APPLICATION NOTE

Baseband ARCNET® To Broadband Interface

AN-201

INTRODUCTION

Broadband communication systems offer the advantage of accommodating multiple voice and data signals over the same coaxial cable. This type of system is frequently found in large manufacturing and process plants, or in large campuses where cabling lengths are significant and vendors are discouraged from installing proprietary cabling systems. Although more complex than baseband systems (one signal over one cable), broadband offers exceptional flexibility in that the cable system remains in place as user equipment is added or deleted from the broadband network. Of course, this flexibility only exists for broadband compatible user equipment, but is not the case with equipment supporting conventional baseband ARCNET communication. For ARCNET equipment to function over a broadband system, a baseband to broadband interface is required. This interface can be implemented using Contemporary Control Systems, Inc. (CCSI)MOD HUBplus active hub with an installed MXFI-BB broadband interface. The MOD HUBplus enclosure has built-in two ports of baseband ARCNET BNC connections. A baseband ARCNET node or hub is connected to either one of these ports using RG-62/u coaxial cable. Connection to the broadband network is accomplished using a length of RG-6/u coaxial cable with F connectors at each end. One end attaches to a user tap on the broadband network and the other end to the RF data modem, which is part of the MXP-BB broadband interface. This cable is usually referred to as drop cable, and the terminating resistor that is attached to the user end must be removed before connecting the RF data modem. All other baseband nodes requiring attachment to the broadband network are similarly connected using the same equipment configuration.

Broadband Communication System

A broadband communication system in a plant is similar to a cable access television (CATV) system and is actually derived from CATV standards. At the beginning of the cabling system is the headend splitter which creates several spurs, or legs, of cabling to which RF data modems are attached. Attached to the RF data modems are user equipment. The logic-level data stream of “1s” and “0s” from the user equipment to the modems results in corresponding frequency-shifted-keyed(FSK) tones on the cable system. These frequency shift tones occupy a single channel; however, transmit and receive channel frequencies are not the same, thereby facilitating full duplex operation. The receive channel and transmit channel are separated by 192.25 MHz and together are called a channel pair. RF data modems transmit at the lower frequency of the channel pair and receive at the higher. To the broadband network, the lower frequencies are called inbound channels and the higher frequencies outbound. Although there are many channel pairs, the IEEE 802.4 specification requires that equipment with signaling speeds of 1 MHz and above, such as ARCNET, be allocated to channels beginning with 2'-O. Because of the RF data modern used for this application, five channel pairs are available for user equipment allowing for the mixing of five local area networks (LANS) onto one cable.

Channel pairs supported by the RF data modems used as part of the baseband to broadband interface are as follows:

Channel Pair	Transmit Frequency (Mhz)	Receive Frequency (Mhz)
2’ to O	53.75 - 59.75	246 - 252
3’ to P	59.75 - 65.75	252 - 258
4’ to Q	65.75 - 71.75	258 - 264
4A’ to R	71.75 - 77.75	264 - 270
5’ to S	77.75 - 83.75	270 - 276

Practice has it that a channel pair can be fully specified by simply identifying the receive channel. Therefore, the five available channels are: O, P, Q, R and S. This is important since all nodes of any one network must operate over the same channel pairs. An RF data modem operating over channel P cannot communicate to one operating over channel R. In fact, the channel pair must be specified when ordering so that the appropriate RF data modem is selected. For example, MXP-BBP specifies a broadband interface operating over channels 3’ and P.

In addition to providing cable spurs to RF data modems, the headend has also attached a major piece of equipment. Since RF data modems “talk” on one channel but “hear” on another, equipment is needed to convert the lower frequency transmit data to the higher receive frequency so that all RF data modems on the network can hear the transmitting modem. Either a translator or remodulator can provide this up conversion and are attached to the headend. The remodulator is superior to the translator because weak receive signals are retransmitted at standard signal levels. Translators simply provide the up conversion. There are two types of translators. The modular translator was designed for modular cabling systems or what is called a pre-engineered system. This is a cabling system that “rolls out of the box.” It has precut cable lengths and provisions for user taps. There are no amplifiers in the system, so the system is referred to as a passive system. The modular translator can translate five channel pairs but will only work on passive systems.

