

Transfer Switch Communications

Technical Data

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General Description

The purpose of a communication network is to move data from one place to another. This Technical Data will describe the variety of methods for moving data from Automatic Transfer Switch equipment to remote devices such as computers, modems and operator interface terminals.

Physical Connections

An important consideration for moving data from one point to another deals with the physical characteristics of the network. These characteristics are divided into topics including topology, media and physical signaling issues.

Topology

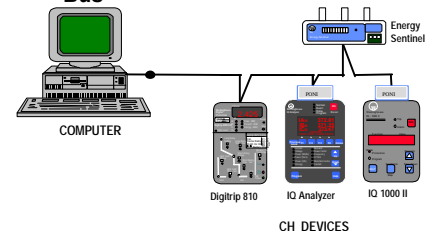
Defines how devices are connected to each other. Typically we have 2 main types of connections.

- **Point to Point**



A type of connection where two stations communicate over a dedicated link. RS-232 connections always use the point-to-point topology. Advantages include low cost and simple connections. Disadvantages include the complexity and cost of adding additional nodes.

- **Bus**



Multiple devices connected on a common wire. Advantages include reduced wiring and ease of installation. Disadvantages include loss of communication to multiple devices during a wire break.

Media

How the network is physically connected together. Data is typically transmitted over (in increasing cost):

- **Straight wires** - An example is telephone cable (26 gauge, 4 conductor)
- **Twisted Shielded Pair (TSP)** - 2 conductor, twisted wire with a metal shield around it. The wire is twisted and shielded to help prevent electrical noise from getting onto the wire or from the communication wire into other circuits. (Noise is undesirable as it can change the 1's to 0's in a message, altering the meaning of the message.)
- **2 TSP** - Two twisted shield pair of wires in a single cable used for networks that have separate transmit receive requirements or that send duplicate signals down 2 cables to check for data corruption.
- **Coax cable** - A single conductor surrounded by a plastic material, a shield, and an outside coating.
- **Fiber Optic Cable** - A thin glass or plastic tube used to conduct light signals.
- **Air** - No physical wires.

Physical Signaling

The signal level and type used to transmits the 1's and 0's on a network. Examples include:

- **Voltage level** - Different voltage levels mean a 1 or a 0 (i.e. +12V=1, -12V=0)
- **Impedance** - Different impedance's signify 1 or 0.
- **Frequency** - Different frequency levels (FSK- FM radio is an example) or amplitudes of the frequency(ASK- AM radio...) corresponds to a 1 or a 0.
- **Light** - Presence or absence of light signify a 1 or 0.

The physical specification contributes to cost, how many devices are supported on the network, the distance the network will cover, the reliability of the data, and the availability of the data. A point to point network, over existing spare telephone lines, using voltage signals may be inexpensive for data from one device, but is expensive if you communicate to more than one device (one wire to each device) and the data is not very reliable as electrical noise can corrupt the data easily

Protocol

Once the data moves from one place to another, a format must be defined such that the both ends of the network

understand what the various combinations of 1's and 0's mean. The meaning of those 1 and 0 combinations is termed the "protocol" The protocol consists of:

Bit Rate

Defines how fast data is transmitted, designated in bits per second. While not technically correct, common usage equates the term "baud" with bits per second (i.e. 9600 baud = 9600 bits per second or approx. 0.02 seconds to transmit 200 bits). Baud (from Jean-Maurice-Emile Baudot, the French inventor of the teletype) technically means the number of signal transitions per second. Since modern modulation schemes encode multiple bits into one signal transition, baud and bit rate are not equivalent. Also, since baud defines the number of signal transitions per second, it is a measure of a rate, where rate means number of occurrences per second. Therefore, the common usage of the phrase "baud rate" is incorrect. The word "rate" is redundant as it would be translated as "signalling rate rate". Unfortunately, the incorrect phrase "baud rate" is in common usage and most telecommunications professionals will not question your use of that phrase.

Access method or bus arbitration

Decides when a device sends data. There are several methods:

- **Master - slave**
A single device (i.e. a personal computer) controls and manages the communications on the network. It asks for information from devices (slaves) on its network and gives information to the slaves. The key disadvantage is that it is expensive to add additional masters to the network.
- **Peer to peer**
Each of the devices on a network can talk on the network, directly to any other device on the network. The communication is managed in a couple of ways. One method is a token, or permission to speak, is passed around the network to each device in turn. The node with the token tells what it has to say and asks what it needs to know, then passes the token to the next device. Another method is multiple access, collision detection. In that method, a given device checks for network activity if it needs information or needs to send information. If no other node is heard, it transmits to the network. If another device is talking, it waits until the first device is done. If two devices talk at once,

both devices realize it, stop talking, wait a different and predetermined amount of time before starting again. Each device on the network has a different amount of wait time, depending on its priority and the amount of time since it last spoke. This minimizes the likelihood of a reoccurrence of the collision.

Message Structure

Defines size, how messages are organized, and what messages mean. Each 1 or a 0 is a single bit. A message can consist of any number of bits. The position of the bit as well as its value (0,1) is important and defined by the protocol. Messages contain overhead; information necessary to determine where the message came from, the type of message it is, the intended destination of the message, error detection, and start/stop designation, in addition to the data that is being transferred. The amount of overhead varies by protocol and has a significant impact on the throughput of a network (i.e. a protocol that defines a 25 bit message that requires 1 start, 1 stop bit, a 5 bit address, 5 bits error detection, 1 bit for data message indication, leaves only 12 bits for data. To transfer 96 bits of data, requires 200 bits to be transmitted.)

Summary

Protocol typically affects throughput of a network and its connectivity. Once you have defined the physical characteristics of the communication network and the protocol that the network will use, you must select the hardware and software that will operate with such a network. Close analysis is required as even if the physical specification is identical, two devices may not talk because of different protocols. A common question heard is "if both computers have an RS-232 port, why won't they communicate?" As we have read above, there are many details that must be met first.

Answers to Some Frequently Asked Questions

Why not develop one physical layer and protocol that all companies will use for communications?

Efforts have been made to standardize communications since the early 1970's. Most end user customers want that and C-H as a company supports that philosophy. The issue is however that no communication specification meets all application needs and as a result, agreement on that one protocol/physical characteristic has been illusive. Some of

the selection characteristics for a network are as follows:

- # of devices supported
- Length and flexibility of data line routing
- Noise immunity
- Throughput of data vs. data requirements
- Data structure (small, medium, or large data messages)
- Electrical isolation/withstand
- Connectivity (the ability for one system or network to talk to another)
- Installed cost

Eventually, there will probably be multiple lower level networks in a plant, all doing what they do best for their application, with a gateway (a method of connecting different networks together) to other networks that need to access this information.

What is an open protocol vs. a proprietary protocol?

A proprietary protocol is one in which a company elects to keep its protocol and physical characteristics secret and to maintain control of all interfaces. Open systems are a matter of degrees. On one end of the spectrum, a company may develop gateways to its system. On the other end, a protocol/physical layer is made available to everyone, hardware can be manufactured by anyone, and the protocol characteristics are such that each company's products will communicate exactly like any others. For example, the INCOM protocol used on some IQ Transfer Switch products is an open protocol in that the protocol is published and support software is given to third party companies to develop both hardware and software interfaces. The physical layer is less open, in that communication chip availability is controlled by C-H. However, that chip is sold to third parties, and communication card interfaces are available. DeviceNet is open from a protocol standpoint and more open from a physical layer, in that the "chip" is sold by multiple vendors. Modbus is a protocol that is used by IQ Transfer products (using the Modbus MINT converter or Modbus Gateway) plus the Soft-Load Transfer Switch and the Peaking Switch. Modbus is supported by hundreds of third party vendors.

