ARCNET® for Control

For all your Industrial Networking Applications

- Network Interface Modules
- Repeaters, Links and Hubs
- Routers and Gateways
- Analyzers & Evaluation Systems

CONTEMPORARY CONTROLS®

Our Vision Continues
in Industrial Networking

Dear Customer,

In Industrial networking, there has been a long history of technologies battling for dominance. There is a long list of losers, relegated to the bone yard of obsolete technology. And a few winners, like Ethernet and TCP/IP—and ARCNET®.

While ARCNET did not achieve the vast popularity of Ethernet, still after two decades it continues to be used in tens of thousands of installations. Today, ARCNET is still being designed into new products. Why? Because as a high-speed, long-distance Ethernet alternative, it is inexpensive, well-supported, provides ultra-reliable performance and lends itself to supporting both open and proprietary design features as desired by OEMs.

My company, Contemporary Controls, is the world's leading supplier of OEM ARCNET components and tools. My company is ready to equip you with the knowledge and support you need to implement an open or proprietary, low-cost, high-speed network in your OEM design.

ARCNET is a powerful technology that continues to operate "under the hood" within thousands of machines and systems in dozens of industries. It continues to perform day after day, year after year. It can work for you too. Call us to discuss your specific application: 630/963-7070. Our support team is here, ready to support your next design.

Sincerely,

George Thomas
President

Contemporary Controls celebrates 30 years in control.

Celebrating 30 Years in Control

INTRODUCTION

Ever wonder why ARCNET® remains a time-proven technology? This catalog provides the answer to the question.

Imagine yourself as a designer or engineer working on an ARCNET project and you encounter some difficulty. As a recognized name in ARCNET, Contemporary Controls publishes this ideal resource to help in taking your project from start to finish—adding to a line or even upgrading an entire system.

It's both a tutorial and a product guide. All our Hubs, Network Interface Modules (NIMs) and Analyzers are designed to allow users to find solutions for lower cost and reduced downtime.

And our skilled technical support team will provide advice on how best to configure your ARCNET application or simply respond to a problem so you may get back to work with the guarantee that your system will be "up and running."

Having said all that, the opportunities for ARCNET are increasing.

Visit our website, www.arccontrol.com, to learn how we made a difference in this technology.

Contemporary Controls

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Quality Policy

Our MISSION is to develop, manufacture and market industrial networking technology to the benefit of our automation customers worldwide.

Our VISION is to be regarded by our customers as experts in the industrial networking technologies we support.

Our VALUES are the foundation of how we conduct business.

- Our customers depend upon us to deliver products and services that meet their needs. Their success provides us the means to exist.
- Our suppliers are important to our success and, therefore, we treat them as partners.
- Each employee is considered a professional, independent of position, and a contributor to the success of the organization.
- We are all members of a working team, striving to develop innovative products, technologies, and processes.
- We stress quality in everything we do and know we can do better through continuous improvement efforts.
- The ethical way of doing business is the only way.

RoHS Compliance Plan Available for Our Customers

It is a fact that small amounts of lead have been used in electronic products for years. And today's environment movement is helping individuals understand the dangers of such hazardous materials and how it affects our quality of life issues.

Contemporary Controls is concerned about the environment. They are taking action with regards to the new European Union guidelines on hazardous materials used in electronic products.

The European Parliament and the Council of the European Union (EU) has released directive 2002/95/EC on restricting the use of certain hazardous substances (RoHS) in electrical and electronic equipment.

A second directive, 2002/96/EC, focuses on waste electrical and electronic equipment (WEEE). This directive calls for the prevention of waste electrical and electronic equipment, and in addition, the reuse, recycling, and other forms of recovery of such wastes so as to reduce the disposal of waste. Both directives will have a strong impact on the company's operations and future business and they are committed to embrace these standards for all their products, and all the countries they sell to.

The company will continue to manufacture leaded products including ARCNET, CAN and Industrial Ethernet as long as leaded component inventory exists. Once leaded inventory is exhausted, the transition to lead-free production will begin the end of 2005 and to fully lead-free production to begin no later than April 2006. As each product is examined, its status and planned date for conversion to RoHS compliance will be appended to the RoHS Compliant Product Roadmap.

Our customers will be encouraged to review the RoHS Compliant Product Roadmap posted on our main website (www.ccontrols.com), to be ensured that a product of interest is scheduled to be converted to lead-free. If not, then we will make a recommendation on a possible substitution if practical.

Questions regarding a particular product should be directed to the sales department at 1-630-963-7070. We will attempt everything to accommodate the needs of our customers during this transition period.

What's Inside ARCNET for Control

ARCNET—The Hidden Real-Time Network

ARCNET, once quite popular in office automation, has reinvented itself into an embedded networking technology that is frequently found in applications such as industrial control, building automation, transportation, robotics and gaming. Extremely popular in Japan, America, and Europe, ARCNET is now making inroads into China with some of the top China universities incorporating ARCNET into projects.

Over 11 Million Nodes

Like Ethernet and Controller Area Network (CAN), ARCNET is a data-link layer technology with no defined application layer. Designers write their own application layer to meet their particular needs and frequently do not advertise the fact that ARCNET is being used in their product. ARCNET receives no name recognition, but it is frequently the network of choice in embedded applications. Over 11 million ARCNET nodes have been sold giving ARCNET the credibility it deserves.

Deterministic Performance

Originally introduced at about the same time as Ethernet, ARCNET incorporates a token-passing protocol where media access is determined by the station with the token. When a station receives the token, it can either initiate a transmission to another station or it must pass the token to its logical neighbor. All stations are considered peers and no one station can consume all the bandwidth since only one packet can be sent with each token pass. This scheme avoids collisions and gives ARCNET its greatest advantage in real-time applications—it is deterministic! Thus, the designer can accurately predict the time it takes for a particular station to gain access to the network and send a message. This is of particular importance for control or robotic applications where timely responses or coordinated motion is needed.

Large Packet Size

CAN was originally designed for the automotive electronics market and has experienced success as a device- level network when used with higher layer protocols such as DeviceNet and CANopen. ARCNET is best considered a controller-level network because of its higher performance over CAN. CAN communication is limited to 1 Mbps and it can only send eight data bytes per frame. Newer ARCNET chips can transmit at 10 Mbps and data packets can be up to 507 bytes in length. Not only is ARCNET faster than CAN, ARCNET can send more data per transmission.

Variable Data Rate Up to 10 Mbps

Another advantage of using ARCNET is that it supports multiple physical layers. The original physical layer was a dipulse transceiver which was optimized for 2.5 Mbps. Newer generation transceivers are much smaller in size and can operate up to 10 Mbps. A designer can select popular and lower cost EIA-485 transceivers when distances are relatively short. For higher isolation voltage, a transformer-coupled device is available that will also operate up to 10 Mbps. The advantage of these transceivers is that they will operate over a bus topology. One of the complaints regarding Ethernet is the need to operate in a star topology which requires the use of hubs. Not only does the hub require a source of power, the designer needs to find a place to mount the hub, and it represents a single source of failure. For embedded applications, bus topology is much more convenient since hubs are not required.

Reliable Message Delivery

Another problem with Ethernet is the requirement to add a transport-layer protocol. Of course, the most popular transport-layer protocol is TCP, but the code size for a TCP/IP stack is near 50 kB. Small microcontrollers either lack the memory capacity for this stack or the processing power to execute both the stack and the application. Embedded applications do not require a full seven-layer communication model. An application layer, data-link layer and physical layer are all that is needed. Industrial automation protocols such as DeviceNet and CANopen are prime examples. Their data-link layer is CAN and transport functionality, such as guaranteed message delivery, is handled at the application layer. The same can be done with ARCNET. In fact, ARCNET controllers have some built-in transport-layer functionality. All messages are appended with a CRC-16 frame check sequence and if the frame was received successfully at the destination station, an acknowledgment is automatically sent back to the originating station without any software intervention. This feature in ARCNET simplifies software development, and it is absent in both CAN and Ethernet.

Simple Microprocessor Bus Interface

ARCNET has other unique features that facilitate embedded design development. The COM20020 family of ARCNET controllers were designed for a simple eight-bit bus microprocessor interface. The complete communication protocol is handled by the ARCNET controller. This includes token-passing, network configuration and error handling. Unlike Ethernet, ARCNET has built-in flow control.

A message will not be sent to a destination node without the availability of a receive buffer. This further off-loads the software requirements and ensures that messages need not be resent because of receiver errors. ARCNET controllers are competitively priced, and there are no licenses or expensive development platforms that must be purchased. Only standard embedded design tools are required to develop a system.

Works With BACnet®

ARCNET is one of the approved data links for the BACnet protocol. BACnet Building Automation and Control Network was developed by the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) and has now become an ISO standard. A well-known protocol in the United States and Europe, BACnet is becoming popular in China as well, and the standard has been translated into Chinese.

Simple To Use

If you ask a designer why he or she uses ARCNET, the answer will usually be, "It is simple to use, low cost, extremely rugged and high performing." Newer ARCNET controller chips have an extremely small footprint, making it ideal for embedded applications. Unlike TCP/IP Ethernet networks with complex 48-bit addressing and assignment, ARCNET nodes can only number 255 and can be set by a simple 8-position DIP switch.

The opportunities for using ARCNET are enormous—from Pachinko machines and high-speed trains in Japan to process automation and motor drive controllers in Europe. ARCNET continues to perform in non-stop applications.

Features

- Deterministic Performance—Users Can Calculate the Worst Case Node-to-Node Message Time
- Logical Ring—Nodes Automatically Find Their Neighbor to Create A Ring
- Automatic Reconfiguration—A New Node Joins the Ring Automatically Without Software Intervention
- Broadcast and Directed Messages
- Multi-Master with Automatic Token Generation
- Cabling Options—Coaxial, Fiber Optic, EIA-485 Twisted-Pair
- High Speed—Standard 2.5 Mbps, Optionally 19 kbps to 10 Mbps
- Low-Protocol Overhead—3 or 4 Bytes—Good Usage of Available Bandwidth
- Variable Packet Size—0 to 507 Bytes
- Bit Rate Scalable up to 10 Mbps—Grows with Your Application
- High Noise Immunity
- Easy and Simple Manageable Technology—No Special Development Tools Required

—Information courtesy of the ARCNET Trade Association

What is ARC Control

What is ARC Control?

ARC Control is a family of ARCNET-compatible products including network interface modules, active hubs, network analyzers, and other devices designed for use in control applications. The ARCNET technology is defined in ANSI/ATA878.1–1999. Although ARCNET is nearly 30 years old, it has evolved to be the network of choice for embedded or control applications where deterministic, real-time performance is a necessity.

Why choose ARC Control over office-grade equipment?

Office-grade ARCNET connectivity equipment also conforms to the ANSI/ATA878.1–1999 standard and will successfully communicate with ARC Control. There are several reasons why ARC Control is superior to office-grade equipment when used in industrial and commercial applications.

Temperature

Office-grade equipment is typically specified over a +5°C to +40°C (+41°F to 104°F) temperature range while industrial controllers such as programmable logic controllers (PLCs) are rated from 0°C to +60°C (+32°F to +140°F). ARCNET equipment should have equal or better temperature ratings as the equipment to which it is connected. This range is beyond the capabilities of office-grade equipment, but is covered by the ARC Control family without the use of fans which are undesirable in industrial applications.

Mounting

Control devices are usually mounted onto sub-panels which are installed into industrial control panels. Devices are secured by mounting tabs or snapped onto DIN-rails. ARC Control equipment can be mounted in this fashion. It makes for a nice, clean, and rugged installation resistant to vibration. ARC Control equipment looks like it belongs with its companion devices. Office-grade equipment is intended for tabletop installation and seldom has provisions for secure mounting. Frequently, the units are left unmounted or attached using Velcro®, duct tape or a special shelf is fabricated at an additional cost for their mounting. Office-grade equipment is out of place in an industrial control panel.

Power Supply

Industrial systems are usually powered from a common low-voltage control transformer or low-voltage DC power supply. The ARC Control family will operate over a wide range of AC or DC voltages compliant to the needs of most control applications. The key to this flexibility is a wide-range DC-to-DC converter. The converter can operate during brownout conditions utilizing a large input capacitor to ride out spikes and dropouts that can frequently occur with factory power sources. Additional connections are provided for redundant power schemes to ensure the greatest amount of uptime. Office-grade equipment is usually mains-powered or requires a wall-mounted plug-in transformer that is inconvenient in a control panel and susceptible to inadvertent disconnection, compromising the system's reliability.

Regulatory Requirements

Simply embracing ARCNET standards does not remove the requirement to conform to various agency regulations not required in the office. Seldom does office-grade ARCNET equipment meet the unique requirements of industrial automation or even building automation. ARC Control products are designed and tested to the higher electromagnetic compatibility (EMC) immunity standards required for industrial equipment. Some products are UL 1950 listed for use in information technology equipment. Others are UL 864 recognized for smoke and fire-protective applications. All the products carry the CE Mark for installation in the European Union.

Extended Product Life Cycle

Original Equipment Manufacturers (OEMs) require a stable bill-of-material (BOM) without the additional expense and effort to requalify a replacement for an obsolete device. This is especially true when the OEM equipment has been qualified for agency approvals and subject to factory surveillance. This can be a challenge when using state-of-the-art electronic devices so Contemporary Controls makes every effort to ensure that its ARC Control line will have an acceptable product life cycle in support of its OEM customers. This is not the case with office-grade equipment that is frequently changed without notification, making it difficult to specify and procure the same item even over a short time span.

Responsive Technical Support

Contemporary Controls recognizes that ARCNET is a powerful technology and understanding how it functions and how it can aid a customer's application can be a confusing process. The company continually educates its market about the workings and benefits of the technology through seminars, white papers, articles, conferences, website and through our EXTENSION newsletter articles. The company provides responsive phone support and technical advice on how best to configure an ARCNET application using ARC Control. Vendors of office-grade equipment seldom answer a call or are unknowledgeable of the unique requirements of the controls industry.

Choosing the Right Product for Your Application

The ARC Control family of ARCNET products consists of Network Interface Modules (NIMs), repeaters, links, hubs, evaluation systems, network analyzers and router/gateways. In order to select the proper equipment for your application, it is necessary to review some of the basic components found in ARCNET systems.

ARCNET Controller Chips

The original ARCNET controller chip was the COM90C26 which required a separate clock generator named the COM90C32. The data rate was fixed at 2.5 Mbps. With the popularity of the ISA bus, several chips were introduced, compatible with the original COM90C26. The COM90C65 was intended for 8-bit ISA buses (XT) while the COM90C66 was designed for 16-bit ISA buses (AT). Both of these new chips integrated the clock generator functionality and streamlined the bus interface. To simplify ARCNET's use in embedded applications, the COM20020 was introduced with an 8-bit microcontroller bus interface. Again, compatibility was maintained with earlier generation ARCNET controller chips. However, the COM20020 had additional features such as variable data rates up to 5 Mbps. The COM20020 family was expanded to include the COM20019 for low-speed applications and the COM20022 for high-speed applications up to 10 Mbps, with the latter having a 16-bit interface. The COM20020 family is considered current technology while the COM90C26, COM90C65, and COM90C66 are legacy technology.

Computer Bus Structures

Network Interface Modules are available for all the popular bus structures. In some instances, different ARCNET controller chips are available for the same bus structure. The following table identifies those computer bus structures supported with ARC Control NIMs.

Transceiver Options

ARCNET technology is extremely flexible and numerous physical layers can function successfully with ARCNET controller chips. ARC Control supports the most popular physical layers, although some OEMs have chosen to design their own physical layer to meet their unique needs. Each physical layer supported in the ARC Control family is identified by a transceiver designation.

Connector choices vary with the type of transceiver. What follows is a description of those physical layers that are supported as a standard offering. These designations apply to all ARC Control products.

-CXS Coaxial Star (BNC Connector)

This is the original ARCNET transceiver very much in use today. Operating at 2.5 Mbps, this transceiver is intended for either point-to-point, star or distributed star topologies.

A BNC connector completes the connection to RG-62/u coaxial cable. A dipulse is used for signaling which is suitable for this transformer-coupled transceiver. The -CXS provides long distance (up to 2000 feet) and excellent noise immunity.

-CXB Coaxial Bus (BNC Connector)

The -CXB is similar to the -CXS and will operate together as long as cabling rules are maintained. The -CXB is the bus version of the -CXS except it eliminates the need for hubs. However, hubs or repeaters can be used to extend network distances. The -CXB offers multiple access to stations over a single segment although overall segment length is reduced from the -CXS. Like the -CXS, dipulse signaling is used as well as the same BNC connector. BNC tees and terminators are required when using -CXB transceivers which is not the case with the -CXS transceiver.

-FOG Fiber Optic Glass (Multimode) (ST or SMA Connectors)

Fiber optic cable can be supported by ARCNET as well. The -FOG transceiver identifies support for a duplex 850 nm multimode link. One port is used for receive and one for transmit.

Computer Bus Structures

Bus	Description	Standard
ISA	Personal Computer Industry Standard Architecture	IEEE P996
PC Card	PCMCIA PC Card Standard	PCMCIA PC Card Standard Feb. 1995
PCI 5.0V	PCI Local Bus	PCI R2.1
PCI 3.3V	PCI Local Bus	PCI R2.2
CompactPCI	Compact PCI Local Bus	PCI R2.2 and PICMG 2.1 R2.0
PC/104	Embedded Personal Computer Module	PC/104 V2.4
USB 1.1	Universal Serial Bus 1.1	USB R1.1 Sept. 23, 1998
USB 2.0	Universal Serial Bus 2.0	USB R2.0 April 27, 2000

Two connector styles are supported—the ST and the SMA. Cabling supported includes the conventional 62.5/125 μm as well as the 50/125 μm and 100/140 μm versions. Maximum distances vary with core size. Return-to-zero (RZ) encoding is used with fiber optics. Fiber optics provide long distances and immunity from harsh electrical environments.

-FG3 Fiber Optic Glass (Single-mode ST Connectors)

For long-haul, fiber optic applications, single-mode cable (9 μm) and compatible transceivers will yield distances up to 46,000 feet. A duplex single-mode cable is required with the transceiver operating at 1300 nm. Encoding is the same as the -FOG, but interoperability is not possible due to different operating wavelengths. Connectors are ST. Multimode cabling is a possibility but with reduced distance.

-TPS Twisted-pair Star (RJ-11 Connector)

The popularity of using twisted-pair cabling created the need for this type of transceiver. The -TPS utilizes a -CXS transceiver with a BALUN (balanced-unbalanced) circuit in order to convert the single-ended output of the -CXS to a balanced output suitable for driving twisted-pair cable. The connector is an RJ-11. Since this is a star transceiver, it is to be used for point-to-point connections in a star or distributed star topology. The transceiver can also be used as the end-of-line connection in a twisted-pair bus topology (-TPB or -TB5) as long as proper wiring connections are maintained. Since the built-in BALUN creates a phase reversal, field connections must be flipped when mating a -TPS transceiver with either a -TPB or -TB5.

-TPB Twisted-pair Bus (RJ-11 or Screw Connectors)

The -TPB is the twisted-pair version of the -CXB and, in fact, utilizes the same -CXB circuitry. However, additional components are used to convert the single-ended -CXB to a balanced output suitable for twisted-pair wiring. Two RJ-11 connectors are used at the interface which are bussed together allowing for daisy-chaining wiring. This also provides a location for end-of-line termination if RJ-11 style terminators are used. On some models either a 3- 4- or 5-position screw connector is used.

-TB5 Twisted-pair Bus (RJ-45 or Screw Connectors)

The -TB5 is identical to the -TPB except for the modular connector. Instead of two RJ-11 connectors, two RJ-45 connectors are used instead. As with the -TB5, daisy-chained bus connections are allowed with provision for end-of-line terminators. In this case, RJ-45 style terminators must be used.

-485 Backplane DC-coupled EIA-485 (RJ-11, RJ-45 or Screw Connectors)

With the introduction of the COM20020 family of ARCNET controllers came support for the popular EIA-485 physical layer. The COM20020 family will operate in either backplane or non-backplane mode. With backplane mode, a simple interface to EIA-485 transceivers is possible. Dipulse signaling is not used in backplane mode. Instead, Return-to-Zero (RZ) is used. The -485 transceiver provides a bus connection over a limited distance. Connectors include the RJ-11 or 3- and 5-position screw style.

-485D Non-backplane DC-coupled EIA-485 (RJ-11, RJ-45 or Screw Connectors)

To invoke backplane mode requires a change in the software driver. If this is not desirable, a non-backplane implementation of EIA-485 is possible by using the -485D. The capabilities of the -485D and -485 are the same, and they produce the same RZ signaling on the cable.

-4000 Backplane AC-coupled EIA-485 (RJ-11, RJ-45 or Screw Connectors)

By AC-coupled EIA-485, we mean transformer-coupled, providing a much higher level of isolation from DC-coupled designs. AC-coupled transceivers require different encoding to eliminate any DC component in the signaling. The encoding is Alternate Mark Inverted (AMI). The -4000 is a backplane mode transceiver that utilizes either RJ-11 or 3- and 5-position screw connectors.

-485X Non-backplane AC-coupled EIA-485 (RJ-11, RJ-45 or Screw Connectors)

The non-backplane version of the AC-coupled EIA-485 transceiver is the -485X. As with the -4000, AMI encoding is used. Connectors are either RJ-11 or RJ-45 or 3- and 5-position screw connectors.

For a detailed explanation of how backplane and non-backplane are implemented, see tutorial pages 69-70.

Connectors

Depending upon the transceiver selected, connector options vary even within a transceiver type. A selection guide has been provided to assist in determining what connector is available. Connector details are included in the technical portion of the catalog. What follows are descriptions of the various connectors found in ARC Control Equipment.

C—BNC Coaxial Connector—"Baby" NC connectors are used on coaxial cable transceivers such as the -CXS and -CXB. RG-62/u cable is generally used with this connector.

ST—ST Fiber Optic Connector—"Straight Tip" fiber optic connector commonly used in the industry. This quarter-turn connector prevents the possibility of over tightening.

SMA—SMA Fiber Optic Connector—An older-type fiber optic connector that is still found in the industry. The continuous thread creates the possibility of over tightening.

R1—Single Shielded RJ-11 Modular Jack—This 6-position, 4-contact modular jack is intended for shielded or unshielded twisted-pair cabling.

R1D—Dual Shielded RJ-11 Modular Jack—Dual connector version of the R1 connector. Connections are bussed between the dual connectors.

R2D—Dual Unshielded RJ-11/45 Modular Jack—Dual modular jack of the 8-position, 4-contact variety that will accommodate either RJ-11 or RJ-45 plugs. Intended for unshielded twisted-pair cabling, the connections are bussed between the dual connectors.

R5D—Dual Shielded RJ-45 Modular Jack—Dual modular jack of the 8-position, 8-contact variety that will accommodate RJ-45 plugs. It is intended for either shielded or unshielded twisted-pair cabling.

S3, S4, S5—Multi-position removable screw connector used with twisted-pair cabling. Connections can have either 3, 4 or 5 positions.

