# 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 two 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. Modbus (RS-485 and Ethernet) and INCOM protocols can operate with this topology. Advantages include reduced wiring and ease of installation. Disadvantages include loss of communication to multiple devices during a wire break, and added complexity in managing and troubleshooting devices.

Media

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

• Straight wires - An example is telephone cable (26 gauge, 4 conductor)

• Twisted Shielded Pair (TSP) - Two 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.

• CAT 5e/6e - Four twisted unshielded pairs of wires in a single cable. Used for Ethernet protocols such as Modbus TCP and Ethernet IP.

• 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 impedances 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. However, it will become 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 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”. A typical protocol consists of: data rate, access methods, and data structure.

Bit Rate

A 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 approximately 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 “signaling rate.” Unfortunately, the incorrect phrase “baud rate” is commonly used 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

For more information visit: www.eaton.com/ats
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 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, which 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. It 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, and then 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 re-occurrence of the collision.

Message Structure

The 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 despite the physical specification being identical; two devices may not talk because of different protocols. A common question asked 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 Eaton Corporation supports that philosophy. The issue is, however, that no communication specification meets all application needs. 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

Typically, there will 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 its 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 legacy 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 Eaton. 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 an open protocol that is supported natively in our newer ATS offerings. Legacy devices can use converters such as mPONI’s and Modbus gateways to communicate via Modbus. 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 also 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 and 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 given number of devices and distance.

What affects noise immunity?
Typically the selection of physical signaling, type of media, and bit rate (in that order), affect noise-withstand. Light over fiber cable or frequency shift keying (FSK) are the most noise immune. Like-wise, 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 Eaton ATS Controllers?
The ATC-300+ and 900 controllers have native Modbus support over 2-wire RS-485. This creates cost savings for our customers by eliminating external communications adapters when using these controllers. RS-485 supports up to 4000 feet of cabling between nodes, and up to 32 devices on one network.

The ATC-600 and 800 (Legacy Devices) have the capability to connect to the Eaton INCOM network using IPONI modules. This network uses a bus topology over a twisted shielded pair of wires using the frequency (FSK) signaling method. This physical layer was chosen to keep installed costs 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 allow 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 Eaton legacy 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-drop ping up to 32 RS-485 devices on one twisted shielded pair.

Lonworks FT-10 running at 78 kbps (as implemented on the Eaton legacy 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 (Legacy) Search www.eaton.com
- Modbus Search www.modbus.org
- Lonworks (Legacy) Search www.echelon.com

Applications
The remaining pages document certain details on connecting Eaton 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 (Legacy)

 Active Control (Modbus/Lonworks)
- ATC-300+ (Native Modbus Only)
- ATC-900 (Native Modbus Only)
- Soft Load Closed Transition (Legacy)
- Peaking Switch (Legacy)
Current Applications

ATC 300+/900 to PC (Serial RS-485)

Components Required

**RS-485 to RS-232 Converter**
Since most computers do not include RS-485 ports, install a converter (B&B 485SD9TB or equivalent) to convert the 2-wire twisted pair to a 9-pin RS-232 port.

**RS-232 Cable**
Standard serial RS-232 cable required to connect from your RS-485 converter to your PC.

**Belden 3106A Cable**
The RS-485 signal is suitable for transmission for up to 4000 feet using Belden 3106A or equivalent low capacitance cable.

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.

**120 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. Resistors must be placed at BOTH ends of the communication cable chain.

Note that ATC-300+/900’s have 120 Ohm termination resistor toggle switches (SW1) built in to their Modbus ports. Both resistors must be the same resistance, and should match the characteristic impedance of the cable you are using. Consult TD17513 for more information on field wiring.

Software Visual Designer
Visual Designer is Eaton’s HMI Development Software for PCs running Microsoft Windows embedded operating systems. With a maximum of 64k tags and eight communication drivers, it will meet all of your ATS connectivity needs.

For more information, see www.eaton.com and search for Visual Designer.