What are some communication standards sanctioned by independent governing bodies?

Currently, there are no standards groups that "sanction" both the physical and protocol specifications. ANSI/EIA

(American National Standards Institute / Electronic Industries Alliance) has developed several physical layer standards - RS 232, RS 422, RS 485. Even nodes that use the same protocol (e.g. Modbus), may have other aspects that prevent communications. For example, Modbus does not define what data is stored in a particular "register" within a node. Neither does it define what is stored in that register (bit data, integer data, floating point number, etc.). For communications to occur with any meaning, the Modbus master must know these two aspects. Note that since the protocol has not been standardized, almost all manufacturers that have implemented one of those standards have developed their own aspects (register mapping, data type/format) - therefore few truly "communicate" with each other without some additional configuration on either the Master or Slave end. Protocols such as INCOM and DeviceNet completely define all aspects of the communications network and so make interconnecting nodes of those types easier. IEC, NEMA, IEEE, ISA, etc. are all investigating standards for both physical & protocols, but are far away from sanctioning any one protocol and physical standard.

What affects throughput?

Throughput is affected by both physical and protocol characteristics. The number of devices talked to, the media/physical signal used, the bus arbitration method (master slave or peer to peer), the amount of data each device sends back, the amount of useful data sent back (i.e. if all you want is energy, but you have to get all information, a lot more bits will be sent), and the bit rate all determine throughput. In addition, noise immunity is affected. Usually, the higher the bit rate, the lower the noise immunity for a give number of devices and distance.

What affects noise immunity?

Typically the selection of physical signaling, type of media, and bit rate, affects noise-withstand in that order. Light over fiber cable or frequency shift keying (FSK) are the most noise immune. Likewise, the lower the bit rate, the better the noise rejection. Error detection tolerates noisy communication by rejecting the message, and asking for a new transmission (slowing throughput).

What are the physical & protocol layers of Cutler-Hammer ATS?

For the ATC-400, 600 and 800, each includes the capability to connect to the Cutler-Hammer INCOM network. This network uses a bus topology over a twisted shielded pair of wires using frequency (FSK) signaling method. This physical layer was chosen to keep installed cost low by connecting up to 1000 devices on a "bus", allowing that cable to be run in tray with or next to power cables and still offer effective noise immunity, and allowing up to 10,000 feet of cable. The message structure is also extremely efficient in an effort to keep throughput high at 9600 baud. Each data message consists only of data asked for, minimizing the number of bits required to be transmitted and maximizing throughput.

The Cutler-Hammer Soft-Load Closed Transition transfer switches and Peaking Switches include both Modbus (RS-232 and RS-485) and Lonworks (FT-10) communications. RS-232 supports a 50 foot point-to-point connection.

RS-485 supports up to 4000 feet of cabling between the furthest nodes and supports multi-dropping up to 32 RS-485 devices on one twisted shielded pair.

Lonworks FT-10 running at 78 kbps (as implemented on the Cutler-Hammer Soft-Load and Peaking Switches) uses a twisted shielded pair and supports up to 32 devices with up to 500 meters of cable between any two nodes.

Further Reading

- **INCOM**
Search www.ch.cutler-hammer.com and type in keyword IMPACC
- **Modbus**
Search www.modbus.org
- **Lonworks**
Search www.echelon.com

Applications

The remaining pages document certain details on connecting Cutler-Hammer transfer switch (and other) equipment to communications systems. Those solutions are broadly divided into so-called passive control and active control transfer switch equipment.

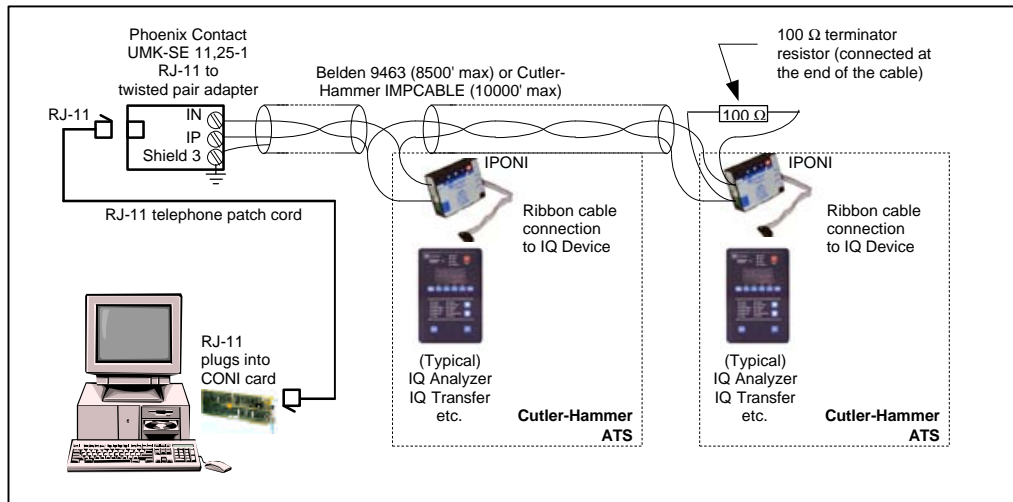
Passive Control (INCOM/Modbus)

- ATC400 / 600 / 800

Active Control (Modbus/Lonworks)

- Soft Load Closed Transition
- Peaking Switch

ATC 400/600/800 Direct Connect-CONI



Components Required

CONI

An ISA bus card for a Windows PC that permits the computer to directly connect with the INCOM twisted pair network.. When the CONI (Computer Operated Network Interface) card is connected as shown (at the end of the line), move the red DIP switch on the CONI (marked Termination) to the "ON" position. If the CONI is installed in the middle of the line, move the Termination DIP switch to "OFF" and install a second 100 ohm termination resistor at the other end of the line.

RJ-11 Cable

Standard telephone patch cord available from any electronics store. Included with the CONI card.

Belden 9463 or IMPCABLE

To minimize communications problems, use this specified twisted shielded pair. The INCOM cabling standard permits taps from the main cable up to 200 feet long. Each tap may have up to 64 nodes. See Cutler-Hammer document TD17513 (<http://www.ch.cutler-hammer.com/unsecure/cms1/00017513.PDF>) for more information. Note that the shield connection is grounded only at the Phoenix Contact terminal block. All other shield connections are tied together but left ungrounded.

IPONI

The INCOM Product Operated Network Interface translates the low level data signals obtained from the IQ device into robust signal that can be transmitted for 8500 feet using Belden 9463 or up to 10000 feet using IMPCABLE.

100 Ohm Terminator Resistor

Minimizes reflections by absorbing excess energy that has been transmitted onto the twisted pair cable. 1/4 watt, carbon, 5% recommended. Do not use wirewound resistors.

Phoenix Contact UMK Terminal Block

Ships with the CONI. Used to interconnect a stripped pair of wires to the RJ-11 jack on the CONI card.

Software: PowerPort

PowerPort is a program that connects a Windows based PC with a device that uses the INCOM protocol. (see <http://www.ch.cutler-hammer.com/unsecure/html/pmp/PowerPort.html>) for a free download.