A higher performance translator is also available for active systems (cable systems with amplifiers). These translators support either five bands (five channel pairs) or one band for the same cost. If additional performance is required, a remodulator can be selected; however, remodulators are higher in cost and support only one band. For a five band system, five remodulators would be required. It is important to verify that either a remodulator or a translator is present at the headend that supports the channel pair that is to be used.

A typical system would have a four or eight port splitter located at the headend with two of the splitter taps used for translator or remodulator connections. Usually four spurs emanate from the splitter with any unused ports plugged. To reduce line losses and cable delay, a high-grade 1/2” or 3/4” coaxial cable serves as the “backbone” for the spurs. Approximately every 1000 feet, amplifiers are installed which pass inbound signals up to the headend and outbound signals away from the headend. Four port user taps are located at convenient intervals down each spur. User connections are provided by 100 foot RG-6/u drop cables connected to the user taps with an F connector at the user end. Unused cables must be plugged with terminating resistors. The insertion loss for user taps and splitters vary and are determined by the architects of the broadband system.

These are the components that make up a broadband communication system, but are not supplied as part of the baseband ARCNET to broadband interface. It is assumed that a broadband communication system is already installed and working with the proper cable, headend, translator or remodulator, splitters, and user taps. To attach an ARCNET signal to this network requires connection of the RF data modem supplied with the interface package to an unused drop cable on the communication system. This is done for every ARCNET node that is to be attached to the broadband system. The best analogy is that we are providing a compatible telephone to an existing telephone network. We are not concerned about the telephone network itself.

MODHUBplus

The MODHUB*plus* active hub was designed to accommodate extended range ARCNET applications over non-conventional media. An example of such an application is connecting ARCNET to long-haul twisted-pair cable which is accommodated by the use of an expansion module installed into the MODHUB*plus* active hub. The MODHUB*plus* provides the specialized timing electronics required to handle the excessive delay and jitter experienced with twisted-pair cable. This same timing electronics is necessary since similar disturbances will be experienced on broadband systems. The MODHUB*plus* also has two permanent coaxial baseband ARCNET ports for conventional ARCNET connections. An ARCNET node is attached to one of these two ports. Baseband ARCNET signals consist of a dipulse to represent a logic “1” and no pulse for a logic “0.” The dipulse is detected and transferred to the MODHUB*plus* backplane for use by the expansion modules inserted into its housing. For broadband systems, a broadband expansion module is required.

MXP-BB BROADBAND INTERFACE

The MXP-BB broadband interface consists of a broadband expansion module that installs into the MODHUB*plus*, an external RF data modem, and a 3 foot-shielded cable that connects the two devices. The broadband expansion module serves several purposes besides supplying 5 volt power to the RF data modem. The modem requires separate receive and transmit signals which must be extracted from the ARCNET signal. These same signals must also be conditioned to RS-422 levels to be compatible with the modem. The logic “1” signal present on the MODHUB*plus* backplane is in return-to-zero (RZ) format. The RF data modem requires a non-return-to-zero (NRZ) format for operation. To obtain this format requires a 20 MHz clock derived from the MODHUB- *plus* timing electronics. When a dipulse is received from an ARCNET node connected to one of the baseband ports, an RZ signal is presented to the broadband expansion module which converts the signal to NRZ format. This signal is used to generate transmit enable and transmit data signals to the RF data modem. When the RF data modem receives a signal, it generates carrier and receive data signals to the broadband expansion module. This data stream is converted to dipulses by the MODHUB*plus* circuitry which is fed to the baseband ARCNET nodes via the two BNC ports. Another concern is the excessive jitter and delay that is introduced by the broadband system which cannot be accommodated by conventional active hubs. The timing module on the MODHUB*plus* has a buffer that captures data with a high degree of jitter and retransmits the data back onto the network at normal data spacing. In this way, jitter on the network does not accumulate. In addition to interface circuitry, status indicators on the broadband expansion module assure that the RF data modem is operating properly. In addition to “carrier” and “data” detection circuits, a “modem alarm” circuit is present to verify that a proper headend system is present on the network.

