San Antonio, Texas. A local area network, or LAN, is a combination of hardware and software that enables two or more computers to share database information, hardware resources, and application programs.

The term ARCNET is a combination of two acronyms: ARC, which stands for Attached Resource Computer; and NET, for NETwork.

The ARCNET system is a baseband network, which transmits digital signals one message at a time. The ARCNET system is also deterministic, which means that the worst-case response time in transmissions between nodes can be predicted.

Benefits

The major benefits of the ARCNET system are the following:

- performance
- high reliability
- easy expandability

The ARCNET system transmits data at a rate of 2.5 megabits per second. While other networks may have faster bit rates (e.g., Ethernet is 10 megabits per second), ARCNET data throughput is comparable due to its efficiency in transmitting small packets of information in Building Automation System (BAS) applications.

If the ARCNET cable on a bus or mixed network is cut or fails, the network splits and acts like two smaller networks on either side of the break. Also, the ARCNET system can be expanded easily, with minimal additional hardware.

These benefits have contributed to the ARCNET system success. It now has a large installed user base with over four million nodes operating successfully worldwide.

Components

The components of the ARCNET system include both hardware and software. The hardware components include the following:

- **ARCNET Boards**--An ARCNET board is installed in each node of a network. Each board has a coax connector or terminal block to which the wiring between the nodes is connected.
- **Active Hubs**--Active hubs are multi-port repeaters that retransmit messages to every node on the network and provide isolation between nodes.
- **Active Links**--Active links are 2-port repeaters that retransmit messages between the nodes.
- **Transmission Medium**--The transmission medium choices for the ARCNET system are coaxial, twisted pair, and optical fiber. In most applications, coax cable is selected because it provides excellent noise and interference protection at an affordable cost.

The software components include:

- **Software Drivers**--Drivers are programs that control the passage of data over the network.
- **Network Operating System Software**--This is a set of programs that services user requests for network resources, such as access to data files and operator devices.

Introduction to N1 LAN

The Metasys Network uses the ARCNET technology in the N1 LAN circuit boards and software that are contained in the Operator Workstation and the Network Control Module (NCM). These devices communicate over cable or twisted pair via their N1 LAN boards. All N1 LAN components are transformer isolated.

The N1 LAN uses the standard ARCNET protocol that features token passing. The N1 LAN supports the distributed nature of the Metasys Network, in which each node has a specific function to perform and relies on others only for shared data. This Johnson Controls implementation is called Dynamic Data Access. For example, one node might be located in the basement and serve a chiller, while another node may be located in the penthouse and serve the cooling towers. In addition, the nodes could share data, such as the same outside air temperature.

The N1 LAN can be wired in a star, bus, or mixed network configuration. A star network features two or more nodes connected to an active hub. A bus network features a layout in which the nodes are wired in a daisy chain, and uses an active hub or active link for expansion. Components of both the star and bus networks can be used together to provide a mixed network.

The N1 LAN can address up to 255 nodes and physically connect 50 nodes.

Theory of Operation

The N1 LAN is a token-passing network. A token is a unique combination of bits, which grants a node permission to transmit. The token is passed continually around the network from node to node. When a node receives the token, it becomes the momentary master of the network. It can either transmit a message, if it has one, or pass the token on to the node with the next-highest address. If this node is the highest node, it passes the token to the node with the lowest address, and the process continues. Token passing uses a logical ring concept, as shown in Figure 5.

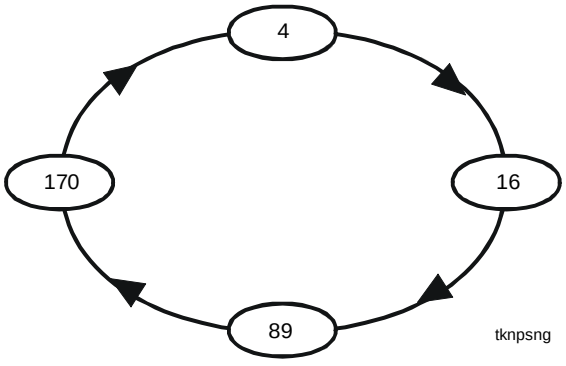


Figure 5: Symbolic Representation of Token Passing

As Figure 5 indicates, Node 4 passes the token to Node 16, which passes it to Node 89, which passes it to Node 170, which passes it to Node 4 to continue the token passing from the beginning.

The primary benefits of a token-passing protocol are:

- there is no possibility of data collisions occurring on the network, since only one node can transmit at a time
- the token protocol is fair to all nodes, since each node is offered an equal opportunity to transmit data
- the token protocol is designed such that the access delay time for any given network and maximum number of nodes can be calculated

The N1 LAN reconfigures itself when nodes are added or deleted from the network. During reconfiguration, each node in the network determines the address of the node with the next highest address. The reconfiguration process is transparent to the user, and takes no longer than 61 milliseconds.

Components

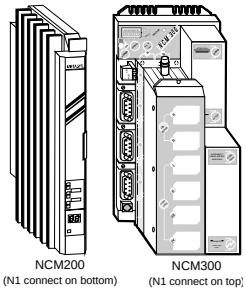
The following table lists the N1 LAN components as may be required by the network configurations and media. Each of these components is shown graphically on the next two pages.

Table 2: N1 LAN Components

Component	Configuration			Media		
	Star	Bus	Mixed	Coax	Twisted Pair	Fiber
NCM200 or NCM300	x	x	x	x	x	
NCM350 or NCM350-8	x	x	x	x	x	
ARCNET Board	x	x	x	x	x	
T-connectors	x	x	x	x		
Terminator Caps	x	x	x	x		
Balun Adapters	x	x	x		x	
Crimp-on Connectors	x	x	x	x		
Feedthrough Adapters	x	x	x	x		
Active Hub	x	x	x	x	x	x
Active Interconnect (AI)		x	x	x		
Ethernet Card	x				x	x

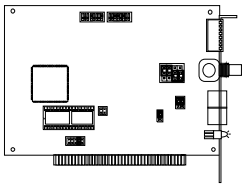
Note: Many of the N1 LAN components are vendor products. Refer to the *Ordering Instructions* section for a list of all vendor products that have been tested with the N1 LAN.

The following paragraphs briefly describe each component:

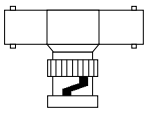


- **NCM**--The NCM200 or NCM300 is required. For the NCM200, an N1 LAN daughter board inside the NCM handles token passing, reconfigurations, and messages. For the NCM300, a separate Instrument Society of America (ISA) compatible ARCNET board installed in the ISA slot handles these tasks. For the NCM350, a separate ISA-compatible ARCNET or Ethernet board installed in the ISA slot handles these tasks.

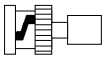
- **Ethernet Board (ISA)**--Refer to *N1 Ethernet/IP Network Technical Bulletin (LIT-6360175)* in this manual for information on Ethernet.



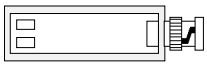
- **ARCNET Board (ISA)**--This ISA board installs into the ISA card slot on the NCM300 or Operator Workstation. It allows the NCM or Operator Workstation to communicate over the N1 LAN and handles token passing, reconfigurations, and messages.



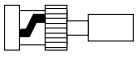
- **T-connectors**--A T-connector is required at each Operator Workstation, active link, and NCM.



- **Terminator Caps**--These are 93-ohm resistors that are required to properly terminate the N1 LAN. They prevent signal reflections. A terminator cap is required at each node in a star network, and at the end of each bus segment in a bus network.

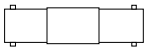


- **Balun Adapters**--This adapter converts between coax cable and twisted pair wire. An adapter is required because the N1 LAN components are primarily designed for use with coax cable.

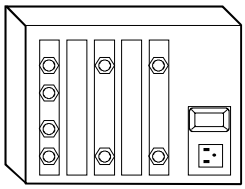


- **Crimp-on Coax Connectors**--These are Bayonet-Neill-Concelman (BNC) plug terminators that are crimped on an end of coax cable.

  Note: Twist-on coax connectors are not recommended, since over time they tend to loosen.



- **Feedthrough Adapters**--These are BNC feedthrough jacks. One is required to keep the N1 LAN continuous when a node in the middle of the line is disconnected.



- **Active Hub**--The active hub is a multi-port repeater used in a star, bus, or mixed configuration. It retransmits messages to every node on the network and provides electrical isolation between nodes. A message received on one port is retransmitted on all other ports of the hub. An active hub called MOD HUB-16 from Contemporary Control Systems, Inc. (CCSI) is recommended. Each hub has internal 93-ohm termination and, therefore, does not require external terminators.

  The versatile MOD HUB-16 supports coax, twisted pair, and optical fiber by using expansion modules that plug into the main unit to provide 4, 8, 12, or 16 ports for the chosen media. By using the module that features two coax and two fiber connections, the MOD HUB-16 can also be used to link coax cable to optical fiber.

  The fixed port active hub version supports repeater and media linking applications. Refer to CCSI AI Series hubs.

  Note: The N1 LAN does not support passive hubs (devices that split the LAN to allow for additional nodes).

- **Selected Media**--The N1 LAN is designed to use RG-62/U coaxial cable. Twisted pair and optical fiber can also be used. However, twisted pair requires a Balun adapter to convert from twisted pair to coax; optical fiber requires a special active hub to convert from fiber to coax.

Specifications

Table 3: Specifications

Product Name	N1 Local Area Network
Protocol	Token-passing, ARCNET compatible, Dynamic Data Access
Error Checking	Cyclic Redundancy Check (CRC)
Communication Rate	2.5 megabits per second
Addressable Nodes	Up to 255
Termination Method	End-of-line resistor (93-ohm) at end of each bus segment
Surge Protection	Tested to pass IEEE 587 and 472 waveforms up to 1500 volts (without external surge protection)
Media Types	Coaxial (RG-62/U) Twisted pair wire (telephone cable, 24 AWG or larger, 100-ohms at 1 MHz) Optical fiber (62.5 microns, duplex, multimode)
Configuration Choices	Star Bus Mixed (star + bus)
Standard Components	
For the NCM	Outside Vendor ARCNET Board (NCM300 only)
For the Operator Workstation	Johnson Controls® or Outside Vendor ARCNET Board
Vendor Components	
For Star Configuration	4- to 16-port Active Hub (coax/twisted pair/fiber) Contemporary Control Systems MOD HUB 16 BNC T-connector (required at each Operator Workstation and NCM) 93-ohm Terminator Cap (required at each Operator Workstation, Communication Terminal Board, and NCM)
For Bus Configuration	2-port Active Hub and Link Coax: CCSI AI Series Fiber: CCSI AI Series BNC T-connector (required at each Operator Workstation, NCM, and active hub) 93-ohm Terminator Cap (required at each node and active hub that is at the end of line)
For Mixed Configuration	Mix of star and bus components

Installation Procedures

Planning Considerations

This section describes briefly what you need to know when planning to install the N1 LAN.