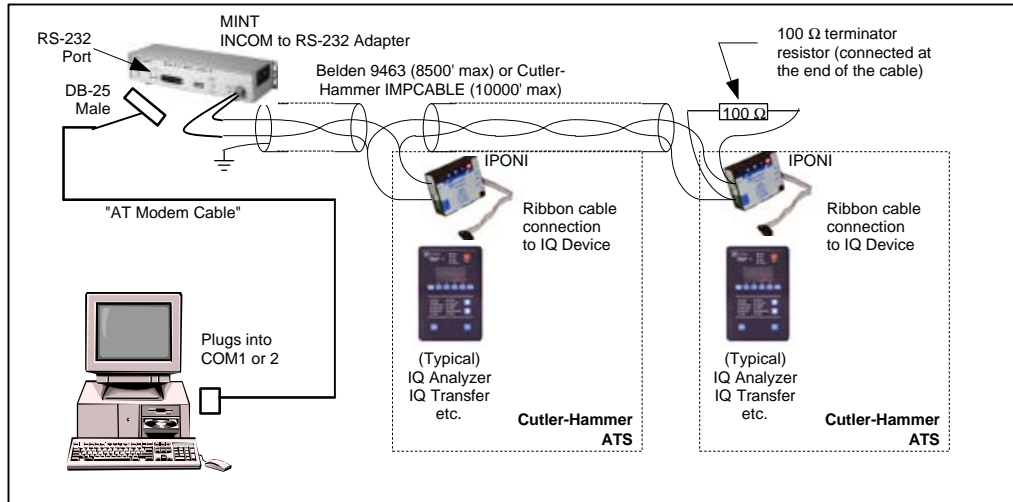
Software: PowerNet

A more powerful Windows based software suite that permits multiple simultaneous connections with up to 1000 IQ devices. Features include alarm logging, trending, reporting, programming and monitoring of all connected IQ devices

Ordering Instructions

Ordering a transfer switch with option 48A causes the switch to be supplied with an IPONI mounted. The switch is then ready for connection to customer supplied Belden 9463 or IMPCABLE pulled by the contractor to the switch. The customer will be responsible for purchasing the CONI (order by description from your transfer switch representative) and the PowerPort or PowerNet software.

ATC 400/600/800 Direct Connect-MINT



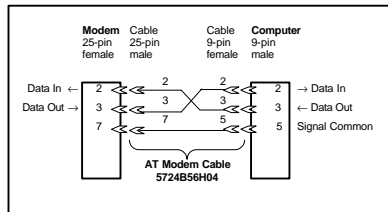
Components Required

MINT

Master INCOM Network Translator connects an RS-232 based device (e.g. computer serial port port, modem, PLC) to the INCOM network. The MINT supports bit rates of 1200, 2400, 9600 and 19200 bps. Also supports INCOM data rates of 9600 and 1200 baud.

AT Modem Cable

Standard "straight-through" 25 pin male to 9-pin female cable. The RS-232 port only requires 3 wires for operation, although the MINT can be configured for RTS/CTS hardware handshaking to support half-duplex (2-wire) modems.



Belden 9463 or IMPCABLE

To minimize communications problems, use this specified twisted shielded pair. The INCOM cabling standard permits taps from the main cable up to 200 feet long. Each tap may have up to 64 nodes. See Cutler-Hammer document TD17513 (<http://www.ch.cutler-hammer.com/unsecure/cms1/00017513.PDF>) for more information. Note that the shield connection is grounded only at the MINT. All other shield connections are tied together but left ungrounded.

IPONI

The INCOM Product Operated Network Interface translates the low level data signals obtained from the IQ device into robust signal that can be transmitted for 8500 feet using Belden 9463 or up to 10000 feet using IMPCABLE.

100 Ohm Terminator Resistor

Minimizes reflections by absorbing excess energy that has been transmitted onto the twisted pair cable. 1/4 watt, carbon, 5% recommended. Do not use wirewound resistors.

Software: PowerPort

PowerPort is a program that connects a Windows based PC with a device that uses the INCOM protocol. (see <http://www.ch.cutler-hammer.com/unsecure/html/pmp/PowerPort.html> for a free download.

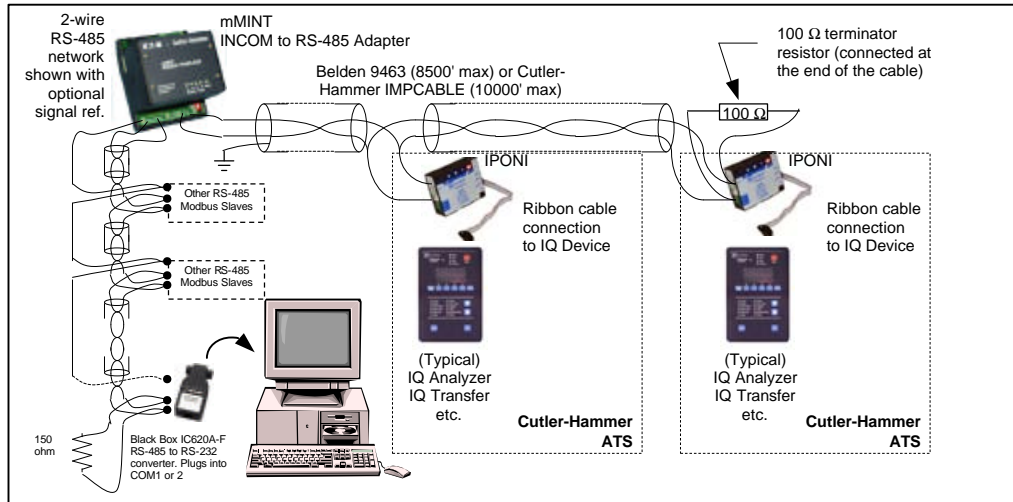
Software: PowerNet

A more powerful Windows based software suite that permits multiple simultaneous connections with up to 1000 IQ devices. Features include alarm logging, trending, reporting, programming and monitoring of all connected IQ devices.

Ordering Instructions

Ordering a transfer switch with option 48A causes the switch to be supplied with an IPONI mounted. The MINTII interface can be ordered by description from your transfer switch representative. The cable connecting the MINT to the computer is ordered as Cutler-Hammer style 5724B56H04.

**ATC 400/600/800 Direct Connect-
Modbus MINT (mMINT)**



Components Required

Modbus MINT (mMINT)

The mMINT connects an RS-485 based Modbus master device (e.g. computer, modem, PLC) to an INCOM network. The mMINT supports bit rates of 1200, 9600 and 19200 bps. Supports INCOM data rate of 9600 bits per second only.

RS-485 to RS-232 Converter

The RS-485 signal is suitable for transmission for up to 4000 feet using Belden 3106A or equivalent low capacitance cable. Since most computers do not include RS-485 ports, install a converter (Black Box IC620A-F or equivalent) to convert the 2-wire twisted pair to a 9-pin RS-232 port.

Some RS-485 devices utilize the third wire "signal reference" lead defined by the RS-485 standard. The mMINT includes support for that terminal.

Note that unlike INCOM or Lonworks, RS-485 is a polarity sensitive standard. When multidropping cable between nodes, connect each terminal marked "A" (or -) together and connect all terminals marked "B" (or +) together in a daisy chain fashion. Refer to the mMINT instruction leaflet IL 66A7508H01 for more information.

Belden 9463 or IMPCABLE

To minimize communications problems, use this specified twisted shielded pair. The INCOM cabling standard permits taps from the main cable up to 200 feet long. Each tap may have up to 64 nodes. See Cutler-Hammer document TD17513 (<http://www.ch.cutler-hammer.com/unsecure/cms1/00017513.PDF>) for more information. Note that the shield connection is grounded only at the mMINT. All other shield connections are tied together but left ungrounded.

IPONI

The INCOM Product Operated Network Interface translates the low level data signals obtained from the IQ device into robust signal that can be transmitted for 8500 feet using Belden 9463 or up to 10000 feet using IMPCABLE.

100 Ohm Terminator Resistor

Minimizes reflections by absorbing excess energy that has been transmitted onto the twisted pair cable. 1/4 watt, carbon, 5% recommended. Do not use wirewound resistors.

150 Ohm Terminator Resistor

RS-485 networks typically have a higher impedance and so require a different termination resistance. As with the INCOM termination resistor, use a carbon type, 5%, 1/4 watt (or larger) device. Do not use wirewound resistors as they do not present a "pure" resistance, but rather contain a significant reactance component at the frequencies that appear on this network. The result is that the reflections are not attenuated as effectively as with carbon resistors.