RF Data Modem

Attachment to the broadband communication system requires the use of an RF data modem. An Allen-Bradley 3 MHz

LAN/PC-2 broadband modem accommodates the 2.5 MHz switching speed of ARCNET. The RF data modem has a type F female connector for attachment to the broadband network. Both transmit and receive signals coexist on this connector. Power and logic signals are made to a male DB-15 connector. Logic signals to and from the modem are RS-422 compatible and include separated receive data and transmit data signals along with some control signals. Five different RF data modems exist to cover the five available channel pairs. Modems cannot be field converted to a different channel pair. A watchdog timer is also present on the modem. If the modem continues to transmit for longer than 10 ms, it will disable automatically.

CALCULATING NETWORK DELAYS

In a conventional baseband ARCNET system, delays are introduced due to cable length and active hub delays. If the network delay exceeds 31 µs between the two furthest nodes, extended timeouts must be selected on each network interface adapter; otherwise, the system will become unreliable. Attention must also be paid to delays in broadband systems.

Delays in broadband systems are due to cable length, RF data modems, amplifiers, translators, or remodulators. Use the following table to calculate a delay budget.

Device	Delay (µs)	Per Unit
Translator	4	ea
Remodulator	4	ea
Amplifier	0.1	ea
RF Data Modem	2	ea
1/2" Cable	1.0	1000 ft
RG-6/u	1.2	1000 ft
Splitter	0	ea
User Taps	0	ea
MODHU*Bplus*	1.2	ea

Broadband systems consist of spurs emanating from a headend, and it is only necessary to consider the length of the longest spur. With this configuration, the worst case delay is experienced by two nodes located at the far end of the longest spur. If one node communicates to the other, the first node transmits down the spur to the headend and the destination node receives the transmission sent back by the headend. Therefore, the delay due to the cable is twice that which would be expected. For example, assume a broadband system consists of a translator, four spurs of 1500, 2400, 2600 and 3000 feet, drop cables of 100 feet each, and amplifiers located every 1000 feet. The delay budget would be calculated as follows:

Device	Delay (µs)	Comment
Translator	4.0	only one per system
Amplifier	0.4	2 amps but inbound and outbound delays
1/2” Cable	6.0	6000’ round trip
RG-6/u	0.24	2 drops
RF Data Modem	4.0	2 modems
MODHUB*plus*	2.4	2 broadband interfaces
	17.04	

The 17.04µs delay is well within the 31µs allowed for ARCNET. Therefore, standard timeouts can be used.

SIGNAL STRENGTH

The IEEE 802.4 specification dictates the appropriate signal levels for broadband signals. The RF data modem transmits at a minimum level of +35 dBmv and a maximum level of +50 dBmv and receives at levels between -10 dBmv to +14 dBmv. There are no user adjustments for output level.

INSTALLATION

The first decision when specifying equipment is the selection of the MODHUB*plus* enclosure. There are two choices of enclosures. The MHP-S is a four slot tabletop mount, while the MHP-SF is a four slot flange-mounted enclosure suitable for panel board installations. Both units can be specified for 220 volt 50 hertz operation by adding an "E" to the end of the MODHUB*plus* part number. The user can then connect the appropriate IEC style power cord for the country of interest.

The second decision that must be made is the selection of the frequency pair that is to be used making sure that the channel pair is available and that a headend translator exists for the selected channel pair. There are only five possible channel pair choices and, therefore, five MXP-BB model numbers. The receive channel letter description specifies the proper MXP-BB broadband interface and the RF data modem unique to the specified channel pair. The broadband expansion module that is included in the MXP-BB interface is the same for all frequencies. This module is inserted into the empty slot of the MODHUB*plus*. A three-foot shielded cable is then installed connecting the RF data modem with the broadband expansion module.