Notes

ARCNET
Product Guide

Transceiver and Connector Selection Guides

Network Interface Modules

Bus	Controller	Data Rate Mbps	Model	Transceivers (see page 17 for Connector Legend) -4000	-485	-485D	-485X	-CXB	-CXS	-FOG -SMA	-FOG -ST	-TB5	-TPB	-TPS
CompactPCI	20022	1.25-10	CPCI22-4000	S3 R5D										
CompactPCI	20022	.156-10	CPCI22-485		S3									
CompactPCI	20022	2.5	CPCI22-CXB					C						
CompactPCI	20022	2.5	CPCI22-CXS						C					
CompactPCI	20022	.156-10	CPCI22-FOG-ST								ST			
CompactPCI	20022	2.5	CPCI22-TB5									R5D		
PCI 3.3V	20022	1.25-10	PCI20U-4000	R5D										
PCI 3.3V	20022	.156-10	PCI20U-485		S3									
PCI 3.3V	20022	.156-10	PCI20U-485D			S3								
PCI 3.3V	20022	1.25-10	PCI20U-485X				S3							
PCI 3.3V	20022	2.5	PCI20U-CXB					C						
PCI 3.3V	20022	2.5	PCI20U-CXS						C					
PCI 3.3V	20022	2.5	PCI20U-TB5									R5D		
PCI 5.0V	20020	.156-5	PCI20-485		S3 R5D									
PCI 5.0V	20020	.156-5	PCI20-485D			S3 R5D								
PCI 5.0V	20020	1.25-5	PCI20-485X				S3 R5D							
PCI 5.0V	20020	2.5	PCI20-CXB					C						
PCI 5.0V	20020	2.5	PCI20-CXS						C					
PCI 5.0V	20020	.156-5	PCI20-FOG-SMA							SMA				
PCI 5.0V	20020	.156-5	PCI20-FOG-ST								ST			
PCI 5.0V	20020	2.5	PCI20-TB5									S3 R5D		
PC Card	20022	.156-10	PCM20H-485		S3									
PC Card	20022	.156-10	PCM20H-485D			S3								
PC Card	20022	1.25-10	PCM20H-485X				S3							
PC Card	20022	2.5	PCM20H-CXB					C						
PC Card	20022	2.5	PCM20H-TB5									R5D		
PC Card	20022	2.5	PCM20H-TPB										R1D	
PC/104	20020	.156-5	PC10420-485		S3 R2D									
PC/104	20020	.156-5	PC10420-485D			S3 R2D								
PC/104	20020	1.25-5	PC10420-485X				S3 R2D							
PC/104	20020	2.5	PC10420-CXB					C						
PC/104	20020	2.5	PC10420-CXS						C					
PC/104	20020	.156-5	PC10420-FOG-SMA							SMA				
PC/104	20020	.156-5	PC10420-FOG-ST								ST			
PC/104	20020	2.5	PC10420-TPB										S3 R2D	

Network Interface Modules

Bus	Controller	Data Rate	Model	Transceivers (see page 17 for Connector Legend)										
		Mbps		-4000	-485	-485D	-485X	-CXB	-CXS	-FOG -SMA	-FOG -ST	-TB5	-TPB	-TPS
PC104	20022	1.25-10	PC10422-4000	S3 R2D										
PC/104	20022	.156-10	PC10422-485		S3 R2D									
PC/104	20022	.156-10	PC10422-485D			S3 R2D								
PC/104	20022	.125-10	PC10422-485X				S3 R2D							
PC/104	20022	2.5	PC10422-CXB					C						
PC/104	20022	2.5	PC10422-CXS						C					
PC/104	20022	2.5	PC10422-TPB										S3 R2D	
PC/104	90C66	2.5	PC10466-CXB					C						
PC/104	90C66	2.5	PC10466-CXS						C					
PC/104	90C66	2.5	PC10466-FOG-SMA							SMA				
PC/104	90C66	2.5	PC10466-FOG-ST								ST			
PC/104	90C66	2.5	PC10466-TPB										R2D	
ISA(XT)	90C65	2.5	PCX-CXB					C						
ISA(XT)	90C65	2.5	PCX-CXS						C					
ISA(XT)	90C65	2.5	PCX-FOG-SMA							SMA				
ISA(XT)	90C65	2.5	PCX-FOG-ST								ST			
ISA(XT)	90C65	2.5	PCX-TPB										R1D	
ISA(XT)	90C65	2.5	PCX-TPS						C					R1
ISA(AT)	90C66	2.5	PCA66-CXB					C						
ISA(AT)	90C66	2.5	PCA66-CXS						C					
ISA(AT)	90C66	2.5	PCA66-FOG-SMA							SMA				
ISA(AT)	90C66	2.5	PCA66-FOG-ST								ST			
ISA(AT)	90C66	2.5	PCA66-TPB										S4 R1D	
ISA(XT)	20020	.156-5	PCX20-485		S3 R1D									
ISA(XT)	20020	.156-5	PCX20-485D			S3 R1D								
ISA(XT)	20020	1.25-5	PCX20-485X				S3 R1D							
ISA(XT)	20020	2.5	PCX20-CXB					C						
ISA(XT)	20020	2.5	PCX20-CXS						C					
ISA(XT)	20020	.156-5	PCX20-FOG-SMA							SMA				
ISA(XT)	20020	.156-5	PCX20-FOG-ST								ST			
ISA(XT)	20020	2.5	PCX20-TPB										S3 R1D	
USB 2.0	20022	1.25-10	USB22-4000	R5D										
USB 2.0	20022	1.56-10	USB22-485		R5D									
USB 2.0	20022	2.5	USB22-CXB					C						
USB 2.0	20022	2.5	USB22-TB5									R5D		

Repeaters, Links and Hubs

Fixed-Port Hubs

AI-FR Redundant Fiber Ring Hubs

QuickLink Fixed-Port Hubs

EXP Expansion Modules for MOD HUB Series of Modular Active Hubs

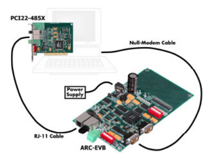
Data Rate Mbps	Model	Transceivers (see page 17 for Connector Legend) -CXS	-CXB	-TPS	-TPB	-TB5	-FOG -SMA	-FOG -ST	-FG3 -ST	-485 -485D	-485X -4000
.078-10	AI2-485									2S5	
.078-10	AI2-485/FOG-ST							ST		S5	
1.25-10	AI2-485X										2S5
1.25-10	AI2-485X/FOG-ST							ST			S5
2.5	AI2-CXB		2C								
2.5	AI2-CXB/FOG-ST		C					ST			
2.5	AI2-TPB				2S5						
2.5	AI2-TPB/FOG-ST				S5			ST			
.078-10	AI3-485									3S5	
.078-10	AI3-485/FOG-ST							ST		2S5	
1.25-10	AI3-485X										3S5
1.25-10	AI3-485X/FOG-ST							ST			2S5
2.5	AI3-CXS	3C									
.078-10	AI3-FOG-ST/485							2ST		S5	
1.25-10	AI3-FOG-ST/485X							2ST			S5
2.5	AI3-FOG-ST/CXB		C					2ST			
2.5	AI3-FOG-ST/TB5					R5D		2ST			
2.5	AI3-TB5					3R5D					
2.5	AI-FR/CXB		C					2ST			
2.5	AI-FR/TB5					R5D		2ST			
.078-10	AI-USB/485									2S5	
1.25-10	AI-USB/485X										2S5
2.5	AI-USB/CXS	2C									
2.5	Ai-USB/TB5					2R5D					
2.5	QL-CXS	8C									
2.5	QL-CXS-E	8C									
2.5	QL-TPS			8R1							
2.5	QL-TPS-E			8R1							
2.5	EXP-485									4R1	
2.5	EXP-485/FG3-ST								ST	R1	
2.5	EXP-485/FOG-SMA						2SMA			2R1	
2.5	EXP-485/FOG-ST							2ST		2R1	
2.5	EXP-485X										4R1
2.5	EXP-485X/2FG3								2ST		R1

Repeaters, Links and Hubs

Routers and Gateways

AI-SRVR

Analyzer & Evaluation Systems



ARCNET Evaluation System

ANA Network Analyzer

Data Rate Mbps	Model	Transceivers -CXS	-CXB	-TPS	-TPB	-TB5	-FOG -SMA	-FOG -ST	-FG3 -ST	-485 / -485D	-485X / -4000
2.5	EXP-485X/FG3-ST								ST		R1
2.5	EXP-485X/FOG-SMA						2SMA				2R1
2.5	EXP-485X/FOG-ST							2ST			2R1
2.5	EXP-CXS	4C									
2.5	EXP-CXS/2FG3	C							2ST		
2.5	EXP-CXS/485	2C								2R1	
2.5	EXP-CXS/485X	2C									2R1
2.5	EXP-CXS/FG3-ST	C							ST		
2.5	EXP-CXS/FOG/SMA	2C					2SMA				
2.5	EXP-CXS/FOG-ST	2C						2ST			
2.5	EXP-FOG-SMA						4SMA				
2.5	EXP-FOG-ST							4ST			
2.5	EXP-TPS			4R1							
2.5	EXP-TPS/CXS	2C		2R1							
2.5	EXP-TPS/FG3-ST			R1					ST		
2.5	EXP-TPS/FOG-SMA			2R1			2SMA				
2.5	EXP-TPS/FOG-ST			2R1				2ST			
.078-10	AI-SRVR/485									S3	
1.25-10	AI-SRVR/485X										S3
2.5	AI-SRVR/CXB		C								
2.5	AI-SRVR/TB5										R5D
1.25-10	ARC-EVS										S3 R1D
.078-10	ANA		C		S3 R1D					S3 R1D	S3 R1D

Connector Legend

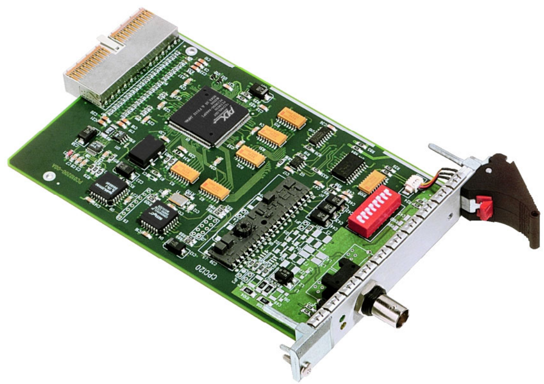
Code	**Connector Type**
C	BNC coaxial
R1	RJ-11
R1D	RJ-11, dual jacks
R2D	Hybrid dual jacks accept RJ-11 or RJ-45
R5D	RJ-45, dual jacks
S3	3-position screw terminal
S4	4-position screw terminal
S5	5-position screw terminal
SMA	SMA fiber
ST	ST fiber

EXAMPLE:
S3, R1D means a 3-position screw terminal and one RJ-11 connector

Network Interface Modules

CPCI22 Series

Network Interface Modules for CompactPCI Bus Computers



Features

- Utilizes COM20022 ARCNET controller
- Interfaces ARCNET with CompactPCI bus computers
- Low-profile 3U form factor
- Hot-swapping
- Supports coaxial, fiber optic, and twisted-pair cabling including EIA-485
- Automatic configuration of I/O and interrupt
- High-speed I/O access to the COM20022
- NDIS or null stack driver for Windows
- Suitable with all the Contemporary Controls' MOD HUB and AI Series active hubs
- CMOS design for low-power consumption

The CPCI22 Series links CompactPCI bus compatible computers with the ARCNET Local Area Network. The combination of a low-profile, 3U form factor, hot-swap capability, and solid performance can be found in this product. These features make it well-suited for use in industrial and telecommunications applications.

The CPCI22 bus allows for jumperless configuration and Plug and Play (PnP) operation. Hot-swapping is an essential benefit for operators of high-availability systems. The module functions with either an NDIS driver or with a null stack driver in a Windows environment.

This network interface module incorporates the COM20022 ARCNET controller chip. New features include command chaining, sequential access to internal RAM, duplicate node ID detection, and variable data rates up to 10 Mbps. Bus contention problems are reduced since the module's interrupt level and I/O base address are assigned through PnP. There is no requirement for wait-state arbitration.

Each CPCI22 module has two LEDs for monitoring network operation and bus access to the module.

Several versions of the CPCI22 are available. The CPCI22-4000 provides transformer-coupled AC EIA-485 operation. The CPCI22-485 supports DC-coupled EIA-485 backplane mode. The CPCI22-CXB supports a coaxial bus configuration usually requiring no hubs. CPCI22-CXS supports coaxial star configurations requiring external active or passive hubs. Other versions include the CPCI22-FOG-ST which supports fiber optic cable with ST connectors. The CPCI22-TB5 supports twisted-bus cabling using RJ-45 connectors.

Ordering Information

Model	Description
CPCI22-4000	COM20022 AC-coupled EIA-485 (backplane) NIM
CPCI22-485	COM20022 DC-coupled EIA-485 (backplane) NIM
CPCI22-CXB	COM20022 coaxial bus NIM
CPCI22-CXS	COM20022 coaxial star NIM
CPCI22-FOG-ST	COM20022 ST fiber optic NIM
CPCI22-TB5	COM20022 twisted-pair bus NIM

PCI20U Series

Network Interface Modules for Universal PCI Bus Computers

Features

- Utilizes COM20022 ARCNET controller
- Interfaces ARCNET with PCI and PCI-X bus computers
- Enhanced software capabilities over earlier generation ARCNET controllers
- Node address switch selects one of 255 possible station addresses
- Automatic configuration of I/O and interrupt
- High-speed I/O access to the COM20022
- Supports coaxial and twisted-pair cabling including EIA-485
- Variable data rates up to 10 Mbps utilizing the various EIA-485 transceiver options
- Suitable with all Contemporary Controls' MOD HUB and AI Series active hubs
- CE Mark

Since most PC motherboards have migrated from the +5 PCI Bus to the +3.3 V PCI bus, universal voltage PCI ARCNET Network Interface Modules (NIMs) such as the PCI20U Series are required. The PCI20U Series links PCI and PCI-X bus compatible computers with the ARCNET Local Area Network (LAN). In addition, the PCI20U Series supports the PCI Add-in Card specification. Both standard-height and half-height brackets are provided.

The PCI bus allows for jumperless configuration and Plug and Play operation (PnP). The module operates with either an NDIS driver or with a null stack driver in a Windows environment. DOS drivers will operate in real-time systems when used with our enabler software.

Since the PCI20U is a universal voltage PCI card it can be used in either a PCI-X slot or a conventional PCI slot. PCI-X is an enhancement to the original PCI Local Bus Specification enabling devices to operate at speeds up to 133 MHz. If a PCI20U is installed into a bus capable of PCI-X operation, the clock remains at the 33 MHz frequency causing all other devices on that bus to use the conventional PCI protocol.

The PCI20U incorporates the COM20022 ARCNET controller chip with enhanced features over the earlier generation ARCNET chips. New features include command chaining, sequential access to internal RAM, duplicate node ID detection, and variable data rates up to 10 Mbps. Bus contention problems are minimized since the module's interrupt level and I/O base address are assigned through PnP. There is no requirement for wait-state arbitration.

This device exploits the new features of the COM20022 such as 10 Mbps communications utilizing the various EIA-485 transceiver options. This includes DC-coupled and AC-coupled (transformer) EIA-485 variants. Conventional 2.5 Mbps dipulse signaling is also supported.

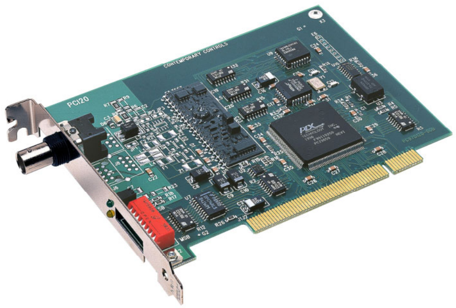
Each PCI20U module has two LEDs for monitoring network operation and bus access to the module. It is equipped with an 8-position, general purpose DIP switch which could be used to reassign the ARCNET node address without removing the module. Ultimately, the node address is configured via software so the DIP switch can be used for user-defined functions.

Ordering Information

Model	Description
PCI20U-4000	20022 PCI AC-coupled EIA-485 (backplane) NIM
PCI20U-485	20022 PCI DC-coupled EIA-485 (backplane) NIM
PCI20U-485D	20022 PCI DC-coupled EIA-485 (non-backplane) NIM
PCI20U-485X	20022 PCI AC-coupled EIA-485 (non-backplane) NIM
PCI20U-CXB	20022 PCI coaxial bus NIM
PCI20U-CXS	20022 PCI coaxial star NIM
PCI20U-TB5	20022 PCI twisted-pair bus NIM

PCI20 Series

Network Interface Modules for PCI Bus Computers



Features

- Utilizes COM20020 ARCNET controller
- Interfaces ARCNET with PCI bus computers
- Software compatible with CC's COM20020-based series of network adapters for the ISA, PC/104 and PC Card bus systems
- Command chaining for enhanced performance
- Supports coaxial, fiber optic, and twisted-pair cabling including EIA-485
- Variable data rates up to 5 Mbps
- Node address switch selects one of 255 possible station addresses
- Automatic configuration of I/O and interrupt
- Plug and Play (PnP) operation
- Jumperless configuration
- NDIS or null stack driver for Windows
- Suitable with all the Contemporary Controls' MOD HUB and AI Series active hubs
- CE Mark

The PCI20 Series of network interface modules (NIMs) interfaces ARCNET with PCI bus computers. The high performance PCI bus allows for jumperless configuration or Plug and Play (PnP) operation.

The PCI20 incorporates the newer COM20020 ARCNET controller chip with enhanced features over the earlier generation ARCNET chips. New performance and integration enhancements include command chaining operation and an internal 2K x 8 RAM buffer. There is no requirement for wait-state arbitration.

Each PCI20 module has two LEDs. The green LED indicates that the module is transmitting data on the network, and the yellow LED indicates bus access to the module. The PCI20 also has an external DIP switch so that node addresses can be easily reassigned without removing the module.

Several versions of the PCI20 ARCNET NIM exist. The PCI20-CXS supports coaxial star configurations requiring external active or passive hubs. The PCI20-CXB supports coaxial bus configuration in which no hubs are required. Other models include the PCI20-FOG which supports fiber optic cable with either ST or SMA connectors. The PCI20-TB5 supports twisted-pair bus cabling using RJ-45 connectors. There are some models that support EIA-485 communication with each model using RJ-45 and screw terminal connectors.

Ordering Information

Model	Description
PCI20-485	20020 PCI DC-coupled EIA-485 (backplane) NIM
PCI20-485D	20020 PCI DC-coupled EIA-485 (non-backplane) NIM
PCi20-485X	20020 PCI AC-coupled EIA-485 (non-backplane) NIM
PCI20-CXB	20020 PCI coaxial bus NIM
PCI20-CXS	20020 PCI coaxial star NIM
PCI20-FOG-SMA	20020 PCI SMA fiber optic NIM
PCI20-FOG-ST	20020 PCI ST fiber optic NIM
PCI20-TB5	20020 PCI twisted-pair bus NIM

PCM20H Series

Network Interface Modules for PC Card Computers

Features

- Utilizes COM20022 ARCNET controller
- Interfaces ARCNET with PC Card bus computers
- Thin 5.0 mm Type II form factor
- Deterministic, high-speed ARCNET token-passing Local Area Network (LAN)
- Supports coaxial and twisted-pair cabling including EIA-485
- Backplane or non-backplane mode operation
- Transparent operation after loading enabler software in DOS or Windows environments
- Variable data rates up to 10 Mbps
- Suitable with all Contemporary Controls' MOD HUB and AI Series active hubs
- CMOS design for low-power consumption

The PCM20H Series of ARCNET Network Interface Modules (NIMs) links PC Card compatible computers with the ARCNET Local Area Network, providing easy connection to laptop and notebook-style computers.

The Series follows release 2.1 of the PC Card standard Type II (5.0 mm thick) cards. The ARCNET transceiver circuitry is located in a detachable MAU (Medium Access Unit) which plugs into the PCM20H adapter. MAUs exist for various cabling media including coaxial and twisted-pair cable, and are all interchangeable with one another. A 15-pin connector with a short cable attaches the MAU to the adapter.

The PCM20H is designed with the COM20022 ARCNET controller chip, offering data rates up to 10 Mbps. New features include command chaining, sequential access to internal RAM, duplicate node ID detection plus an improved adapter case, and MAU cable combination with a locking mechanism.

There are six models of the PCM20H. Each one designated by a specific transceiver. The PCM20H-CXB supports either coaxial star or bus networks. Two models accommodate traditional ARCNET over twisted-pair cabling, but with different connectors—the PCM20H-TB5 uses the RJ-45 connector and the PCM20H-TPB uses the RJ-11 connector. Four models support the EIA-485 protocol. The PCM20H-485D and the PCM20H-485X implement backplane mode automatically via built-in hardware DC and AC respectively. With the PCM20H-485, the backplane mode is set via software for DC-coupling.

The product is shipped with a 3.5" (9 cm) disk containing our DOS, Windows 3.x and Windows 95, and 98 enabler software. Once loaded, programs written for the PCX20 ISA bus adapter will operate transparently with the PCM20H.

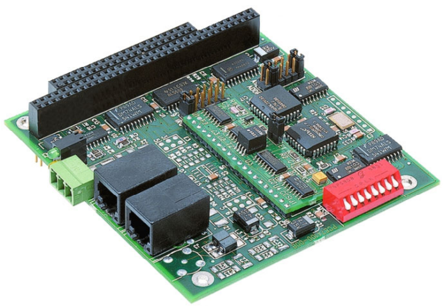
Ordering Information

Coaxial cable units are shipped with a tee connector and terminator for use with coaxial star networks. Twisted-pair units are shipped with RJ-11 or RJ-45 terminators. All units contain a disk with the enabler software for use with certain operating systems.

Model	Description
PCM20H-485	20022 PC Card DC-coupled EIA-485 (backplane) NIM
PCM20H-485D	20022 PC Card DC-coupled EIA-485 (non-backplane) NIM
PCM20H-485X	20022 PC Card AC-coupled EIA-485 (non-backplane) NIM
PCM20H-CXB	20022 PC Card coaxial bus NIM
PCM20H-TB5	20022 PC Card twisted-pair bus NIM (RJ-45 connector)
PCM20H-TPB	20022 PC Card twisted-pair bus NIM (RJ-11 connector)

PC10420 Series

Network Interface Modules PC/104 Bus Computers



Designed to operate with PC/104™ compatible computers, the PC10420 Series of ARCNET Network Interface Modules (NIMs) uses the COM20020 ARCNET controller chip with enhanced features. New features include command chaining, sequential access to internal RAM, duplicate node ID detection, and variable data rates up to 5 Mbps. Bus contention problems are reduced since the module only needs an I/O address. There is no requirement for wait-state arbitration.

Each PC10420 has two LEDs on the board for monitoring network operation and providing bus access. The green LED indicates that the module is receiving data on the network, and the yellow LED indicates bus access to the module. The PC10420 also has an external 8-bit DIP switch so that node addresses can be easily reassigned without removing the module.

The PC10420 is available in several transceiver options. Each transceiver, which is matched to a particular cable type, is identified by a three-character suffix appended to the model numbers. The capabilities of each transceiver differs. The PC10420-CXS accommodates coaxial star configurations requiring external active or passive hubs. The PC10420-CXB supports a coaxial bus configuration usually without hubs. Other models are the PC10420-FOG which supports fiber optic cable with either ST or SMA connectors. The PC10420-TPB supports two-pair bus cabling using RJ-11 connectors. The PC10420-485D supports the EIA-485 DC-coupled cabling standard while the PC10420-485X provides transformer-coupled EIA-485 operation.

If the software driver you intend to use sets the COM20020 into backplane mode, you will need to use the PC10420-485 version. The AC-coupled EIA-485 transceiver offers certain advantages. No bias adjustments are necessary since each transceiver has its own fixed bias network isolated by a pulse transformer. DC-coupled technology, however, offers longer distances and will operate over all six data rates.

Features

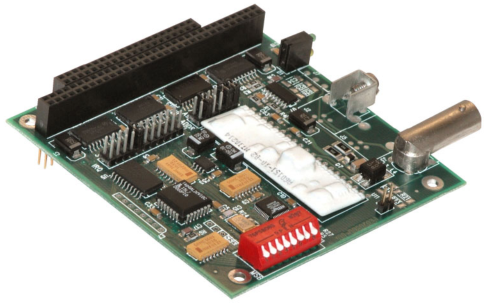
- Utilizes COM20020 ARCNET controller
- Interfaces ARCNET with PC/104 bus computers
- I/O-only mapping reduces bus contention problems
- No requirement for wait-state arbitration
- Deterministic, high-speed ARCNET token-passing Local Area Network (LAN)
- Enhanced software capabilities over earlier generation ARCNET controllers
- Node address switch selects one of 255 possible station addresses
- Variable data rates up to 5 Mbps
- Supports coaxial, fiber optic, and twisted-pair cabling including EIA-485
- Interacts with all Contemporary Controls' MOD HUB and AI Series active hubs
- CMOS design for low-power consumption

Ordering Information

Model	Description
PC10420-485	20020 PC/104 DC-coupled EIA-485 (backplane) NIM
PC10420-485D	20020 PC/104 DC-coupled EIA-485 (non-backplane) NIM
PC10420-485X	20020 PC/104 AC-coupled EIA-485 (non-backplane) NIM
PC10420-CXB	20020 PC/104 coaxial bus NIM
PC10420-CXS	20020 PC/104 coaxial star NIM
PC10420-FOG-SMA	20020 PC/104 SMA fiber optic NIM
PC10420-FOG-ST	20020 PC/104 ST fiber optic NIM
PC10420-TPB	20020 PC/104 twisted-pair bus NIM

PC10422 Series

Network Interface Modules for PC/104 Computers



The PC10422 Series of ARCNET Network Interface Modules (NIMs) enables ARCNET connectivity for PC/104™ compatible computers. It is designed with the COM20022 controller chip.

The COM20022 controller chip incorporates improved features over earlier generation ARCNET chips such as command chaining, sequential access to internal RAM, and duplicate node ID detection. Bus contention problems are reduced since the module only requires an I/O address. There is no requirement for wait-state arbitration. The +5V only operation decreases system cost by eliminating multiple voltage power sources.

Two LEDs on the module's board monitor network operation and bus access to the module. The PC10422 is equipped with an eight–position, general-purpose DIP switch used to assign the ARCNET node address without removing the module. The node address is configured via software so the DIP switch can also register user-defined functions such as data rate, cable interface, or master/slave status of the PC/104 system.

The PC10422 is designed with several flexible cabling options. The PC10422-CXS supports coaxial star configurations requiring external active or passive hubs. The PC10422-CXB accommodates a coaxial bus configuration requiring no hubs, allowing multiple modules to communicate over a single coaxial cable. Similarly, the PC10422-TPB supports twisted-pair bus cabling using either RJ-11 or screw terminal connectors.