Software: Customer-provided SCADA Solution
The other software solution is to use a 3rd party off-the-shelf SCADA system. Anything with a Modbus RTU communication driver should work. Modbus register mapping is available on Eaton’s website. For the ATC-900, consult IB14006EN; for the ATC-300+, consult IB140004EN.

Ordering Instructions
Both the ATC-300+ and the ATC-900 controllers come with Modbus RS-485 enabled by default. No special ordering instructions are required. The switch is then ready for connection to customer supplied Belden 3106A cable pulled by the contractor to the switch. The customer will be responsible for purchasing the RS-232 serial cable, RS-485 to 232 converter, resistors (if needed), and any applicable PC Modbus software.
Transfer Switch Communications

ATC 300+ /900 to PC (via Serial-to-Ethernet Gateway)

Components Required

Modbus Serial-to-Ethernet Gateway
These devices allow you to place serial-only equipped devices on an Ethernet network. Since most PC’s have an Ethernet connection, this is a very desirable setup.

Eaton has two serial-to-Ethernet gateways available: the ELC-CAENET and the PXG series. The PXG series gateways allow for direct PC monitoring, web-based monitoring, data logging, alarm handling, and many other features. The ELC-CAENET is a simple pass-through device with no additional monitoring or data logging. Note that the PXG is capable of operating in pass-through mode as well, allowing the use of external SCADA monitoring.

Cat 5/6 Ethernet Cable
Standard Ethernet cable required to connect your PC to the gateway.

Belden 3106A Cable
The RS-485 signal is suitable for transmission for up to 4000 feet using Belden 3106A or equivalent low capacitance cable.

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.

120 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.

Resistors must be placed at BOTH ends of the communication cable chain. Note that ATC-300+/900’s have 120 Ohm termination resistor toggle switches (SW1) built in to their Modbus ports. Both resistors must be the same resistance, and should match the characteristic impedance of the cable you are using. Consult TD17513 for more information on field wiring.

Software: Power Xpert Insight and Foreseer
Power Xpert Insight allows you to view the device information you want to see, easily manage alarms, and view and compare trend data. It is designed to scale easily from a small school or data center to a global manufacturing operation, providing greater value over time.

Foreseer Software was developed from the ground up to support thousands of devices, connections, device parameters and data logging. It is fully scalable to support a single data center, or multiple facilities no matter where they are in the world. It facilitates monitoring of infrastructure pieces, including HVAC, UPS, power distribution systems (meters, motor control, variable frequency drives, etc.), generators, fire-detection, security systems, and other communicating sub-systems from hundreds of manufacturers—all on one screen.

Software: Visual Designer
Visual Designer is Eaton’s HMI Development Software for PCs running Microsoft Windows embedded operating systems. With a maximum of 64k tags and eight communication drivers, it will meet all of your ATS connectivity needs. Requires the use of pass-through mode on the gateway.

For more information, see www.eaton.com and search for Visual Designer.

Software: Customer-provided SCADA Solution
The other software solution is to use a 3rd party off-the-shelf SCADA system. Anything with a Modbus RTU communication driver should work. Modbus register mapping is available on Eaton’s website. For the ATC-900, consult IB14006EN; for the ATC-300+, consult 66A7787.

Ordering Instructions
Both the ATC-300+ and the ATC-900 controllers come with Modbus RS-485 enabled by default. No special ordering instructions are required. The PXG series gateway and the ELC-CAENET can be ordered for installation into your transfer switch from your Eaton ATS rep. The switch is then ready for connection to customer supplied Ethernet Cat5/6 cable pulled by the contractor to the switch. The customer will be responsible for connecting additional RS-485 devices to the gateway for monitoring (unless otherwise discussed with your Eaton rep).
ATC 300+ 900 to HMI (via Serial RS-485)

Components Required

RS-485 Enabled ATS Controller
The ATC-300+ and 900 come with Modbus-enabled ports as standard. Up to 8 ATC-300+ and 900’s can be daisy-chained together and viewed on a single HMI screen.