Space

The active hubs and links, components of the N1 LAN, can be mounted in any convenient place near an NCU, or between NCUs. These components do not need to be installed in separate enclosures, since their enclosures provide adequate protection. Refer to vendor literature for mounting details.

Environment

The operating environment for the N1 LAN and its components must maintain temperatures within the range of 0 to 50°C (32 to 122°F) while maintaining relative humidity at a value of 10 to 90% (non-condensing).

Power

The Operator Workstation N1 board is powered from the Operator Workstation's power supply. The NCM300/350 N1 board is powered from the NCM300/350 power supply.

The active link requires an external source of 115 VAC at 0.20 A (or 230 VAC at 0.10 A) at a frequency of 60 Hz (or 50 Hz). The MOD HUB-16 Active Hub requires an external source of 115 VAC at 0.5 A (or 230 VAC at 0.25 A) at a frequency of 60 Hz (or 50 Hz).

Design Considerations

This section contains considerations that are important to designing and laying out the N1 LAN. How to choose the network configuration, media, and components is also covered.

General

Consider the following factors when deciding how to design and lay out the network:

- system performance requirements
- number of nodes
- physical location of the nodes
- system expansion

System Performance Requirements

The performance of the N1 LAN depends mostly on how many nodes are installed and how the system's functions and features are applied at these nodes. For example, a system with many nodes with light data sharing will operate more efficiently than a system with few nodes and heavy data sharing. Therefore, you need to consider how the data is shared when designing the system applications.

Number of Nodes

By using active hubs and links, as many as 50 nodes can reside on one network. Since the N1 can have up to 255 addresses, this is a function of system performance, not node addressing.

Physical Location of the Nodes

The minimum distance between two nodes is six feet. You must install at least six feet of cabling between the two nodes, or the NCMs may cycle online and offline or other communication problems may occur. This minimum cable length also applies to links and hubs.

The allowable distance between the farthest nodes on the N1 LAN is up to four miles, regardless of which media is chosen. For the maximum allowable distance between nodes on a single segment, consult the cable length tables in the two sections that follow.

System Expansion

Over time, the control needs of a building may require additional nodes. You'll need an active hub or link to expand the network if the maximum number of nodes per segment or the maximum length of a bus segment has been reached. (See the *Installation Guidelines* section for details.)

Adding nodes to the N1 LAN is not complicated. The star network affords the easiest expandability if one of its active hubs has an unused port. However, the bus network is easier to expand than the star network if the latter requires an additional active hub. Nodes can be added to either configuration until up to 50 devices are connected.

Choosing a Configuration

Three different N1 LAN network configurations are available: star, bus, and mixed. The star network is recommended for NCUs and Operator Workstations that are widely separated from each other (500 to 1500 feet). The bus network, on the other hand, is best for NCUs and Operator Workstations that are situated close to each other (under 500 feet). A mixed network is best for systems with some nodes that are close to each other and others that are widely separated.

Use the following table to help decide which configuration is best.

Table 4: N1 LAN Network Configurations

Cost	Lowest: Highest:	Bus Star Mixed
Ease of Installation	Easiest: Hardest:	Bus Star Mixed
Ease of Maintenance and Troubleshooting	Easiest: Hardest:	Star Bus Mixed
Flexibility	Greatest: Least:	Mixed Bus Star
Reliability	Highest: Lowest:	Bus Star Mixed

Choosing a Transmission Medium

The media choices for the N1 LAN are coaxial, twisted pair, and optical fiber. Coax cable is used in most installations because it provides excellent noise and interference protection. Twisted pair, a less expensive choice, is best suited for short distances. Optical fiber, which provides optimum noise immunity and lightning protection, can be used for runs between buildings.

The N1 LAN components are designed for coax cable, so if you want to use twisted pair, Balun adapters are needed; if you want to use optical fiber, a coax-to-fiber module for the MOD HUB is required.

Notes: If you select twisted pair wire, you must use the type recommended in the *Ordering Instructions* section of this document. No other wire type should be used.

Also, in a twisted pair installation, Balun adapters do not allow for more than two nodes to be linked on a single segment (i.e., nodes cannot be daisy-chained). The use of more than two Baluns significantly degrade the N1 signal. In fact, coax cable should always be used for the N1, unless the building has a short run of prewired twisted pair that you need to use. If you must use twisted pair, the star configuration is best.

Choosing the Components

The following is a list of components that you need to specify. The components apply to either network configuration selected, unless otherwise indicated.

- **Ethernet Card**--Refer to *N1 Ethernet/IP Network Technical Bulletin (LIT-6360175)* for information on Ethernet.
- **ARCNET Board**--One required for each Operator Workstation and each NCM300 that will be on the N1 LAN.
- **T-connectors**--One required for each ARCNET board and two required for each active link. Also, one T-connector is required for each NCM on the network.
- **Terminator Caps**--One required at each end-of-line node and end-of-line active link.
- **Balun Adapters**--One required at the coax port of each node that needs a media conversion from coax to twisted pair.
- **Crimp-on Connectors**--One required at each end of coax cable.
- **Feedthrough Adapters**--One required to maintain the continuity of the N1 LAN when the network is spliced between two nodes that are not at end of line.
- **Active Hub (MOD HUB-16)**--(Star and mixed networks only) The MOD HUB-16 contains modules that provide connections to coax, twisted pair, and optical fiber.
- **AI Series External Fixed Port Active Hubs**--(Bus and mixed networks only) Required only if the network signal needs to be regenerated or if the media type is changing. The active link that is used on the N1 LAN has two ports.

Installation Guidelines

The following section describes guidelines to follow when installing the N1 LAN.

General

There are a few installation considerations that you should be aware of when routing the N1 LAN wiring. They are:

- Follow all NEC and local code restrictions.
- Do not wire more than 50 nodes to any one network.
- Install a T-connector on the coax connector of every node on the network, except MOD HUB-16s. The T-connector is used for termination or continuation of the N1 LAN.
- Make sure to install at least six feet of cabling between two nodes, links, or hubs.
- Do not allow loose T-connectors or adapters to touch the metal surface of the NCU base frame. To ensure that this doesn't happen, wrap electrical tape around metal components or install a plastic shroud around these components.
- Follow vendor recommendations for connectors, accessories, and methods of termination.

Cable Layout

The acceptable cable layout for the N1 LAN depends on whether you have chosen a star, bus, or mixed network.

For a Star Network

Follow the maximum cable lengths as shown in Figure 6 for a star network. Use active hubs to extend the N1 LAN.

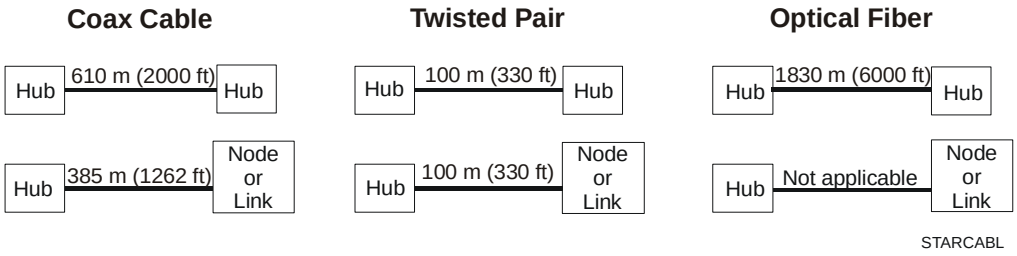


Figure 6: Maximum Distances for Star Network

Figure 7 shows an example of a coax cable layout for a star network.