The Series also accommodates three separate EIA-485 physical-layer implementations. The PC10422-485D supports the EIA-485 DC-coupled cabling standard while the PC10422-485X provides transformer-coupled EIA-485 operation. Certain applications require that the COM20022 be operated in backplane mode. The PC10422-4000 is intended for these applications and supports the transformer-coupled EIA-485 physical-layer interface. All EIA-485 models are fitted with dual RJ-11s and a three-position screw terminal connector to ease field wiring.

Features

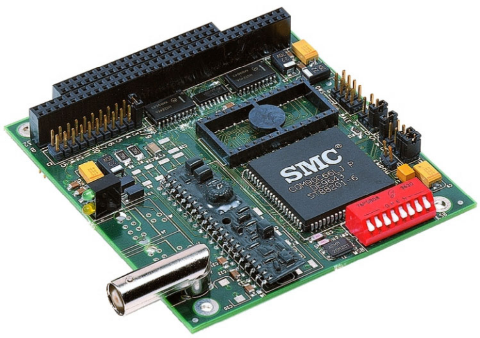
- Utilizes COM20022 ARCNET controller
- Interfaces ARCNET with PC/104 bus computers
- Zero wait-state arbitration typical
- Deterministic, high-speed 2.5 Mbps ARCNET token-passing Local Area Network (LAN)
- Enhanced software capabilities over earlier generation ARCNET controllers
- Supports coaxial and twisted-pair cabling including EIA-485
- Command chaining for enhanced performance
- Node address switch selects one of 255 possible station addresses
- Variable data rates up to 10 Mbps
- Interacts with all Contemporary Controls' MOD HUB and AI Series active hubs
- CMOS design for low-power consumption

Ordering Information

Model	Description
PC10422-4000	20022 PC/104 AC-coupled EIA-485 (backplane) NIM
PC10422-485D	20022 PC/104 DC-coupled EIA-485 (non-backplane) NIM
PC10422-485X	20022 PC/104 AC-coupled EIA-485 (non-backplane) NIM
PC10422-CXB	20022 PC/104 coaxial bus NIM
PC10422-CXS	20022 PC/104 coaxial star NIM
PC10422-TPB	20022 PC/104 twisted-pair bus NIM

PC10466 Series

Network Interface Modules for PC/104 Computers



The PC10466 Series of ARCNET Network Interface Modules (NIMs) enables ARCNET connectivity for PC/104™ compatible computers.

At the core of the PC10466's design is the 16-bit COM90C66 ARCNET controller chip. New features include command chaining and sequential I/O mapping of the internal RAM buffer. There is usually no requirement for wait-state arbitration. This product is backward compatible with earlier generation 90C26 and 90C65 8-bit ARCNET controllers and will operate as a replacement. However, to use the expanded features of the COM90C66, an improved software driver is required.

Each PC10466 module has two LEDs on the board. The green LED indicates that the module is transmitting data on the network, and the yellow indicates bus access to the module. The PC10466 has an external DIP switch so that node address can be easily reassigned without removing the module.

An 8-bit DIP switch is used to set the ARCNET address. Any value except zero is a valid ARCNET node address. If zero is set in the switches, the ARCNET LAN adapter will disable its transmitter and not join the network until a non-zero node ID is set via software. The RAM buffer cannot be accessed when the node ID is zero.

Five versions of the PC10466 exist. The PC10466-CXS supports coaxial star configurations requiring external active or passive hubs. The PC10466-CXB accommodates coaxial bus configuration usually requiring no hubs. The maximum segment length is1000 feet and the maximum number of Network Interface Modules that can be connected to a segment is eight. Other models are the PC10466-FOG that supports fiber optic cable with either ST or SMA connectors. With fiber optic connections only star and distributed star topologies are supported. The PC10466-TPB supports twisted-pair bus cabling using RJ-11 or screw terminal connectors.

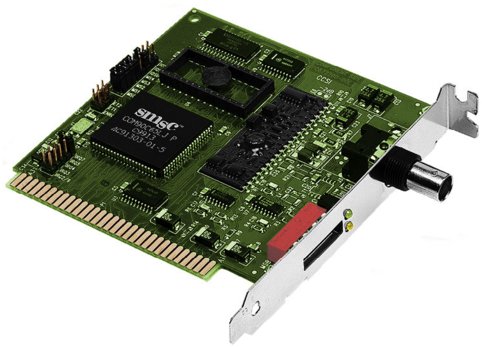
Features

- Utilizes COM90C66 16-bit ARCNET controller
- Interfaces ARCNET with PC/104 bus computers
- Zero wait-state arbitration typical
- Deterministic, high-speed 2.5 Mbps ARCNET token-passing Local Area Network (LAN)
- COM90C26/90C65 software compliant
- Command chaining for enhanced performance
- Supports coaxial, fiber optic, and twisted-pair cabling
- Supports either memory mapped or I/O mapped RAM buffer
- Node address switch selects one of 255 possible station addresses
- Boot ROM socket for diskless workstations
- Interacts with all Contemporary Controls' MOD HUB and AI Series active hubs
- CMOS design for low-power consumption

Ordering Information

Model	Description
PC10466-CXB	90C66 PC/104 coaxial bus NIM
PC10466-CXS	90C66 PC/104 coaxial star NIM
PC10466-FOG-SMA	90C66 PC/104 SMA fiber optic NIM
PC10466-FOG-ST	90C66 PC/104 ST fiber optic NIM
PC10466-TPB	90C66 PC/104 twisted-pair bus NIM

Network Interface Modules for ISA (XT) Bus Computers



The PCX Series of ARCNET Network Interface Modules (NIMs) links XT/AT (ISA) compatible computers with the ARCNET Local Area Network. The Series is the ideal match for XT bus ISA compatibility.

The PCX incorporates the COM90C65 ARCNET controller chip, and the module works with either XT or AT (ISA) backplanes. Jumpers are used to set the interrupt, the memory, and I/O base addresses.

Each PCX module has two LEDs on the board for monitoring network operation and bus access to the module. It also has an external DIP switch so that node addresses can be easily reassigned without removing the module. Interrupt lines are jumper selectable.

The PCX Series is available in five cabling options. The PCX-CXS supports coaxial cable in a star configuration. The PCX-CXB accommodates coaxial cable in a bus configuration. Both the PCX-TPS and PCX-TPB support twisted-pair, respectively in a star and bus configuration. The PCX-FOG accommodates duplex glass fiber optic cable with either ST or SMA connectors.

Features

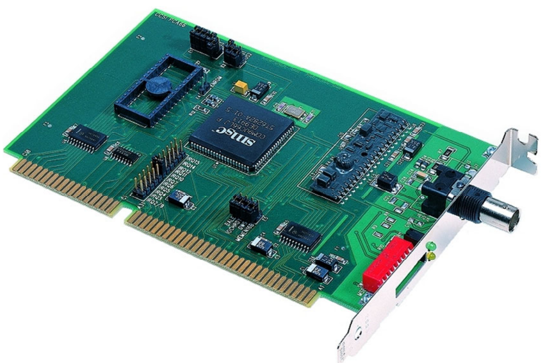
- Utilizes COM90C65 ARCNET controller
- Interfaces ARCNET with XT/AT (ISA) bus computers
- One-third height PC board
- Supports coaxial, twisted-pair, or glass fiber optic cabling
- Supports 16 kB memory mapping, minimizing memory addressing conflicts
- Provides socket for 8 kB auto-boot ROM
- Node address switch accessible without removing the PCX from computer
- CMOS design for low-power consumption

Ordering Information

Model	Description
PCX-CXB	9065 PC coaxial bus NIM
PCX-CXS	9065 PC coaxial star NIM
PCX-FOG-SMA	9065 PC SMA fiber optic NIM
PCX-FOG-ST	9065 PC ST fiber optic NIM
PCX-TPB	9065 PC twisted-pair bus NIM
PCX-TPS	9065 PC twisted-pair star NIM

PCA66 Series

Network Interface Modules for ISA Bus Computers



The PCA66 Series of network interface modules (NIMs) connects ISA compatible computers with the ARCNET Local Area Network (LAN).

It is manufactured with the 16-bit COM90C66 ARCNET controller chip with improved attributes over earlier ARCNET chips. New features are command chaining and sequential I/O mapping of the internal RAM buffer. There is typically no requirement for wait-state arbitration. The PCA66 is backward compatible with earlier 90C26 and 90C65 8-bit ARCNET controllers and will operate as a replacement. In order to use the expanded features of the COM90C66, an enhanced software driver is necessary.

Each PCA66 module has two LEDs on the board. The green LED indicates that the module is transmitting data on the network, and the yellow LED indicates bus access to the module. The PCA66 also has an external DIP switch so that node addresses can be easily reassigned without removing the module.

An 8-bit DIP switch is used to set the ARCNET node address. Any value except zero is a valid ARCNET node address. If zero is set in the switches, the ARCNET LAN adapter will disable its transmitter and not join the network until a non-zero node ID is set via software. The RAM buffer cannot be accessed when the node ID is zero.

Five versions of the PCA66 exist. The PCA66-CXS supports coaxial star configurations requiring external active or passive hubs. The PCA66-CXB accommodates coaxial bus configuration usually requiring no hubs. The maximum segment length is 1000 feet, and the maximum number of Network Interface Modules that can be connected to a segment is eight. Other models are the PCA66-FOG that supports fiber optic cable with either ST or SMA connectors. With fiber optic connections, only star and distributed star topologies are supported. The PCA66-TPB supports twisted-pair bus cabling using RJ-11 or screw terminal connectors.

Features

- Utilizes COM90C66 16-bit ARCNET controller
- Interfaces ARCNET with AT (ISA) bus computers
- Zero wait-state arbitration typical
- Deterministic, high-speed 2.5 Mbps ARCNET token-passing Local Area Network (LAN)
- COM90C26/90C65 software compliant
- Command chaining for enhanced performance
- Supports coaxial, fiber optic, and twisted-pair cabling
- Supports either memory-mapped or I/O-mapped RAM buffer
- Node address switch selects one of 255 possible station addresses
- Boot ROM socket for diskless workstations
- Suitable with all the Contemporary Controls' MOD HUB and AI Series active hubs
- CMOS design for low-power consumption
- CE Mark

Ordering Information

Model	Description
PCA66-CXB	90C66 AT coaxial bus NIM
PCA66-CXS	90C66 AT coaxial star NIM
PCA66-FOG-SMA	90C66 AT SMA fiber optic NIM
PCA66-FOG-ST	90C66 AT ST fiber optic NIM
PCA66-TPB	90C66 AT twisted-pair bus NIM

PCX20 Series

Network Interface Modules for ISA (XT) Bus Computers

The PCX20 Series of Network Interface Modules (NIMs) offers reliable ARCNET connectivity for XT/AT compatible computers.

The PCX20 incorporates the COM20020 ARCNET controller chip with advanced features over earlier ARCNET chips. These are command chaining, sequential access to internal RAM, duplicate node ID detection, and variable data rates up to 5 Mbps. Bus contention problems are lessened since the module only needs an I/O address. There is no requirement for wait-state arbitration.

Each PCX20 module has two LEDs on the board for monitoring network operation and bus access to the module. It also has an external DIP switch so that node addresses can be easily reassigned without removing the module.

There are several versions within the PCX20 Series. The PCX20-CXS supports coaxial star configurations requiring external active or passive hubs. The PCX20-CXB accommodates a multidrop or coaxial bus configuration, typically without any hubs. Other versions include the PCX20-FOG for fiber optic cable with either ST or SMA connectors. The PCX20-TPB supports multidrop twisted-pair cabling using RJ-11 and screw terminal connectors. The PCX20-485 has EIA-485 DC-coupled backplane operation, while the PCX20-485D supports non-backplane mode DC-coupled EIA-485. The PCX20-485X is designed for transformer-coupled EIA-485 (non-backplane) operation.

Features

- Utilizes COM20020 ARCNET controller
- Interfaces ARCNET with XT/AT (ISA) bus computers
- I/O-only mapping reduces bus contention problems
- No requirement for wait-state arbitration
- Deterministic, high-speed ARCNET token-passing Local Area Network (LAN)
- Enhanced software capabilities over earlier generation ARCNET controllers
- Supports coaxial, fiber optic, and twisted-pair cabling including EIA-485
- Node address switch selects one of 255 possible station addresses
- Variable data rates up to 5 Mbps
- Suitable with all the Contemporary Controls' MOD HUB and AI Series active hubs
- CMOS design for low-power consumption

Ordering Information

Model	Description
PCX20-485	20020 PC DC-coupled EIA-485 (backplane) NIM
PCX20-485D	20020 PC DC-coupled EIA-485 (non-backplane) NIM
PCX20-485X	20020 PC AC-coupled EIA-485 (non-backplane) NIM
PCX20-CXB	20020 PC coaxial bus NIM
PCX20-CXS	20020 PC coaxial star NIM
PCX20-FOG-SMA	20020 PC SMA fiber optic NIM
PCX20-FOG-ST	20020 PC ST fiber optic NIM
PCX20-TPB	20020 PC twisted-pair bus NIM

USB22 Series

Network Interface Modules for USB Computers

Features

- USB interface to the ARCNET network
- Send/receive ARCNET packets from USB connected computer
- Compatible with the baseband ARCNET network
- Supports coaxial and twisted-pair networks including AC- and DC-coupled EIA-485
- Operates with either the USB 1.1 or 2.0 standard
- Incorporates a COM20022 ARCNET controller
- Embedded microcontroller provides 128 Kbytes of receiver buffering
- LED indicator indicates port activity
- Powered from USB port on computer

The USB22 Series of ARCNET Network Interface Modules (NIMs) links Universal Serial Bus (USB) computers with the ARCNET Local Area Network. USB has become a very popular means of connecting either desktop or laptop computers to peripherals because it provides a very high-speed interface (up to 480 Mbps) and does not require the insertion of a separate NIM into the computer. The USB22 incorporates the COM20022 which represents the latest ARCNET technology supporting data rates as high as 10 Mbps. Models exist for the most popular ARCNET physical layers. A high-performance microcontroller handles the transfer of data between ARCNET and USB. The NIM is powered from the USB port on the computer or from a USB hub.

The USB22 is compatible with the high-speed USB 2.0 standard, thereby providing an extremely fast and convenient method of accessing an ARCNET network without the requirement of installing a network interface module into a computer. Since most modern computers are sold equipped with a USB port, it is only necessary to make a direct connection between the computer and the USB22. The USB22 will also operate with the earlier lower-speed USB 1.1 standard.

When the USB cable is first attached to a Windows 2K/XP machine, the user is prompted for a driver on a disk. Contemporary Controls (CC) provides a USB driver and DLL with an Application Programming Interface (API) that is very similar to CC's Null Stack Driver API. By not using a protocol stack, a null stack driver provides superior performance over a layered protocol stack by directly linking the application to the ARCNET hardware. This approach is useful when timely access to a real-time network like ARCNET is required. To assist the customer, CC provides some utility programs such as TALK that demonstrate how to communicate with the API.

The USB22 incorporates a high-speed microcontroller with up to 128 Kbytes of ARCNET receiver buffering to aid the reception of broadcast messages or when monitoring networks with high traffic levels. With a 480 Mbps USB link, the potential of dropping ARCNET packets is remote.

The USB22 receives its power from the USB port on the USB computer and will operate with or without a USB hub. It is available in several models that will support either DC- or AC-coupled EIA-485, coaxial bus or twisted-pair networks. It is shipped with a CD containing a Windows 2K/XP compatible DLL and driver, along with a USB cable.

Ordering Information

Model	Description
USB22-4000	20022 USB AC-coupled EIA-485 (backplane) NIM
USB22-485	20022 USB DC-coupled EIA-485 NIM
USB22-CXB	20022 USB coaxial bus NIM
USB22-TB5	20022 USB twisted-pair NIM

Repeaters, Links and Hubs

AI Interconnect Series

Features

- Compatible with the baseband ARCNET network
- Supports either 2 or 3 ports
- Panel-mount enclosure
- Optional DIN-rail mounting kit
- Configurations available for either link, repeater or hub operation
- Supports coaxial, twisted-pair, and fiber optic cabling
- LED indicator identifies reconfiguration of the network
- Minimizes bit jitter with precision-delay line timing
- Watch-dog timer prevents hub lockup
- Hub unlatch delay digitally controlled
- Wide-range, low-voltage AC or DC powered
- Provision for redundant power sources
- Variable data rates from 78 kbps to 10 Mbps
- Works with all the Contemporary Controls' Network Interface Modules (NIMs) and active hubs
- Accommodates AC- or DC-coupled EIA-485 networks

The ARCNET Interconnect (AI) Series of external fixed-port hubs are the cost-effective answer to expand ARCNET Local Area Networks by way of repeaters, links, and hubs. Repeaters can expand a network using the same cabling technology. A link can mix two cabling technologies functioning as a media converter. A hub can add a segment and give support for distributed star topologies. The AI can implement all three of these expansion methods depending upon the number of ports on the AI. The AI2 provides two ports for repeater and link applications while the AI3 implements the hub function. However, the AI2 and AI3 utilize the same robust hub timing electronics found in CC's MOD HUB series of modular active hubs. This includes precision delay line timing, digitally-controlled timers for dependable operation and reduced bit jitter.

The AI operates from either wide-range, low-voltage AC (8 to 24 VAC) or DC (10 to 36 VDC) power. Redundant power sources can be attached for critical applications.

The AI Series supports variable data rates from 78 kbps to 10 Mbps to accommodate the newer ARCNET controller chips and popular EIA-485 transceivers. A watchdog timer prevents hub lockup eliminating the necessity of cycling power on a failed hub.

Active hubs increase the robustness of ARCNET networks —up to 2,000 feet (610 m) on coaxial segments and 6,000 feet (1825 m) on multimode fiber optic segments. They maximize the distance that can be achieved on each cable segment. They block interference to the network by squelching reflections caused by open or shorted cable segments attached to the hub. Unused hub ports need not be terminated. Active hubs allow for a distributed star topology, minimizing the cabling required in a plant. Links and repeaters provide extensions to bus systems or bridging to other cable media.

Each AI port has an LED to indicate the reception of data or the passing of the token. One LED on this unit indicates that the device is operating properly while another indicates the occurrence of a network reconfiguration.

Ordering Information—Repeaters

Model	Description
AI2-485	DC-coupled EIA-485 repeater
AI2-485X	AC-coupled EIA-485 repeater
AI2-CXB	Coaxial bus repeater
AI2-TPB	Twisted-pair bus repeater

Ordering Information—Links

Model	Description
AI2-485/FOG-ST	DC-coupled EIA-485 to fiber optic link
AI2-485X/FOG-ST	AC-coupled EIA-485 to fiber optic link
AI2-CXB/FOG-ST	Coaxial bus to fiber optic link
AI2-TPB/FOG-ST	Twisted-pair bus to fiber link

Ordering Information—Hubs

Model	Description
AI3-485	DC-coupled EIA-485 hub
AI3-485X	AC-coupled EIA-485 hub
AI3-CXS	Coaxial star hub
AI3-485/FOG-ST	DC-coupled EIA-485 to fiber hub
AI3-485X/FOG-ST	AC-coupled EIA-485 to fiber hub
AI3-FOG-ST/485	Fiber backbone to DC-coupled EIA-485
AI3-FOG-ST/485X	Fiber backbone to AC-coupled EIA-485
AI3-FOG-ST/CXB	Fiber backbone to coaxial bus hub
AI3-FOG-ST/TB5	Fiber backbone to twisted-pair bus hub
AI3-TB5	Twisted-pair bus hub

Accessories

Model	Description
AI-XFMR	Wall-mount transformer 120 VAC (nom)
AI-XFMR-E	Wall-mount transformer 230 VAC (nom)
AI-DIN	TS-35 DIN-rail mounting kit
BNC-T	BNC “T” connector
BNC-TER	93 ohm BNC terminator
TB5-TER	100 ohm RJ-45 terminator
TPB-TER	100 ohm RJ-11 terminator

AI-FR Redundant Fiber
Ring Hubs

Features

- Compatible with the baseband ARCNET network
- Provides redundant connection in case of ring failure
- Two ports for ring connection and one port for drop connection
- Panel-mount enclosure
- Optional DIN-rail mounting kit
- Minimizes bit jitter with precision delay-line timing
- Watch-dog timer prevents hub lockup
- Hub unlatch delay digitally controlled
- Supports coaxial or twisted-pair drops
- LED indicators report network reconfigurations and valid port activity
- Wide-range, low-voltage AC or DC powered
- Provision for redundant power sources
- Data rate of 2.5 Mbps
- Fiber backbone fault monitoring via relay contact

ARCNET is to be cabled as either a star or bus network, but never as a ring. However, a ring topology is possible under some circumstances. The ring warrants merit when the goal is to provide redundant cabling so that continuity can be preserved in case of cable failure. If one cable within the ring becomes disabled for any reason, another path remains available to pass messages. It was Contemporary Controls' objective that the AI-FR be developed and implemented to achieve fiber optic redundancy in an otherwise non-redundant networking technology.

The AI-FR is an application-specific active hub, providing integrity status of the redundant fiber backbone. Redundant network topology, explained as a fiber optic ring with a local drop, is established with three-port hubs—each incorporating the fault monitoring principle. A single fault is noted by an opening of a fault relay although communications is maintained.

The AI-FR operates from either low-voltage AC (8 to 24 VAC) or DC (10 to 36 VDC) power. Redundant power sources can be attached for critical applications.

LED indicators aid troubleshooting. Port activity LEDs, labeled 1, 2, & 3 report ARCNET traffic is being received on the respective port. The status LED will flash at a periodic rate when the AI-FR is properly powered, stating the hub is idle. When lit continuously, this LED indicates that ARCNET traffic is being received and faithfully regenerated to the other ports on the hub. The RECON LED will flash to show a routine network reconfiguration as ARCNET nodes enter or leave the network.

The hub is available in two models. The AI-FR/CXB provides fiber ring continuity with a coaxial bus local drop while the AI-FR/TB5 accommodates a twisted-pair bus local drop. Units can be panel or DIN-rail mounted.

Ordering Information

Model	Description
AI-FR/CXB	Fiber ring backbone with coaxial bus drop
AI-FR/TB5	Fiber ring backbone with twisted-pair bus drop

Accessories

Model	Description
AI-XFMR	Wall-mounted transformer 120 VAC (nom)
AI-XFMR-E	Wall-mounted transformer 230 VAC (nom)
AI-DIN	TS-35 DIN-rail mounting kit
BNC-T	BNC "T" connector
BNC-TER	93-ohm BNC terminator
TB5-TER	100-ohm RJ-45 terminator

A redundant fiber ring is constructed with two or more AI-FR hubs and fiber optic cables connected in a ring topology. Each hub provides a local drop through which standard ARCNET devices may access the backbone and benefit from the redundant cabling. Signal delay constraints impose a 2 km limit on the ring circumference when no more than five AI-FR hubs are being used. By decreasing the circumference, more hubs can be employed—allowing additional devices to share the redundant ring.

In absence of an ARCNET signal, the three-port AI-FR hub has all its receivers enabled and all its transmitters disabled. When a drop port senses a signal, it becomes the sole receiving port and its transmitter is disabled—while the other two backbone ports become transmitters with their receivers disabled. With a fiber ring properly configured, activity from the two backbone ports will travel along the ring in two directions—clockwise and counterclockwise. A receiving AI-FR located on the ring will latch onto activity sensed by one of the backbone ports and ignore the redundant transmission seen on the other port. In the event that both ports receive simultaneous data, priority is given to port 2. If the ring is broken at any one point, the network will function in a traditional star topology.

The unlatch delay (which squelches any recirculating message) has been increased from 5.9 µs to 11.9 µs for greater distance. This delay must exceed the total delay due to fiber propagation (5 ns/m) and the number of AI-FR hubs (330 ns/hub). If no data is received after 11.9 µs, the hub assumes that transmission is complete and reverts to its quiescent state with all receivers enabled and all transmitters disabled.

Fault Monitoring—Vital Safeguards for Preserving Network Integrity

The AI-FR hub's most essential requirement is to provide reliable data transfer. The failure of fiber cables remains a common concern—especially if the cabling is installed in underground or hard-to-service locations. In case of a fiber failure, the AI-FR fiber ring maintains uninterrupted communication by virtue of its redundant data path.

In addition to preserving data flow, the AI-FR incorporates a fault relay by which fiber ring continuity can be monitored. Using this relay, a fiber failure can be quickly detected and the problem location identified and the repair scheduled—all while data traffic is maintained.

Access to the fault relay contacts is provided by a pair of terminals on the AI-FR's front panel. By connecting these terminals to a workstation or other user-provided equipment, data path integrity can be monitored. When open, the relay contacts of a particular hub indicate one of three important fault conditions: an open in a fiber attached to the hub, a loss of power to the hub, or a failure of the hub itself.

An AI-FR hub should sense data on both of its fiber ports. But if the signal is continuously absent on one of the receiving fibers for a period of 1.6 seconds, the fault relay contacts will open. Therefore, an open relay occurring at only one hub will indicate one bad fiber in either of the duplex pairs attached to that hub. If a complete duplex pair fails, neither of the two hubs connected by the pair will receive data along that path—and the opening of both fault relays in the two hubs will state a complete failure of the fiber pair which connects them.