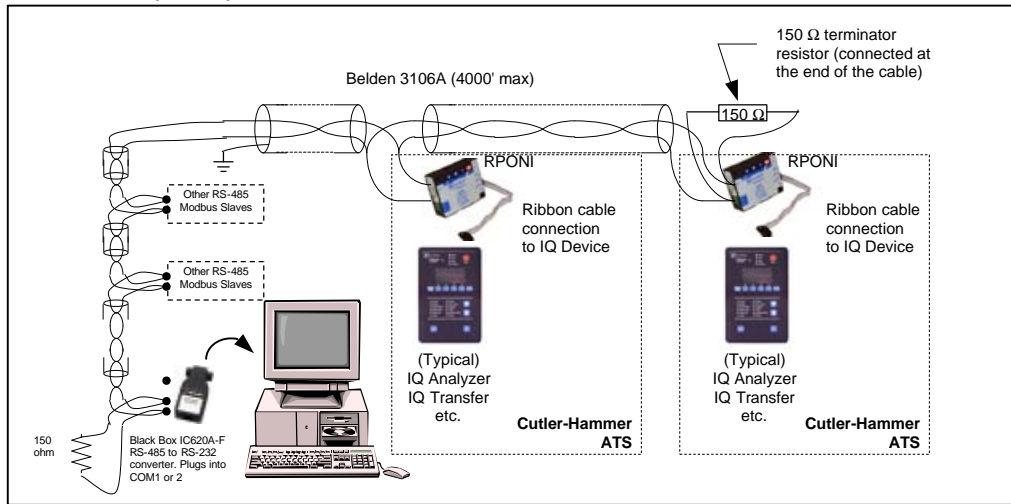
Software: Customer Provided

Users typically specify a Modbus interface to Cutler-Hammer transfer switches because they have existing Modbus infrastructure into which they wish to include the transfer switches. In that case, the customer would provide the Modbus master software. Cutler-Hammer, however, does provide several options for providing a Modbus master software solution. These include the shrink wrapped *DG Monitor*, optionally provided with our Soft Load transfer switches. If this does not provide the functionality desired, a full custom solution utilizing our Cutler-Hammer Engineering Services and Systems (CHES) group is available. Contact CHES or your transfer switch representative more information on the custom software programming services available.

Ordering Instructions

Order the transfer switch with option 48A to include the IPONI mounted. Order the mMINT by description from your transfer switch representative. Also needed is the Belden 9463 or CH IMPCABLE cable for the INCOM wiring and Belden 3106A or equivalent for the RS-485 wiring and the Black Box IC620A-F (or equivalent) RS-485 to RS-232 converter to interface to a computer, modem or PLC RS-232 serial port.

**ATC 400/600/800 Direct Connect-
Modbus PONI (RPONI)**



Components Required

Modbus PONI (RPONI)

The RPONI connects an RS-485 based Modbus master device (e.g. computer, modem, PLC) to a single IQ devices (meter, protective relay, etc.) using a twisted, shielded pair of wire (Belden 3106A or equivalent). The RPONI supports bit rates of 1200, 9600 and 19200 bps.

RS-485 to RS-232 Converter

The RS-485 signal is suitable for transmission for up to 4000 feet using Belden 3106A or equivalent low capacitance cable. Since most computers do not include RS-485 ports, install a converter (Black Box IC620A-F or equivalent) to convert the 2-wire twisted pair to a 9-pin RS-232 port.

Note that unlike INCOM or Lonworks, RS-485 is a polarity sensitive standard. When multi-dropping cable between nodes, connect each terminal marked "A" (or -) together and connect all terminals marked "B" (or +) together in a daisy chain fashion.

RPONI

The RS-485 Product Operated Network Interface translates the low level data signals obtained from the IQ device into an RS-485 signal that can be transmitted 4000 feet using Belden 3105A cable.

150 Ohm Terminator Resistor

Use a carbon type, 5%, 1/4 watt (or larger) device. Do not use wirewound resistors as they do not present a "pure" resistance, but instead contain a significant reactive component at the frequencies that appear on this network. The result is that the reflections that occur when the signal reaches the end of the line are not attenuated as effectively as with carbon resistors.

Software: Customer Provided

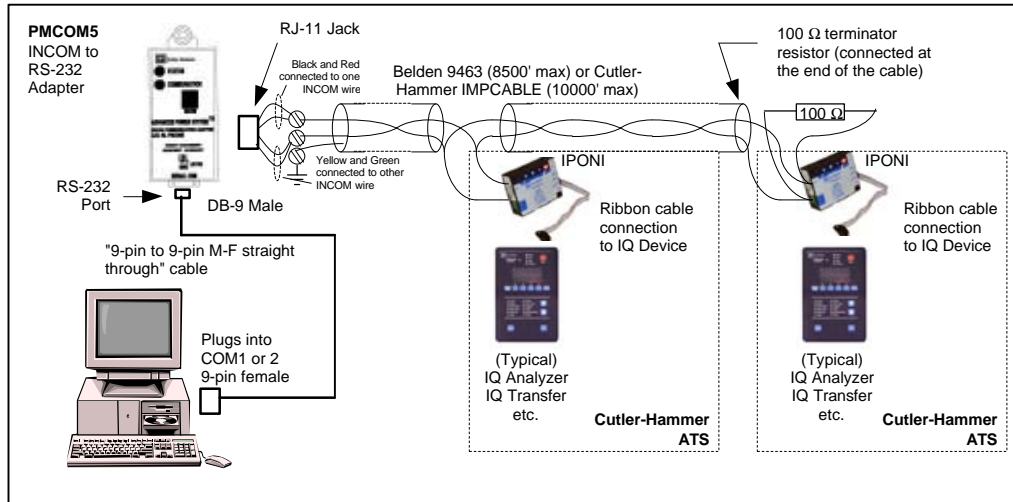
Users typically specify a Modbus interface to Cutler-Hammer transfer switches because they have existing Modbus infrastructure into which they wish to include the transfer switches. In that case, the customer would provide the Modbus master software. Cutler-Hammer, however, does provide several options for providing a Modbus master software solution. These include the shrink wrapped *DG Monitor*, optionally provided with our Soft Load transfer switches. If this does not provide the functionality desired, a full custom solution utilizing our Cutler-Hammer Engineering Services and Systems (CHESS) group is available. Contact CHESS or your transfer switch representative more information on the custom software programming services available.

The program MODSCAN (www.win-tech.com/html/modscan32.htm) can be used to to verify your Modbus devices are working properly and that the network is set up properly.

Ordering Instructions

Order the transfer switch with option 48F to include the RPONI mounted with the transfer switch. Also needed is the Belden 3106A or equivalent for the RS-485 wiring and the Black Box IC620A-F (or equivalent) RS-485 to RS-232 converter to interface to a computer, modem or PLC RS-232 serial port.

**ATC 400/600/800 Direct Connect-
PMCOM5**



Components Required

PMCOM5

The device (the "mini-MINT") connects an RS-232 based device (e.g. computer serial port, modem, PLC) to the INCOM network. The PMCOM5 only supports bit rates of 9600 and an INCOM data rate of 9600 baud. Legacy INCOM devices (e.g. white PONIs) are not supported. Also, the RS-232 port does not support hardware handshaking, therefore it may not be applied to half-duplex, 2-wire systems. The PMCOM5 works best direct connected to a computer or a modem. The PMCOM5 operates on 120 Vac.

9-Pin to 9-Pin Straight Through Cable

Standard "straight-through" 9 pin male to 9-pin female cable. The RS-232 port only requires 3 wires for operation (pins 2, 3 and 5, e.g. Black Box EQN301-0006.)