DB-9 to Terminal Block Converter
This provides termination points for your RS-485 wiring to connect to your Eaton HMI. Eaton recommends the EasyAdapters.com MDB9-TB10+ adapter (or equivalent).

Belden 3106A Cable
The RS-485 signal is suitable for transmission for up to 4000 feet using Belden 3106A or equivalent low capacitance cable. 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.

120 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. Resistors must be placed at BOTH ends of the communication cable chain. Note that ATC-300+/900’s have termination resistor toggle switches (SW1) built in to their Modbus ports. Both resistors must be the same resistance, and should match the characteristic impedance of the cable you are using. Consult TD17513 for more information on field wiring.

Human Machine Interface (HMI)
Eaton ATS has pre-programmed 7-inch HMI’s available for purchase. The HMI dynamically supports any combination ATC-300+ and ATC-900’s, up to a maximum of 8 controllers per HMI. Please note that HMI’s are not capable of converting serial data received from the controller(s) to Ethernet. They cannot be used as a Serial-to-Ethernet Gateway device.

Software: Delta DOPSoft
Delta DOPSoft is ATS’s development software for industrial-rated HMI’s. The ATS product line has firmware applications available for the 7” DOP-100 series HMI’s. Customers may also create their own custom HMI designs from scratch using DOPSoft. It is available as a free download from Delta’s website.

For more information, see www.deltaww.com and search for DOPSoft.

Ordering Instructions
Both the ATC-300+ and the ATC-900 controllers come with Modbus RS-485 enabled by default. To order a pre-programmed HMI with your ATS, ask for option 48RAC/48MRAC; consult your local Eaton ATS rep for more details.
## ATC 300+ /600/800/900 to HMI (via Serial-to-Ethernet Gateway)

### Components Required

**Modbus Serial-to-Ethernet Gateway**

These devices allow you to place serial-only equipped devices on an Ethernet network.

Eaton has two serial-to-Ethernet gateways available: the ELC-CAENET and the PXG series. The PXG series gateways allow for direct PC monitoring, web-based monitoring, data logging, alarm handling, and Modbus TCP/IP pass-through for the HMI. The ELC-CAENET is a simple pass-through device with no additional monitoring or data logging.

**Cat 5/6 Ethernet Cable**

Standard Ethernet cable required to connect the gateway and HMI(s) to the plant network.

**Belden 3106A Cable**

The RS-485 signal is suitable for transmission for up to 4000 feet using Belden 3106A or equivalent low capacitance cable.

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.

**120 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.

Resistors must be placed at BOTH ends of the communication cable chain. Note that ATC-300+ /900’s have termination resistor toggle switches (SW1) built in to their Modbus ports. Both resistors must be the same resistance, and should match the characteristic impedance of the cable you are using. Consult TD17513 for more information on field wiring.

**Human Machine Interface (HMI)**

Eaton ATS has pre-programmed 7-inch HMI’s available for purchase.

The HMI dynamically supports any combination ATC-300+ and ATC-900’s, up to a maximum of 8 controllers per HMI. Additionally, multiple HMI’s may be connected to a single Ethernet network for expanded flexibility in monitoring locations.

**Software: Delta DOPSoft**

Delta DOPSoft is ATS’s development software for industrial-rated HMI’s. The ATS product line has firmware applications available for the 7” DOP-100 series HMI’s. Customers may also create their own custom HMI designs from scratch using DOPSoft. It is available as a free download from Delta’s website.

For more information, see www.deltaww.com and search for DOPSoft.

**Ordering Instructions**

Both the ATC-300+ and the ATC-900 controllers come with Modbus RS-485 enabled by default. To order a pre-programmed HMI with your ATS, ask for options 48RAC/48MRAC, and 48D or 48G. Consult your local Eaton ATS rep for more details. You will need to provide plant network details (device IP’s/Subnets) if you would like your HMI and gateways pre-configured from the factory. If this is not provided, you may incur additional costs during startup as Engineering Services will need to update the HMI firmware with the correct IP information.
Legacy Applications

ATC 400/600/800 Direct Connect - CONI (Legacy)

Components Required

CONI (legacy device - no longer available)

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. For more information, see www.eaton.com and in the search box, type 00017513.PDF. 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 a robust signal that can be transmitted for 8,500 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 and PowerNet (Legacy)

These are legacy software packages that have reached EOL (end of life). They are no longer maintained by Eaton. You may still receive tech support on existing installations by calling 877-ETN-CARE.