When power is provided to the AI-FR, the fault relay contacts close as normal operation is assumed. If power to the AI-FR is interrupted, the relay contacts will open and thus report a problem. If the hub malfunctions and fails to keep the relay contacts closed, the open contacts will indicate service. If a hub fails, either from power loss or for other reasons, the two hubs which normally communicate with it will fail to receive data from the downed hub. They too will indicate a fault.

AI-USB Hub with USB Interface

Features

- Functions as both a hub and USB interface to the ARCNET network
- Send/receive ARCNET packets from USB-connected computer
- Compatible with the baseband ARCNET network
- Two external hub ports for expansion
- Supports coaxial and twisted-pair networks including AC- and DC-coupled EIA-485
- Operates with either the USB 1.1 or 2.0 standard
- Incorporates a COM20022 ARCNET controller
- Embedded microcontroller provides 128 Kbytes of receiver buffering
- LED indicators identify reconfigurations and port activity
- Minimize bit jitter with precision delay-line timing
- Low-voltage AC or DC powered

The AI-USB is an ARCNET active hub that not only provides the same hub functionality as an AI Series hub, but provides access to the ARCNET network via Universal Serial Bus (USB) on a host PC. In terms of a hub, the AI-USB can be viewed as a three port hub—two external ARCNET ports and one internal. The internal hub port has an embedded connection to a USB ARCNET adapter (Network Interface Module) resident in the AI-USB. The USB connection is brought out so that a laptop or desktop computer can gain Plug and Play access to an ARCNET network.

The AI-USB is compatible with the high-speed USB 2.0 standard, thereby providing an extremely fast and convenient method of accessing an ARCNET network without the need of installing a network interface module into a computer. Since most modern computers are sold equipped with a USB port, it is only necessary to make a direct connection between the computer and the AI-USB. The AI-USB will also operate with the earlier, lower-speed USB 1.1 standard.

An ideal application for the AI-USB is when it is desirable to have temporary access to an ARCNET network by simply hooking up to a laptop computer using its USB port. By having the AI-USB permanently connected to the ARCNET network, network field wiring is not disturbed when attaching the USB cable. In this way an ARCNET network can be monitored, stations can be configured, and troubleshooting can be accomplished with minimal disruption to the network. With two external hub ports, the AI-USB can be inserted between two bus connections and function as a bus extender. Models are available for coaxial star, twisted-pair bus, and both AC- and DC-coupled EIA-485.

When the USB cable is first attached to a Windows 2K/XP machine, the user is prompted for a driver. Contemporary Controls (CC) provides a disk containing a null stack driver. A null stack driver provides superior performance over a layered protocol stack by directly linking the application to the ARCNET hardware. This approach is useful when timely access to a real-time network like ARCNET is required.

The AI-USB has the same style power connectors as the AI Series of hubs. The unit can be powered from a wide-range of low-voltage AC or DC power sources and provision exists for redundant power connections. It is shipped with a CD containing a Windows 2K/XP driver along with a USB cable.

Ordering Information

Model	Description
AI-USB/485	USB interface with two DC-coupled EIA-485 ports
AI-USB/485X	USB interface with two AC-coupled EIA-485 ports
AI-USB/CXS	USB interface with two coaxial star ports
AI-USB/TB5	USB interface with two twisted-pair bus ports

QuickLink Fixed Port Hub Series

Features

- Compatible with the baseband 2.5 Mbps ARCNET network
- Supports coaxial and twisted-pair cabling
- Minimizes bit jitter with precision delay-line timing
- Watch-dog timer prevents hub lockup
- Hub unlatch delay digitally controlled
- Low-voltage AC powered
- Interoperates with all the Contemporary Controls' network interface modules (NIMs) and active hubs
- External transformer included

The QuickLink (QL) Series of external fixed-port hubs provides the best in reliability, simplicity, and economy for expanding ARCNET local area networks. A hub allows for adding a segment and supporting distributed star topologies. These eight-port hubs use the same robust hub timing electronics found in CC's MOD HUB Series such as precision delay-line timing, digitally-controlled timers for dependable operation, and reduced bit jitter. A watchdog timer prevents hub lockup, eliminating the necessity of cycling power in case of transmission error.

The QuickLink operates from low-voltage AC power (8 to 24 VAC). For convenience, each unit is shipped with a wall-mount transformer with a 6' (2 m) low-voltage cord so it may work from mains power. The standard model functions from 120 VAC nominal voltage while the QL-CXS-E and QL-TPS-E models operate from 230 VAC nominal voltage. These models have a continental Europe plug for the provided transformer. Consequently, although nominally designed for powering from a 24 VAC source, this hub can also be powered from a 24 VDC source, irrespective of the polarity of the applied voltage, with no degradation of performance.

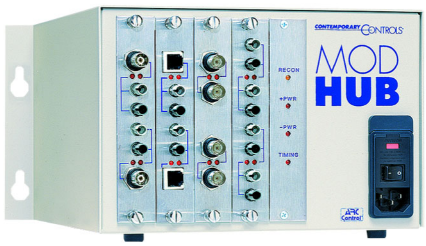
Active hubs increase the robustness of ARCNET networks. They maximize the distance possible on each cable segment—up to 2,000 feet (610 m) on coaxial segments. They block interference to the network by squelching reflections caused by open or shorted cable segments attached to the hub. Unused hub ports need not be terminated. Active hubs reduce the cabling required in a facility. Two or more QuickLink hubs may be cascaded, allowing distributed star topology.

The -TPS units are available with signal polarity inversion.

Ordering Information

Model	Description
QL-CXS	Coaxial star eight-port hub 120 VAC (nom)
QL-CXS-E	Coaxial star eight-port hub 230 VAC (nom)
QL-TPS	Twisted-pair star eight-port hub 120 VAC (nom)
QL-TPS-E	Twisted-pair star eight-port hub 230 VAC (nom)

MOD HUB Modular
Hub Series



The MOD HUB Series of modular active hubs provides the most flexibility for cabling ARCNET networks in a star topology. The MOD HUB Series can also link bus topologies by connecting the hub to one end of each bus segment.

These 4-slot chassis hubs offer worry-free operation using low-power, low-heat CMOS components; high-efficiency LED lights; plus a special cooling system inherent in the design; and network diagnostic capability using LED indicators.

LEDs monitor proper hub operation such as timing and power supply status. An additional LED identifies when network reconfigurations occur.

The standard model has rubber feet and can mount on a table or desk. Different enclosure styles are available. Using the rack-mounting kit, two 4-slot enclosures can be mounted in a standard 19" (48.3 cm) rack requiring 7" (7.8 cm) of vertical rack space. In addition, the MODHUB-16F is a flanged unit for wall or panel mounting. Flexibility is built-in. You need to order only the amount and type of connection for your application. Several expansion modules exist in the EXP Series, each supporting two, three, or four ports. Mix and match coaxial cable, twisted-pair wire as well as glass fiber optic cable in the same hub.

Several combination expansion modules can easily mix two cabling types on one module. Expansion modules reside in a 16-port enclosure (four slots). Ports can easily be added in the field with removable EXP expansion modules.

As for regulatory compliance, all models are UL 60950 Listed and C-UL Listed, and adhere to CSA 22.2 No. 60950 for Safety of Information Technology Equipment.

A universal power supply accommodates world-wide voltages and frequencies. An IEC connector allows for the use of country-specific power cords.

Features

- Compatible with the baseband 2.5 Mbps ARCNET network
- Supports up to 16 ports in four slots
- One size enclosure: 4-slot
- Offers easy expansion with EXP Series plug-in modules
- Mixes coaxial, twisted-pair, and glass fiber optic cable in one hub
- LED indicator identifies reconfiguration of the network
- Minimizes hub jitter with precision delay-line timing
- Provision for rack mounting
- Watch-dog timer prevents hub lockup
- Hub unlatch delay digitally controlled
- Universal voltage power supply
- Suitable with all the Contemporary Controls' Network Interface Modules (NIMs) when operating at 2.5 Mbps
- UL 60950 Listed

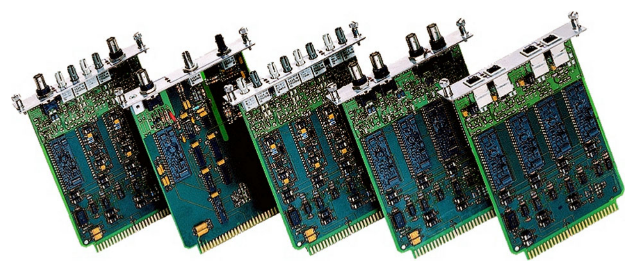
Ordering Information

First, order the MOD HUB enclosure you need. Then, choose the particular mix of expansion modules that will fill the enclosure. Refer to the EXP data sheet for detailed information.

Model	Description
MODHUB-16	16-pt. powered card cage (120 V 50/60 Hz)
MODHUB-16E	16-pt. powered card cage (230 V 50/60 Hz)
MODHUB-16EF	16-pt. powered card cage, flange mounted (230 V 50/60 Hz)
MODHUB-16F	16-pt. powered card cage, flange mounted (120 V 50/60 Hz)

Accessories

Model	Description
MTG-RAK	MODHUB rack-mounting kit



By using the EXP Series of expansion modules, you can achieve multi-media cabling support for the MOD HUB Series of active hubs. Coaxial cable, twisted-pair wire, and glass fiber optic cable can all operate on the same network by choosing the appropriate expansion module.

Each expansion module accommodates from two to four ports of the transceiver, with each port designed to support a specific cable technology. Transceivers are identified by a suffix designation (e.g., -FOG) which follows the EXP model number. Certain expansion modules mix two cable technologies within one module, reducing costs in some applications.

Expansion modules can be inserted into empty slots in any hub within the MOD HUB Series without regard for power consumption. Cabling technologies can be freely mixed—offering great flexibility in configuring hub, media converter, and repeater applications. Expansion modules are fastened using thumb screws and can be installed in the field. Each port has an LED to indicate network activity.

Expansion modules support star and distributed star topologies (node-to-hub and hub-to-hub connections). However, bus segments, including popular AC- or DC-coupled EIA-485 segments, can also be extended using expansion modules.

Features

- Compatible with baseband ARCNET networks
- Works with all the MOD HUB series active hubs
- Supports star or distributed star topologies
- Interfaces to either single-mode or multimode fiber optics
- Internal BALUNs support twisted-pair cabling
- Coaxial, fiber optic, and twisted-pair cabling
- Extends AC- or DC-coupled EIA-485 segments
- Supports either SMA or ST fiber connectors
- Activity LEDs on each port isolate network faults

Ordering Information

Model	Description	Number of Ports
EXP-485	4-port DC-coupled EIA-485 expansion module	4
EXP-485X	4-port AC-coupled EIA-485 expansion module	4
EXP-485X/2FG3	1-port AC-coupled 485/2-port 1300 nm fiber expansion module	1/2
EXP-485X/FG3-ST	1-port AC-coupled 485/1300 nm fiber expansion module	1/1
EXP-485/FOG[1]	2-port 485/fiber expansion module	2/2
EXP-485X/FOG[2]	2-port 485X/fiber expansion module	2/2
EXP-CXS	4-port coaxial star expansion module	4
EXP-CXS/485	2-port coaxial/485 expansion module	2/2
EXP-CXS/485X	2-port coaxial/485X expansion module	2/2
EXP-CXS/2FG3	1-port coaxial/2-port 1300 nm fiber expansion module	1/2
EXP-CXS/FG3-ST	1-port coaxial/1300 nm fiber expansion module	1/1
EXP-CXS/FOG[1]	2-port coaxial/fiber expansion module	4
EXP-FOG[1]	4-port fiber expansion module	4
EXP-TPS	4-port twisted-pair expansion module	4
EXP-TPS/CXS	2-port twisted-pair/coaxial expansion module	2/2
EXP-TPS/FOG[1]	2-port twisted-pair/fiber expansion module	2/2

[1] Specify the type of fiber optic connector by adding the appropriate suffix (-ST for ST or -SMA for SMA).

[2] Specify the type of fiber optic connector by adding the appropriate suffix (-ST for ST or -SM for SMA).

Routers and Gateways

AI-SRVR
ARCNET to Ethernet Server

Features

- Connect between Ethernet and baseband ARCNET
- Supports coaxial and twisted-pair ARCNET networks including AC- and DC-coupled EIA-485
- Provides 10/100 Ethernet TCP/IP connection
- 256 separate ARCNET receive buffer mailboxes
- Monitor all ARCNET traffic
- A DLL for Windows 2K/XP clients is provided
- Resident web server provides status information
- Configurable through an EIA-232 console port and via Telnet
- Low-voltage AC or DC powered
- Provisions for redundant power connections
- DIN-rail or panel mounted
- CE Mark

The AI-SRVR provides connectivity between an ARCNET network and an Ethernet network, allowing a client on the Ethernet side access to nodes on the ARCNET side. The AI-SRVR functions as an ARCNET server by executing communication requests from an Ethernet client. Any number of Ethernet TCP/IP clients can initiate requests to any node on an ARCNET network. The AI-SRVR will receive ARCNET packets and send the data to Ethernet clients or reverse the process for packets transmitted from the Ethernet.

Both ARCNET and Ethernet are data link technologies with different medium access methods, frame sizes, and link layer protocols. With Ethernet, the most popular transport layer protocol is TCP/IP, but ARCNET is usually found in embedded applications that do not use TCP/IP. ARCNET also does not utilize a universal application layer so it is best to query ARCNET by examining raw packets. It is up to the Ethernet client to interpret the meaning of the raw packets. This approach allows for any ARCNET network to be queried by an Ethernet client regardless of the application layer protocol being used with ARCNET.

An ARCNET network can consist of 255 possible nodes. Node address "0" is reserved for broadcast messages. The AI-SRVR will consume one address and will participate in the token-passing protocol on the ARCNET network. The AI-SRVR can operate in promiscuous mode and, therefore, can monitor all ARCNET traffic. It reserves 256 mailboxes for the maximum number of nodes plus one for broadcast messages. Each mailbox has a first in-first out (FIFO) memory whose depth can be set. A mailbox captures the packet data originating from a source node. The AI-SRVR will capture all packets originating from the nodes that it is configured to accept. The packets will be stored in mailboxes that correspond to the source node addresses.

Ordering Information

Model	Description
AI-SRVR-1/485	Single Node ARCNET Server for DC-coupled EIA-485
AI-SRVR-1/485X	Single Node ARCNET Server for AC-coupled EIA-485
AI-SRVR-1/CXB	Single Node ARCNET Server for coaxial bus
AI-SRVR-1/TB5	Single Node ARCNET Server for twisted-pair bus
AI-SRVR-8/485	Eight Node ARCNET Server for DC-coupled EIA-485
AI-SRVR-8/485X	Eight Node ARCNET Server for AC-coupled EIA-485
AI-SRVR-8/CXB	Eight Node ARCNET Server for coaxial bus
AI-SRVR-8/TB5	Eight Node ARCNET Server for twisted-pair bus

Accessories

Model	Description
AI-XFMR	Wall-mount transformer 120 VAC (nom)
AI-XFMR-E	Wall-mount transformer 230 VAC (nom)
AI-DIN	TS-35 DIN-rail mounting kit
BNC-T	BNC "T" connector
BNC-TER	93-ohm BNC terminator
TB5-TER	100-ohm RJ-45 terminator

Two methods of receiving packets are possible. The first method is the polling mode where the Ethernet client must continually check mailboxes for data. If not polled in time, data will be lost. The second method is the automatic forwarding mode. Packets in mailboxes are automatically forwarded to the requesting Ethernet clients.

The Ethernet side of the AI-SRVR appears as any other 10/100 Mbps Ethernet TCP/IP station requiring an IP address assignment. An Ethernet client can write data to the ARCNET network by simply specifying the ARCNET destination address and appending the data to be sent. A number of Ethernet clients can do the same. The AI-SRVR will receive the requests and execute the writes using its own ARCNET node address as the source address. It will continue to process requests from Ethernet clients in the order they are received. To facilitate this process, Contemporary Controls provides a DLL for use with Windows 2K/XP clients.

Configuration of the AI-SRVR is accomplished through an EIA-232 serial port. The Ethernet IP address and ARCNET node address are set in this fashion. Once configured, a resident web server can be accessed to determine the operational status of the AI-SRVR.

The AI-SRVR can also operate in the "AI-PROXY" mode. When used in AI-PROXY mode, the AI-SRVR can allow ARCNET devices on separate networks to communicate directly over an Ethernet network. One AI-SRVR-1 is needed for each ARCNET device as each AI-SRVR-1 acts as a "proxy" for one ARCNET device (see Figure 1). The AI-SRVR, basically, sends received ARCNET packets over the Ethernet network to an appropriate AI-SRVR for re-transmission on its ARCNET network. This allows ARCNET nodes on separate ARCNET networks to communicate over an Ethernet network.

As the AI-SRVR-1 can act as a proxy for only one ARCNET node, the AI-SRVR-8 was created to provide one device which would represent multiple ARCNET nodes. The AI-SRVR-8 can act as a proxy for up to eight ARCNET nodes (see Figure 2). The AI-SRVR-1 and the AI-SRVR-8 can also be used together, for example, to add one remote ARCNET node to an eight node ARCNET system (see Figure 3). Multiple AI-SRVR-8 devices can be used when more than eight ARCNET nodes are to be represented.

These devices have the same power connections as the AI Series of hubs. The unit can be powered from a wide range of low-voltage AC or DC power sources and provisions exist for redundant power connections.

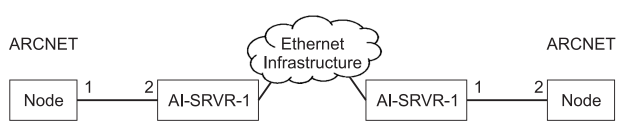


Figure 1. Two AI-SRVR-1 devices interconnecting two ARCNET nodes.

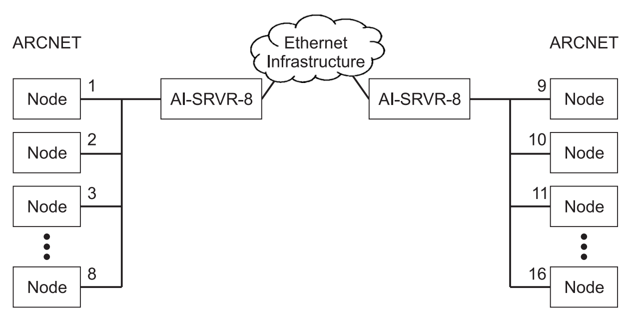


Figure 2. Two AI-SRVR-8 devices interconnecting 16 ARCNET nodes.

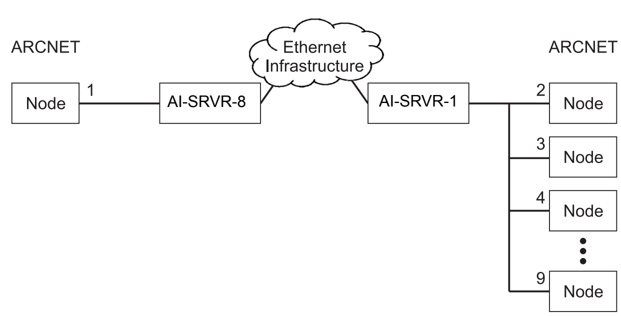
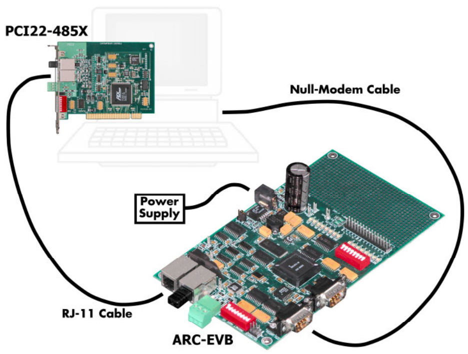


Figure 3. One AI-SRVR-8 and one AI-SRVR-1 interconnecting nine ARCNET nodes.

Analyzers & Evaluation Systems

ARC-EVS ARCNET

Evaluation System



Features

- Outfitted with all the components required to have an ARCNET network "up and running" in less than 10 minutes
- Uses the latest state-of-the-art technology with a COM20022 ARCNET controller
- Prototyping area for customer components
- Includes Keil compiler/debugger and allows users to debug their ARCNET code on the board
- Atmel T89C51 microcontroller which allows for the uploading of firmware into FLASH and its execution
- 16 kB of flash and 63 kB of RAM
- Sample ARCNET firmware and sample Windows application program
- Supports data rates up to 10 Mbps using transformer-coupled ARCNET transceiver
- Implements Modbus protocol over ARCNET

Good simulation tools are essential in the process of embedded software development. That's why Contemporary Controls designed the ARCNET Evaluation System (ARC-EVS)—blending unique ARCNET features and functionality into a learning tool for exploring embedded ARCNET. By employing the hardware and software provided in the ARC-EVS, the user can have a demonstration system "up and running" in less than 10 minutes. The user supplies the PC with a Windows OS and everything else is in the kit. The kit contains: one PCI20U-485X ARCNET interface adapter (for installation in a PCI slot in the PC); one ARC-EVB ARCNET evaluation board with eight input switches and eight LED outputs; power supply; RJ-11 cable to connect the PCI20U-485X to the ARC-EVB; two terminators to terminate the ends of the network cable; software drivers for Windows 95, 98, 2000, NT, and XP; sample application software to read and display the input status and to control the LED outputs; and one null modem cable to do a serial download and debugging of an application program.

The product's key element is the ARC-EVB designed with an Atmel T89C51 microcontroller. The microcontroller contains 16 kB of FLASH memory to hold the test application (Modbus over ARCNET)—or the user's firmware. This enables the user to download their firmware into FLASH and execute it. The FLASH memory can also hold the Keil monitor, permitting users to debug their embedded ARCNET code on the board.

The board is also equipped with the SMSC COM20022 ARCNET controller (backward compatible with the COM20020) which supports data rates from 156 kbps to 10 Mbps using a 20 MHz crystal.

The ARC-EVS functions in three modes. The first mode is the Keil debug mode in which the board will execute a Keil monitor program. The user will download his application into the board's RAM and control its execution through the Keil debugger. In the second mode the user can program the Atmel microcontroller with the ARCNET firmware allowing communication with a Windows PC using the provided PCI20U card and the sample Windows application. The third mode lets the user download and execute his own firmware in the FLASH memory of the board.

The sample Windows application lets the user view and set eight bits of I/O on the ARC-EVB via the special Modbus over ARCNET protocol. An 8-position DIP switch acts as the input device and eight associated LEDs report the state of each input. An additional eight LEDs indicate the status of the output signals. The PCI20U-485X is a PCI-based ARCNET interface adapter containing the same ARCNET controller COM20022. When the card is inserted in a computer and connected to the ARC-EVB via the RJ-11 cable, a functional network is created.

Ordering Information

Model	Description
ARC-EVS	ARCNET Evaluation System

ANA ARCNET
Network Analyzer

Features

- Accurately monitors real-time data traffic
- Displays all low-level ARCNET frame types including ITT, FBE, ACK, NAK, and Packet data
- Intelligent acquisition unit that does not rely on PC for real-time storage
- Supports complex triggering on ITT, FBE, ACK, NAK, and Packet data
- 512 kB acquisition memory for larger storage
- Supports coaxial, twisted-pair, DC- or AC-coupled EIA-485
- Saves data to disk as text for future review
- Extensive hotkeys allow use with or without mouse
- User-friendly design
- Operates with Windows 98, ME, 2000, and XP
- Uses all common ARCNET data rates
- Connects to PC using USB 1.1 interface

The newest generation of ARC Detect® ARCNET network analyzers will allow engineers to capture and decode low-level ARCNET messages that controllers use to initiate and control a packet transmission. The ARCNET Network Analyzer (ANA) proves indispensable when examining the data sent over embedded ARCNET networks.

It provides the ability to view all frame types including invitations to transmit (ITT), free buffer enquiry (FBE), acknowledgments (ACK), negative acknowledgments (NAK), as well as the ability to view the transmitted ARCNET packets (PAC).

Most analyzers only display transmitted packets because they incorporate an ARCNET controller chip for capturing packets. The ANA does not use an ARCNET chip but reconstructs complete ARCNET activity by observing the symbols on the cable.

The ANA has a 2.5 microsecond timer resolution for all recorded events and will operate at the 10 Mbps upper limit of ARCNET.

This product operates on a standard PC or a notebook computer with a USB interface. It directly accommodates coaxial star and bus, twisted-pair and DC or AC EIA-485. Data rates can range from 156 kbps to 10 Mbps.

The ANA does not rely on the PC for real-time acquisition. Its USB module contains its own CPU, memory and custom triggering hardware to facilitate capture of all transmissions. Any unrecognizable transmission will be captured and displayed as well as including any noise transients and reconfiguration bursts.

Ordering Information

ARCNET Network Analyzer includes the program on CD-ROM, an intelligent data acquisition unit, a USB interface cable, and external power supply. The CD contains a manual of instructions, an ARCNET tutorial, and supplementary information.