Belden 9463 or IMPCABLE

To minimize communications problems, use this specified twisted shielded pair. The INCOM cabling standard permits taps from the main cable up to 200 feet long. Each tap may have up to 64 nodes. See Cutler-Hammer document TD17513 (<http://www.ch.cutler-hammer.com/unsecure/cms1/00017513.PDF>) for more information. Note that the shield connection is grounded only at the PMCOM5. All other shield connections are tied together but left ungrounded.

IPONI

The INCOM Product Operated Network Interface translates the low level data signals obtained from the IQ device into a robust signal that can be transmitted

for 8500 feet using Belden 9463 or up to 10000 feet using IMPCABLE.

100 Ohm Terminator Resistor

Minimizes reflections by absorbing excess energy that has been transmitted onto the twisted pair cable. 1/4 watt, carbon, 5% recommended. Do not use wirewound resistors.

Software: PowerPort

PowerPort is a program that connects a Windows based PC with a device that uses the INCOM protocol. (see <http://www.ch.cutler-hammer.com/unsecure/html/pmp/PowerPort.html> for a free download.

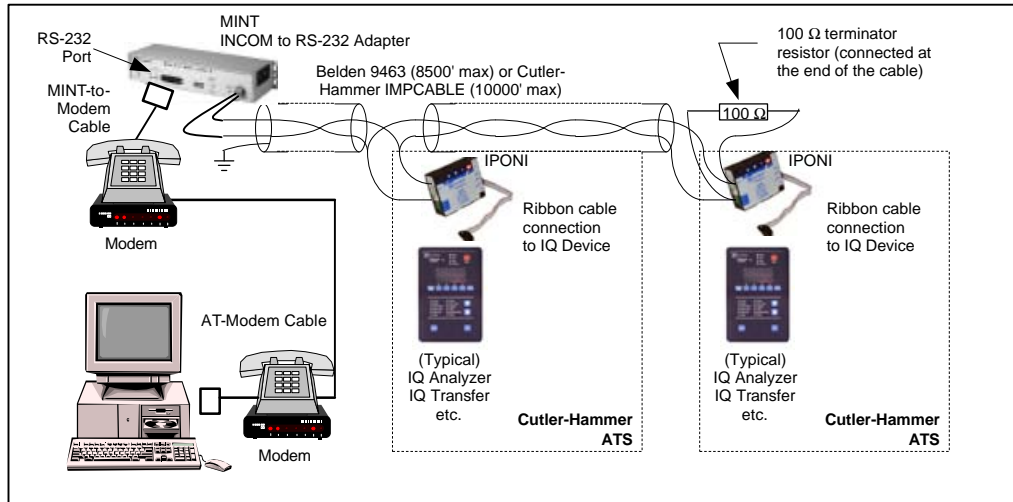
Software: PowerNet

A more powerful Windows based software suite that permits multiple simultaneous connections with up to 1000 IQ devices. Features include alarm logging, trending, reporting, programming and monitoring of all connected IQ devices.

Ordering Instructions

Ordering a transfer switch with option 48B causes the switch to be supplied with an IPONI mounted. In addition, a PMCOM5 and a 9-pin to 9-pin cable (suitable for connection to a 9-pin COM port on your computer) is supplied. The only remaining items needed for a functioning system are the customer supplied wiring (Belden 9463 or CH IMPCABLE) and a copy of either PowerPort or PowerNet software to load onto the computer.

ATC 400/600/800 Modem to-MINT



Components Required

MINT

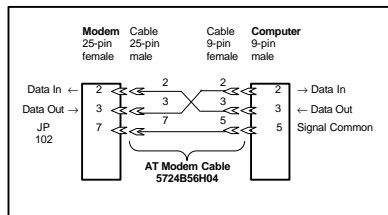
Master INCOM Network Translator connects an RS-232 based device (e.g. computer serial port, modem, PLC) to the INCOM network. The MINT supports bit rates of 1200, 2400, 9600 and 19200 bps. Also supports INCOM data rates of 9600 and 1200 baud.

Modem

An RS-232 to tone converter. RS-232 is limited to only 50 feet, whereas a tone signal may connect to a phone system and allow for much further communications. Modems are available in a variety of types:

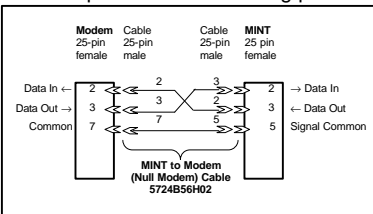
- Dial-Up
- Lease Line (2 or 4 wire)

AT Modem Cable



MINT to Modem Cable

Most external modems have a 25-pin RS-232 port with the following pinouts:



- Pin 2 Data In to modem
- Pin 3 Data Out from modem
- Pin 7 Signal Ground

These signals must be connected to the MINT. Since the MINT pinouts are identical to those of the modem, we must use a "cross-over" or "null-modem" cable.

Note that since both the modem and the MINT will have female connectors, the necessary cable will have 25-pin male connectors on each end.

Belden 9463 or IMPCABLE

To minimize communications problems, use this specified twisted shielded pair. The INCOM cabling standard permits taps from the main cable up to 200 feet long. Each tap may have up to 64 nodes. See Cutler-Hammer document TD17513 (<http://www.ch.cutler-hammer.com/unsecure/cms1/00017513.PDF>) for more information. Note that the shield connection is grounded only at the MINT. All other shield connections are tied together but left ungrounded.

IPONI

The INCOM Product Operated Network Interface translates the low level data signals obtained from the IQ device into

robust signal that can be transmitted for 8500 feet using Belden 9463 or up to 10000 feet using IMPCABLE.

100 Ohm Terminator Resistor

Minimizes reflections by absorbing excess energy that has been transmitted onto the twisted pair cable. 1/4 watt, carbon, 5% recommended. Do not use wirewound resistors.

Software: PowerPort

PowerPort is a program that connects a Windows based PC with a device that uses the INCOM protocol. (see <http://www.ch.cutler-hammer.com/unsecure/html/pmp/PowerPort.html>) for a free download.

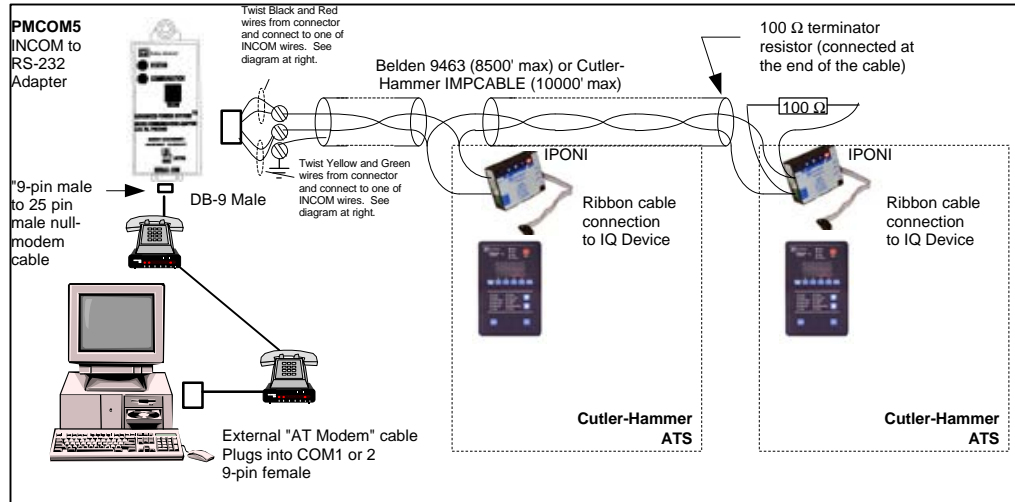
Software: PowerNet™

A more powerful Windows based software suite that permits multiple simultaneous connections with up to 1000 IQ devices. Features include alarm logging, trending, reporting, programming and monitoring of all connected IQ devices

Ordering Instructions

Option code 48A includes the IPONI mounted to your transfer switch, ready for connection to the customer supplied Belden 9463 or CH IMPCABLE twisted pair. Not supplied, but needed, are the MINTII, the 5724B56H04 "AT Modem Cable" and the "5724B56H02 "MINT to Modem" cable. Each of these three parts may be ordered by these part numbers from your transfer switch representative.