Software: Power Xpert Insight / Foreseer

These software suites provide data monitoring and control, but require the use of Eaton’s Power Xpert Gateway. The PC may connect to the gateway via USB or Ethernet only, not via CONI cards.

Ordering Instructions

IQ Transfer, CONI, PowerNet, and PowerPort are legacy devices, and are no longer available. Please consult Eaton tech support for any questions with your existing legacy equipment.
ATC 400/600/800 Direct Connect - MINT (Legacy)

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.

**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.

**IPONI**
The INCOM Product Operated Network Interface translates low level data signals obtained from the IQ device into a robust signal that can be transmitted for 8,500 feet using Belden 9463 or up to 10,000 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 and PowerNet (Legacy)**
These are legacy software packages that have reached EOL (end of life). They are no longer maintained by Eaton. You may still receive tech support on existing installations by calling 877-ETN-CARE.

**Software: Power Xpert Insight / Foreseer**
These software suites provide data monitoring and control, but require the use of Eaton’s Power Xpert Gateway. The PC may connect to the gateway via USB or Ethernet only, not via CONI cards.

**Ordering Instructions**
This is a legacy device, and is no longer available. Please consult Eaton tech support for any questions with your existing legacy equipment.

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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. For more information, see www.eaton.com and in the search box, type 00017513.PDF. Note that the shield connection is grounded only at the MINT. All other shield connections are tied together but left ungrounded.

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For more information visit: www.eaton.com/ats
ATC 400/600/800 Direct Connect - Modbus MINT Legacy

Components Required

Modbus MINT (mMINT)
The mMINT connects an RS-485 based Modbus master device (e.g. computer serial port, modem, PLC) to the 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 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. 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. For more information, see www.eaton.com in the search box, type 00017513.PDF. 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 low level data signals obtained from the IQ device into a robust signal that can be transmitted for 8,500 feet using Belden 9463 or up to 10,000 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 Eaton 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. The Eaton business, however, does offer 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 Eaton Engineering Services and Systems (EESS) group is available. Contact EESS or your transfer switch representative for more information on the custom software programming services available.

Ordering Instructions
This is a legacy device, and is no longer available. Please consult Eaton tech support for any questions with your existing legacy equipment.
**Components Required**

**PMCOM5**

The device known as 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 when directly connected to a computer or a modem. The PMCOM5 operates on 120V AC.

**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).

**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. For more information, see www.eaton.com and in the search box, type 00017513.PDF. 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 low level data signals obtained from the IQ device into a robust signal that can be transmitted for 8,500 feet using Belden 9463 or up to 10,000 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 and PowerNet (Legacy)**

These are legacy software packages that have reached EOL (end of life). They are no longer maintained by Eaton. You may still receive tech support on existing installations by calling 877-ETN-CARE.

**Software: Power Xpert Insight / Foreseer**

These software suites provide data monitoring and control, but require the use of Eaton’s Power Xpert Gateway. The PC may connect to the gateway via USB or Ethernet only, not via CONI cards.

**Ordering Instructions**

This is a legacy device, and is no longer available. Please consult Eaton tech support for any questions with your existing legacy equipment.
ATC 400/600/800 Modem to - MINT (Legacy)

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, as well as INCOM data rates of 9600 and 1200 baud.

Modem

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).

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 9363 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. For more information, see www.eaton.com and in the search box, type 00017513.PDF. 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 low level data signals obtained from the IQ device into a robust signal that can be transmitted for 8,500 feet using Belden 9463 or up to 10,000 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 and PowerNet (Legacy)

These are legacy software packages that have reached EOL (end of life). They are no longer maintained by Eaton. You may still receive tech support on existing installations by calling 877-ETN-CARE.