Model	Description
ANA	ARCNET Network Analyzer

Technical Specifications

Electromagnetic Compatibility

Regulatory Approvals

Mechanical Diagrams

Power Wiring Diagrams

A Look at Accessories

Glossary & Abbreviations of ARCNET Terms

ARCNET Tutorial

Customer Service Information

ARCNET Trade Association

Network Interface Modules

Model	Current Requirements (mA)				Dimensions
	+3.3 V	+5 V	–12 V	V I/O	
CPCI22-4000	30	400	N/A	20	3.93” x 6.30” (100 mm x 160 mm)
CPCI22-485	30	400	N/A	20	
CPCI22-CXB	30	400	N/A	20	
CPCI22-CXS	30	400	N/A	20	
CPCI22-FOG-ST	30	500	N/A	20	
CPCI22-TB5	30	400	N/A	20	
PCI20U-4000	30	400	N/A	20	2.50” x 4.72” (64 mm x 95 mm)
PCI20U-485	30	400	N/A	20	
PCI20U-485D	30	400	N/A	20	
PCI20U-485X	30	400	N/A	20	
PCI20U-CXB	30	400	N/A	20	
PCI20U-CXS	30	400	N/A	20	
PCI20U-TB5	30	400	N/A	20	
PCI20-485	N/A	400	N/A	N/A	4.20” x 5.50” (107 mm x 140 mm)
PCI20-485D	N/A	400	N/A	N/A	
PCI20-485X	N/A	400	N/A	N/A	
PCI20-CXB	N/A	400	50	N/A	
PCI20-CXS	N/A	400	20	N/A	
PCI20-FOG-SMA	N/A	500	N/A	N/A	
PCI20-FOG-ST	N/A	500	N/A	N/A	
PCI20-TB5	N/A	400	50	N/A	
PCM20H-485	N/A	100	N/A	N/A	3.37” x 2.126” x 0.196” (85 mm x 54 mm x 5 mm) MAU—3.175” x 1.835” x 1.005” (81 mm x 46 x 26 mm) Cable—11,125” (28.3 cm) Approx. MAU base to adapter base
PCM20H-485D	N/A	100	N/A	N/A	
PCM20H-485X	N/A	100	N/A	N/A	
PCM20H-CXB	N/A	120	N/A	N/A	
PCM20H-TB5	N/A	120	N/A	N/A	
PCM20H-TPB	N/A	120	N/A	N/A	
PC10420-485	N/A	200	N/A	N/A	3.55” x 3.775” (90 mm x 95 mm)
PC10420-485D	N/A	200	N/A	N/A	
PC10420-485X	N/A	200	N/A	N/A	
PC10420-CXB	N/A	200	50	N/A	
PC10420-CXS	N/A	200	20	N/A	
PC10420-FOG-SMA	N/A	300	N/A	N/A	
PC10420-FOG-ST	N/A	300	N/A	N/A	
PC10420-TPB	N/A	200	50	N/A	

Model	Current Requirements (mA)				Dimensions
	+3.3 V	+5 V	–12 V	V I/O	
PC10422-4000	N/A	200	N/A	N/A	3.55″ x 3.775″ (90 mm x 95 mm)
PC10422-485D	N/A	200	N/A	N/A	
PC10422-485X	N/A	200	N/A	N/A	
PC10422-CXB	N/A	200	N/A	N/A	
PC10422-CXS	N/A	200	N/A	N/A	
PC10422-TB5	N/A	200	N/A	N/A	
PC10466-CXB	N/A	200	50	N/A	3.55″ x 3.775″ (90 mm x 95 mm)
PC10466-CXS	N/A	200	20	N/A	
PC10466-FOG-SMA	N/A	300	N/A	N/A	
PC10466-FOG-ST	N/A	300	N/A	N/A	
PC10466-TPB	N/A	200	50	N/A	
PCX-CXB	N/A	150	50	N/A	3.90” x 4.30” (99 mm x 109 mm)
PCX-CXS	N/A	150	20	N/A	
PCX-FOG-SMA	N/A	200	N/A	N/A	
PCX-FOG-ST	N/A	200	N/A	N/A	
PCX-TPB	N/A	150	50	N/A	
PCX-TPS	N/A	150	20	N/A	
PCA66-CXB	N/A	200	50	N/A	4.20” x 6.50” (106 mm x 165 mm)
PCA66-CXS	N/A	200	20	N/A	
PCA66-FOG-SMA	N/A	300	N/A	N/A	
PCA66-FOG-ST	N/A	300	N/A	N/A	
PCA66-TPB	N/A	200	50	N/A	
PCX20-485	N/A	200	N/A	N/A	3.50″ x 4.30″ (99 mm x 109 mm)
PCX20-485D	N/A	200	N/A	N/A	
PCX20-485X	N/A	200	N/A	N/A	
PCX20-CXB	N/A	200	50	N/A	
PCX20-CXS	N/A	200	20	N/A	
PCX20-FOG-SMA	N/A	300	N/A	N/A	
PCX20-FOG-ST	N/A	300	N/A	N/A	
PCX20-TPB	N/A	200	50	N/A	
USB22-4000	N/A	500	N/A	N/A	4.95” x 3.75” x 1.15” (126 mm x 95 mm x 30 mm)
USB22-485	N/A	500	N/A	N/A	
USB22-CXB	N/A	500	N/A	N/A	
USB22-TB5	N/A	500	N/A	N/A	

Electromagnetic Compatibility

Standard	Test Method	AI-FR Fiber Ring Hubs	AI Interconnect Series	AI-SRVR ARCNET Server	AI-USB Hub with USB Interface	MOD HUB Modular Hub Series	QuickLink Fixed-Port Hub Series
EN 55024	EN 61000-4-2	4 kV Contact 8 kV Air	4 kV Contact 8 kV Air	4 kV Contact 6 kV Air	6 kV Contact 8 kV Air	4 kV Contact 8 kV Air	8 kV Contact
EN 55024	EN 61000-4-3	10 V/m 80 MHz to 1 GHz	10 V/m 80 MHz to 1 GHz	10 V/m 80 MHz to 1 GHz	10 V/m 80 MHz to 1 GHz	10 V/m 80 MHz to 1 GHz	10 V/m 80 MHz to 1 GHz
EN 55024	EN 61000-4-4	1 kV Clamp 2 kV Direct	1 kV Clamp 2 kV Direct	1 kV Clamp 2 kV Direct	1 kV Clamp 2 kV Direct	1 kV Clamp 2 kV Direct	1 kV Clamp 2 kV Direct
EN 55024	EN 61000-4-5	1 kV L to L 2 kV L to Earth	1 kV L to L 2 kV L to Earth	1 kV L to L 2 kV L to Earth	1 kV L to L 2 kV L to Earth	1 kV L to L 2 kV L to Earth	1 kV L to L 2 kV L to Earth
EN 55024	EN 61000-4-6	10 V rms	10 V rms	10 V rms	10 V rms	10 V rms	10 V rms
EN 55024	EN 61000-4-11	1 Line Cycle @ 100% Dip 1 to 5 seconds @ 100% Dip	1 Line Cycle @ 100% Dip 1 to 5 seconds @ 100% Dip	1 Line Cycle @ 100% Dip 1 to 5 seconds @ 100% Dip	1 Line Cycle @ 100% Dip 1 to 5 seconds @ 100% Dip	1 Line Cycle @ 100% Dip 1 to 5 seconds @ 100% Dip	1 Line Cycle @ 100% Dip 1 to 5 seconds @ 100% Dip
EN 55022	CISPR 22 Radiated	Class A	Class A	Class A	Class A	Class A	Class A
EN 55022	CISPR 22 Conducted	Class A	Class A	Class A	Class A	Class A	Class A
CFR 47, Part 15	ANSI C63.4	Class A	Class A	Class A	Class A	Class A	Class A

Standard	**Test Method**	**Description**
EN 55024	EN 61000-4-2	Electrostatic Discharge
EN 55024	EN 61000-4-3	Radiated Immunity
EN 55024	EN 61000-4-4	Fast Transient Burst
EN 55024	EN 61000-4-5	Voltage Surge
EN 55024	EN 61000-4-6	Conducted Immunity
EN 55024	EN 61000-4-11	Voltage Dips & Interruptions
EN 55022	CISPR 22	Radiated Emissions
EN 55022	CISPR 22	Conducted Emissions
CFR 47, Part 15	ANSI C63.4	Radiated Emissions

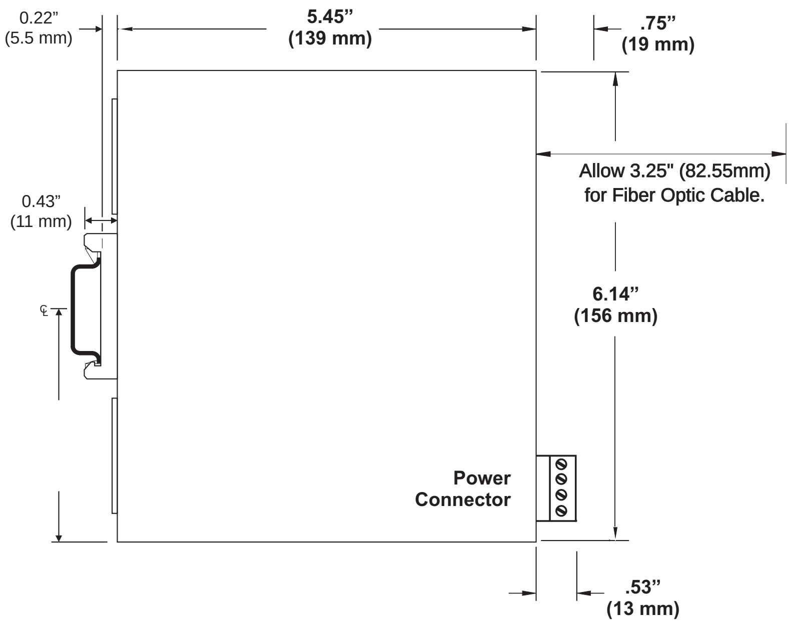
Regulatory Approvals

Standard	AI-FR Fiber Ring Hub	AI Interconnect Series	AI-SRVR ARCNET Server	AI-USB Hub with USB Interface	MOD HUB Modular Hub Series	QuickLink Fixed-Port Hub Series
CE Mark 93/68/EEC	All Models	All Models	All Models	All Models	All Models	All Models
UL 60950 Listed	N/A	N/A	N/A	N/A	All Models	N/A
C-UL Listed, CSA 22.2 No. 60950	N/A	N/A	N/A	N/A	All Models	N/A

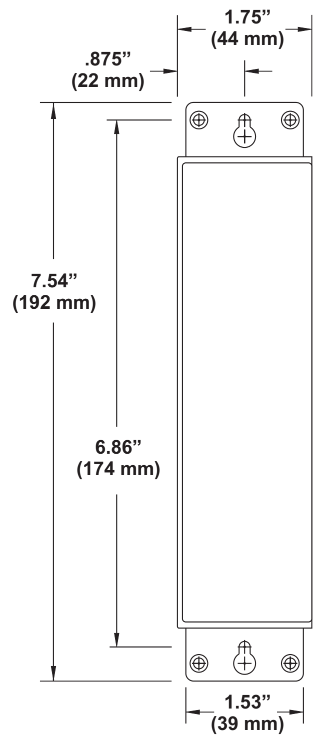
Standard	**Description**
CE Mark—93/68/EEC	CE Marking Device
UL 60950 Listed	Safety of Information Technology Equipment
C-UL Listed, CSA 22.2 No. 60950	Safety of Information Technology Equipment

Notes

Mechanical Diagrams

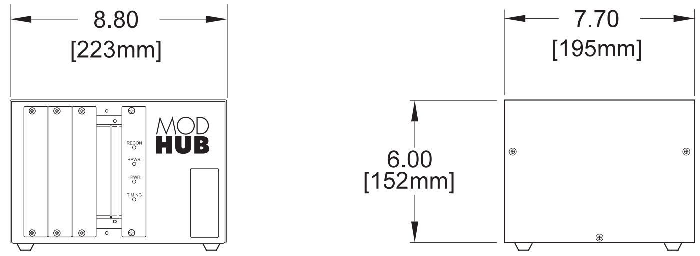


Side View showing DIN-rail Clip
(Mounting Brackets Retracted)



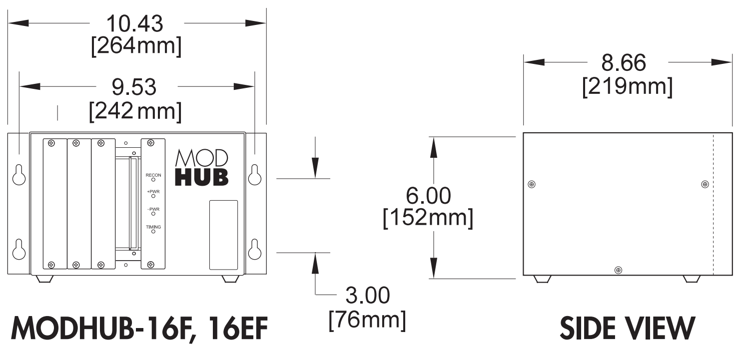
Front View with
Mounting Brackets Extended

AI Series



MODHUB-16, 16E

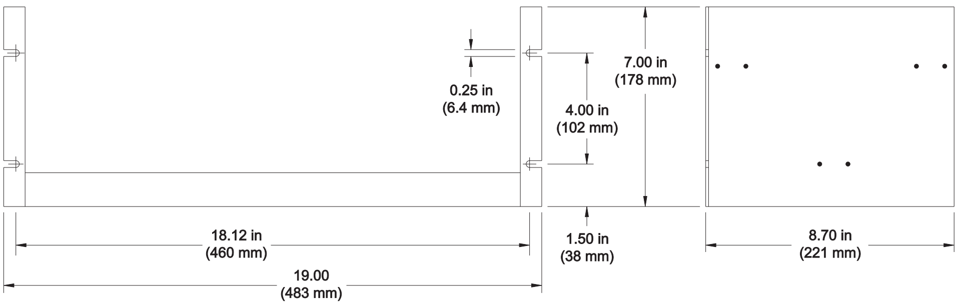
SIDE VIEW



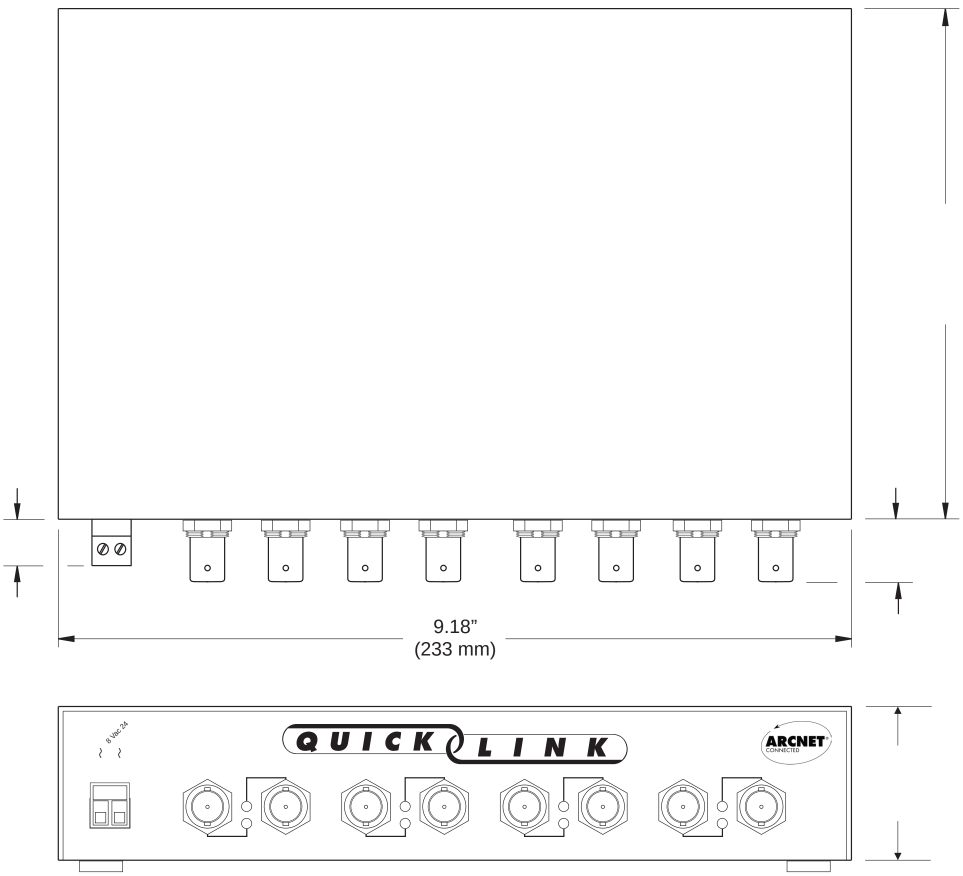
MODHUB-16F, 16EF

SIDE VIEW

MOD HUB Series



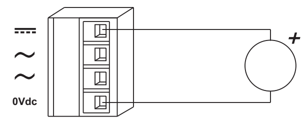
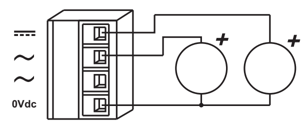
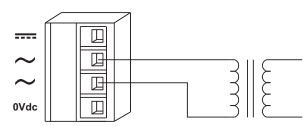
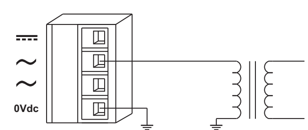
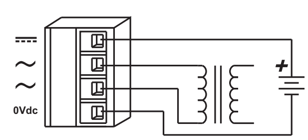
Mounting Rack

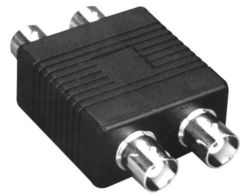


QuickLink Series

Power Wiring Diagrams

Refers to AI, AI-FR, AI-SRVR and AI-USB

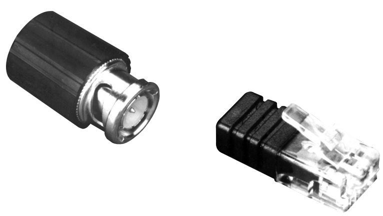
DC Powered	
Redundant DC Powered	
AC Powered	
AC Powered with Grounded Secondary	
AC Powered with Battery Backup	



Passive Hub

Passive Hubs can be used to interconnect three or four computers together in a star topology. Cable lengths cannot exceed 100 feet (30 m) and unused ports must be terminated. Passive Hubs cannot be cascaded.

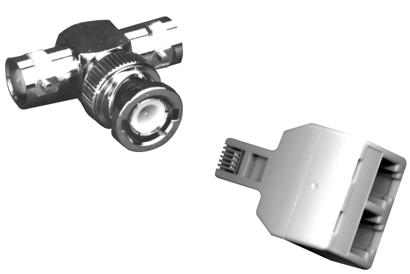
Model	Description
HUB-PASSIVE	Four-port passive hub



Terminators

Passive terminators are used to terminate unused passive hub ports or to terminate the ends of bus segments. These terminators feature 1% resistance tolerance.

Model	Description
BNC-TER	93 ohm BNC terminator
TPB-TER	100 ohm RJ-11 terminator
TB5-TER	100 ohm RJ-45 terminator

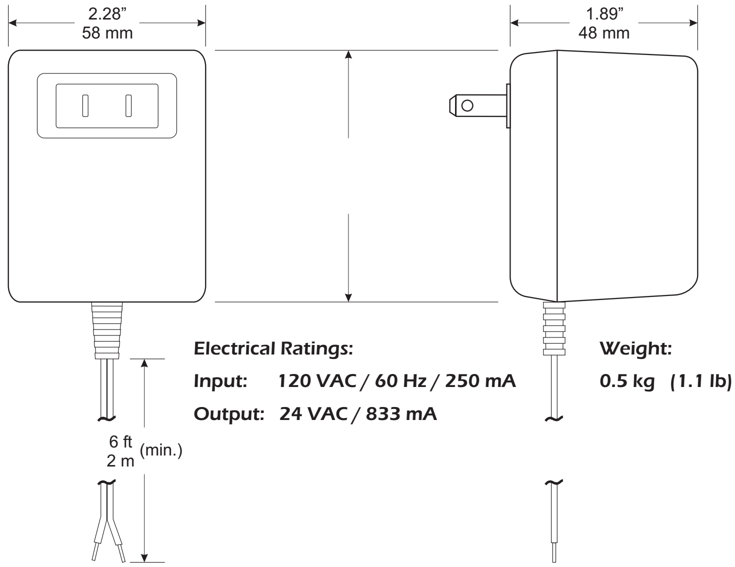


Tee Connectors

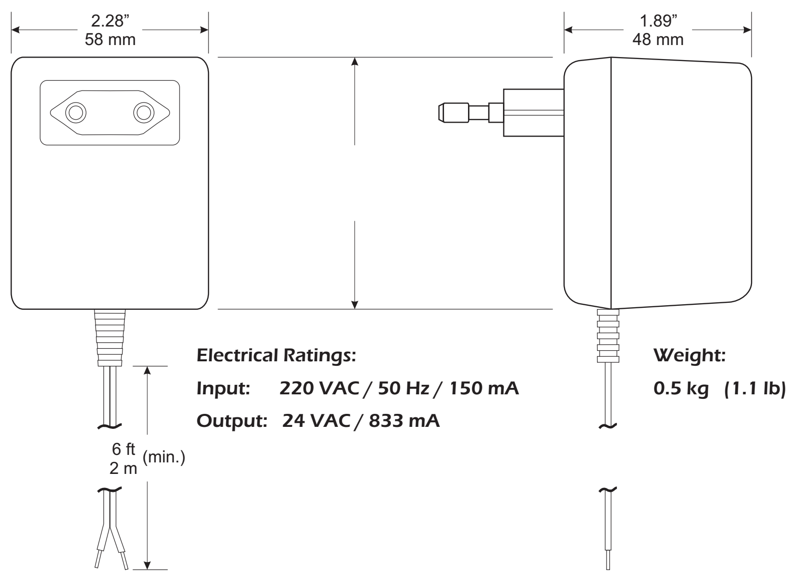
Tee connectors are used to attach a bus segment to either a network interface module or active hub. These connectors are available for either twisted-pair or coaxial cabling.

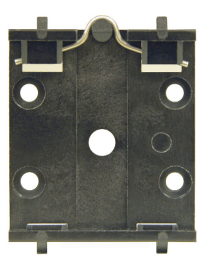
Model	Description
BNC-T	BNC “T” connector
RJ11-T	RJ-11 “T” connector

AI-XFMR Direct Plug-In 120 VAC Transformer



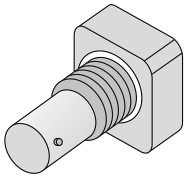
AI-XFMR-E Direct Plug-In 220 VAC Transformer





AI-DIN TS-35 DIN-rail Mounting Clip

C

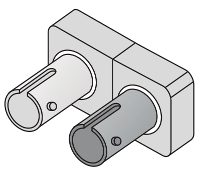


BNC Connector

Signal Assignments

Position	TRANSCEIVER – CXS	– CXB
Center Pin	Line +	Line +
Outer Sleeve	Line –	Line –

ST

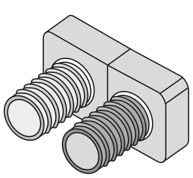


ST Fiber Optic Connector

Signal Assignments

Connector	TRANSCEIVER – FOG	– FG3
Dark Gray	Rx	Rx
Light Gray	Tx	Tx

SMA

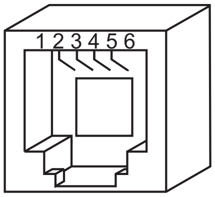


SMA Fiber Optic Connector

Signal Assignments

Connector	TRANSCEIVER – FOG
Dark Gray	Rx
Light Gray	Tx

R1

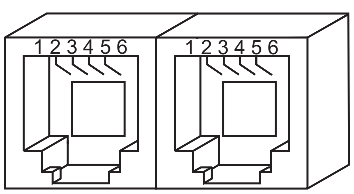


Single Shielded RJ-11 Receptacle

Modular Connector Pin Assignments

Position	TRANSCEIVER – 485	– 485X	–TPS
1	N/A	N/A	N/A
2	Not used	Not used	Not used
3	Line –	Line –	Line +
4	Line +	Line +	Line –
5	Not used	Not used	Not used
6	N/A	N/A	N/A

R1D



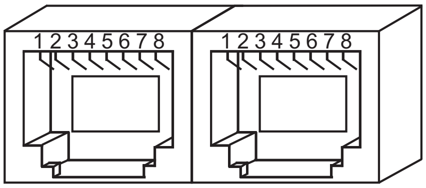
Dual Shielded RJ-11 Receptacle

Modular Connector Pin Assignments

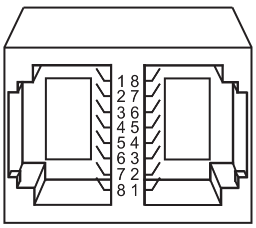
Position	TRANSCEIVER – 485	–485D	–485X	–TPB
1	N/A	N/A	N/A	N/A
2	Not used	Not used	Not used	Not used
3	Line –	Line –	Line	Line –
4	Line +	Line +	Line	Line +
5	Not used	Not used	Not used	Not used
6	N/A	N/A	N/A	N/A

Note: Connections are bussed between the two connectors.