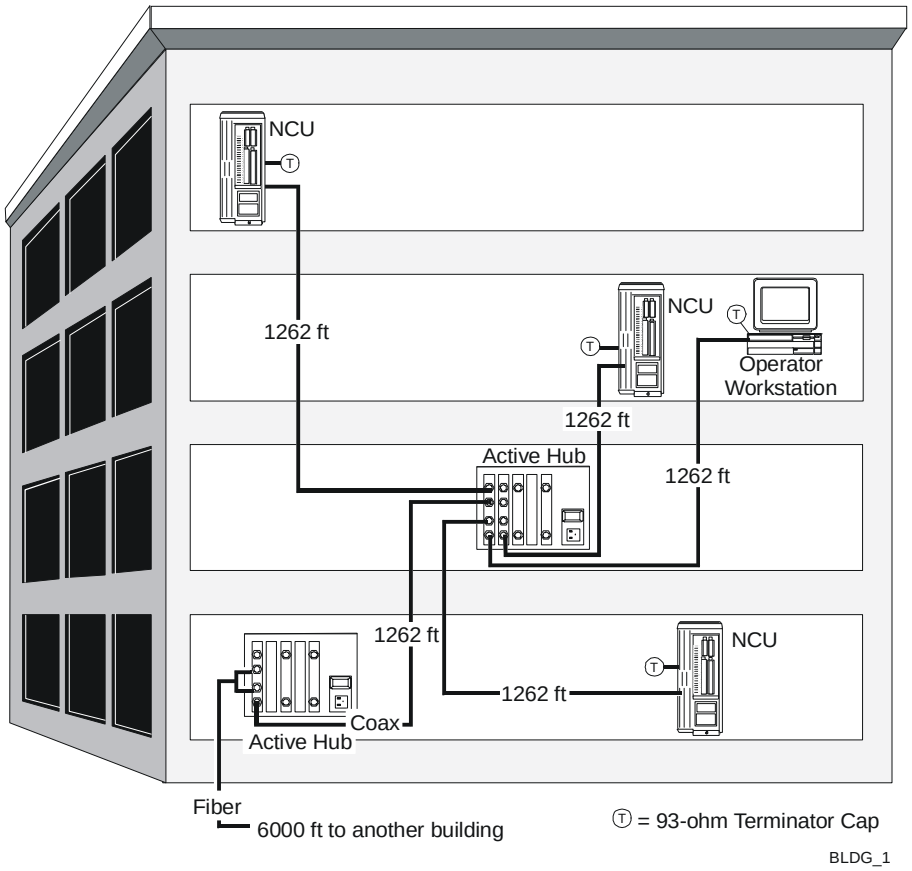
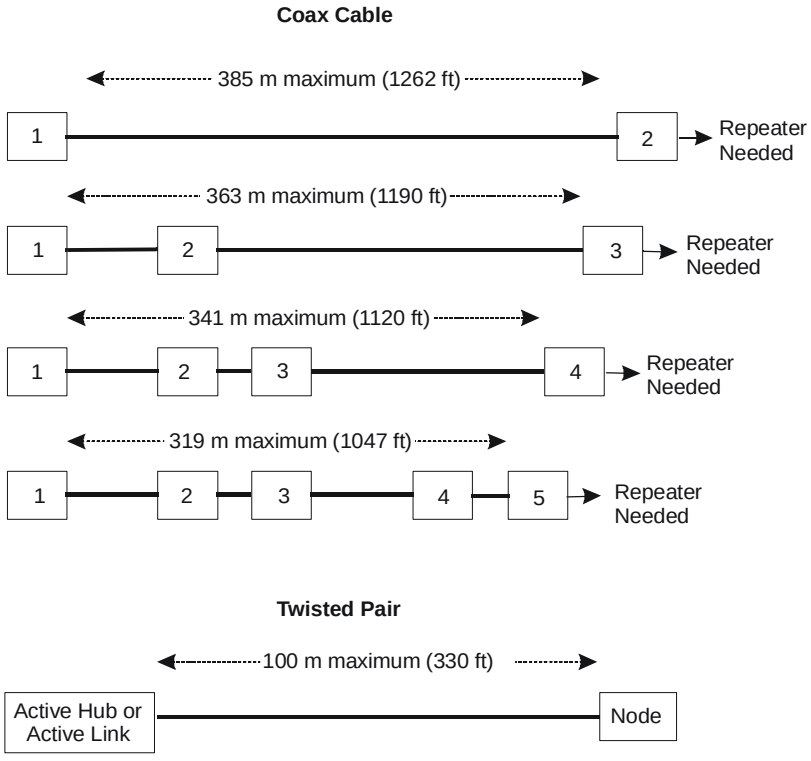


Figure 7: Cable Layout for a Star Network

For a Bus Network

The maximum number of nodes and devices that can be daisy-chained to form a bus network depends on the length of the bus segment. Figure 8 indicates the maximum number of nodes (Operator Workstations and NCUs), hubs, and links allowed on one bus segment. For example, if you are using coax and have three nodes to connect, the maximum length without a repeater (active link or active hub) is 363 m (1190 feet). To extend the N1 beyond 1190 feet, install an active link or hub. For a second example, let's say you have six nodes over 1500 feet. Since only five nodes are allowed on a bus segment, you'll need to add a repeater after the fifth node at the point where the length of the N1 is less than or equal to 319 m (1047 feet). You can then add the sixth node off the repeater.



Note: Each numbered block represents a node, active hub, or active link. Twisted pair cable requires the use of Balun adapters. Since Baluns can be used only in a point-to-point configuration (not daisy chained), no more than two Baluns should be used.

BUSCABL

Figure 8: Maximum Lengths for Bus Network

Figure 9 shows an example of a coax cable layout for a bus network.

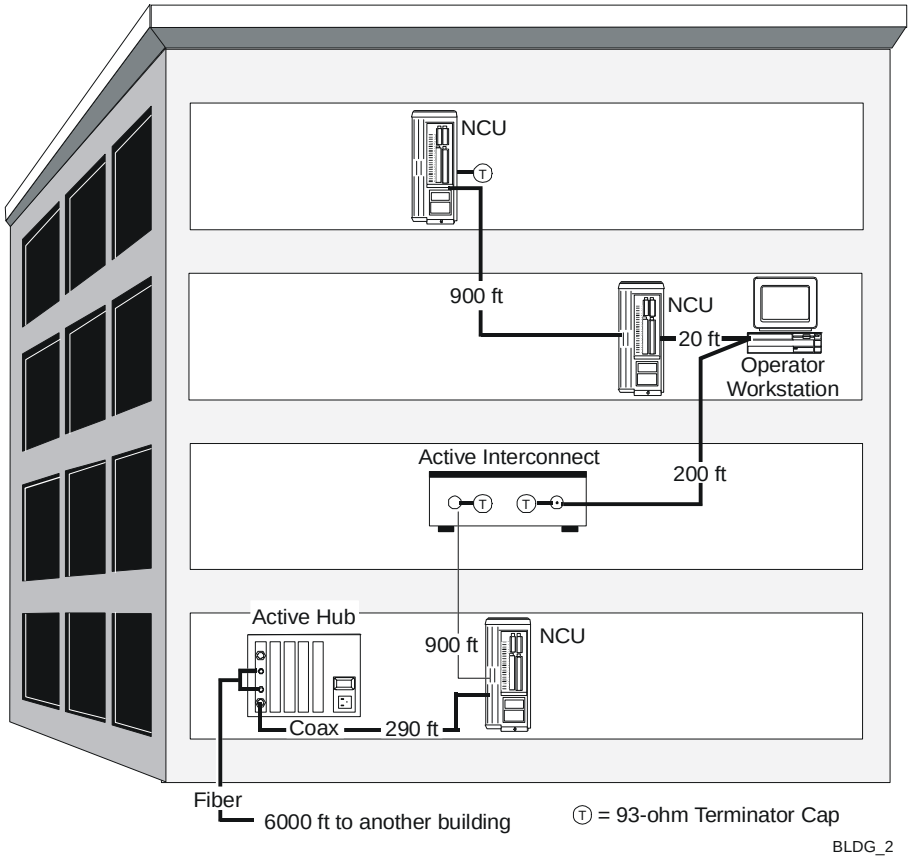


Figure 9: Cable Layout for a Bus Network

For a Mixed Network

Figure 10 shows an example of a cable layout for a mixed network. The cable lengths are maximums obtained from the tables on the previous pages.

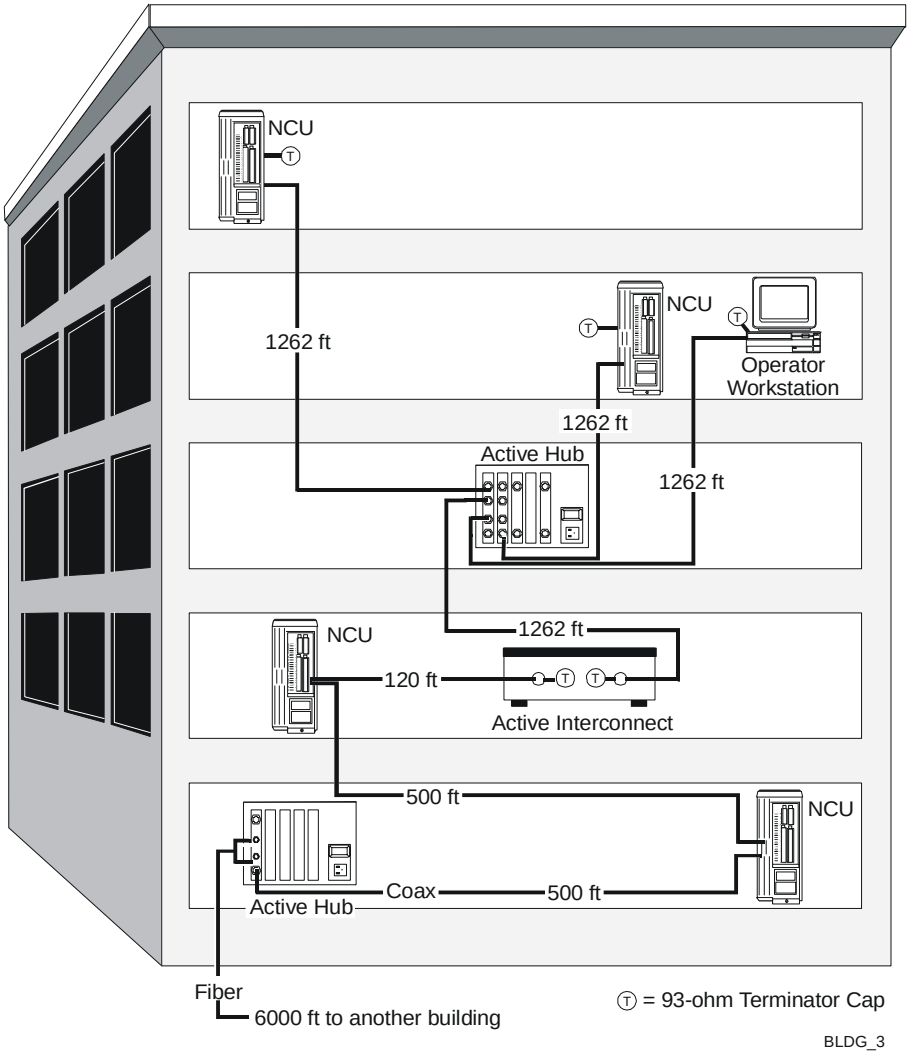


Figure 10: Cable Layout for a Mixed Network

Wiring Details

The wiring instructions depend on whether the N1 LAN is a star, bus, or mixed network.

> **!** CAUTION: To avoid damage to equipment or possible electrical shock, be sure that the power supply to each node has been disconnected before wiring commences.

Wiring for a Star Network

Figure 11 shows an example of how the components of a star network are wired. For more details, refer to the *Network Control Module 200 Series Technical Bulletin (LIT-636025)* and the *Network Control Module 300 Series Technical Bulletin (LIT-6360251)*. Follow these steps:

1. Install the modules that are needed at the active hub, referring to the manufacturer's literature. Insert a cable into an open port on the hub. The hub has internal termination, so 93-ohm terminators *are not* required on the open ports.
2. Route the cable from the active hub to the NCU.
3. **NCM200**

   Install a T-connector on the NCM's coax port (located on bottom of NCM). Wire the N1 cable from the active hub to one side of the T-connector. Install a 93-ohm terminator cap on the other side.