Software: Power Xpert Insight and Foreseer

These software suites provide data monitoring and control, but require the use of Eaton’s Power Xpert Gateway. The PC may connect to the gateway via USB or Ethernet only, not via CONI cards.

Ordering Instructions

This is a legacy device, and is no longer available. Please consult Eaton tech support for any questions with your existing legacy equipment.
ATC 400/600/800 Modem to - PMCOM5 (Legacy)

Components Required

PMCOM5

The device known as 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 when directly 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 Hyper-terminal 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 “auto-baud.” 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 120V AC 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

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATZ0</td>
<td>reset modem</td>
</tr>
<tr>
<td>AT&amp;F0</td>
<td>load factory default profile</td>
</tr>
<tr>
<td>ATE0</td>
<td>disable local echo</td>
</tr>
<tr>
<td>ATF0</td>
<td>disable xmit data echo</td>
</tr>
<tr>
<td>ATS0=1</td>
<td>answer on 1st ring</td>
</tr>
<tr>
<td>AT&amp;B1</td>
<td>set fixed serial bit rate</td>
</tr>
<tr>
<td>AT&amp;D0</td>
<td>ignore DTR hang up</td>
</tr>
<tr>
<td>AT&amp;H0</td>
<td>ignore xmt flow control</td>
</tr>
<tr>
<td>AT&amp;IO</td>
<td>ignore rcv flow control</td>
</tr>
<tr>
<td>AT&amp;N6</td>
<td>connect at 9600 bps</td>
</tr>
<tr>
<td>AT&amp;R1</td>
<td>modem ignores RTS</td>
</tr>
<tr>
<td>AT&amp;U6</td>
<td>min connect speed: 9600 bps</td>
</tr>
<tr>
<td>ATYO</td>
<td>power on profile 0 selected</td>
</tr>
<tr>
<td>AT&amp;W0</td>
<td>write to NVRAM</td>
</tr>
</tbody>
</table>

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. For more information, see www.eaton.com and in the search box, type 00017513.PDF. Note that the shield connection is grounded only at the PMCOM5. All other shield connections are tied together but left ungrounded.

AT Modem Cable

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

<table>
<thead>
<tr>
<th>Computer 9-pin male</th>
<th>Modem 25-pin female</th>
<th>Cable 25-pin male</th>
<th>9-pin female</th>
<th>Cable 25-pin female</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Data Out</td>
<td>Data In</td>
<td>Data Out</td>
<td>Data In</td>
<td>Signal Common</td>
</tr>
<tr>
<td>JP 102</td>
<td></td>
<td></td>
<td></td>
<td>AT Modem Cable 5724856H04</td>
</tr>
</tbody>
</table>

IPONI

The INCOM Product Operated Network Interface translates low level data signals obtained from the IQ device into a robust signal that can be transmitted 8,500 feet using Belden 9463 or up to 10,000 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

This is a legacy device, and is no longer available. Please consult Eaton tech support for any questions with your existing legacy equipment.
ATC 400/600/800 Ethernet 10BASE-T (Legacy)

Components Required

**EPONI (10BASE-T version)**

The Ethernet Product Operated Network Interface connects an IQ device such as the IQ Transfer to an Ethernet unshielded twisted pair network (CAT5 UTP 10BASE-T RJ-45 connector). The EPONI operates at 10 Mbps. If connected to a 100 or 1,000 Mbps Ethernet LAN, do not connect to an Ethernet hub. Instead, be sure to connect the EPONI to an Ethernet switch that supports a 10 Mbps device. The more sophisticated switch will handle the details of retransmitting the Ethernet message at the slower 10 Mbps rate to the EPONI.

**CAT5 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 EPONI) to an Ethernet hub.

The EPONI 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 certain 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.