Generally, an RG-62/u drop cable is available for broadband user equipment. Disconnect the terminator from the end of the drop cable and connect the cable to the female "F" connector located on the RF data modem. That completes the broadband connection.

There are two BNC baseband connectors on the MODHUB*plus* timing module (this is the module that is permanently installed into the MODHUB*plus*). Both of these ports are coaxial star ports (-CXS, low impedance); therefore, no external terminators are required when connecting to ARCNET baseband equipment. However, there are several rules that must be followed. Only use one of these two baseband ports since ALL ARCNET nodes must appear on the broadband system as peers to one another. Therefore, more than one bus connected ARCNET node cannot be attached to one MODHUB*plus*. If the ARCNET equipment has a high impedance bus transceiver, then connect a "T" connector and a 93 ohm terminator at the transceiver end, but no terminator at the MODHUB*plus* end. Standard ARCNET cabling rules apply for making the baseband ARCNET connection. Power can now be applied to the MODHUB*plus*.

Indicator Lights

There are indicator lights present on the timing module, broadband expansion module, and RF data modem that can be quite helpful to the installer. The timing module indicators, when lit, are defined as follows:

RECON – A network reconfiguration is taking place. (Note: The RECON detection is only valid if the TIMING light is on.)

+PWR – The +5 volt power supply within the hub is functioning properly.

-PWR – The -5 volt power supply within the hub is functioning properly.

TIMING – A valid ARCNET signal is present from either one of the baseband ports or from the broadband system; and the internal timing circuitry within the hub is properly regenerating the signal.

In addition to the above indicators, the timing module has two unmarked indicators adjacent to the BNC connectors. These are port activity indicators that light when the port is "receiving" data from a device connected to the port.

The broadband expansion module also has indicators whose definitions, when they are lit, are as follows:

MODEM ALARM – No carrier echo from the broadband system was experienced within a prescribed time frame.

DATA – Data has been "received" from the broadband system other than the data sent by the broadband expansion module.

CARRIER – A carrier has been detected on the broadband system.

The RF data modem also has an indicator.

POWER – Indicates that +5 volt power is present in the modem which is sourced by the MODHUB*plus*.

Checkout

During checkout the various indicators can be quite helpful. Disconnect both the broadband and baseband cabling to each ARCNET baseband to broadband interface. The following indicators should be lit on each interface: RECON, +PWR, -PWR and POWER. Connect an active baseband node to one interface, and the MODEM ALARM should light on the timing module. The interface is trying to transmit on the broadband system, but cannot detect any data or carrier. Therefore, the DATA and CARRIER indicators are off. The system continues to send reconfiguration bursts in its attempt to link up to another ARCNET node. The other interfaces on the system will not show a MODEM ALARM since they are not transmitting.