   NCM300

   Install a T-connector on the NCM's coax port (located on the NCM's ARCNET board). Wire the N1 cable from the active hub to one side of the T-connector. Install a 93-ohm terminator cap on the other side.

   NCM350

   Install as you would an NCM300 if using an ARCNET board. If using an Ethernet board, see the *N1 Ethernet/IP Network Technical Bulletin (LIT-6360175).*
4. Install a T-connector into the coax port of the ARCNET board, at the Operator Workstation. Wire the N1 cable from the active hub to one side of the T-connector. Install a 93-ohm terminator cap on the other side of the T-connector.

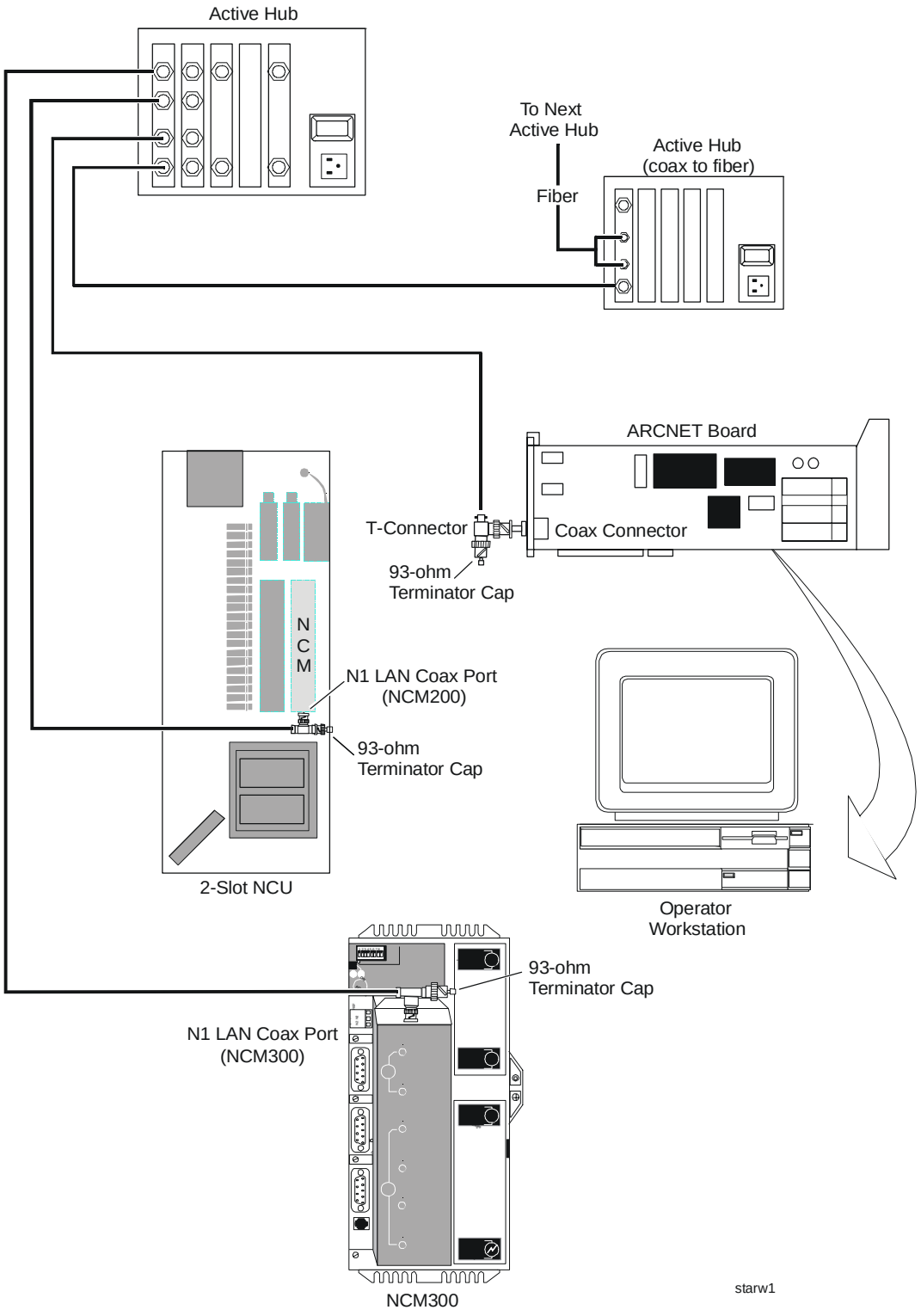


Figure 11: Wiring Star Network Components

Wiring for a Bus Network

Figure 12 shows an example of how the components of a bus network are wired. The steps required depend on which type of NCM is used and whether the node is at the end of line. Follow these steps:

1. **NCM200**

   Install a T-connector into the NCM's coax port, if the NCU *is not at the end of line*. Wire the N1 cable from the previous node to one side of the T-connector. Wire another length of N1 cable to the other side of the T-connector that you will wire to the next node.

   Install a T-connector into the NCM's coax port, if the NCU *is at the end of line*. Wire the N1 cable from the previous node to one side of the T-connector. Install a 93-ohm terminator into the other side.

   NCM300/350

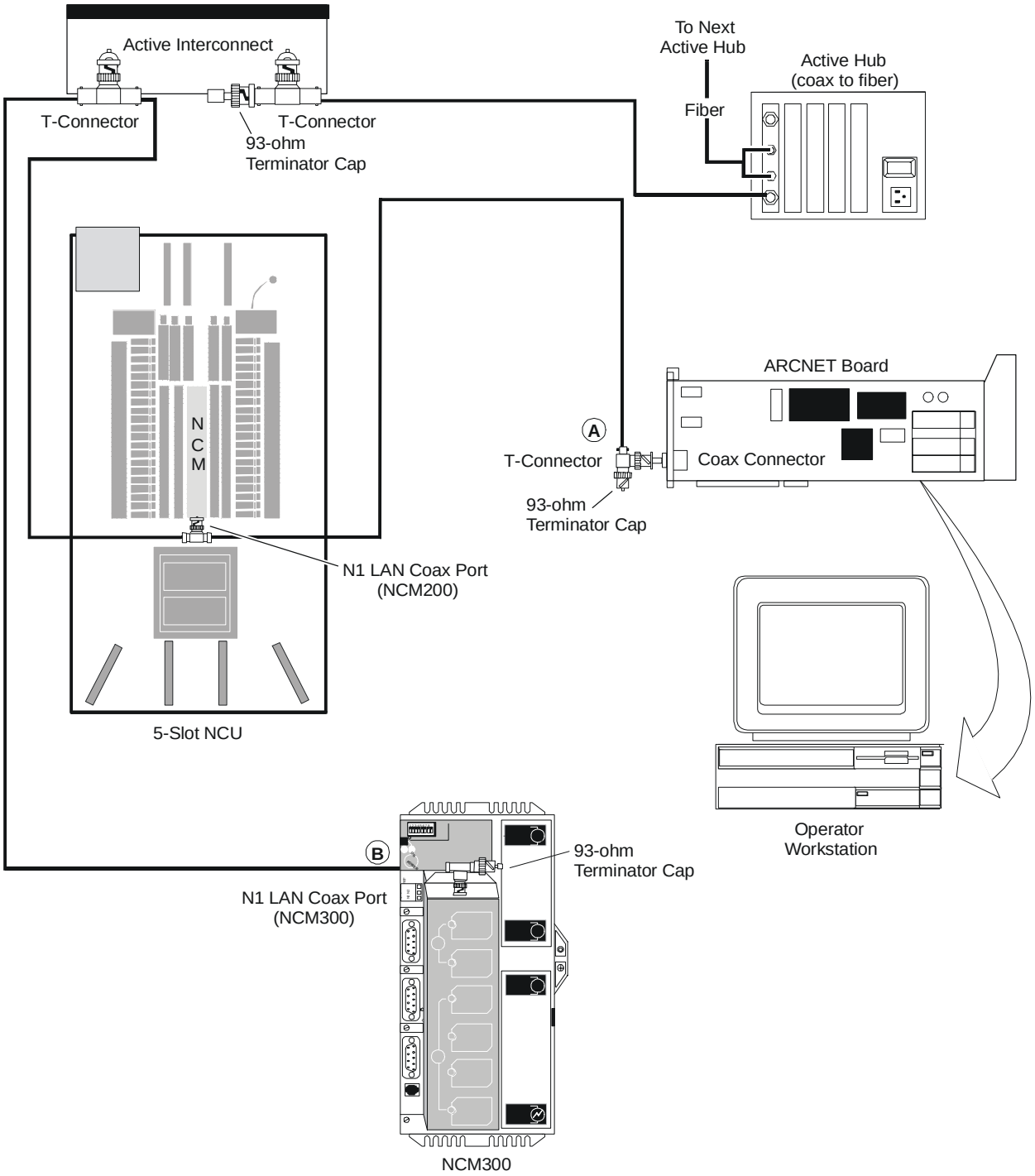
   Install a T-connector into the coax port on the ARCNET board, if the NCM300/350 *is not at the end of line*. Wire the N1 cable from the previous node to one side of the T-connector. Wire another length of N1 cable to the other side of the T-connector that you will wire to the next node.

   Install a T-connector into the coax port on the ARCNET board, if the NCM300/350 *is at the end of line*. Wire the N1 cable from the previous node to one side of the T-connector. Install a 93-ohm terminator into the other side.

2. Install a T-connector to the coax port of the ARCNET board for each Operator Workstation.

3. Wire the N1 cable from another node to one side of the T-connector, for an Operator Workstation that *is not at the end of line*. Wire another length of N1 cable to the other side of the T-connector that is to be wired to the next node.

   Wire the N1 cable from another node to one side of the T-connector, for an Operator Workstation that *is at the end of line*. Install a 93-ohm terminator into the other side.



Notes: If the NCU has an NCM200, terminate the N1 to the coax port on the bottom of the NCM.
If an NCM300 is being used, terminate the N1 to the coax connector on the NCM's ARCNET board (top).

Total cable length between Points A and B must not exceed distance limitations given in Figure 8.

busw1

Figure 12: Wiring Bus Network Components

4. Install a T-connector into each coax port (Figure 13) of the link. If you need to extend the N1 LAN, you need an active link. Connect the coax cable from the previous node or device to either T-connector. Connect the coax cable that will be routed to the next node to the other T-connector. Then, to establish proper impedance, install a 93-ohm terminator to the unused sides of the T-connectors.