R5D



Dual Shielded RJ-45 Receptacle

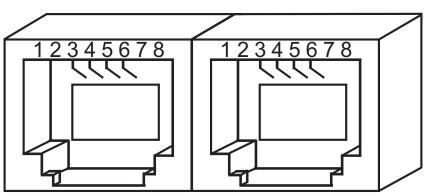


Modular Connector Pin Assignments

	TRANSCEIVER				
Position	– 485	–485D	–4000	–485X	–TB5
1	Not used	Not used	Not used	Not used	Not used
2	Not used	Not used	Not used	Not used	Not used
3	Not used	Not used	Not used	Not used	Not used
4	Line –	Line –	Line	Line	Line –
5	Line +	Line +	Line	Line	Line +
6	Not used	Not used	Not used	Not used	Not used
7	Not used	Not used	Not used	Not used	Not used
8	Not used	Not used	Not used	Not used	Not used

Note: Connections are bussed between the two connectors.

R2D



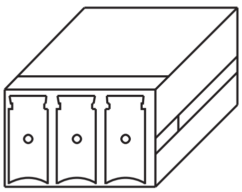
Dual Unshielded RJ-11/45 Receptacle

Modular Connector Pin Assignments

	TRANSCEIVER				
Position	– 485	–485D	–4000	–485X	–TB5
1	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	N/A	N/A
3	Not used	Not used	Not used	Not used	Not used
4	Line –	Line –	Line	Line	Line –
5	Line +	Line +	Line	Line	Line +
6	Not used	Not used	Not used	Not used	Not used
7	N/A	N/A	N/A	N/A	N/A
8	N/A	N/A	N/A	N/A	N/A

Note: Connections are bussed between the two connectors.

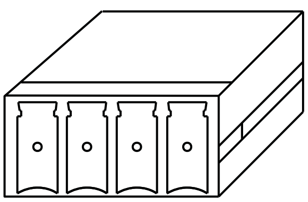
S3



3-position Screw Terminal Receptacle

Pin	TRANSCEIVER – 485	–485D	–4000	–485X	–TPB	–TB5
1	Line +	Line +	Line	Line	Line +	Line +
2	Line –	Line –	Line	Line	Line –	Line –
3	Shield	Shield	Shield	Shield	Shield	Shield

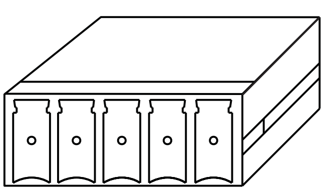
S4



4-position Screw Terminal Receptacle

Pin	TRANSCEIVER –TPB
1	Line +
2	Line –
3	Line +
4	Line –

S5



5-position Screw Terminal Receptacle

Pin	TRANSCEIVER – 485	– 485X	–TPB
A	Line +	Line	Line +
B	Line –	Line	Line –
SH	Shield	Shield	Shield
A	Line +	Line	Line +
B	Line –	Line	Line –

Note: Internally, A is connected to A and B is connected to B.

Glossary & Abbreviations of ARCNET Terms

ARCNET is one of the major LAN technologies well-suited for real-time control applications in both the industrial and commercial marketplace. With its popularity in America, Europe and now China, it's important to understand the common terms associated with this technology.

Alert—Alert Burst. Consists of six unit intervals of mark (logic "1") used at the beginning of all ARCNET transmissions.

ACK—Acknowledgment. An ARCNET frame sent to acknowledge either successful receipt of a data packet or to acknowledge that the destination node has a free data buffer.

Address—Uniquely identifies a station or node.

AMI—Alternate Mark Inversion. Symbols that indicate a mark returns to zero during the bit time and alternates in polarity on successive marks. This type of encoding is used with AC-coupled EIA-485 transmissions.

ARCNET—Attached Resource Computer Network (ARCNET) is a low-cost, token-passing LAN system, developed by Datapoint Corporation in the 1970s.

BACnet—Term for the Building Automation and Control networking protocol (ANSI/ASHRAE Standard 135-2001). BACnet is a non-proprietary communication protocol standard conceived by a consortium of building managers, system users, and manufacturers under the auspices of ASHRAE.

Bandwidth—The maximum capacity of a network channel. Usually expressed in bits per second (bps). ARCNET channels have bandwidths of up to 10 Mbps.

Broadcast—A transmission initiated by one station and sent to all stations on the network.

Category 5—Twisted-pair cable with electrical characteristics suitable for 10/100 twisted-pair Ethernet media systems, but sometimes used with ARCNET cabling.

Coaxial Cable—Electrical transmission cable with a center conductor and an outer electrical shield. Used in both broadband and baseband systems.

CRC—Cyclic Redundancy Check. An error-checking technique used to ensure the fidelity of received data.

Data Link Layer—Layer 2 of the OSI reference model. This layer passes data between the network layer and the physical layer. The data link layer is responsible for transmitting and receiving frames. It usually includes both the Media Access Control (MAC) protocol and Logical Link Control (LLC) layers.

DCE—Data Communications Equipment. Any equipment that relays data between Data Terminal Equipment (DTE). DCEs are not considered end devices or stations.

Dipulse—An encoded symbol to indicate a mark condition consisting of a single sine wave followed by an equal time of inactivity. Originally used for signaling over coaxial cable.

Driver—Software module that interfaces to a specific physical device such as a network interface card.

DTE—Data Terminal Equipment. Any piece of equipment at which a communication path begins or ends. A station (computer or host) on the network capable of initiating or receiving data.

Robust **High Speed** ARCNET **Low Cost** **Simple to Install** **Deterministic**

Baud—A baud is a unit of signaling speed representing the number of discrete signal events per second and, depending upon the encoding, can differ from the bit rate.

Bit—A binary digit. The smallest unit of data, either a zero or a one.

Bit Rate—The amount of bits that can be sent per second. Usually described in units of kbps or Mbps and frequently referred to as the data rate.

Bridge—A device that connects two or more networks at the data link layer (layer 2 of the OSI model).

Bus—A shared connection for multiple devices over a cable or backplane.

Encoding—A means of combining clock and data information into a self-synchronizing stream of signals.

Error Detection—A method that detects errors in received data by Cyclic Redundancy Checks (CRC) or a checksum.

Extended Timeouts—By extending the timeouts on all ARCNET controllers within a network, greater distances in overall cabling can be achieved. This may be a requirement when larger networks with fiber optic segments are to be implemented.

FBE—Free Buffer Enquiry. A frame used to enquire if the receiving node has a free data buffer.

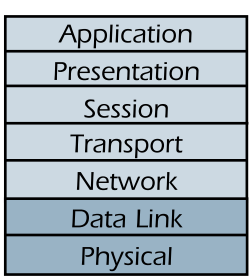
ARCNET—Embedded Network, Industrial LAN or Fieldbus?

ARCNET was originally classified as a Local Area Network or LAN. A LAN is defined as a group of nodes that communicate to one another over a geographically-limited area, usually within one building or within a campus of buildings. That was the intent of ARCNET when it was originally introduced as an office automation LAN by Datapoint Corporation in the late 1970s. Datapoint envisioned a network with distributed computing power operating as one larger computer. This system was referred to as ARC (Attached Resource Computer) and the network, that connected these resources, was called ARCNET.

ARCNET's use as an office automation network has diminished. However, ARCNET continues to find success in the industrial and building automation industries because its performance characteristics are well-suited for control. ARCNET has proven itself to be very robust. ARCNET also is fast, provides deterministic performance, and can span long distances making it a suitable fieldbus technology.

The term fieldbus is used in the industrial automation industry to signify a network consisting of computers, controllers, and devices mounted in the "field." ARCNET is an ideal fieldbus. Unlike office automation networks, a fieldbus must deliver messages in a time-predictable fashion. ARCNET's token-passing protocol provides this timeliness. Fieldbus messages are generally short. ARCNET packet lengths are variable from 0 to 507 bytes with little overhead and, coupled with ARCNET's high data rate, typically 2.5 Mbps, yields quick responsiveness to short messages. Fieldbuses must be rugged. ARCNET has built-in CRC-16 (Cyclic Redundancy Check) error checking and supports several physical cabling schemes including fiber optics. Finally, there must be low software overhead. ARCNET's data-link protocol is self-contained in the ARCNET controller chip. Network functions such as error checking, flow control, and network configuration are done automatically without software intervention.

In terms of the International Organization of Standards OSI (Open Systems Interconnect) Reference Model, ARCNET provides the Physical and Data Link layers of this model. In other words, ARCNET provides for the successful transmission and reception of a data packet between two network nodes.



A node refers to an ARCNET controller chip and cable transceiver connected to the network. Nodes are assigned addresses called MAC (Medium Access Control) address and one ARCNET network can have up to 255 uniquely assigned nodes.

Deterministic Performance

The key to ARCNET's performance and its attractiveness as a control network is its token-passing protocol. In a token-passing network, a node can only send a message when it receives the "token." When a node receives the token, it becomes the momentary master of the network. However, its mastery is short-lived. The length of the message that can be sent is limited and, therefore, no one node can dominate the network since it must relinquish control of the token. Once the message is sent, the token is passed to another node allowing it to become the momentary master. By using token-passing as the mechanism for mediating access of the network by any one node, the time performance of the network becomes predictable or deterministic. In fact, the worst case time that a node takes to deliver a message to another node can be calculated. Industrial networks require predictable performance to ensure that controlled events occur when they must. ARCNET provides this predictability.

Logical Ring

A token (ITT—Invitation to Transmit) is a unique signaling sequence that is passed in an orderly fashion among all the active nodes in the network. When a particular node receives the token, it has the sole right to initiate a transmission sequence or it must pass the token to its logical neighbor. This neighbor, which can be physically located anywhere on the network, has the next highest address to the node with the token. Once the token is passed, the recipient (likewise) has the right to initiate a transmission. This token-passing sequence continues in a logical ring fashion serving all nodes equally. Node addresses must be unique and can range from 0 to 255 with 0 reserved for broadcast messages.

For example, assume a network consisting of four nodes addressed 6, 109, 122, and 255 (see Figure 1). Node assignments are independent of the physical location of the nodes on the network. Once the network is configured, the token is passed to the node with the next highest node address even though another node may be physically closer. All nodes have a logical neighbor and will continue to pass the token to their neighbor in a logical ring fashion regardless of the network's physical topology (see Figure 2).

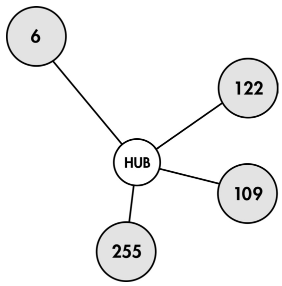


Figure 1. Physical network

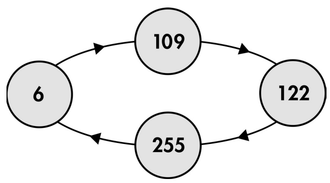


Figure 2. Logical ring

Directed Messages

In a transmission sequence, the node with the token becomes the source node, and any other node targeted by the source node for communication becomes the destination node. First, the source node inquires if the destination node is in a position to accept a transmission by sending out a Free Buffer Enquiry (FBE). The destination node responds by returning an Acknowledgment (ACK) meaning that a buffer is available. If it returns a Negative Acknowledgment (NAK), no buffer is available. Upon an ACK, the source node sends out a data transmission (PAC) with from 0 to 507 bytes of data (PAC). If the data was properly received by the destination node as evidenced by a successful CRC test, the destination node sends another ACK. If the transmission was unsuccessful, the destination node does nothing, causing the source node to timeout. The source node will, therefore, infer that the transmission failed and will retry after it receives the token on the next token pass. The transmission sequence terminates, and the token is passed to the next node. If the desired message exceeds 507 bytes, the message is sent as a series of packets—one packet every token pass. This is called a fragmented message. The packets are recombined at the destination end to form the entire message.

Broadcast Messages

ARCNET supports a broadcast message, which is an unacknowledged message to all nodes. Instead of sending the same message to individual nodes one message at a time, this message can be sent to all nodes with one transmission. Nodes that have been enabled to receive broadcast messages will receive a message that specifies node 0 as the destination address. Node 0 does not exist on the network and is reserved for this broadcast function. No ACKs or NAKs are sent during a broadcast message, making broadcast messaging fast.

Automatic Reconfigurations

Another feature of ARCNET is its ability to reconfigure the network automatically if a node is either added or deleted from the network. If a node joins the network, it does not automatically participate in the token-passing sequence. Once a node notices that it is never granted the token, it will jam the network with a reconfiguration burst that destroys the token-passing sequence. Once the token is lost, all nodes will cease transmitting and begin a timeout sequence based upon their own node address. The node with the highest address will timeout first and begin a token-pass sequence to the node with the next highest address. If that node does not respond, it is assumed not to exist. The destination node address is incremented and the token resent. This sequence is repeated until a node responds. After that time, the token is released to the responding node, and the address of the responding node is noted as the logical neighbor of the originating node. The sequence is repeated by all nodes until each node learns its logical neighbor. At that time the token passes from neighbor to neighbor without wasting time on absent addresses.

If a node leaves the network, the reconfiguration sequence is slightly different. When a node releases the token to its logical neighbor, it continues to monitor network activity to ensure that the logical neighbor responds with either a token pass or a start of a transmission sequence. If no activity is sensed, the node that passed the token infers that its logical neighbor has left the network and immediately begins a search for a new logical neighbor by incrementing the node address of its logical neighbor and initiating a token pass. Network activity is again monitored and the incrementing process and resending of the token continues until a new logical neighbor is found. Once found, the network returns to the normal logical ring routine of passing tokens to logical neighbors.

With ARCNET, reconfiguration of the network is automatic and quick without any software intervention.

Unmatched Cabling Options

ARCNET is the most flexibly cabled network. It supports bus, star, and distributed star topologies. In a bus topology, all nodes are connected to the same cable. The star topology requires a device called a hub (passive or active) which is used to concentrate the cables from each of the nodes. The distributed star (all nodes connect to an active hub with all hubs cascaded together) offers the greatest flexibility and allows the network to extend to greater than four miles (6.7 km) without the use of extended timeouts. Media support includes coaxial, twisted-pair, and glass fiber optics.

NIMS AND HUBS

Network Interface Modules

Each ARCNET node requires an ARCNET controller chip, and a cable transceiver that usually resides on a Network Interface Module (NIM). NIMs also contain bus interface logic compatible with the bus structure they support. These network adapters are removable and are, therefore, termed "modules." ARCNET NIMs are available for all the popular commercial bus structures. NIMs differ in terms of the ARCNET controller they incorporate, and the cable transceiver supported.

ARCNET Controllers

The heart of any NIM is an ARCNET controller chip that forms the basis of an ARCNET node (see Table 1). Datapoint Corporation developed the original ARCNET node as a discrete electronics implementation, referring to it as a Resource Interface Module or RIM. Standard Microsystems Corporation (SMSC) provided the first Large-Scale Integration (LSI) implementation of the technology. Since then, other chip manufacturers were granted licenses to produce RIM chips.

ARCNET Controllers	
MODEL	DESCRIPTION
90C26	First generation controller
90C65	XT bus interface
90C98A	XT bus interface
90C126	XT bus interface
90C165	XT bus interface
90C66	AT bus interface
90C198	AT bus interface
20010	Microcontroller interface
20019	Microcontroller interface
20020	Microcontroller interface
20022	Microcontroller interface
20051+	Integral microcontroller

Table 1. There are several ARCNET controllers in existence.

Today, SMSC and its subsidiary, SMSC–Japan, provide the leadership in new ARCNET chip designs.

Use of Hubs

Hubs facilitate cabling by interconnecting multiple NIMs and, in most cases, they exercise no control over the network. Their primary function is to provide a convenient method of expanding a network.

There are two types of hubs that can perform this task—a passive hub or an active hub.

Passive Hubs

Passive hubs are inexpensive, require no power and their sole purpose is to match line impedances, which they do with resistors. These hubs usually have four ports to connect four coaxial star transceivers. One of the disadvantages of these hubs is that they limit the network to 200 feet and each segment of the network to 100 feet. Also, unused ports must be terminated with a 93-ohm resistor for proper operation. Passive hubs are used on small (four nodes or less) coaxial star networks.

Active Hubs

Active hubs are essentially multi-port electronic repeaters. Although they require power, active hubs support all cabling options, support longer distances than passive hubs, provide isolation, guard against cabling faults, and reflections. These are the hubs which are used to cable distributed star networks.

Unused ports on an active hub need not be terminated. Unlike passive hubs, active hubs do not attenuate signals and can be cascaded. A cable failure will affect only one port on an active hub. Active hubs are available as either internal or external devices. Internal hubs reside inside a computer that also has a NIM, while external hubs are stand-alone devices.

Active hubs can be configured as two-port devices as well. A link is a two-port device with differing cable options on each port, allowing for the transition of one medium type to another such as coaxial to fiber conversion. Sometimes this is referred to as a media converter. A repeater is a two-port device of the same cable option.

TOPOLOGIES

Multiple Topologies

Topology refers to the arrangement of cables, NIMs, and hubs within a network. With ARCNET, there are several choices. Once the topology is specified, the selection of transceivers can proceed.

Point-To-Point

In the point-to-point connection, only two NIMs are used. This is the simplest of networks. Each NIM effectively terminates the other NIM. No hub is required (see Figure 3).

Figure 3. Point-to-Point

Star

The star connection requires hubs. Each NIM connects to one port on the hub that effectively terminates the connected NIM. Since only one NIM is connected to any one hub port, faults in a cable or at a node can be easily isolated. Cabling a facility is often easier with a star topology (see Figure 4).

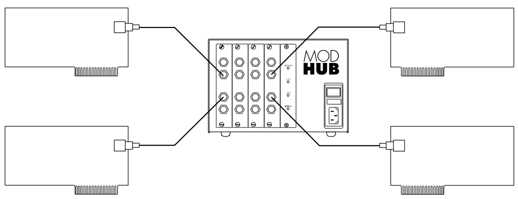


Figure 4. Star topology

Distributed Star (Tree)

If several active hubs are used, a distributed star topology can be implemented. This topology is the most flexible cabling method available in ARCNET LANs since both node-to-hub and hub-to-hub connections are supported. Two or more active hubs, each supporting a cluster of connected nodes, are linked together by a backbone cable.

The distributed star topology helps reduce cabling costs since each node connects to a local hub, eliminating the need to run each node's cable over to one wiring location. Like the star configuration, nodes are isolated from one another (see Figure 5).

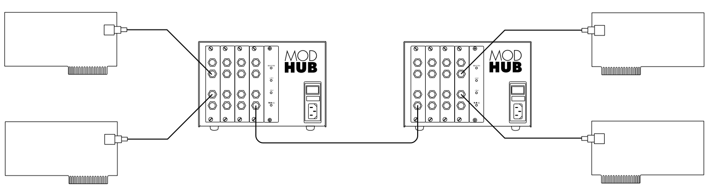


Figure 5. Distributed star topology

Bus

In the bus configuration, NIMs equipped with high impedance transceivers or EIA-485 drivers must be used. Using RG-62/u coaxial cable and BNC "tees," or twisted-pair cable, several NIMs can be connected without the use of a hub. Termination is provided by the installation of a resistive terminator at both ends of the cable segment. The advantage of this configuration is that no hub is required. The disadvantage is that one node failure could disrupt the complete network. Also, cabling distances are less than the star or point-to-point connection (see Figure 6).

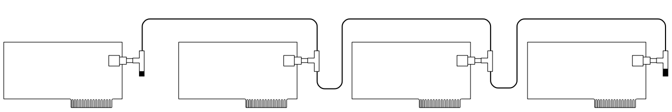


Figure 6. Bus configuration

Star/Bus

To bridge a bus topology to a star requires an active hub. In this case, the active hub acts as both a terminator for the bus and a repeater for the network. Remove the passive terminator from one end of the bus and connect that end to one port on the active hub (see Figure 7). Other ports on the active hub can now be used for other bus or star connections.

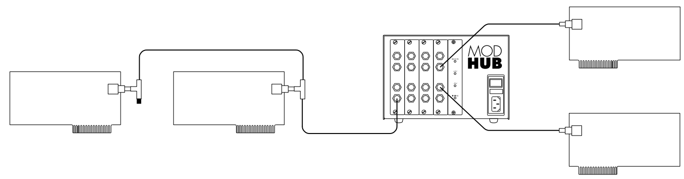


Figure 7. Star/bus topology

Daisy-Chain

Daisy chaining of NIMs requires two connectors or a single connector with redundant connections per NIM. Internally the two connections are bussed together and, therefore, do not truly represent a daisy-chain connection but that of a bus. Daisy chaining is best used with RJ-11 connectors. The unused connectors at each end of the daisy-chain can then be used with RJ-11-style terminators (see Figure 8).

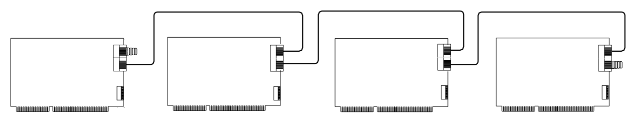


Figure 8. Daisy chaining

Multidrop

A multidrop topology is a variation of the bus topology where a short "drop" cable from the tee connection is allowed. There has not been any study on the effects and limitation of drop cables so this topology is not allowed.

Ring

ARCNET does not normally allow for a ring or a loop connection. Unreliable operation of the network will be experienced if a loop is implemented or if a distributed star topology is violated by introducing a loop connection back to any one node. However, with that said, there are possible implementations of a fiber optic ring that can provide reliable operation and redundancy under certain conditions.

TRANSCEIVERS

Transceiver Options

Various types of transceivers are available depending upon the topology and cable selected. Usually a suffix is appended to the product's model number to identify which transceiver exists with that product. This practice is utilized on both active hub and network interface modules.

Coaxial Star

Typically, ARCNET is cabled with RG-62/u coaxial cable (with BNC connectors) in a star topology, with each NIM connecting directly to a port on an active or passive hub. Alternatively, RG-59/u coaxial cable can be used, but at a cost of reduced distances between a node and a hub. Overall, coaxial cable offers good performance, good noise immunity, low propagation delay, low signal attenuation, sufficient ruggedness, and low cost. The coaxial star configuration also provides the longest coaxial distance and simplified troubleshooting.

Coaxial Bus

RG-62/u coaxial cable can be used in a bus configuration using BNC tee connectors with passive terminators at each end of the cable. Although hubs are not required, cabling options are restricted and troubleshooting is much more difficult. There is a minimum distance between adjacent nodes. Coaxial bus is used when reliable coaxial cable communication is required in a hubless system when shorter distances are involved.

Twisted-Pair Star

Unshielded twisted-pair wiring such as Category 5 or IBM Type 3 (#24 or #22 AWG solid copper twisted-pair cable or telephone wiring) can be used. BALUNs are required at both the hub and NIM to use this cable. Some twisted-pair NIMs and hubs have internal BALUNs so external BALUNs are not needed. Twisted-pair is convenient to install. However, its attenuation exceeds coaxial, its noise immunity is less, and its maximum length between a node and a hub is lower. RJ-11 or RJ-45 connectors are often used with this cable.

Twisted-Pair Bus

The convenience of twisted-pair wiring can be used in a bus configuration without the use of BALUNs. Dual RJ-11 or RJ-45 jacks are provided so modules can be wired in a "daisy-chain" fashion even though electrically they are connected as a bus. Distances are limited as well as node count. Passive terminators are inserted in unused jacks at the far end of the segment. For small hubless systems this approach is attractive.

Glass Fiber Optics

Duplex glass, multimode fiber optic cable uses either SMA or ST connectors and is available in three sizes measured in microns: 50/125, 62.5/125 and 100/140. Larger core sizes launch more energy allowing longer distances. The industry appears to have selected 62.5/125 as the preferred size. This core size, operating with 850 nm transceivers, provides long distances, reasonable cost, immunity to electrical noise, lightning protection, and data security. Glass fiber optic cable is used in hazardous areas and inter-building cabling on campus installations or whenever metallic connections are undesirable. Connectors can be either SMAs or STs. The STs look like a small BNC and are more tolerant to abuse than SMA. ST connectors have become more popular than the traditional SMA connector.

For very long distances up to 14 km, single-mode fiber optics operating at 1300 nm is recommended. Cable attenuation is much less at 1300 nm than at 850 nm.

DC-Coupled EIA-485

One popular cabling standard in industrial installations is EIA-485. A single twisted-pair supports several nodes over a limited distance. Screw terminal connections or twin RJ-11 jacks are provided so that the modules can be wired in a "daisy-chain" fashion. EIA-485 offers a hubless solution, but with limited distance and low common-mode breakdown voltage.

AC-Coupled EIA-485

The EIA-485 transformer-coupled option provides the convenience of EIA-485 connectivity, but with a much higher common-mode breakdown voltage. Distances and node count are reduced from the DC-coupled EIA-485 option. The AC-coupled option is insensitive to phase reversal of the single twisted-pair that connects the various nodes, but may not operate over the full range of data rates of the newer ARCNET controllers.