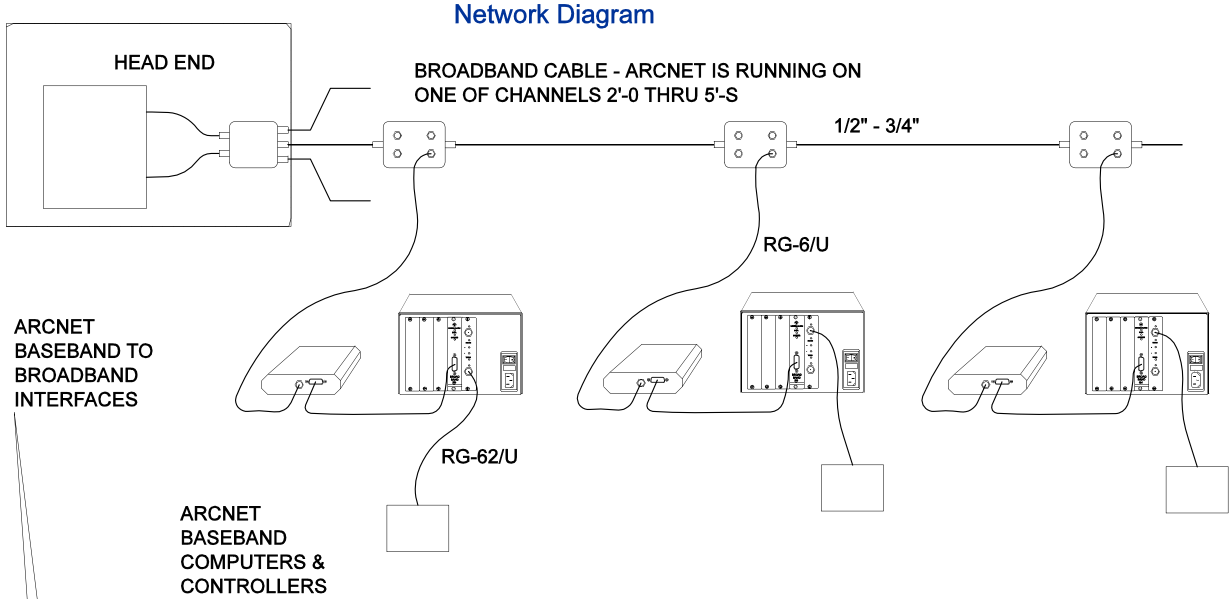
Connect the broadband cable to all the interfaces. The interface with the active baseband node connected should not indicate a modem alarm if the proper headend translator is installed and functioning. Reconfiguration bursts will continue to occur since no other nodes are on the broadband network, but the CARRIER indicator will now be lit since the interface will detect its own carrier sent to the headend. However, the DATA light will remain off. It only displays data received from other nodes and not its own because it regards its own data as an invalid echo. However, all other interfaces will have their DATA and CARRIER indicators on since they are receiving the reconfiguration bursts from the one node on the network.

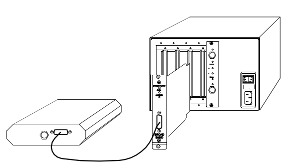
Connect another baseband node to one of the other broadband interfaces, and the RECON light should extinguish. All interfaces should have their DATA, CARRIER, TIMING, PWR and POWER lights on. RECON and MODEM ALARM should be off, and the port activity lights should be on for those ports with active baseband ARCNET ports connected. This is the normal status for all the indicator lights.

Factory Testing

CCSI has established a broadband network at its facility to system test the baseband ARCNET to broadband interface. The broadband network consists of a modular translator, 1000' of cable, with splitters of sufficient attenuation to test the gain of the RF data modem. CCSI's standard ARCNET data integrity test is then imposed upon the network to ensure a reliable system.

MODHUBplus Broadband Solution
Network Diagram





MHP-S	MODHUBplus ENCLOSURE	
MHP-SF	MODHUBplus FLANGE MOUNT ENCLOSURE	
MXP-BBO	ARCNET TO BROADBAND CHANNEL PAIR	2'-O
MXP-BBP	ARCNET TO BROADBAND CHANNEL PAIR	3'-P
MXP-BBQ	ARCNET TO BROADBAND CHANNEL PAIR	4'-Q
MXP-BBR	ARCNET TO BROADBAND CHANNEL PAIR	4A'-R
MXP-BBS	ARCNET TO BROADBAND CHANNEL PAIR	5'-S

ORDERING

The complete baseband ARCNET to broadband interface requires a MODHUB*plus* enclosure and a MXP-BB broadBand interface specified for the desired channel.

MODEL	**DESCRIPTION**	
MHP-S	MODHUB*plus* Enclosure	
MHP-SF	MODHUB*plus* Enclosure Flanged-mounted	
MXP-BBO	ARCNET to Broadband Channel Pair	2'-O
MXP-BBP	ARCNET to Broadband Channel Pair	3'-P
MXP-BBQ	ARCNET to Broadband Channel Pair	4'-Q
MXP-BBR	ARCNET to Broadband Channel Pair	4A'-R
MXP-BBS	ARCNET to Broadband Channel Pair	5'-S

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