**Power Supply**

As the IQ Transfer does not provide sufficient 24V DC control power for the EPONI, a separate external power supply is needed (if a source of 24V DC @300 mA is not available elsewhere). The power supply is only needed for the IQ Transfer. Other IQ Devices (IQ Analyzer, DP4000, etc.) provide sufficient internal power to support the EPONI without the need for an external power supply. This power supply is included when you order the option 48D as discussed below.

**Ordering Instructions**

This is a legacy device, and is no longer available. Please consult Eaton tech support for any questions with your existing legacy equipment.
ATC 400/600/800 Ethernet 10BASE-FL Multi-mode (Legacy)

Components Required

**EPONI (Multi-mode Fiber Version)**

The Ethernet Product Operated Network Interface connects an IQ device, such as the IQ Transfer, to an Ethernet fiber optic network using multi-mode fiber and Type ST connectors. The EPONI operates at 10 Mbps. If connected to a 100 or 1,000 Mbps Ethernet LAN, do not connect to an Ethernet hub. Instead, be sure to connect the EPONI to an Ethernet switch that supports a 10 Mbps device. The more sophisticated switch will handle the details of retransmitting the Ethernet message at the slower 10 Mbps rate to the EPONI.

**Multi-mode Patch Cable**

Ethernet 10BASE-FL (fiber optic) supports up to 6500 feet of cabling between any two nodes. Two fibers are used to connect the EPONI-F to an Ethernet hub.

If you need to connect to a single-mode fiber network, install a “single-mode to multi-mode” converter (Black Box LH7401A-STSC-R2). Single-mode fiber is more expensive, but supports longer distances (20-40 km are typical) and is usually used on 100 or 1,000 Mbps LANs. Note that the Type SC (rather than the Type ST supplied with the EPONI-F) is usually specified with single-mode fiber networks. The LH7401A-STSC-R2 provides SC connectors for the single-mode fiber connection and ST connectors for the multi-mode connection. The EPONI, without an external converter, supports multi-mode fiber only.

Another method of providing single-mode fiber connectivity for the IQ Transfer is to supply the 10BASE-T EPONI and purchase a 10BASE-T to single-mode converter (Black Box LMC005A-R2).

**Ethernet Hub (Switch)**

As 10BASE-FL (fiber) is a point-to-point topology, a certain method is required to connect multiple nodes into a larger network. This is accomplished by connecting each 10BASE-FL 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. This 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.

**Power Supply**

As the IQ Transfer does not provide sufficient 24V DC control power for the EPONI, a separate external power supply is needed (if a source of 24V DC @300 mA is not available elsewhere).

The power supply is only needed for the IQ Transfer. Other IQ Devices (IQ Analyzer, DP4000, etc.) provide sufficient internal power to support the EPONI without the need for an external power supply. This power supply is included when you order the option 48D.

**Ordering Instructions**

This is a legacy device, and is no longer available. Please consult Eaton tech support for any questions with your existing legacy equipment.

For more information visit: www.eaton.com/ats
Soft Load / Peaker Modem Connect - Modbus / RS-232 (Legacy)

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 only discuss the Modbus RTU RS-232 connection when using modems. The default (and nonadjustable) 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
- Multi-mode Patch Cable

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 Hyper-terminal 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 RS-232 port on the GPC (pins 79, 77 and 76). The GPC is connected to a reliable source of 24V DC 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

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATZ0</td>
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<tr>
<td>AT&amp;F0</td>
<td>load factory default profile</td>
</tr>
<tr>
<td>ATE0</td>
<td>disable local echo</td>
</tr>
<tr>
<td>ATFO</td>
<td>disable xmit data echo</td>
</tr>
<tr>
<td>ATSO 1</td>
<td>answer on 1st ring</td>
</tr>
<tr>
<td>AT&amp;B1</td>
<td>set fixed serial bit rate</td>
</tr>
<tr>
<td>AT&amp;D0</td>
<td>ignore DTR hang up</td>
</tr>
<tr>
<td>AT&amp;H0</td>
<td>ignore xmt flow control</td>
</tr>
<tr>
<td>AT&amp;I0</td>
<td>ignore rcv flow control</td>
</tr>
<tr>
<td>AT&amp;N6</td>
<td>connect at 9600 bps</td>
</tr>
<tr>
<td>AT&amp;R1</td>
<td>modem ignores RTS</td>
</tr>
<tr>
<td>AT&amp;U6</td>
<td>min connect speed: 9600 bps</td>
</tr>
<tr>
<td>ATYO</td>
<td>power on profile 0 selected</td>
</tr>
<tr>
<td>AT&amp;W0</td>
<td>write to NVRAM</td>
</tr>
</tbody>
</table>