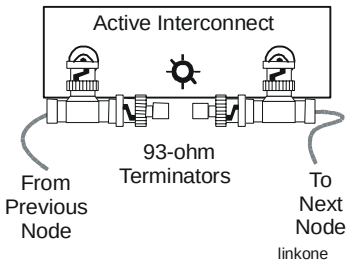


Figure 13: Active Interconnect Extending the Network

Figure 14 shows other valid methods of wiring coax cable to an active link. In any of these variations, you must install a 93-ohm terminator cap into all open sides of T-connectors.

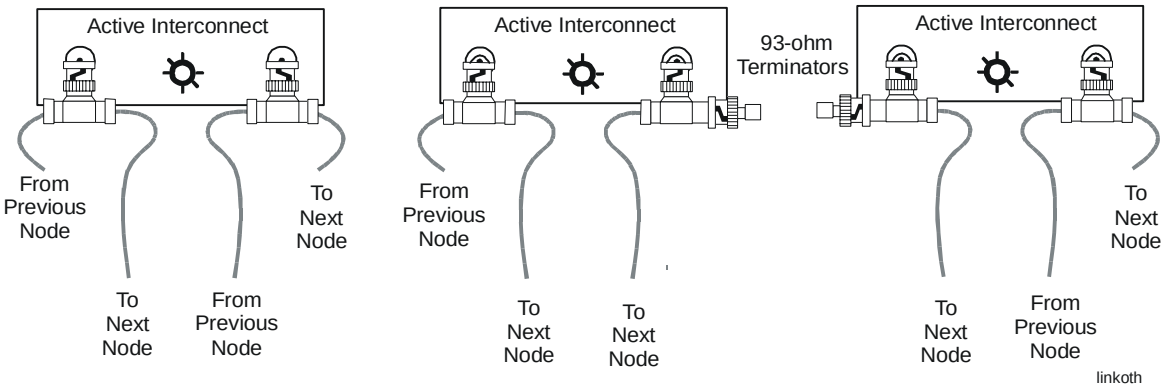


Figure 14: Various Methods of Wiring Coax to an Active Interconnect

Wiring for a Mixed Network

Use the wiring details in Figure 13 and Figure 14 to wire the components of a mixed network.

Wiring a Balun Adapter

Since the N1 LAN is designed for coax cable, Balun adapters are needed if the network is to use twisted pair. The adapter converts between coax cable and twisted pair. Figure 15 shows how to wire a Balun adapter.

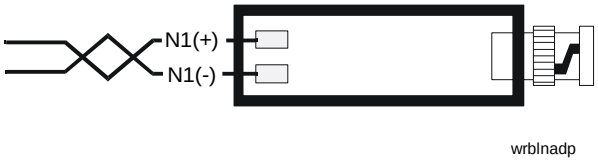


Figure 15: Wiring a Balun Adapter

The correct and incorrect use of Balun adapters is shown in Figure 16.

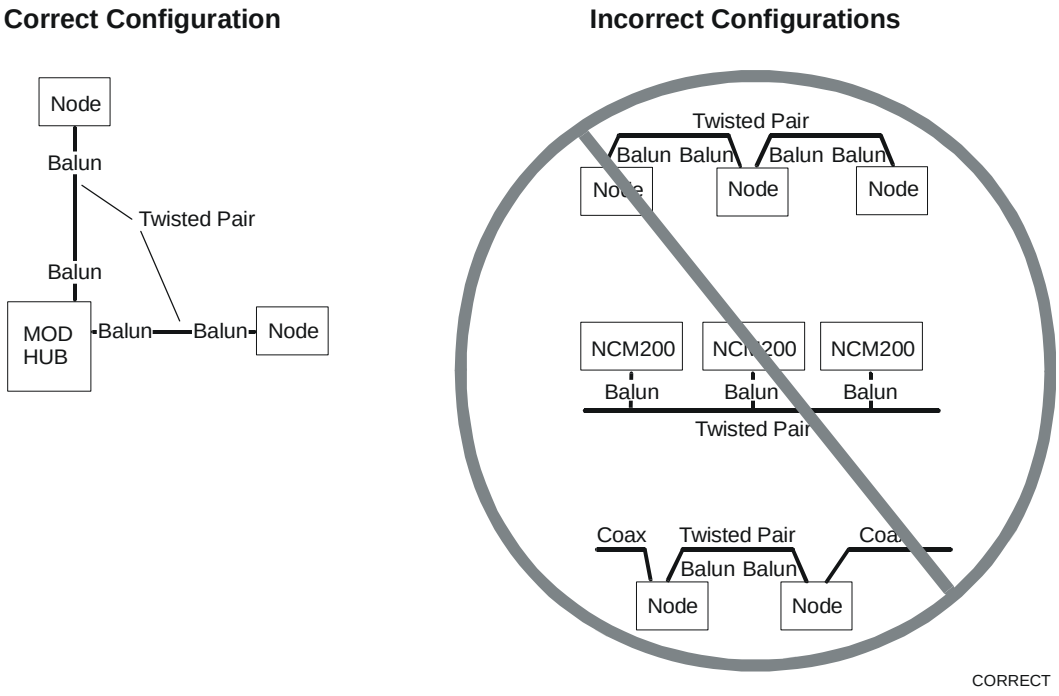


Figure 16: Using Balun Adapters

As the third incorrect configuration illustrates, twisted pair should not be mixed with coax on the same run. This is because the signal losses caused by two Balun adapters may be high enough to make communication with additional nodes over coax difficult.

Installing the ARCNET Board

The ARCNET board is a required component for the NCM300 and Operator Workstation and **may** be used for the NCM350 and Operator Workstation. It fits into one of the available expansion board slots on the NCM300 or Personal Computer (PC).

The procedure for installing the ARCNET board involves setting the switches and jumpers properly, and installing the board firmly into the expansion slot.

For the NCM300/350, set the ARCNET board switches as follows:

Table 5: Settings for NCM300 ARCNET Board

Parameter	Setting
Interrupt Level (IRQ)	4
Memory Base Address	C000H
Enhanced or Compatible Mode	Compatible Mode
I/O Base Address	300H
Bus or Star Configuration	As appropriate (typically Bus)
Network Node Address	Must be set to the same N1 Node Address as defined for the NCM in DDL or online generation.

For the Operator Workstation (OWS), set the ARCNET board switches for your particular board as follows:

Table 6: Settings for OWS ARCNET Board (WS-PS2N1A-0)

Parameter	Setting
Interrupt Level (IRQ)	7
Dual Port RAM Segment Address	Segment C000 (or C200) For PS/2 60-071: Segment DC00
I/O Port Address Range	600-603

Table 7: Settings for OWS ARCNET Board (SMC PC130E or PC270E)

Parameter	Setting
Interrupt Level (IRQ)	7
Memory Base Address	CC00
I/O Base Address	2E0
RAM Offset Select	00
Topology Select	Bus
Network Node Address	Must be set to the same N1 Node Address as defined for the OWS in DDL or online generation.

Table 8: Settings for OWS ARCNET Board (Thomas-Conrad TC6242-AIO)

Parameter	Setting
Interrupt Level (IRQ)	7
Memory Base Address	C800
Compatible Mode	SW1 7,8=Down (Off)
I/O Base Address	2E0
High Impedance Bus	For coax: JP8,9,10,14,15=Up JP12,13=Down For twisted pair: JP8,9,10,12=Up JP13,14,15=Down
Network Node Address	Must be set to the same N1 Node Address as defined for the OWS in DDL or online generation.

Table 9: Settings for OWS ARCNET Board (Johnson Controls NU-NET101-0)

Parameter	Setting
Interrupt Level (IRQ)	7
Memory Base Address	C800
Enhanced or Compatible Mode	Compatible Mode
I/O Base Address	2E0
Bus or Star Configuration	As appropriate (typically Bus)
Network Node Address	Must be set to the same N1 Node Address as defined for the OWS in DDL or online generation.

For detailed instructions on how to set these values, consult the configuration guide that was supplied with your ARCNET board.

For more instructions on installing the ARCNET board into the PC, refer to the *Operator Workstation Technical Bulletin (LIT-636013)*.

Installing Hubs and Links

Active hubs and active links may be installed in any convenient place where power is available. This may be inside or near an NCU, or between NCUs. The layout of the network will determine the exact location of these devices. They do not need to be installed in separate enclosures, since their enclosures provide adequate protection. Refer to the vendor's literature for installation instructions.

Installing Active Hub for Optical Fiber Conversion

An N1 LAN that will be extended with optical fiber can use a pair of MOD HUB Active Hubs (Figure 17). These devices convert the N1 LAN signal for transmission over optical fiber. Follow these steps:

1. Install the fiber conversion module into the MOD HUB.
2. Wire the N1 cable from the previous node into the coax port on the MOD HUB.
3. Wire the fiber between this MOD HUB and another MOD HUB at the remote location.
4. To complete the conversion, wire the N1 cable to the remote node.

For more detailed instructions, refer to the manufacturer's installation literature.

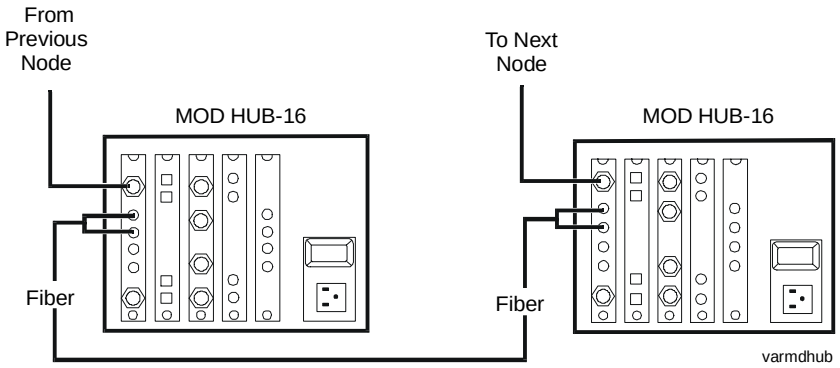


Figure 17: Method of Wiring to a MOD HUB for Fiber Conversion

Installing the Ethernet Board

To install the Ethernet board, refer to the *N1 Ethernet/IP Network Technical Bulletin (LIT 6360175)*.