ATC 400/600/800 Modem to-PMCOM5



Components Required

PMCOM5

The device (the "mini-MINT") connects an RS-232 based device (e.g. computer serial port, modem, PLC) to the INCOM network. The PMCOM5 only supports bit rates of 9600 and an INCOM data rate of 9600 baud. Legacy INCOM devices (e.g. white PONIs) are not supported. Also, the RS-232 port does not support hardware handshaking, so it cannot be applied to half-duplex, 2-wire systems. The PMCOM5 works best direct connected to a computer or a modem.

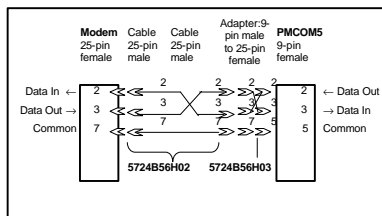
Modem

As the PMCOM5 cannot provide or use modem control signals, the modem must be programmed to ignore them. Usually this is accomplished by sending the set up string "AT&H0" from Hyperterminal set to 9600 baud to the modem via a separate "straight-through" cable connected between the computer's COM port and the modem's serial port. This set up string disables transmit Flow Control causing the modem to ignore signals on pins 4,6,7 and 8. Note that the modem must be configured so that its serial port only transmits data at 9600. While certain USRobotics modems accomplish with a setup string, most modems "autobaud". That is, they listen to the last communication sent to them on the serial port and configure the bit rate to match that data. There are no commands that set the serial port bit rate. Since the PMCOM5 cannot initiate communications to force an autobaud, the user must configure the modem with a separate device (laptop computer for example), then connect the cable to the PMCOM5. The PMCOM5 must be connected to a reliable source of 120

Vac since we do not want a power up of the PMCOM5 to cause a spurious message that is interpreted by the modem as data, causing the modem to attempt to autobaud again.

Recommended Modem Setup

- ATZ0 reset modem
- AT&F0 load factory default profile
- ATE0 disable local echo
- ATF0 disable xmitted data echo
- ATS0=1 answer on 1st ring
- AT&B1 set fixed serial bit rate
- AT&D0 ignore DTR hang up
- AT&H0 ignore xmt flow control
- AT&I0 ignore rcv flow control
- AT&N6 connect at 9600 bps
- AT&R1 modem ignores RTS
- AT&U6 min connect speed: 9600 bps
- ATY0 power on profile 0 selected
- AT&W0 write to NVRAM



9-Pin to 25-Pin Null Modem Cable

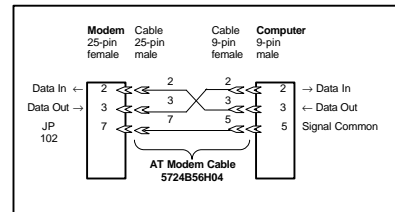
Standard "null-modem" (pins 2 and 3 crossed, 5 straight through, other pins may be disconnected or optionally looped back; 7 connected to 8 and 4 connected to 6 both sides) 9 pin male to 9-pin female cable. The RS-232 port only requires 3 wires for operation (pins 2, 3 and 5).

Belden 9463 or IMPCABLE

To minimize communications problems, use this specified twisted shielded pair. The INCOM cabling standard permits taps from the main cable up to 200 feet

long. Each tap may have up to 64 nodes. See Cutler-Hammer document TD17513 (<http://www.ch.cutler-hammer.com/unsecure/cms1/00017513.PDF>) for more information. Note that the shield connection is grounded only at the PMCOM5. All other shield connections are tied together but left ungrounded.

AT Modem Cable



IPONI

The INCOM Product Operated Network Interface translates the low level data signals obtained from the IQ device into robust signal that can be transmitted for 8500 feet using Belden 9463 or up to 10000 feet using IMPCABLE.

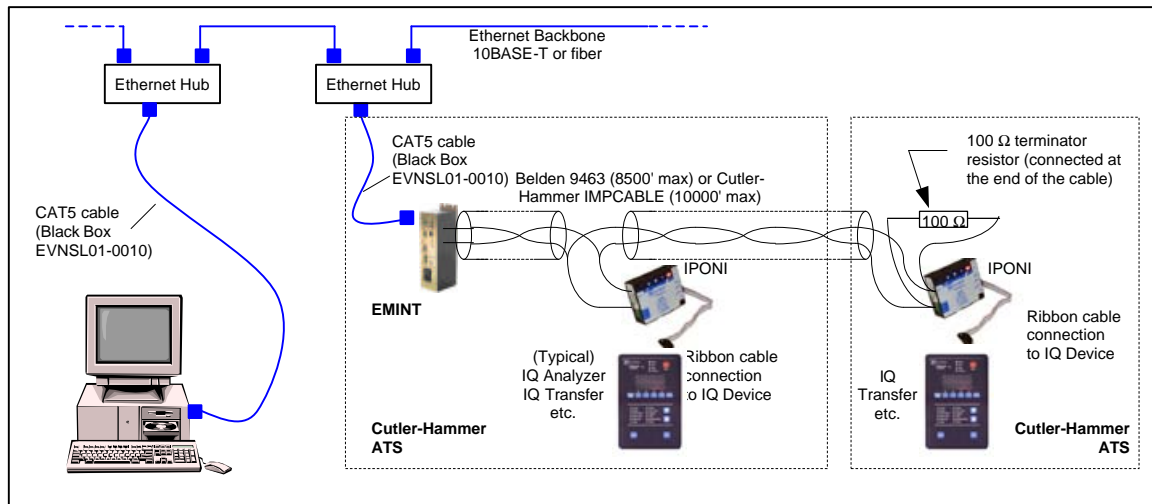
100 Ohm Terminator Resistor

Minimizes reflections by absorbing excess energy that has been transmitted onto the twisted pair cable. 1/4 watt, carbon, 5% recommended. Do not use wirewound resistors.

Ordering Instructions

Ordering a transfer switch with option 48C causes the switch to be supplied with an IPONI mounted. In addition, a PMCOM5, a 25-pin to 25-pin null modem cable and a 9-pin to 25-pin adapter are supplied (suitable for use with 25-pin modems).

ATC 400/600/800 Ethernet 10BASE-T



Components Required

EMINT

The Ethernet Master Incom Network Translator connects an INCOM twisted pair network to an Ethernet unshielded twisted pair network (CAT 5 UTP 10BASE-T RJ-45 connector). The EMINT operates at 10 Mbps. If connected to a 100 or 1000 Mbps Ethernet LAN, do not connect directly to a Ethernet hub unless that hub supports autoswitching to support devices connected at 10 Mbps. These more sophisticated autoswitching hubs and Ethernet switches will handle the details of retransmitting the Ethernet message at the slower 10 Mbps rate to the EMINT.

CAT 5 Patch Cable

Ethernet 10BASE-T supports up to 300 feet of cabling between any two nodes. A "straight-through" cable is used to connect a device (computer network interface card [NIC] or EMINT) to an Ethernet hub.

The EMINT can connect directly to the 10BASE-T port of the computer if a "cross-over" cable is used. Order Black Box EVCRB85-0010 or equivalent.