CABLE

Once the topology and transceiver are specified, the cable can be selected. There are basically three choices in cabling: coaxial, twisted-pair, and fiber optic. Each type has its advantages and when using active hubs all three types of cabling can be mixed within one network—an example of ARCNET's extreme flexibility.

Coaxial Cable

RG-62u was the original choice for cabling ARCNET systems and it is recommended over RG-59/u, if possible. Compared to RG-59/u (75 ohm), RG-62/u (93 ohm) is a better impedance match to the coaxial transceiver, has less attenuation and therefore yields greater distances. Standard BNC connectors and tees are used. Coaxial cable is relatively inexpensive and provides the highest propagation factor compared to other alternatives.

Twisted-Pair

Unshielded twisted-pair cabling can be used with several transceivers including those for EIA-485. We recommend either Category 5 or IBM Type 3 (although other unshielded twisted-pair cable with similar characteristics will also work). Twisted-pair cable is inexpensive and convenient to use and easy to terminate. However, twisted-pair cable has much greater attenuation than coaxial cable and, therefore, has limited distance capability.

Fiber Optics

Fiber offers the greatest distance, but it requires more attention to its application. There are many varieties of cables and cable pairs. The use of 62.5/125 duplex cable for conventional installations and single-mode for long distances is suggested. For indoor applications tight buffering is recommended and for outdoor applications loose buffering is recommended. Study the attenuation figures for the specified fiber to ensure that it is within the available power budget. Fiber optics can span the greatest distance, but has a lower propagation factor than coaxial cable. It may be necessary to calculate the resulting signal delay to ensure it is within ARCNET limits.

Electrical Code

Cable installations must comply with both federal and local ordinances. Plenum-rated (within air distribution systems) and riser-rated (between floors) cables are available, but at a higher cost, to meet the requirements of the National Electric Code (NEC). Consult the relevant documents for applicability when installing an ARCNET network.

COAXIAL CABLE OFFERS GOOD PRICE/PERFORMANCE

The original ARCNET specification called for RG-62/u coaxial cable as the medium between hubs and NIMs. With the desire to eliminate hubs, the bus transceiver was developed, but RG-62/u coaxial cable remained as the specified cable. Therefore, there are two transceivers: coaxial star for distributed star systems and coaxial bus for hubless systems.

P1, P2 Signaling

All ARCNET controller chips develop two signals called P1 and P2 that drive the coaxial transceiver, sometimes referred to as the hybrid, (see Figure 9). Both P1 and P2 are negative true signals of 100 ns in duration with P2 immediately following P1 when operating at the default 2.5 Mbps data rate. These signals occur when an ARCNET controller transmits a logic "1." If a logic "0" is to be transmitted, no pulses are sent and the line remains idle. The sum of P1 and P2 is 200 ns. However, one signaling interval of ARCNET requires 400 ns. The remaining 200 ns are absent of signaling. A center-tapped transformer is wired to two drivers connected to P1 and P2. When P1 is received by the transceiver, the coaxial cable is driven in a positive direction for the duration of the pulse. When P2 is received by the transceiver, the coaxial cable is driven in a negative direction for the duration of the pulse. The resulting signal is called a dipulse that approximates a single sine wave. Since this all occurs over a 200 nanosecond interval, the waveshape appears as a 5 MHz signal instead of 2.5 MHz which is what we would expect with ARCNET. Therefore, cable attenuation calculations should be made at 5 MHz instead of 2.5 MHz. Since the dipulse has no DC component, transformer operation is simplified.

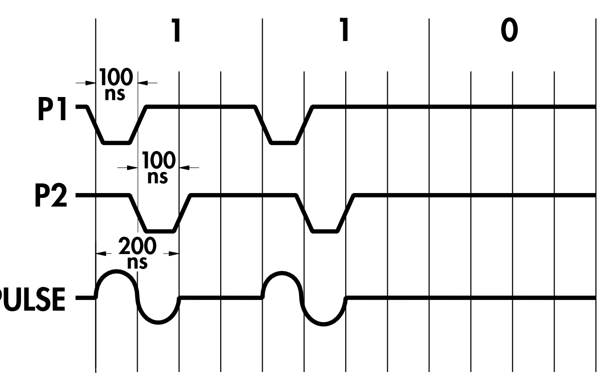


Figure 9. P1, P2 signaling

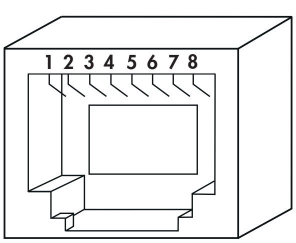
Star vs. Bus

The coaxial star transceiver and the coaxial bus transceiver both receive P1 and P2 signals and generate dipulse signals. However, the star transceiver represents a low impedance (approximately 93 ohms) at all times while the bus transceiver represents a high impedance when idle, allowing for multiple transceivers to be attached to a common bus. Since the two transceivers have a similar appearance, it is important to distinguish one from another.

The capabilities of the two transceivers differ significantly. The star transceiver can drive 2,000 feet (610 m) of RG-62/u cable while the bus can only drive 1,000 feet (305 m). However, the bus transceiver can support eight nodes on a single segment. Connections between nodes are made with BNC tee connectors and coaxial cables of at least six feet (2 m) in length. Passive termination is required at the ends of bus segments. The isolation of the two transceivers is typically 1,000 V DC.

TWISTED-PAIR—INEXPENSIVE AND SIMPLE TO USE

Twisted-pair is also a popular cabling technology. It is inexpensive and easy to terminate. However, it has much higher attenuation than coaxial cable, limiting its use to shorter distances. Frequently, modular jacks and plugs are used to interconnect segments. Twisted-pair cable can be used with conventional coaxial star transceivers if a BALUN is used between the cable and the transceiver. A Patton Electronics Model 400 is recommended for use as an external BALUN. It has a male BNC connector at one end and an RJ-11 jack at the other, and it must be used only with coaxial star transceivers. For convenience, some vendors provide a product that eliminates the need for external BALUNs. The twisted-pair star transceiver incorporates an internal BALUN along with a coaxial star transceiver together as one unit. Simply connect to the provided RJ-11 jack. When using BALUNs, only star and distributed star topologies are supported. No phase reversal of the wiring is allowed. Many modular plug patch cables invert the wiring. To test for this, hold both ends of the cable side by side with the remaining clips facing the same direction. The wire's color in the right-most position of each plug must be the same if there is no inversion of the cable. If this is not the case, the cable is inverted.



Modular Connector Pin Assignments

4-Contacts		6-Contacts		8-Contacts	
Pin	Usage	Pin	Usage	Pin	Usage
1		1		1	
2	LINE–	2		2	
3	LINE+	3	LINE–	3	
4		4	LINE+	4	LINE–
		5		5	LINE+
		6		6	
				7	
				8	

Twisted-Pair Bus

For hubless systems, twisted-pair bus transceivers can be used. Since modular jacks are used and a bus connection is required, two jacks (internally wired together) are provided on each NIM. Field connections are then made in a daisy-chain fashion to each successive NIM. The remaining end jacks are then plugged with passive terminators. A modular plug terminator is available for this use. Each daisy-chain cable must not invert the signals and must be at least six feet long for reliable operation.

Hubs can be used to extend twisted-pair bus segments. Use a twisted-pair star hub port in place of the passive terminator at one end of the segment. Connect to the twisted-pair star port on the hub using an "inverted" modular plug cable. This is necessary since the BALUN in the twisted-pair star port creates a signal inversion that is not compatible with the twisted-pair bus port. The interconnecting inverted cable "rights" the signal. Connect the second twisted-pair bus segment in a similar fashion using an additional twisted-pair star port.

Data Rate Selection

Conventional ARCNET NIMs communicate only at a 2.5 Mbps rate. Newer generation COM20019, COM20020, COM20022, and COM20051 ARCNET controllers have a prescaler that allows communication at other speeds. Although lower data rates facilitate longer bus segments, variable speed hub electronics are required to service these rates. Of course, for hubless systems this is not a problem. Data rates down to 19 kbps are possible with the 20019 controller and as high as 10 Mbps with the 20022. Do not change the data rate on systems with conventional dipulse transceivers since the transceiver is tuned to 2.5 Mbps and can only operate at that data rate.

Backplane Mode

The COM20019, COM20020, COM20022, and COM20051 ARCNET controller family offers additional interfaces not available in earlier generation controllers. Upon power up, the chips default to conventional ARCNET mode where P1 and P2 signals are generated to develop the required dipulse signal. However, if backplane mode is programmed into these chips, the P1 signal is stretched into a 200-ns signal and P2 becomes a clock. The sense of the receiver pin (RXIN) is inverted so that it may be tied directly to the negative true P1. In the simplest configuration, the P1 and RXIN pins of all the controllers that are to communicate to one another, are tied together using a single pull-up resistor. The bus segment must remain extremely short limiting this configuration to applications of several nodes communicating within one instrument (see Figure 10).

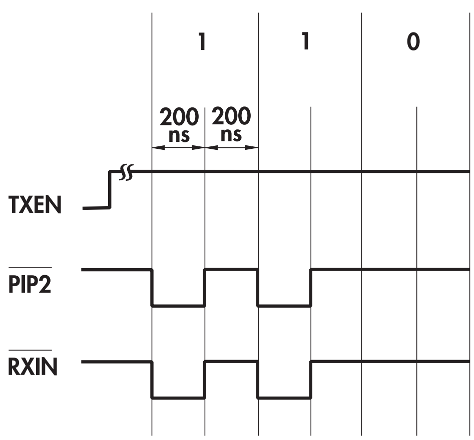


Figure 10. Backplane mode

However, the distances can be extended significantly if driver and receiver electronics are inserted between the P1 signal and RXIN. A logical choice would be EIA-485 due to the popularity of the standard. To implement a party line EIA-485 requires one additional signal called TXEN that is generated by the newer chips. This signal is ignored in conventional dipulse mode and unavailable on earlier ARCNET controllers.

EIA-485—A Popular Industrial Standard

EIA-485 standard supports multimaster operation and is, therefore, suitable for use with ARCNET in either backplane or non-backplane modes. Non-backplane mode implementations require an extended P1 signal and the signal TXEN. Two EIA-485 implementations are supported on ARCNET, DC-coupled and AC-coupled. The capabilities of each approach are different.

DC-Coupled 485

The original EIA-485 specification deals with the problem of data transmission over a balanced transmission line in a party-line configuration. With ARCNET, any node can transmit, enabling multiple drivers and receivers to share a common twisted-pair cable. EIA-485 does not specify a data-link protocol and, therefore, a means must be provided that ensures only one driver has access to the medium at any one time. ARCNET provides its own Medium Access Control (MAC), and it is used to successfully implement the EIA-485 network (see Figure 11).

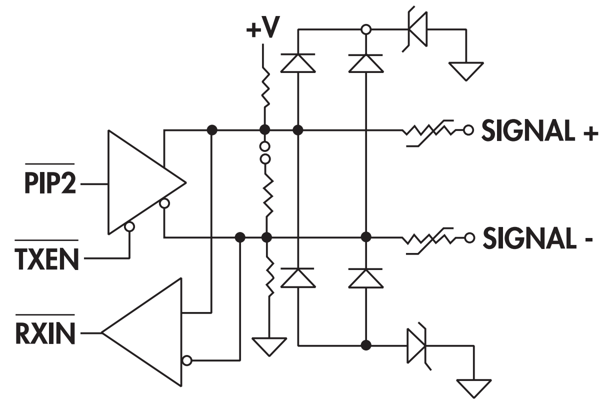


Figure 11. DC-coupled EIA-485

SMSC has made recommendations on how to implement EIA-485 with ARCNET. They studied reflections, signal attenuation, and DC loading. Since EIA-485 does not specify a modulation method or cabling, rules need to be developed for ARCNET-based EIA-485 networks.

To reduce reflections, terminate the cable in its characteristic impedance. Since the driver can be located anywhere along the network, a terminator must be supplied at both ends of the cable. It is recommended that unshielded or shielded twisted-pair cable with characteristic impedance of 100 to 120 ohms be used. Therefore, terminators of similar value must reside at each end of the segment.

Only one driver is enabled at any one time in an operating network. But there are times when no drivers are operational causing the twisted-pair cable to float. Noise and reflections along the line can cause the various receivers to incorrectly detect data creating data errors. These receivers need to be biased into their "off" state to ensure reliable operation. Decreasing the bias resistance improves immunity to reflections, but it can load the drivers excessively. Also, the amount of bias required increases with the number of receivers on the line. Since differential receivers are used, both pull-up and pull-down resistors are required to properly bias the receivers. Through experimentation, SMSC recommends an optimal biasing resistor of 810 ohms. It is recommended that this resistance be distributed over two modules—each located at the ends of a segment in order to simplify the cabling rules.

The modules at the ends of the segment will be strapped for biasing resistors and a line terminator while all other modules will have no biasing or termination. Since two modules are being used to supply bias, their resistors will be increased to 1600 ohms. With this approach, a total of 17 nodes can share a single segment up to 900 feet (274 m) in length.

Although differential line drivers and receivers are used, this fact does not remove the need for a common ground among all the nodes. A cold water pipe connection is a possibility. The common-mode voltage experienced by any one node should not exceed +/- 7 volts. A good grounding system would ensure that this requirement is met.

AC-Coupled EIA-485

One method to achieve a much higher common-mode rating is to transformer-couple the EIA-485 connection (see Figure 12). SMSC has developed such an approach achieving a common-mode rating of 1,000 V DC. This implementation does not require biasing resistors, as does the DC-coupled approach. However, line terminators must still be applied at each end of the cable segment. The AC-coupled EIA-485 approach has the additional advantage that connections to each node are insensitive to phase reversal. This is because the symbol on the cable reverses polarity on successive logic "1"s. This is called Alternate Mark Inverted (AMI) and is incompatible with the DC-coupled EIA-485 which is RZ encoded. Polarity of the wiring need not be observed. However, this implementation is rated at 13 nodes maximum over 700 feet (213 m) of cable (see Figure 13).

Extending bus segments beyond the 700 or 900 foot (213–274 m) limit is possible with the introduction of active hubs.

AC-coupled design may not operate over all data rates so the vendor specifications should be studied.

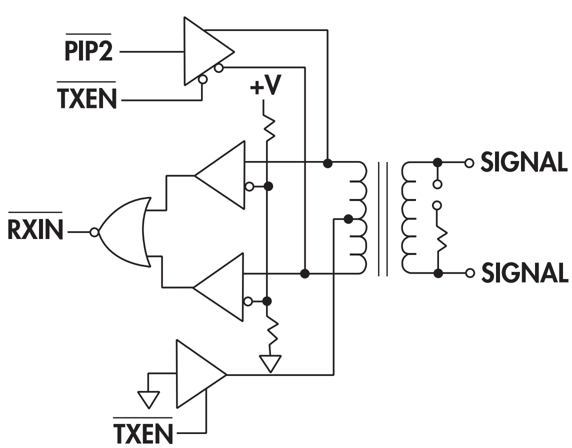


Figure 12. AC-coupled EIA-485

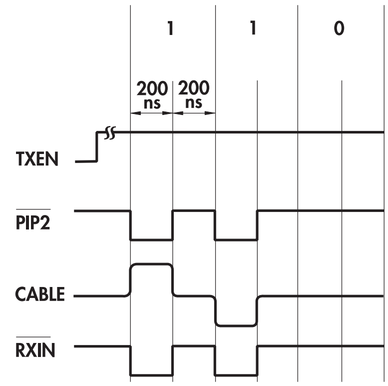


Figure 13. Alternate Mark Inverted Encoding

Termination

A benefit of using active hubs is that no passive termination is required at each port nor must unused ports be terminated. Only bus segments of either coaxial or twisted-pair cabling require termination. Termination for twisted-pair cable includes EIA-485. In general, passive termination equal to the characteristic impedance of the cable needs to be applied at each end of the bus segment. If one end of the bus segment attaches to a port on an active hub, no termination is required at that end.

For RG-62/u cable, use a 93-ohm terminator attached to a BNC tee connector. For twisted-pair cable, use a matching terminator that plugs into the unused RJ-11 connector at each end of the bus segment. If no RJ-11 connector exists, use a discrete resistor attached to screw terminals or with some NIMs—an onboard terminator can be invoked by inserting a jumper.

APPLYING FIBER OPTICS TO ACHIEVE A ROBUST DESIGN

The use of fiber optics in LANs, such as ARCNET, has increased due to the inherent advantages of using fiber. High data rates can be maintained without electromagnetic or radio frequency interference (EMI/RFI). Longer distances can be achieved over that of copper wiring. For the industrial/commercial user, fiber offers high-voltage isolation, possible intrinsic safety, and elimination of ground loops in geographically-large installations. ARCNET will function with no difficulty over fiber optics as long as some simple rules are followed.

There are varying types of fiber optic cabling, but basically the larger size fiber (in diameters of 50, 62.5, and 100 μm for conventional installations) is recommended. With this size fiber, multimode operation will occur, requiring the use of graded-index fiber. Transceivers operating at 850 nm wavelength offer a good performance/cost tradeoff.

A duplex cable is required since each fiber optic port consists of a separate receiver and transmitter which must be cross-connected to the separate receiver and transmitter at the distant end. Only star and distributed star topologies are supported.

For distances beyond 3 km, single-mode fiber optics used with 1300 nm transceivers is recommended. With this approach, segment lengths up to 14 km can be realized.

Optical Power Budget

When specifying a fiber optic installation, attention must be paid to the available optical power budget (see Table 2). The power budget is the ratio of the light source strength to the light receiver sensitivity expressed in dB. This value must be compared to the link loss budget that is based upon the optical cable and optical connectors. The link loss budget must be less than the power budget. The difference is called the power margin which provides an indication of system robustness.

Optical Power Budget (25° C) in dB		
Fiber Size	Wavelength	
(Microns)	850 nm	1300 nm
Single-mode	N/A	13.0
50/125	6.6	21.0
62.5/125	10.4	22.0
100/140	15.9	N/A
200/230 PCS	9.4	N/A

Table 2. Optical power budget

Transmitter power is typically measured at one meter of cable and, therefore, includes the loss due to at least one connector. The outputs vary so each device should be tested to ensure that a minimum output power is achieved (see Table 3). The output power also varies with core sizes. In general, larger cores launch more energy.

Minimum Transmitter Output Power (25° C) in dBm			
Fiber Size	NA	Wavelength	
(Microns)	(Numerical Aperture)	850 nm	1300 nm
Single-mode	N/A	N/A	-22.0
50/125	0.200	-18.8	-14.0
62.5/125	0.275	-15.0	-13.0
100/140	0.300	-9.5	N/A
200/230PCS	0.400	-16.0	N/A

Table 3. Minimum transmitter output power

Receiver sensitivity also varies so tests should be run to determine the least sensitive receiver (see Table 4). The difference between the weakest transmitter and least sensitive receiver is the worst case power budget that should be specified. Realized power budgets will exceed this value since the probability of the worst case transmitter being matched with the worst case receiver is remote. However, it is recommended to use the stated power budgets for each core size.

Minimum Receiver Sensitivities (25° C) in dBm		
Fiber Size	Wavelength	
(Microns)	850 nm	1300 nm
Single-mode	N/A	-35.0
50/125	-25.4	-35.0
62.5/125	-25.4	-35.0
100/140	-25.4	-35.0
200/230 PCS	-25.4	N/A

Table 4. Minimum receiver sensitivity

Link Loss Budget

The cable manufacturer usually specifies the fiber optic cable attenuation for different wavelengths of operation. Use this figure to determine the maximum distance of the fiber link. It is necessary to include losses due to cable terminations. Connectors usually create a loss between 0.5 to 1 dB. For example, assume a 1500 m run of 62.5 cable that the manufacturer specifies as having an attenuation of 3.5 dB per 1000 m. The cable loss will be 5.25 dB. Assuming two connector losses of 0.5 dB each, the link loss budget would be 6.25 dB which is within the 10.4 dB power budget specified. The 4.15 dB difference represents a high degree of margin. A 3 dB margin is what is typically recommended.

Overdrive

Overdrive occurs when too little fiber optic cable is used — resulting in insufficient attenuation. To correct this condition, a jumper is typically removed in each fiber optic transceiver to reduce the gain sufficiently to allow for a zero length of fiber optic cable to be installed between a transmitter and receiver. This is potentially a problem with 100 μm cable.

CALCULATING PERMISSIBLE SEGMENT LENGTHS

A segment is defined as any portion of the complete ARCNET cabling system isolated by one or more hub ports. On a hubless or bus system, the complete ARCNET cabling system consists of only one segment with several nodes, however, a system with hubs has potentially many segments. An ARCNET node is defined as a device with an active ARCNET controller chip requiring an ARCNET device address. Active and passive hubs do not utilize ARCNET addresses and, therefore, are not nodes. Each segment generally supports one or more nodes but in the case of hub-to-hub connections, there is the possibility that no node exists on that segment.

The permissible cable length of a segment depends upon the transceiver used and the type of cable installed. The following table (see Table 5) provides guidance on determining the constraints on cabling distances as well as the number of nodes allowed per bus segment.

Permissible Cable Lengths and Nodes Per Segment (2.5 Mbps)

Transceiver Description	Cable	Connectors	Cable Length		Max Nodes	Notes
			Min	Max	Bus Segment	
coaxial star	RG-62/u	BNC	0	2000ft/610m	N/A	5.5 dB/1000ft max
coaxial star	RG-59/u	BNC	0	1500ft/457m	N/A	7.0 dB/1000ft max
coaxial bus	RG-62/u	BNC	6ft/2m[1]	1000ft/305m	8	5.5 dB/1000ft max
duplex fiber optic (850 nm)	50/125	SMA or ST	0	3000ft/915m	N/A	4.3 dB/km max
duplex fiber optic (850 nm)	62.5/125	SMA or ST	0	6000ft/1825m	N/A	4.3 dB/km max
duplex fiber optic (850 nm)	100/140	SMA or ST	0[2]	9000ft/2740m	N/A	4.0 dB/km max
duplex fiber optic (1300 nm)	single-mode	ST	0	46000ft/14000m	N/A	0.5 dB/km max
duplex fiber optic (1300 nm)	50/125	ST	0[2]	32800ft/10000m	N/A	1.5 dB/km max
duplex fiber optic (1300 nm)	62.5/125	ST	0[2]	35000ft/10670m	N/A	1.5 dB/km max
twisted-pair star	IBM type 3	RJ-11	0	328ft/100m	N/A	uses internal BALUNs
twisted-pair bus	IBM type 3	RJ-11, screw	6ft/2m[1]	400ft/122m	8	
DC-coupled EIA-485	IBM type 3	RJ-11, screw	0	900ft/274m	17	DC-coupled
AC-coupled EIA-485	IBM type 3	RJ-11, screw	0	700ft/213m	13	transformer isolated

[1] This represents the minimum distance between any two nodes or between a node and a hub.

[2] May require a jumper change to achieve this distance.

Table 5. Permissible cable lengths and nodes per segment

The maximum segment distances were based upon nominal cable attenuation figures and worst case transceiver power budgets. Assumptions were noted.

When approaching the maximum limits, a link loss budget calculation is recommended.

When calculating the maximum number of nodes on a bus segment, do not count the hub ports that terminate the bus segment as nodes. However, do consider the maximum length of the bus segment to include the cable attached to the hub ports.

Several bus transceivers require a minimum distance between nodes. Adhere to this minimum since unreliable operation can occur.

DATA LINK LAYER

ARCNET's data-link protocol is fully described in ANSI/ATA 878.1-1999 Local Area Network: Token Bus. Copies are available from the ATA office. ARCNET is properly classified as a token bus technology since a token is the primary means of mediating access to the cable. It operates under the source/destination model since the destination of the message must be identified during a transmission. The term bus implies that each ARCNET node is capable of monitoring all the traffic on the network regardless of destination. This is important when the network is being reconfigured or the detection of a lost token is to be determined. Even when hubs are being used, it is important that all nodes on the network are capable of monitoring all the traffic on the network in order for ARCNET's data link layer to function properly.

Conventional ARCNET operates at 2.5 Mbps and much of the timing information presented assumes that speed. At this speed, a signal element on the medium must occur within 400 ns. For a logic 1, the symbol is a dipulse. For a logic 0, there is the absence of a dipulse. Putting symbols together creates basic symbol units.

Basic Symbol Units

Basic symbol units are the elements used to construct basic frames and reconfiguration bursts.

<**SD**>— Starting Delimiter

1 1 1 1 1 1 (6 symbols)

All ARCNET frames begin with six logic 1s. This is referred to as the Alert Burst.

<**RSU**>— Reconfiguration Symbol Unit

1 1 1 1 1 1 1 1 0 (9 symbols)

<**ISU**>— Information Symbol Unit

1 1 0 d0 d1 d2 d3 d4 d5 d6 d7 (11 symbols)

Each information unit contains 8 bits of data and a 3-bit preamble "110." The definition and value of the data are as follows:

<**SOH**>— Start of Header

0x01

Used to identify a packet

<**ENQ**>— Enquiry

0x85

Used to identify a request for a free buffer.