Commissioning Procedures

Overview

Commissioning involves verifying the N1 LAN installation and modifying an existing N1 to add, delete, or relocate a node.

Verifying N1 LAN Installation

See the *Installation Procedures* section to verify that the N1 LAN is installed properly. In particular, make sure that:

- the installation follows the recommended maximum cable lengths.
- only those nodes that are located at the ends of N1 LAN bus segments have 93-ohm terminators. The nodes between the two end nodes must not have 93-ohm terminators installed.
- the proper cables are being used. The recommendations are: RG-62/U for coax; Belden® 1154A or 1155A for twisted pair; and 62.5 micron for optical fiber.

Modifying an N1 LAN Installation

NCMs and Operator Workstations can be added, deleted, or moved while the N1 LAN is operational. The N1 LAN will reconfigure itself if you add, delete, or reposition a node. The method of changing the network depends on the type of topology--star, bus, or mixed.

Adding a Node

Follow these steps to add an NCM or Operator Workstation (i.e., node) to a star, bus, or mixed network.

Star Network

To add a node to a star network:

1. Follow the procedure for defining a node in the system database (refer to the *Operator Workstation User's Manual*). Be sure to specify a unique node address.
2. If the active hub has an available port, simply connect the new node to that port.
3. If the active hub is full, remove a node and add a new active hub to that available port. On the new active hub, add the new node and replace the node that you removed from the other hub.

Bus Network

To add a node to a bus network:

1. Follow the procedure for defining a new node in the system database (refer to the *Operator Workstation User's Manual*). Be sure to specify a unique node address.
2. If the bus segment has not reached the maximum number of nodes, simply add the node anywhere on the bus line.

   Note: If the node is added at one of the ends of an N1 LAN bus segment, you need to move the 93-ohm terminator to the new end-of-line device.
3. If the bus segment has reached the maximum number of nodes, add an active link to the bus line. If the active link is at the end of line, install a 93-ohm terminator on the free side of the T-connector.

Mixed Network

To add a node to a mixed network, follow the appropriate steps discussed above that apply. For example, you may add a bus segment from an active hub.

Deleting a Node

Follow these steps to delete an NCM or Operator Workstation (i.e., node) from a star, bus, or mixed network.

Star Network

Follow the procedure for deleting a node from the system database (refer to the *Operator Workstation User's Manual*). Then, disconnect its cable from the active hub.

Note: You may disconnect the N1 LAN cable at the NCM or Operator Workstation. If you do so, you must install a 93-ohm terminator on the end of the cable at the NCM or Operator Workstation. Otherwise, reflections of the N1 LAN signal may disturb communications.

Bus Network

Follow the procedure for deleting a node from the system database (refer to the *Operator Workstation User's Manual*).

Then, if the node being deleted **is not at the end of line**, disconnect the T-connector from the NCM or N1 LAN board and replace it with a BNC feedthrough adapter.

If the node being deleted **is at the end of line**, move the terminator to the previous node so as to set it as the new end-of-line device.

Note: When removing nodes, make sure you do not exceed distance limitations.

Mixed Network

Follow the steps above as they apply.

Relocating a Node

The following steps explain how to relocate an NCM or Operator Workstation (i.e., node) while the system is operational.

1. To relocate a node on a star network, disconnect the cable from the hub, relocate the node, reroute the cable, and reconnect the cable. The monitoring Operator Workstation will report the node as offline during relocation, but should report online when you reconnect the node.
2. The instructions for relocating a node on a bus network depend on if this device is at the end of line.

   If the node **is at the end of line**, disconnect the cable and install a 93-ohm terminator cap at its open end. This prevents the N1 from signal reflections. Relocate the node, reroute the cable, and reconnect the cable.

   If the node **is not at the end of line**, disconnect the cable and install a BNC feedthrough adapter to keep the N1 LAN continuous. Relocate the node, reroute the cable, and reconnect the cable.

   Note: When removing nodes, make sure you do not exceed distance limitations.
3. To relocate a node on a mixed network, follow Steps 1 and 2 above as they apply.

Troubleshooting Procedures

This section explains how to troubleshoot the N1 LAN. The problems that may occur will most likely be caused by the following:

- improper switch settings on ARCNET boards
- improper network termination
- incorrect address assignments
- loose coax cable connectors
- malfunctioning active hubs and active links
- lightning protector used on N1
- not enough hard disk space on Operator Workstation

To assist in troubleshooting the N1 LAN, you may use one of the ARCNET network analyzers that are currently on the market. They may help locate and correct problems faster than traditional methods. However, Johnson Controls does not recommend or approve of any particular model.

Checking for Proper Switch Settings

The switches on the ARCNET boards used in the Operator Workstation and NCM300/350 must be set properly, or the nodes will not communicate over the N1 LAN. If a particular node is not responding, check the switch settings on its ARCNET board. See the ARCNET system tables in the *Installing the ARCNET Board* under the *Installation Procedures* section.

Checking for Proper Termination

To verify proper cable termination, you need to check all N1 LAN wiring, the placement of 93-ohm terminators, and the value of the terminators.

All N1 LAN wiring must be electrically continuous (unbroken) from end to end. This requires that each N1 connection has a T-connector installed with two N1 cables connected, or one cable and one 93-ohm terminator cap connected.

Check to make sure only one 93-ohm terminator cap is installed at the ends of each bus segment. The components that can accept terminators include the N1 LAN coax connector on the NCM, the Operator Workstation N1 LAN board, and the active links. If the Operator Workstation N1 LAN board you are using has on-board termination (e.g., the SMC® board), you must disable it. Then, make the end-of-line termination externally--on the T-connector at the back of the board. Also, you must not have a 93-ohm terminator installed on the active hubs; they have internal 93-ohm termination. And lastly, do not place terminators on nodes that are in the middle of the N1.

The 93-ohm terminators must be present on end-of-line devices at all times. If the cable is disconnected from an end-of-line device, a 93-ohm terminator must be placed on the end of the cable. If this is not done, reflections from the unconnected end of the cable may disrupt communications.

The Metasys Network may use old JC/80 coax cable that is rated at 50-ohms. If you use both 93-ohm and 50-ohm cabling on the same network, install an active link to isolate the two different segments. For more details on using 50-ohm cable on the N1 LAN, refer to *JC/80 Coax on N1 LAN Application Note (LIT-6363142)*.

Be sure to use only 93-ohm terminators on the N1 LAN. You can measure the resistance of a terminator with an ohmmeter. Place one lead on the male pin and the other lead to the body of the terminator. The reading should be 93-ohms.

Note: A properly connected N1 LAN has a resistance between 46 and 54-ohms as measured at any point on the LAN **when all coax connectors to ISA ARCNET boards, active hubs, and active links are disconnected**. To measure resistance:

1. Disconnect all coax connectors from ISA ARCNET boards, active hubs, and links.
2. Insert a T-connector anywhere on the N1 LAN.
3. Connect it to an ohmmeter.
4. Measure between the center conductor and the metal housing.

Checking for Incorrect Address Assignments

Incorrect address assignments can cause communication problems. An incorrect address is either not properly defined or defined twice for two different nodes (i.e., duplicate address).

Ensure that each NCM is correctly addressed on the Operator Workstation by checking the NCM focus window. The NCM address must match what the workstation thinks it is, and the NCM archive address must point to the appropriate archive PC.

If two or more nodes have the same address, the N1 Transmit Light-Emitting Diodes (LEDs) on all NCMs blink. This indicates the network is continually reconfiguring. In this situation, communications may be intermittent or may not occur at all.

Inspecting Coax Cable Connectors

A coax connector that is not properly crimped and installed can cause communication problems. You need an ohmmeter to check for bad connectors. First, check for a short by measuring the resistance across the cable at the connector. Then, check for an open by shorting one end of the cable and measuring the resistance again. Bend the cable back and forth at the connector when making these measurements, because sometimes the connection is marginal and will give proper readings in some positions. If defective, cut off the old coax connector and install a new one.

Checking Active Hubs and Active Links

The active hubs and active links feature LEDs that indicate their statuses. When these devices are working properly, the LEDs are On. For detailed troubleshooting information, refer to the manufacturer's literature.

Checking for a Lightning Protector

Lightning protectors should not be used on the N1 LAN. Installing them may cause communication problems. If lightning is a concern, use optical fiber in the segments that need protection from lightning interference.

Checking Operator Workstation's Hard Disk

When available space on the hard disk of the Operator Workstation is reduced to a few thousand bytes (2-3 K), the workstation goes offline. It is no longer able to communicate with other nodes. It is good practice to leave at least 1 MB of hard disk space unused at all times. For jobs at Release 4.0 or later, you can do this automatically in the WIN.INI file on the Operator Workstation. (Refer to the README.OWS file for details.)

Checking for Other Problems

The following is a list of other situations that may occur and what to do about them.

- If a particular NCM is not communicating over the N1 LAN, try bypassing the N1 by connecting to it directly. If you are then communicating, you know that the N1 cables or connections are faulty.
- If you are experiencing download problems over the N1, recompile the DDL software to see if that resolves the problems.
- If database definitions have changed, inspect the changes to ensure that referenced points haven't been erased.
- If you are running the Slide Show (from the Micrografx Designer® application) on your workstation, too short an interval between slides causes the workstation to go offline. To eliminate this problem, extend the interval time to 200 seconds.
- If you cannot run NCSETUP from your Operator Workstation over the N1 LAN, the Interrupt Level (IRQ) and I/O Base Address settings of one of your PC's expansion boards may be the same as these settings for NCSETUP. (IRQ = 7 and I/O Base Address = 2E0.) The only way to rectify this is to either disable the expansion board that is using the same settings or update your system to Metasys Release 7.0, which allows you to alter the NCSETUP default settings.