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 want to interrogate the main control at address 002.

Software: Eaton DG Monitor (Legacy)

DG Monitor is a Windows 98/NT/2000/XP program that communicates with a Soft-Load Transfer Switch or Peaking Switch via a direct RS-232 connection, a modem connection, or 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 Eaton sales representative for a complete listing.

<table>
<thead>
<tr>
<th>Modbus Address</th>
<th>Description</th>
<th>Note: GPC 3-phase connection is assumed to be “Utility”</th>
</tr>
</thead>
<tbody>
<tr>
<td>30002</td>
<td>Read internal clock</td>
<td>GPC 1-phase connection is assumed to be “Generator”</td>
</tr>
<tr>
<td>30030</td>
<td>Utility A Phase Voltage</td>
<td></td>
</tr>
<tr>
<td>30060</td>
<td>Utility B Phase Voltage</td>
<td></td>
</tr>
<tr>
<td>30090</td>
<td>Utility C Phase Voltage</td>
<td></td>
</tr>
<tr>
<td>30150</td>
<td>Utility A Phase Amperes</td>
<td></td>
</tr>
<tr>
<td>30180</td>
<td>Utility B Phase Amperes</td>
<td></td>
</tr>
<tr>
<td>30210</td>
<td>Utility C Phase Amperes</td>
<td></td>
</tr>
<tr>
<td>30310</td>
<td>Utility Watts</td>
<td></td>
</tr>
<tr>
<td>30312</td>
<td>Utility VA</td>
<td></td>
</tr>
<tr>
<td>30316</td>
<td>Utility PF</td>
<td></td>
</tr>
<tr>
<td>30318</td>
<td>Utility Average 3-phase voltage</td>
<td></td>
</tr>
<tr>
<td>30320</td>
<td>Utility Average 3-phase current</td>
<td></td>
</tr>
<tr>
<td>30330</td>
<td>Utility Hz</td>
<td></td>
</tr>
<tr>
<td>30032</td>
<td>Utility A Phase Voltage THD</td>
<td></td>
</tr>
<tr>
<td>30062</td>
<td>Utility B Phase Voltage THD</td>
<td></td>
</tr>
<tr>
<td>30092</td>
<td>Utility C Phase Voltage THD</td>
<td></td>
</tr>
<tr>
<td>30324</td>
<td>Utility Voltage Unbalance</td>
<td></td>
</tr>
<tr>
<td>30326</td>
<td>Utility Current Unbalance</td>
<td></td>
</tr>
<tr>
<td>30340</td>
<td>Demand (watt) meter #1 (connected to Utility), sliding window</td>
<td></td>
</tr>
<tr>
<td>30410</td>
<td>Demand (watt) meter #2 (connected to Generator), sliding window</td>
<td></td>
</tr>
<tr>
<td>30430</td>
<td>Watt-Hour meter #1 (connected to Utility)</td>
<td></td>
</tr>
<tr>
<td>30435</td>
<td>Watt-Hour meter #2 (connected to Generator)</td>
<td></td>
</tr>
<tr>
<td>30300</td>
<td>Generator Watts</td>
<td></td>
</tr>
<tr>
<td>30302</td>
<td>Generator VA</td>
<td></td>
</tr>
<tr>
<td>30304</td>
<td>Generator VAR</td>
<td></td>
</tr>
<tr>
<td>30306</td>
<td>Generator PF (PF = 1-abs((30306 - (30307/65535))), &gt;0: Leading, &lt;0: Lagging)</td>
<td></td>
</tr>
<tr>
<td>30120</td>
<td>Generator Voltage</td>
<td></td>
</tr>
<tr>
<td>30240</td>
<td>Generator Amperes (GPC only)</td>
<td></td>
</tr>
<tr>
<td>30335</td>
<td>Generator Hz</td>
<td></td>
</tr>
<tr>
<td>30445</td>
<td>Generator Runtime Runtime = ((30445*24) + (30446) + (30447/65535))/60</td>
<td></td>
</tr>
<tr>
<td>30604</td>
<td>Synchroscope (12 O’clock: 0 radians, 6 O’clock: pi radians, &lt;0 hand move counterclockwise)</td>
<td></td>
</tr>
<tr>
<td>10001</td>
<td>4: watchdog good, 0: watchdog bad</td>
<td></td>
</tr>
<tr>
<td>10010</td>
<td>Generator 52b input contact (INV is internal GPC function — this register provides the non-inverted input)</td>
<td></td>
</tr>
<tr>
<td>10011</td>
<td>Utility 52b input contact (INV is internal GPC function — this register provides the non-inverted input)</td>
<td></td>
</tr>
<tr>
<td>10012</td>
<td>Service Input contact</td>
<td></td>
</tr>
<tr>
<td>10013</td>
<td>Alarm/Test Reset input contact (INV is internal GPC function — this register provides the non-inverted input)</td>
<td></td>
</tr>
<tr>
<td>10014</td>
<td>Close/Open Transfer input contact</td>
<td></td>
</tr>
<tr>
<td>10015</td>
<td>Transfer Test input contact</td>
<td></td>
</tr>
<tr>
<td>10016</td>
<td>Auto Enabled input contact</td>
<td></td>
</tr>
<tr>
<td>10491</td>
<td>ATS is transferring</td>
<td></td>
</tr>
<tr>
<td>10493</td>
<td>ATS is transferring to Normal</td>
<td></td>
</tr>
</tbody>
</table>
### Soft Load