Ethernet Hub (Switch)

As 10BASE-T is a point-to-point topology, a method is required to connect multiple nodes into a larger network. This is accomplished by connecting each 10BASE-T device to a multiplexing device called a hub. Any message received on any port of the hub is rebroadcast on all other ports of that hub.

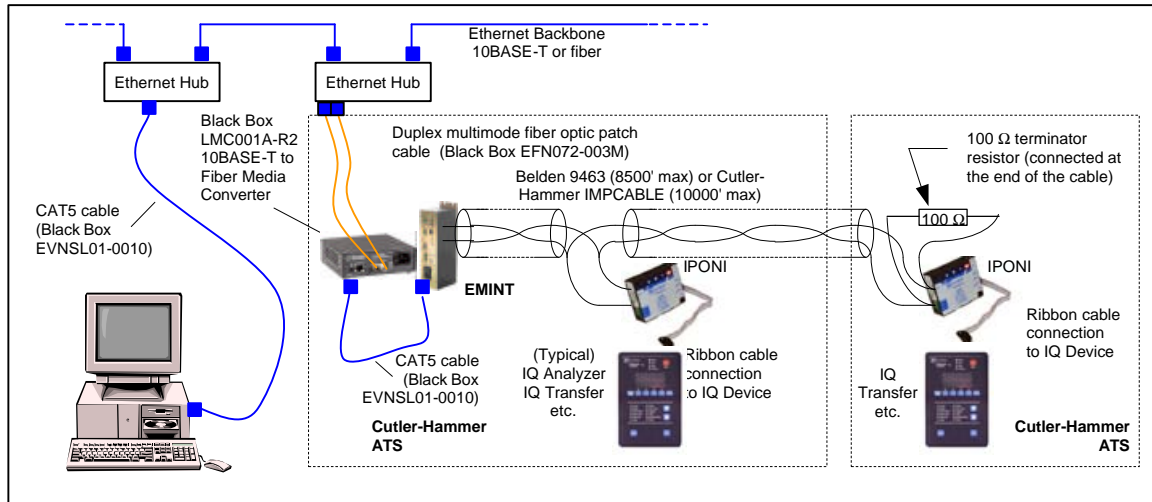
A more advanced version of a hub is called an Ethernet switch. A switch examines the individual Ethernet messages and forwards them to the other ports on the switch as appropriate. This reduces traffic on segments of the Ethernet LAN that do not need to hear messages that are not intended for that segment.

Ordering Instructions

Ordering a transfer switch with option 48A causes the switch to be supplied with an IPONI supply mounted and wired to the IQ Transfer. Order the EMINT separately. Not supplied, but needed are a CAT 5 patch cable and an Ethernet hub or switch.

PowerPort software does not support the EMINT. You must purchase the more powerful PowerNet software to connect to the IQ device using the EMINT.

ATC 400/600/800 Ethernet Fiber



Components Required

EMINT

The Ethernet Master Incom Network Translator connects an INCOM twisted pair network to an Ethernet 10BASE-T twisted pair network. To convert from 10BASE-T to a fiber optic network you use a media converter.

Media Converter

Since fiber is available in several types (single mode or multi-mode) and uses different connectors (ST, SC, etc.) at the cable ends and also has different laser light colors (850 nm or 1300 nm) you must select the appropriate media converter for your application. Black Box (www.blackbox.com) manufactures several models. Choose the Black Box media converter catalog number (LMxxxxx) to match your needs from this list:

- Multimode 850 nm, ST : LMC001A-R2
- Multimode 850 nm, SC : LMC002A-R2
- Multimode 1300 nm, ST: LMC003A-R2
- Multimode 1300 nm, SC: LMC004A-R2
- Singlemode 1300 nm, ST: LMC005A-R2
- Singlemode 1300 nm, SC: LMC006A-R2

The distance limits for the different fiber types are based on the type of fiber and the particular model of media converter selected:

- Multimode : 6500 feet
- Singlemode: 20 km (12.4 miles)
- Singlemode+: 40 km (24.9 miles)

If connected to a 100 or 1000 Mbps Ethernet LAN, do not connect to an Ethernet hub, unless that hub supports devices connected at the slower 10 Mbps rate. Instead, be sure to connect the EMINT to a so-called "autoswitching" or "autosensing" Ethernet switch that

supports a 10 Mbps device. The more sophisticated switch will handle the details of retransmitting the Ethernet message at the 10 Mbps rate required by the EMINT.

Fiber Optic Patch Cable

Ethernet 10BASE-FL (fiber optic) supports up to 6500 feet of cabling between any two nodes when multi-mode fiber is used. Two fibers are used to connect the Black Box media convert to an Ethernet hub. More expensive single-fiber units are available (transmit and receive on different colors of laser light) if you do not have sufficient fibers available between locations.

Note that the Type SC (rather than the Type ST) is usually specified with single-mode fiber networks.

Ethernet Hub (Switch)

As fiber optic transmission is a point-to-point topology, a method is required to connect multiple nodes into a larger network. This is accomplished by connecting each fiber optic device to a multiplexing device called a hub. Any message received on any port of the hub is rebroadcast on all other ports of that hub.

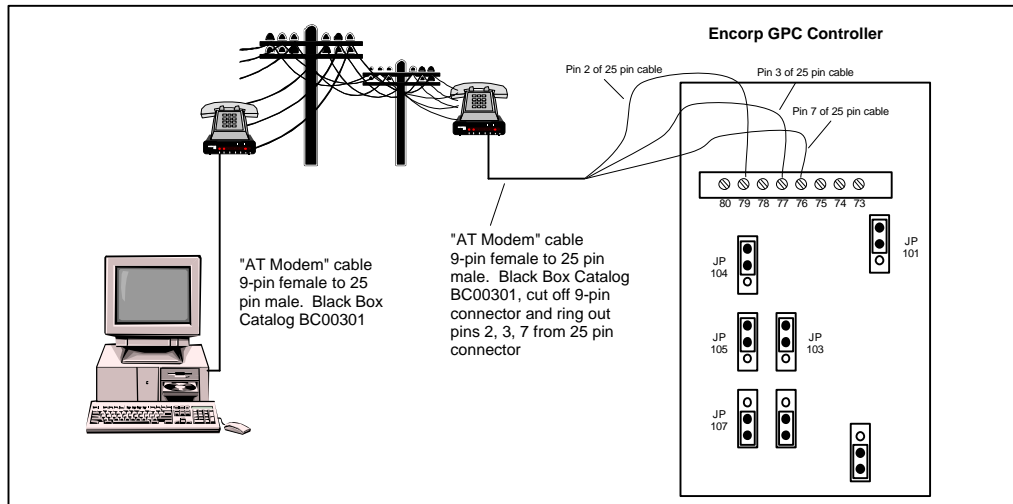
A more advanced version of a hub is called an Ethernet switch. A switch examines the individual Ethernet messages and forwards them to the other ports on the switch as appropriate. This reduces traffic on segments of the Ethernet LAN that do not need to hear messages that are not intended for that segment.

Ordering Instructions

Ordering a transfer switch with option 48A causes the switch to be supplied with an IPONI mounted and wired. Additionally, order from Cutler-Hammer the EMINT (cat: EMINT) and from Black Box Corporation the appropriate media converter (as discussed under the Media Converter section). Finally, both fiber and straight through 10BASE-T CAT 5 patch cords will be needed. Note that the fiber patch cords will depend on connector (SC or ST) and fiber type (multimode or singlemode) chosen. Not included but needed is an Ethernet hub that accepts the fiber optic cabling.

PowerPort software does not support the EMINT. You must purchase the more powerful PowerNet software to connect to the IQ device using the EMINT.