Ordering Instructions

Johnson Controls Code Numbers

Table 10: Ordering Information for Johnson Controls Parts

Description	Order Number
ARCNET Board for NCM300/350 or OWS (ISA)	NU-NET101-0
ARCNET Board for NCM300/350 or OWS (Fire and Smoke Control Application) (ISA)	NU-ARC101-0
Ethernet Card for NCM350 (ISA)	NU-NET301-0
Ethernet Card for OWS	See items available in the *Metasys* section of the *Johnson Controls IT Acquisition Services Computer Price List*.
Active ARCNET Hubs	
4 to 16 Port Coax, Twisted Pair, and/or Fiber	JC-MH-16 (120V) JC-MH-16E (240V)
Flanged Unit for Wall Mounting	JC-MH-16F (120V) JC-MH-16EF (240V)
Flanged Unit in NEMA1 Enclosure	JC-MH-16FN (120V)
Expansion Modules (for MOD HUB-16)	JC-EP-CS (4 port coax) JC-EP-FG (4 port glass fiber) JC-EP-CSFG (2 port coax; 2 port glass fiber)
ARCNET Interconnect (AI) (Coax; 2 Port)	JC-A12-CXB

Table 11: Ordering Information for Johnson Controls Repair Parts

Description	Order Number
NCM200 Network Control Module with N1 Repair	NU-NCM200-700
NCM300-1 Network Control Module Repair	NU-NCM300-701
NCM300 Network Control Module Repair (preconfigured with ARCNET Board)	NU-NCM300-F700
NCM350-1 Network Control Module Repair	NU-NCM350-701
NCM350-8 Network Control Module Repair	NU-NCM350-708
NCM350-8 Based Fire Network Control Module Repair	NU-NCMFire-701

Vendor Part Numbers

To order vendor parts, use the information from the following tables.

Notes: The vendor components recommended below have been tested and approved for use on the N1 LAN. Other products may exist that provide equivalent functions, but have not been tested. Therefore, Johnson Controls does not support the use of equivalent boards, hubs, links, adapters, and connectors.

The ARCNET board for the International Business Machines Corporation (IBM®) PS/2 model is manufactured by Johnson Controls and provides superior surge and overvoltage protection compared to most other commercially available ARCNET boards.

Table 12: ARCNET Boards, Hubs, and Interconnects

Boards, Hubs, and Interconnects		
Description	**Part Number**	**Manufacturer**
ARCNET Board	ARCNET-PC130E (coax) ARCNET-PC270E (twisted pair)	Standard Microsystems Corporation (no longer available)
ARCNET Board	ARCNET-PC130E P/N 750.111 (coax) ARCNET-PC270E P/N 750.13201 (twisted pair)	Standard Microsystems Corporation (no longer available)
ARCNET Board	TC6242-AIO 8-Bit Adapter TC6242-AIO 16-Bit Adapter	Thomas-Conrad Corporation (no longer available)
Expansion Modules (Twisted Pair for MOD HUB-16)	EXP-TPS (4 port twisted pair) EXP-TPS/CXS (2 port twisted pair; 2 port coax) EXP-TPS/FOG-ST (2 port twisted pair; 2 port glass fiber)	Contemporary Control Systems, Inc. 2431 Curtiss Street Downers Grove, IL 60515 Phone: (630) 963-7070 FAX: (630) 963-0109 e-mail: info@ccontrol.com
Active Link (Coax; 2 Port)	Active Link (120V) Active Link (240V)	Standard Microsystems Corporation (no longer available)

Table 13: Coax Cable and Accessories

Description	Indoor	Outdoor	Direct Burial	Plenum (<140°F)	Plenum (<392°F)
Belden P/N	9269	9268	9228	82269	89269
Anixter® P/N	B9269	B9268	B9228	B82269	B89269
Cable Type	RG-62A/U	RG-62A/U	RG-62A/U	RG-62/U	RG-62/U
Shield Effectiveness	95%	95%	95%	95%	95%
Outside Jacket Diameter	0.242 in.	0.260 in.	0.242 in.	0.208 in.	0.208 in.
BNC Crimp-on Connectors					
Anixter P/N	094291	--	160329	194127	194127
Hand Tool					
AMP P/N	58433-1	--	--	--	--
Amphenol P/N	--	--	CTL-1	CTL-1	CTL-1
Anixter P/N	133101	--	140497	140497	140497
BNC Terminator Cap (93-ohm)					
Anixter P/N	124313	124313	124313	124313	124313
BNC T-connector					
Anixter P/N	142330	142330	142330	142330	142330
BNC Feedthrough Adapter					
Anixter P/N	150847	150847	150847	150847	150847
Cable Stripper (use green for crimp-on)					
Anixter P/N (green triple cut)	033657	033657	033657	033657	033657

Note: The coax cable accessories are available from the local AMP dealer or Anixter.

Anixter
4701 W. Schroeder Dr., Suite 170
Brown Deer, WI 53223

1-800-242-5575 (in WI)
1-800-447-8565 (outside WI)
(414) 355-2415 (FAX)

Table 14: Twisted Pair and Accessories

Description	Part Number	Manufacturer
Twisted Pair	Belden 1154A (non-plenum) Belden 1155A (plenum) **No longer available.**	Anixter 4701 W. Schroeder Dr., Suite 170 Brown Deer, WI 53223 1-800-242-5575 (in WI) 1-800-447-8565 (outside WI) (414) 355-2415 (FAX)
Balun Adapter **Arcplex Balun** **Arcplex Balun w/pigtail leads**	430000 430005 **No longer available.**	Manufacturer: NHC Communications, Inc. Montreal, Canada 1-800-361-1965 Attn: Jill Quartz Distributor: Anixter (see above)

Table 15: Optical Fiber and Accessories

Optical Fiber and Accessories					
	Outdoor			Indoor	
	Duct/ Aerial	Direct Burial (Rodent Resistant)	Duct (Below Frost Line)	Non-Plenum	Plenum
Optical Fiber (Dual Fiber, Glass, 62.5 Micron, Multimode)					
Siecor® P/N	002K14-14110-20	002KW5-14130A20	2K81-31130-24	2K81-31130-24	002K82-31141-24
Anixter P/N	370-062-ALTOS-02	370-063-6ALTA-02	370-947-FDDI-02	370-947-FDDI-02	370-949-FDDI-02
Attenuation (dB/km @ 850/1300nm)	3.5/1.0	3.5/1.0	3.75/1.75	3.75/1.75	3.75/1.75
Bandwidth (MHz-km @ 850/1300nm)	160/500	160/500	160/500	160/500	160/500
Cable Diameter mm (inches)	13.1 (0.52)	13.1 (0.52)	4.1 (0.16)	4.1 (0.16)	3.8 (0.15)
Optical Fiber Connectors					
ST-Connector (polish and cure)					
Siecor P/N	95-100-01	95-100-01	95-100-01	95-100-01	95-100-01
Anixter P/N	106716	106716	106716	106716	106716
ST-Connector Tool Kit (for polish and cure connectors)					
Siecor P/N	TKT-012R	TKT-012R	TKT-012R	TKT-012R	TKT-012R
Anixter P/N	163427	163427	163427	163427	163427
Optical Fiber Splicing Accessories					
Fiber Cutter for Mechanical Splicing					
Siecor P/N	FBC-001	FBC-001	FBC-001	FBC-001	FBC-001
Anixter P/N	086541	086541	086541	086541	086541
CAM Splice (pack of five)					
Siecor P/N	95-000-04	95-000-04	95-000-04	95-000-04	95-000-04
Anixter P/N	129467	129467	129467	129467	129467
Optical Fiber Test Equipment					
Attenuation Test Kit (transmits and receives)					
Siecor P/N	OTS-111D-55	OTS-111D-55	OTS-111D-55	OTS-111D-55	OTS-111D-55
Anixter P/N	163425	163425	163425	163425	163425
Access Jumpers (one meter length)					
Siecor P/N	252501K341001m	252501K341001m	252501K341001m	252501K341001m	252501K341001m
ST-Connector Coupler					
Siecor P/N	TER-067	TER-067	TER-067	TER-067	TER-067
Anixter P/N	097289	097289	097289	097289	097289

For technical assistance with fiber applications, contact:

Siecor Corporation
489 Siecor Park
Hickory, NC 28603
1-800-743-2675
Ask for “Duty Engineer.”

Appendix

This section contains N1 LAN information for installations that use the old NCM101 and NCM401 products. Only those instructions that differ from the NCM200 and NCM300/350 instructions are given. All other information is provided in the previous sections of this document.

Components

The NCM101/401 use a Communication Terminal Board for the N1 LAN connection (Figure 18). This board is located in the upper left corner of the 5-slot and 2-slot NCUs, and on the left side of the 1-slot NCU. It is factory installed on the NCU base frame. The board is the central wiring location for devices on the N1 LAN, N2 Bus, and L2 Bus.

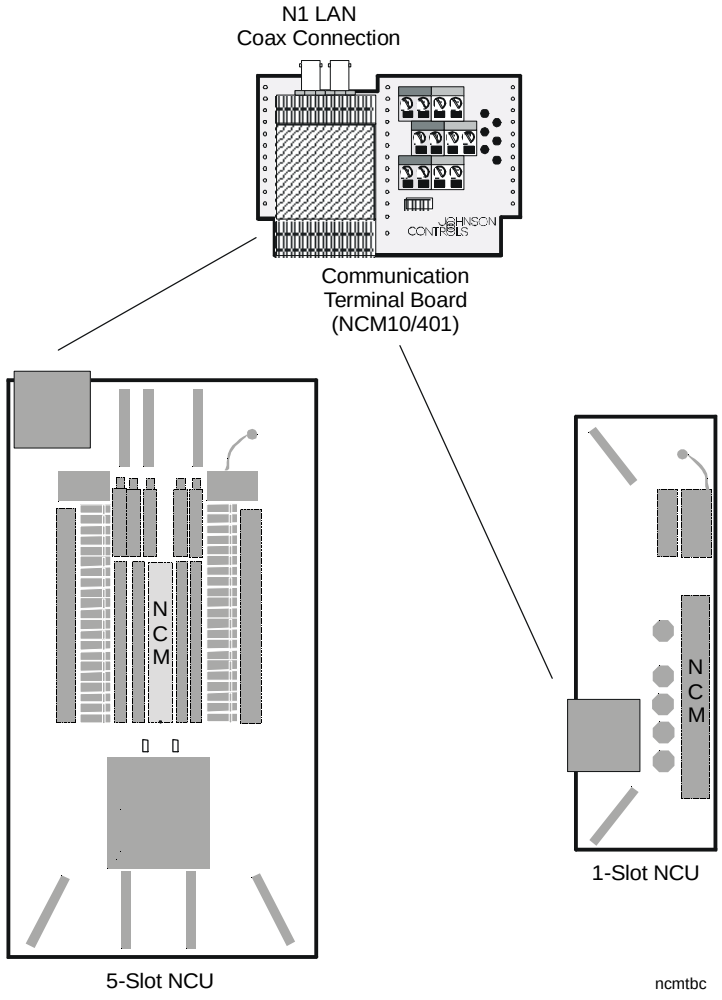


Figure 18: TBC Used for NCM101/401

Installation Guidelines

The following are two installation considerations to be aware of if the NCU contains an NCM101/401:

- Do not use a T-connector at the Communications Terminal Board (TBC). If the NCU contains an NCM200, use a T-connector on the bottom of the NCM to continue the N1 to the next node.
- Install either a 93-ohm terminator or a piece of cable on each coax port of the TBC.