<table>
<thead>
<tr>
<th>Register</th>
<th>Description</th>
<th>Register</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>00020</td>
<td>Close Generator Breaker output contact</td>
<td>00021</td>
<td>Open Generator Breaker output contact</td>
</tr>
<tr>
<td>00022</td>
<td>Close Utility Breaker</td>
<td>00023</td>
<td>Open Utility Breaker</td>
</tr>
<tr>
<td>00024</td>
<td>Spare</td>
<td>00025</td>
<td>Spare</td>
</tr>
<tr>
<td>00026</td>
<td>Sources Synchronized</td>
<td>00027</td>
<td>Start Engine output contact</td>
</tr>
<tr>
<td>40002</td>
<td>Set internal clock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40085</td>
<td>Voltage Bias output (to Genset AVR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4009</td>
<td>Frequency Bias output (to Genset governor)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40302</td>
<td>Generator HiHi voltage trip setting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40304</td>
<td>Generator Hi voltage trip setting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40306</td>
<td>Generator Lo voltage trip setting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40308</td>
<td>Generator LoLo voltage trip setting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40358</td>
<td>Utility HiHi Voltage trip setting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40360</td>
<td>Utility Hi Voltage trip setting</td>
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</tr>
<tr>
<td>40362</td>
<td>Utility Lo Voltage trip setting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40364</td>
<td>Utility LoLo Voltage trip setting</td>
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</tr>
<tr>
<td>40402</td>
<td>Utility HiHi Negative Sequence Overvoltage</td>
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</tr>
<tr>
<td>40404</td>
<td>Utility Hi Negative Sequence Overvoltage</td>
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</table>

### Peaking Switch

<table>
<thead>
<tr>
<th>Register</th>
<th>Description</th>
<th>Register</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>00020</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Note

All 3xxxx and 4xxxx 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 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 digits of fraction are significant).
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