Soft Load / Peaker Modem Connect - Modbus / RS-232



Components Required

Encorp GPC

The GPC includes two serial port connections:

- Modbus RTU slave
 - RS-232 or
 - RS-485 (2-wire)
- Lonworks FT-10 78 kbps

This section will discuss only the Modbus RTU RS-232 connection when using modems. The default (and non-adjustable) settings for the Modbus port are: 9600 bps, no parity, 8 data bits and 1 stop bit.

Remote modem communication via the Modbus connection involves:

- Setting GPC COM port to RS-232 (see jumpers JP101-JP107 above)
- Connecting Modbus Master to RS-232 I/O pins
 - 79 Data Out from GPC
 - 77 Data In to GPC
 - 76 RS-232 common

The GPC RS-232 port does not support hardware handshaking pins (RTS/CTS or DSR/DTR). Data received on terminal 77 of the GPC controller will be examined. If the message is good, the GPC transmits a reply on terminal 79. Both terminals are referenced to terminal 76 as the common.

Modem

As the GPC cannot provide or use modem control signals, the modem must be programmed to ignore them. Usually this is accomplished by sending the set up string "AT&H0" from Hyperterminal set to 9600 baud to the modem via a separate "straight-through" cable connected between the computer's COM

port and the modem's serial port. This set up string disables transmit Flow Control causing the modem to ignore signals on pins 4,6,7 and 8. Note that the modem must be configured so that its serial port only transmits data at 9600. Certain USRobotics modems accomplish with the setup strings. Most modems "autobaud", that is, they listen to the last communication sent to them on the serial port and configure the bit rate to match that data. The original "Hayes" AT command set did not include any commands that set the serial port bit rate. Since the GPC cannot initiate communications to force an autobaud, the user must configure the modem with a separate device (laptop computer for example), then connect the cable to the PMCOM5. The GPC is connected to a reliable source of 24 Vdc since we do not want a power up of the GPC to cause a spurious message that is interpreted by the modem as data, causing the modem to attempt to autobaud again.

Recommended Modem Setup

- ATZ0 reset modem
- AT&F0 load factory default profile
- ATE0 disable local echo
- ATF0 disable xmitted data echo
- ATS0=1 answer on 1st ring
- AT&B1 set fixed serial bit rate
- AT&D0 ignore DTR hang up
- AT&H0 ignore xmt flow control
- AT&I0 ignore rcv flow control
- AT&N6 connect at 9600 bps
- AT&R1 modem ignores RTS
- AT&U6 min connect speed: 9600 bps
- ATY0 power on profile 0 selected
- AT&W0 write to NVRAM

Depending on the model of modem, a DIP switch or other setting may be

necessary to set the modem connected to the GPC into auto-answer mode.

AT Modem Cable

Standard cable where pins 2, 3 and 7 on the 25-pin male connector are connected to pins 2, 3 and 5, respectively on the 9-pin female connector.

Configuring GPC

The Soft-Load and Peaker switches, as standard are shipped with the serial port configured to respond to a message intended for Modbus Node 002. A second internal Modbus Node 001 is reserved for the PLC built within the GPC controller. However, most SCADA systems will wish to interrogate the main control at address 002.

Software: Cutler-Hammer DG Monitor

DG Monitor is a Windows 98/NT/2000/XP program that communicates with a Soft-Load Transfer Switch or Peaking Switch via either a direct RS-232 connection, a modem connection or via a LAN (Modbus TCP/IP) connection.

Software: Other Modbus Master

The GPC understands Modbus function codes 1 (Read Coil Status), 2 (Read Input Status), 3 (Read Holding Registers), 4 (Read Input Registers), 5 Force Single Coil, 6 (Preset Single Holding Register), 15 (Preset Multiple Coils) and 16 (Preset Multiple Registers)

Third parity or custom programs that can interrogate a Modbus slave can directly connect to the Soft-Load transfer switch or the Peaking Switch without modification.

Soft Load / Peaker Modbus Addresses

This table provides a partial cross reference of Modbus register to name for the GPC controller. Refer to your Cutler-Hammer sales representative for a complete listing.

Modbus

Address	Description
30002	Read internal clock
30030	Utility A Phase Voltage
30060	Utility B Phase Voltage
30090	Utility C Phase Voltage
30150	Utility A Phase Amperes
30180	Utility B Phase Amperes
30210	Utility C Phase Amperes
30310	Utility Watts
30314	Utility VA
30312	Utility VAR
30316	Utility PF
30318	Utility Average 3-phase voltage
30320	Utility Average 3-phase current
30330	Utility Hz
30050	Utility A Phase Voltage THD
30080	Utility B Phase Voltage THD
30110	Utility C Phase Voltage THD
30324	Utility Voltage Unbalance
30326	Utility Current Unbalance
30400	Demand (watt) meter #1 (connected to Utility), sliding window
30410	Demand (watt) meter #2 (connected to Generator), sliding window
30430	Watt-Hour meter #1 (connected to Utility)
30435	Watt-Hour meter #2 (connected to Generator)
30300	Generator Watts
30302	Generator VA
30304	Generator VAR
30306	Generator PF (PF = 1-abs(30306-(30307/65535)), >0: Leading, <0: Lagging)
30120	Generator Voltage
30240	Generator Amperes (GPC only)
30335	Generator Hz
30445	Generator Runtime Runtime = ((30445*24)+(30446)+(30447/65535))/60
30604	Synchroscope (12 O'Clock: 0 radians, 6 O'Clock: pi radians, <0 hand move counterclockwise)
10001	4: watchdog good, 0: watchdog bad
10010	Generator 52b input contact (INV is internal GPC function -- this register provides the non-inverted input)
10011	Utility 52b input contact (INV is internal GPC function -- this register provides the non-inverted input)
10012	Service Input input contact
10013	Alarm/Test Reset input contact (INV is internal GPC function -- this register provides the non-inverted input)
10014	Close/Open Transfer input contact
10015	Transfer Test input contact
10016	Engine Run input contact
10017	Auto Enabled input contact
10491	ATS is transferring
10493	ATS is transferring to Normal

Note: GPC 3-phase connection is assumed to be "Utility"
 GPC 1-phase connection is assumed to be "Generator"

Soft Load

00020	Close Generator Breaker output contact
00021	Open Generator Breaker output contact
00022	Close Utility Breaker
00023	Open Utility Breaker
00024	Spare
00025	Spare
00026	Sources Synchronized
00027	Start Engine output contact
40002	Set internal clock
40085	Voltage Bias output (to Genset AVR)
40095	Frequency Bias output (to Genset governor)
40302	Generator Hi-Hi voltage trip setting
40304	Generator Hi voltage trip setting
40306	Generator Lo voltage trip setting
40308	Generator LoLo voltage trip setting
40358	Utility HiHi Voltage trip setting
40360	Utility Hi Voltage trip setting
40362	Utility Lo Voltage trip setting
40364	Utility LoLo Voltage trip setting
40402	Utility HiHi Negative Sequence Overvoltage
40404	Utility Hi Negative Sequence Overvoltage

Peaking Switch

Close Generator Breaker output contact
Open Generator Breaker output contact
Spare
Generator Power Available
Peaking Mode (not used)
Failed to Sync
Sources Synchronized
Start Engine output contact

output = (40085+(40086/65535))/200
 output = (40095+(40096/65535))/200

Note: All 3xxx and 4xxx register data is stored as two-register pair. For example, to read Utility Hz (Modbus register 30330):

59.99	Hz
30330	003B h 59 (decimal)
30331	FE93 h 65171 (decimal)

The fractional part (second register of register pair, in this case 30331) is divided by 65535 to convert to decimal value.

30331 FE93 h 65171 divided by 65535 = 0.994446

Therefore the correct frequency is 59.994446 (only the first two digit of fraction are significant).