Wiring for a Star Network

When wiring the components of a star network for an installation that uses the NCM101/401, wire the N1 cable from the active hub to the coax connector on the TBC. Install a 93-ohm terminator cap on the other coax connector. Refer to Figure 19 below.

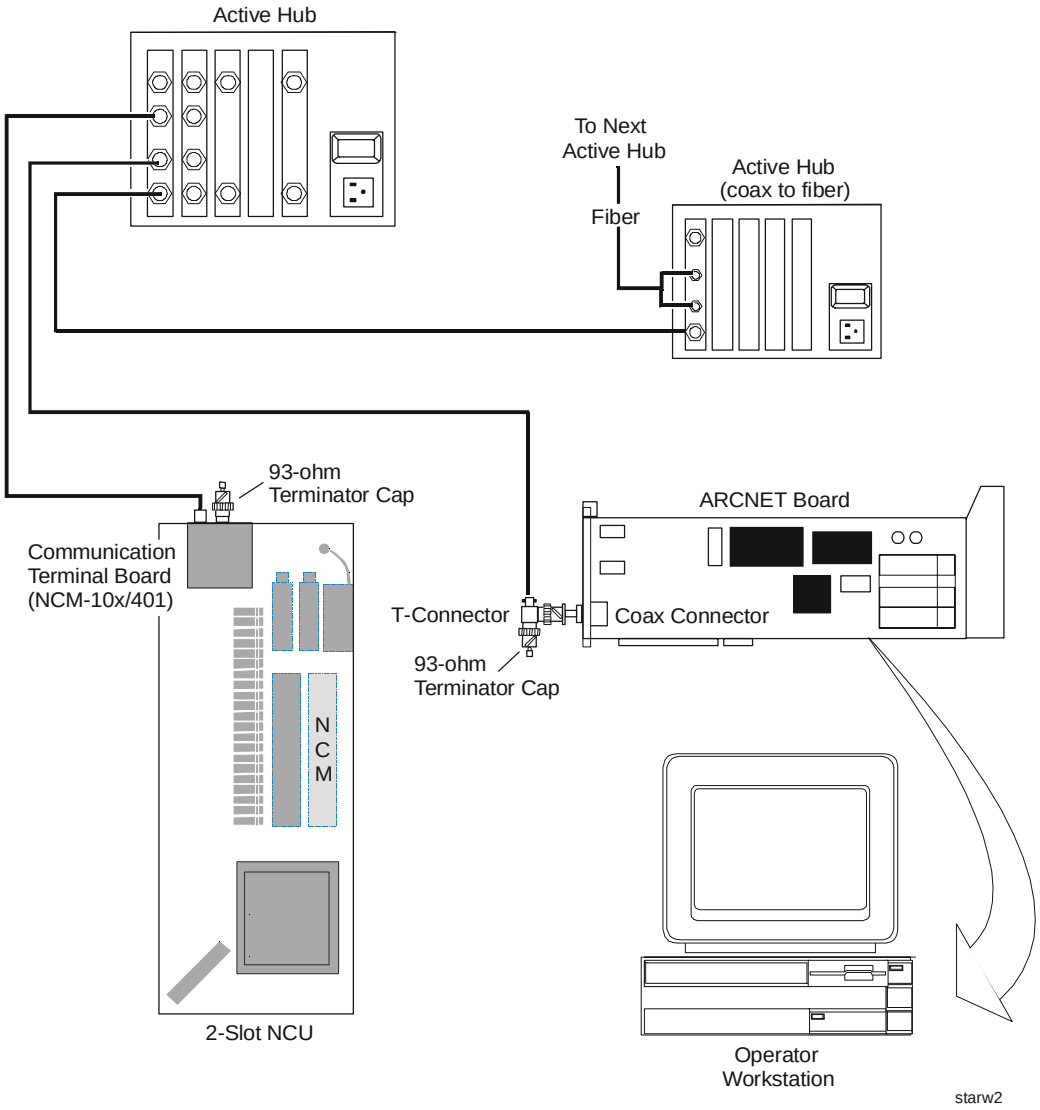
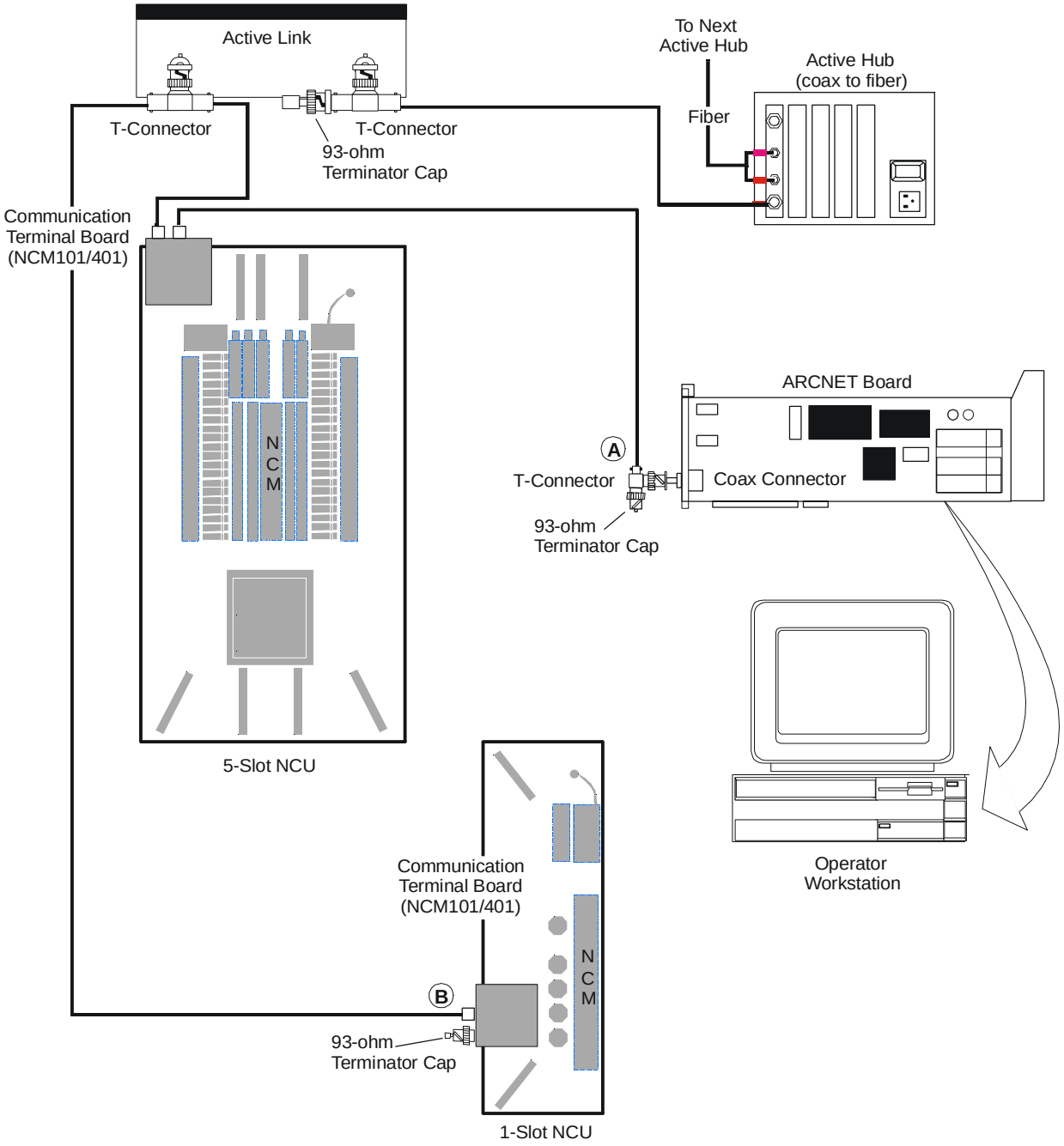


Figure 19: Wiring Star Network Components

Wiring for a Bus Network

When wiring the components of a bus network for an installation that uses the NCM101/401, follow these steps, referring to Figure 20:

- If the NCU **is not at the end of line**, wire the N1 cable from the previous node to one of the coax connectors on the Communication Terminal Board (TBC). Wire another length of N1 cable to the other coax connector that is to be wired to the next node.
- If the NCU **is at the end of line**, wire the N1 cable from the previous node to one of the coax connectors on the Communication Terminal Board (TBC). Install a 93-ohm terminator into the other coax connector.



Note: Total cable length between Points A and B must not exceed distance limitations given in Figure 8.

busw2

Figure 20: Wiring Bus Network Components

Deleting a Node: Bus Network

When deleting an NCM101/401 from the network, disconnect the two coax cables at the Communication Terminal Board, and join the two ends of coax with a BNC feedthrough adapter.

Checking for Proper Termination

All N1 LAN wiring must be electrically continuous (unbroken) from end to end. This requires that each NCU Communication Terminal Board has either two N1 cables connected, or one cable and one 93-ohm terminator cap connected to it.

Checking for Tight TBC Connections

Make sure the ribbon cable that connects the Communication Terminal Board (TBC) to the backplane is secure. To do so, unscrew and pull out the TBC. A single mounting screw holds the board in place. After you have verified that the ribbon cable is connected, reattach the TBC.

Johnson Controls Code Numbers

Table 16: Ordering Information for NCM101/401 Repair Parts

Description	Order Number
Network Control Module (NCM101) with N1 Repair	NU-NCM101-700
Migration Network Control Module (NCM401) with N1 Repair	NU-NCM401-700
Communication Terminal Board (TBC) for NCU	EN-TBC801-0 (replacement)

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