<**ACK**>— Acknowledgment

0x86

Used to identify acceptance

<**NAK**>— Negative Acknowledgment

0x15

Used to identify non-acceptance

<**EOT**>— End of Transmission

0x04

Used to identify a token pass to the logical neighbor.

<NID>— Next Node Identification

0x01 to 0xFF

Used to identify the next node in the token loop. The NID is the logical neighbor of the node with the token.

<SID>— Source Node Identification

0x01 to 0xFF

Used to identify the source node of a packet transmission.

<DID>— Destination Node Identification

0x00 to 0xFF

Used to identify the destination node of a transmission request or a packet transmission.

<CP>— Continuation Pointer

0x03 to 0xFF

Used to identify the length of packet. In short packet mode (0 to 252 bytes), the CP requires only one ISU. In long packet mode (256 to 507 bytes), the CP requires two ISUs.

<SC>— System Code

0x00 to 0xFF

Used to identify a high-level protocol. System codes generally require one ISU, but two ISU system codes exist. System codes have been assigned by Datapoint Corporation. The ATA has a list of system code assignments.

<...DATA...>— Data

Contains the user data. The number of ISUs can range from 0 to 252 in short packet mode and 256 to 507 in long packet mode. Packets which contain 253, 254, or 255 ISUs cannot be sent. Packets of this size are called exception packets and must be padded with null data and sent as a long packet.

<FCS>— Frame Check Sequence

0x00 to 0xFFFF

Contains the appended Cyclic Redundancy Check (CRC-16) for the packet sent. Two ISUs are required.

Frame Format

There are two frame formats with ARCNET. The basic frame format provides control and information between the nodes while the reconfiguration burst is unique to the reconfiguration process. Frames are constructed by putting together basic symbol units.

Basic Frames

There are only five basic frames in the ARCNET data link layer protocol. The five basic frames are as follows:

ITT—Invitation to Transmit (token)
<SD><EOT><NID><NID>

FBE—Free Buffer Enquiry
<SD><ENQ><DID><DID>

ACK—Acknowledgment
<SD><ACK>

NAK—Negative Acknowledgment
<SD><NAK>

PAC—Packet
<SD><SOH><SID><DID><DID><CP><SC>
<...DATA...><FCS>

INVITATION to TRANSMIT (ITT)			
SD	6 bits =	2.4	μs
EOT	11 bits =	4.4	
NID	11 bits =	4.4	
NID	11 bits =	4.4	
		15.6	

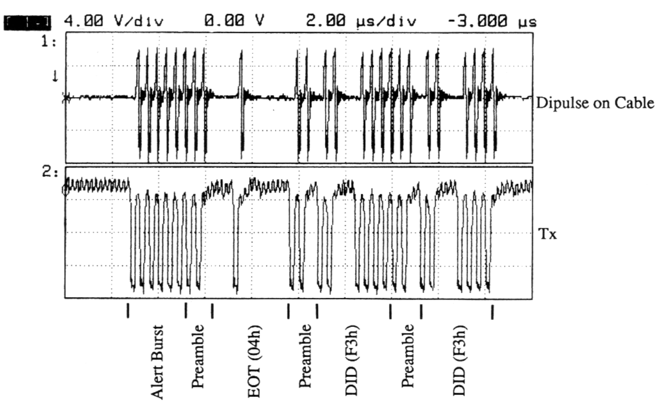
FREE BUFFER ENQUIRY (FBE)			
SD	6 bits =	2.4	μs
ENQ	11 bits =	4.4	
DID	11 bits =	4.4	
DID	11 bits =	4.4	μs
		15.6	

ACKNOWLEDGMENT (ACK)			
SD	6 bits =	2.4	μs
ACK	11 bits =	4.4	
		6.8	μs

NEGATIVE ACKNOWLEDGMENT (NAK)			
SD	6 bits =	2.4	μs
NAK	11 bits =	4.4	
		6.8	μs

SHORT PACKET (PAC)			
SD	6 bits =	2.4	µs
SOH	11 bits =	4.4	
SID	11 bits =	4.4	
DID	11 bits =	4.4	
DID	11 bits =	4.4	
CP	11 bits =	4.4	
SC	11 bits =	4.4	
*n Characters	nx 11 bits=	4.4 n	
FCS	22 bits =	8.8	
		37.6	
		+4.4 n	µs
* 1 less than the number of bytes following CP			

LONG PACKET (PAC)			
SD	6 bits =	2.4	µs
SOH	11 bits =	4.4	
SID	11 bits =	4.4	
DID	11 bits =	4.4	
DID	11 bits =	4.4	
CP	22 bits =	8.8	
SC	11 bits =	4.4	
*n Characters	nx11 bits =	4.4 n	
FCS	22 bits =	8.8	
		42.0	
		+4.4 n	µs
* 1 less than the number of bytes following CP			



There are a few things to notice with these five frames. When passing the token, the NID is sent twice. Likewise, the DID is sent twice when requesting a transmission or sending a packet. The source of an ACK or NAK is not identified. It is implied to come from the destination node. The only time the source node is identified is during a packet transmission. It is not sent during an FBE. It is implied that an FBE comes from the source node.

System Codes

The byte immediately following the continuation pointer in every ARCNET packet must be a system code that acts as a protocol identifier. This allows a number of protocols using independent message formats to coexist on a single physical network. Every packet must have a system code even if there is no intention of supporting multiple protocols on the network.

System code 0x80 is reserved for general-purpose diagnostic use. Any node can send a packet with system code 80 at any time. Any node receiving a packet with system code 80 ignores the packet.

System codes for different operating systems and manufacturers have been assigned by Datapoint Corporation.

Reconfiguration Burst

The reconfiguration burst is a special frame only used in the reconfiguration process. It is a jam signal of sufficient length to destroy any activity occurring on the network ensuring that all nodes are aware that a reconfiguration of the network will take place.

RECON—Reconfiguration Burst

<RSU><RSU>...<RSU> 765 RSUs

DETERMINISTIC TRANSMISSION TIMES

Since ARCNET uses a token-passing means to arbitrate station access to the medium, the time it takes to transmit messages is predictable. In order to make these calculations, it is necessary to understand certain delays inherent in the ARCNET controller and the cable used to interconnect the various stations. The delays due to the ARCNET controller are scalable to the data rate used. The delays at 5 Mbps are half as much as the delays at 2.5 Mbps. The delays due to cabling are not scalable. What follows are the delays for conventional ARCNET operating at 2.5 Mbps.

Tta—Turnaround Time

The ARCNET controller chip has a response time of about 12.6 µs. This is the time between the end of a received transmission and the start of a response to that transmission.

Tpt—Medium Propagation, Token Pass to Logical Neighbor

The medium propagation time is the time it takes for the transmission of a symbol from one point to the receipt of the same symbol at another point. The medium propagation constant varies with the type of media used. In the case of coaxial cable use 4 ns/m; for fiber optics use 5 ns/m; and for twisted-pair use 5.5 ns/m. Therefore, the length of the medium between transmitter and receiver must be known or approximated for calculation purposes. Sometimes an average length is used to simplify calculations. The parameter Tpt refers to the time it takes for a symbol to travel from the node with the token to its logical neighbor. For standard timeouts Tpt should not exceed 31 µs. Remember, this is the one-way propagation time.

Tpm—Medium Propagation, Source Node to Destination Node

Since transmissions can occur between any two nodes, the time it takes for a symbol to travel from the source of the transmission to the destination must be known. Use the same propagation constants as above but determine the distance between the source node and the destination node. For standard timeouts, Tpm should not exceed 31μs.

Tpd—Broadcast Delay Time

Broadcast delay time is the time that elapses from the end of a transmitted broadcast packet until the start of a token pass. At standard timeouts this time is about 15.6 μs.

Trp—Response Timeout

Response timeout is the maximum time a transmitting node will wait for a response. It is approximately equal to two times the maximum medium propagation delay of 31 μs plus the turnaround delay of the ARCNET controller chip. If the response time is exceeded, the transmitting node will assume the destination node is not on the network. The response timeout is about 75.6 μs, and it scales with extended timeouts.

Trc—Recovery Time

This is the time that elapses from the end of a response timeout until the start of a token pass. Trc is about 2 μs.

Tac—Timer Activity Timeout

The timer activity timeout represents the maximum amount of time that the network can experience no activity. If this time is exceeded, a reconfiguration sequence is initiated. The Tac is approximately 82.4 μs.

Token Pass				
ITT	15.6	μs		
Tta	12.6		+	Tpt
	28.2	μs	+	Tpt

Token Pass and Short Packet of n Data Bytes (Successfully Delivered)				
ITT	15.6	μs		
Tta	12.6		+	Tpt
FBE	15.6			
Tta	12.6		+	Tpm
ACK	6.8			
Tta	12.6		+	Tpm
PAC	37.6		+	4.4n
Tta	12.6		+	Tpm
ACK	6.8			
Tta	12.6		+	Tpm
	145.4	μs		
			+	4.4n
			+	Tpt
			+	4Tpm

Token Pass and Packet (Destination Node Receiver Inhibited)				
ITT	15.6	μs		
Tta	12.6		+	Tpt
FBE	15.6			
Tta	12.6		+	Tpm
NAK	6.8			
Tta	12.6		+	Tpm
	75.8	μs		
			+	Tpt
			+	2Tpm

Token Pass and Short Packet of n Data Bytes (Broadcast)				
ITT	15.6	μs		
Tta	12.6		+	Tpt
PAC	37.6		+	4.4n
Tpd	15.6			
	81.4	μs		
			+	4.4n
			+	Tpt

Token Pass and Short Packet of n Data Bytes (Lost ACK)				
ITT	15.6	μs		
Tta	12.6		+	Tpt
FBE	15.6			
Tta	12.6		+	Tpm
ACK	6.8			
Tta	12.6		+	Tpm
PAC	37.6		+	4.4n
Trp	75.6			
Trc	2.0			
	191.0	μs		
			+	4.4n
			+	Tpt
				2Tpm

Token Pass and Packet (Inactive Destination)				
ITT	15.6	μs		
Tta	12.6		+	Tpt
FBE	15.6			
Trp	75.6			
Trc	2.0			
	121.4	μs		
			+	Tpt

Token Pass and Packet (No Response)		
ITT	15.6	μs
Trp	75.6	
Trc	2.0	
	93.2	μs

Calculating Transaction Times

With a knowledge of delay constants and the times required to send different ARCNET frames, calculating transaction times for various transmissions is possible. Precise calculations require a knowledge of the propagation delay constant of the cable as well as the distance between any two nodes that are communicating. This could be complex. A more simplified approach would be to approximate the network by modeling it as a star topology with one central hub. All cable segments would be set equal with the network diameter matching that of the network being modeled. This would mean that the two propagation times (Tpt, Tpm) would be equal and would not change as a function of which two nodes were communicating. Using this model the token loop time can be easily calculated.

CALCULATING TOKEN LOOP TIME

With the above information, the time it takes to make a complete loop of the network can be calculated. Assume there were eight active nodes each connected to a central hub with 85 meters of coaxial cable. The cable distance between any two nodes would be 170 m. Therefore, the two propagation delays would be equal. Assume that the hub delay is 320 ns.

Tpt = Tpm = 170(4) + 320 = 1.0 μs

Each token pass would take 29.2 μs. The total token pass time for all eight nodes would be 233.6 μs.

Now assume that one node successfully transmits a 100 byte message while all other nodes simply pass the token. The time required to pass the token and complete a short packet (100 byte) transmission would be as follows:

Token pass and short packet =

145.4 + 4.4(100) + Tpt + 4Tpm
145.4 + 440 + 1 + 4 = 590.4 μs

Couple this time with seven other token passes (204.4 μs) yields a token loop time of 794.8 μs.

Other combinations of events can be similarly calculated.

EXTENDING ARCNET'S DISTANCE

Extended Timeouts

Originally, ARCNET was specified to have a four-mile (6.7 km) maximum distance limitation which could be achieved with eleven segments of RG-62/u coaxial cable and ten active hubs. The resulting 22,000 feet (6.7 km—slightly more than four miles) represented the worst-case distance between two extreme nodes. Actually, the distance constraint has more to do with time delay. With standard timeouts, the round trip propagation delay between any two nodes plus the turnaround time (the time for a particular ARCNET node to start sending a message in response to a received message which is 12.6 μs) shall not exceed the response timeout of 75.6 μs. This means that the one-way propagation delay shall not exceed 31 μs which is approximately what 22,000 feet (6.7 km) of coaxial cable and ten hubs represent. For the vast majority of systems, this is not an issue. However, when considering a fiber optic system, a delay budget calculation should be performed to determine if extended timeouts are required.

There are four possible timeouts that can be selected using register bits ET1 and ET2 in the ARCNET controller chip. It must be remembered that all ARCNET nodes in the network must be set for the same timeout settings. Upon power-up, all ARCNET controllers assume the standard timeout of 75.6 μs (ET1-ET2=1). Besides the response time, extended timeouts affect the idle time (the time a node waits before incrementing the next ID counter during a reconfiguration) and the reconfiguration time (the time a node waits before initiating a reconfiguration burst). The accompanying table (based upon a 2.5 Mbps data rate) shows the relationship (see Table 6).

ET2	ET1	Response Time (μs)	Idle Time (μs)	Reconfig Time (μs)
0	0	1209.6	1318.4	1680
0	1	604.8	659.2	1680
1	0	302.4	329.6	1680
1	1	75.6	82.4	840

Table 6. Extended timeouts

Delay Budget

Every attempt should be made to ensure that the ARCNET system functions with the standard or default timeouts. This would simplify the installation and maintenance of the network since all ARCNET controllers default to the lesser timeout setting upon power-up without any software intervention.

Use the accompanying chart to sum all the delays encountered between the two geographically furthest nodes (see Table 7). Include the delays resulting from both hubs and cables. Notice that the propagation delay for coaxial cable is less than for fiber optic cabling. If the total amount of one-way direction delay for the worst case situation exceeds 31 μs, then the timeouts must be extended.

Component	Delay (ns)
Passive hub	10/hub
Active hub	320/hub
RG-62/u cable	4/meter
RG-59/u cable	4/meter
IBM type 3 cable	5.5/meter
Single-mode fiber	5/meter
50/125 fiber cable	5/meter
62.5/125 fiber cable	5/meter
100/140 fiber cable	5/meter

Table 7. Delay budget

SOFTWARE AND STANDARDS

OSI Model

The Open Systems Interconnection (OSI) model (see Figure 14) describes the various layers of services that may be required in order for two or more nodes to communicate to one another. ARCNET conforms to the physical layer and the Medium Access Control portion of the data-link layer as defined by IEEE. All layers above the data-link layer collectively are called the protocol stack and the number of services available or used by differing applications vary. The software required to bind a network interface module to a protocol stack is called a driver and many different drivers exist for ARCNET. Drivers require an understanding of the specific ARCNET controllers and should be independent of the protocol above it. The customer has many options.

APPLICATION	
PRESENTATION	
SESSION	
TRANSPORT	
NETWORK	
DATA LINK	Logical Link Control Medium Access Control
PHYSICAL	

Figure 14. OSI Model

Collapsed Stack or Null Stack

The application layer is tied directly to the data link layer. The protocol is provided by the application itself. Customers usually select this proprietary approach when speed of execution is critical and connectivity to other systems is of little interest. A custom driver is written for this implementation. This is a very popular approach for embedded networking (see Figure 15).

APPLICATION
Data Link — ARCNET
Physical — ARCNET

Figure 15. Collapsed stack

ControlLink

SMSC developed IEEE 802.2 services which provide logical link control (LLC) above the MAC sub-layer. This is of interest to some customers.

IPX/SPX

This Internet working standard was developed by Novell and supported by Microsoft derived from the Xerox Network System (XNS) and used with Novell's NetWare. Microsoft's version is called NWLINK (see Figure 16).

APPLICATION
Transport — SPX
Network — IPX
Data Link — ARCNET
Physical — ARCNET

Figure 16. IPX/SPX

NDIS

The Network Driver Interface Specification (NDIS) was developed by Microsoft and 3Com and is used with Windows for Workgroups, Windows 95, 98, and Windows NT. This is a driver specification which allows an ARCNET card to bind to either NetBEUI, IPX/SPX or TCP/IP, or any other protocol for which an NDIS-compatible protocol driver has been written. NDIS 4.0 is a 32-bit driver standard, but Microsoft's support of ARCNET under NDIS has been weak.

NetBIOS

ATA endorsed this session level software adhering to IBM and Microsoft standards. It is used with several peer-to-peer network operating systems and, frequently, the interface to ARCNET systems. NetBIOS may also be added on top of TCP/IP and IPX/SPX.

NetBEUI

The NetBIOS Extended User Interface is both a NetBIOS interface and protocol. This standard is frequently found in Microsoft networks.

ODI

The Open Data-Link Interface (ODI) was developed by Novell and is supported by Microsoft. It is used with Novell's NetWare but can operate on Microsoft platforms beginning with Windows for Workgroups 3.11.

Packet Driver

This standard, created by FTP Software, provides a standard method for applications to interface with compatible real-mode network card drivers. Packet drivers are frequently used by DOS machines and can be used with protocol stacks.

TCP/IP

These protocols from the Internet world are becoming increasingly popular. TCP functions as the transport layer and IP functions at the network layer. These products provide ARCNET connectivity to the Internet (see Figure 17). When installing ARCNET adapters, make sure the proper driver is available from either the adapter supplier or the equipment OEM who specifies the ARCNET adapter.

APPLICATION
Transport — TCP
Network — IP
Data Link — ARCNET
Physical — ARCNET

Figure 17. TCP/IP

WINDOWS DRIVER SUPPORT FROM CONTEMPORARY CONTROLS

We provide Null Stack drivers for Windows 95, 98, ME, 2000, and XP for our PCX20, PCM20, PCI20, AI-USB, and AI-SRVR products. These drivers allow an application to initialize and send/receive raw ARCNET messages. Applications can use the drivers in a polled mode or in an event-driven mode. We provide two methods of interfacing to the drivers. The drivers can use DeviceIOControl function calls for all but the AI-USB and AI-SRVR products. We also provide a DLL interface that allows simple function calls to initialize and send/receive ARCNET messages. An application written using our driver DLL allows it to be utilized with any of our ARCNET NIM products.

We provide NDIS drivers for Windows 95, 98, ME, NT, 2000, and XP for our PCX20, PCM20, and PCI20. This will allow an application to send/receive TCP/IP, IPX/SPX, and NetBEUI over ARCNET. However, there are issues with NDIS support of ARCNET in certain versions of Windows.

More information can be found in our FAQ section of our website. When using a Windows OS, we generally recommend the use of our Null Stack drivers.

Customer Service Information

Warranty

Contemporary Controls (CC) warrants its product to the original purchaser for one year from the product's shipping date. If a CC product fails to operate in compliance with its specification during this period, CC will, at its option, repair or replace the product at no charge. The customer is, however, responsible for shipping the product. CC assumes no responsibility for the product until it is received. This warranty does not cover the repair of products that have been damaged by abuse, accident, disaster, misuse, or incorrect installation.

CC's limited warranty covers products only as delivered. User modification may void the warranty if the product is damaged by installation of the modifications, in which case this warranty does not cover repair or replacement.

This warranty in no way warrants suitability of the product for any specific application.

IN NO EVENT WILL CC BE LIABLE FOR ANY DAMAGES INCLUDING LOST PROFITS, LOST SAVINGS, OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE PRODUCT EVEN IF CC HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, OR FOR ANY CLAIM BY ANY PARTY OTHER THAN THE PURCHASER.

THE ABOVE WARRANTY IS IN LIEU OF ANY AND ALL OTHER WARRANTIES EXPRESSED OR IMPLIED OR STATUTORY, INCLUDING THE WARRANTIES OR MERCHANTABILITY, FITNESS FOR PARTICULAR PURPOSE OR USE, TITLE, AND NONINFRINGEMENT.

Repair or replacement as provided above shall be the purchaser's sole and exclusive remedy and CC's exclusive liability for any breach of warranty.

Technical Support

Contemporary Controls (U.S.A.) will provide technical support on its products by calling +1-630-963-7070 extension Operator each weekday (except holidays) between 8:00 a.m. and 5:00 p.m. Central Time. Contemporary Controls Ltd (U.K.) will provide technical support on its products by calling +44 (024) 7641 3786 each weekday (except holidays) between 8:00 a.m. and 5:00 p.m. United Kingdom time. If you have a problem outside these hours, leave a voice-mail message in the CC after-hours mailbox after calling our main phone number. You can also fax your request by calling 1-630-963-0109 (U.S.) or +44 (024) 7641 3923 (U.K.), or contact us via e-mail at info@ccontrols.com or info@ccontrols.co.uk. You can visit our website at www.ccontrols.com. When contacting us, please leave a detailed description of the problem. We will contact you by phone the next business day or in the manner your instructions indicate. We will attempt to resolve the problem over the phone. If unresolvable, the customer will be given an RMA number so the product may be returned to CC for repair.

Warranty Repair

Products under warranty that were not subjected to misuse or abuse will be repaired at no charge to the customer. The customer, however, pays for shipping the product back to CC while CC pays for the return shipment to the customer. CC normally ships ground. International shipments may take longer. If it has been determined that the product was misused or abused, CC will provide the customer with a quotation for repair. No chargeable work will be done without customer approval.

Non-Warranty Repair

CC provides a repair service for all its products. Repair charges are based upon a fixed-fee basis depending upon the complexity of the product. Therefore, Customer Service can provide a quotation on the repair cost at the time a Returned Material Authorization (RMA) is requested. Customers pay the cost of shipping the defective product to CC and will be invoiced for the return shipment to their facility. No repair will be performed without customer approval. If a product is determined to be unrepairable, the customer will be asked if the product can be replaced with a refurbished product (assuming one is available). Under no circumstances will CC replace a defective product without customer approval. Allow ten working days for repairs.

Contemporary Controls' influence and financial support led to the creation of the ARCNET Trade Association (ATA) in August 1987. Its objective is to develop working standards for ARCNET and to promote the use of ARCNET as a viable networking technology. The ATA is recognized by the American National Standards Institute (ANSI) as a standards development body. It was instrumental in achieving ANSI recognition of the original ARCNET standard and with the revision ANSI/ATA 878.1–1999 Local Area Network: Token Bus. This organization continues to work on other standards that would simplify the implementation of ARCNET in various industries from printing to chemical processing to transportation. The ATA is regarded as a worldwide clearing house for information about this technology.

The ATA has become a virtual organization. Visit their website at www.arcnet.com

ARCNET Trade Association

The ATA has a standards committee that has developed or is developing ARCNET-related standards. Besides endorsing an ARCNET NetBIOS, the ATA is involved with three standards.

- **ANSI/ATA 878.1–1999 Local Area Network: Token Bus**
  This approved standard defines the basic ARCNET technology as well as recommending certain practices that increase reliability and interoperability.

- **ATA 878.2 ARCNET Packet Fragmentation Standard**
  This proposed standard addresses the problem of handling data packets that exceed the maximum number of characters that can be sent in one ARCNET transmission. The data packet is fragmented into manageable ARCNET frames that are recombined at the destination node. The standard is based upon RFC 1201.

- **ATA 878.3 Encapsulation Protocol Standard**
  This proposed standard defines a method in which industry standard master/slave protocols can be encapsulated into ARCNET allowing for multimaster operation.

References

ARCNET Designer's Handbook, Document 61610, Datapoint Corporation, 1983

ARCNET Cabling Guide, Document 51087, Datapoint Corporation, 1988

ARCNET Factory LAN Primer, Contemporary Control Systems, Inc., 1987

RS-485 Cabling Guidelines for the COM 20020, Technical Note 7–5, Revision E, Standard Microsystems Corporation, May 1994

ARCNET's Already Flexible Physical Layer Enhanced with Several EIA–485 Variants, George Thomas, FieldComms USA, June 1997

Notes

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Celebrating

Years in Control

On June 23, 2005, Contemporary Controls celebrated its 30th anniversary. Throughout the years, we have been committed to our mission and serving the needs of our customers in the controls industry. We see the future as one of more progress in all areas of the research and development process. The future holds promise for us to expand our international territory as a supplier of industrial networking products.

For the most up-to-date information on our products, data sheets, and product catalogs visit our website: www.arccontrol.com.

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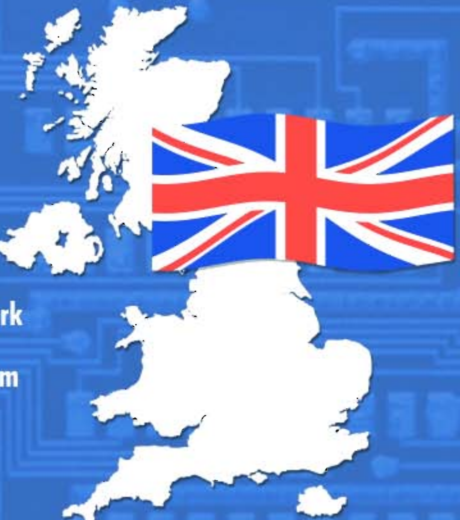

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