INDUSTRIAL CONTROL COMMUNICATIONS, INC.

Instruction Manual

XLTR-1000 Multiprotocol RS-485 Gateway

MILLENNIUM SERIES

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ICC #10756

XLTR-1000
User's Manual

Part Number 10756
Printed in U.S.A.

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APPLICABLE FIRMWARE

Modbus – BACnet Firmware Version 2.100
Modbus – Metasys Firmware Version 2.100
Modbus – Toshiba Firmware Version 2.100
Modbus – Sullair Firmware Version 2.100
BACnet – Metasys Firmware Version 2.100
BACnet – Toshiba Firmware Version 2.100
BACnet – Sullair Firmware Version 2.100
Metasys – Toshiba Firmware Version 2.100
Metasys – Sullair Firmware Version 2.100
Toshiba – Sullair Firmware Version 2.100

Usage Precautions

Operating Environment

- Please use the interface only when the ambient temperature of the environment into which the unit is installed is within the following specified temperature limits:

  Operation: -10 ~ +50°C (+14 ~ +122°F)
  Storage: -40 ~ +85°C (-40 ~ +185°F)

- Avoid installation locations that may be subjected to large shocks or vibrations.
- Avoid installation locations that may be subjected to rapid changes in temperature or humidity.

Installation and Wiring

- Proper ground connections are vital for both safety and signal reliability reasons. Ensure that all electrical equipment is properly grounded.
- Route all communication cables separate from high-voltage or noise-emitting cabling (such as ASD input/output power wiring).

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1. Introduction

Congratulations on your purchase of the ICC XLTR-1000 Multiprotocol RS-485 Communications Gateway. This gateway allows information to be transferred seamlessly between various RS-485-based networks. In addition to the supported fieldbus protocols, the gateway hosts a USB interface for configuring the gateway via a PC.

Before using the gateway, please familiarize yourself with the product and be sure to thoroughly read the instructions and precautions contained in this manual. In addition, please make sure that this instruction manual is delivered to the end user of the gateway, and keep this instruction manual in a safe place for future reference or unit inspection.

For the latest information, support software and firmware releases, please visit http://www.iccdesigns.com.

Before continuing, please take a moment to ensure that you have received all materials shipped with your kit. These items are:

- XLTR-1000 gateway in plastic housing
- Documentation CD-ROM
- DIN rail adapter with two pre-mounted screws
- Four black rubber feet

Note that different gateway firmware versions may provide varying levels of support for the various protocols. When using this manual, therefore, always keep in mind that the firmware version indicated on your unit must be listed on page 2 for all documented aspects to apply.

This manual will primarily be concerned with the gateway’s hardware specifications, installation, wiring, configuration and operational characteristics.

To maximize the abilities of your new gateway, a working familiarity with this manual will be required. This manual has been prepared for the gateway installer, user, and maintenance personnel. With this in mind, use this manual to develop a system familiarity before attempting to install or operate the gateway.

2. Features

Supported Protocols

The gateway currently provides support for the following fieldbus protocols:

- Modbus RTU Master
- Modbus RTU Slave
- Modbus RTU Sniffer
- BACnet MS/TP Client
- BACnet MS/TP Server
- Johnson Controls Metasys N2 Slave
- Toshiba ASD Protocol Master
- Sullair Supervisor Network Master

Note that any combination of these protocols may be configured on the gateway's "RS-485 A" and "RS-485 B" ports.

Supported Baud Rates

The gateway currently provides support for the following baud rates:

- 2400
- 4800
- 9600
- 19200
- 38400
- 57600
- 76800
- 115200

Note that not all protocols support every baud rate listed above. Refer to section 9 for more information.

Field-Upgradeable

As new firmware becomes available, the gateway can be upgraded in the field by the end-user. Refer to section 8.1 for more information.

USB Interface

The gateway can be connected to a PC via a USB mini type-B cable. This simultaneously supplies power while providing the ability to configure the gateway, monitor data, and update firmware on the device using the ICC Gateway Configuration Utility. Refer to section 8.1 for more information.

Flexible Mounting Capabilities

The gateway includes all hardware for desktop, panel/wall and DIN-rail mounting capabilities. Refer to section 6.1 for more information.

3. Gateway Concepts

The XLTR-1000 is a member of the Millennium Series communication gateways. Members of this family are designed to provide a uniform interface, configuration and application experience. This commonality reduces the user's learning curve, reducing commissioning time while simplifying support. All Millennium Series gateways are configured using the ICC Gateway Configuration Utility. The XLTR-1000 provides simultaneous support for two different communication protocols, allowing complex interchanges of data between otherwise incompatible networks.

The heart of the Millennium Series concept is its internal database. The database is a 4 KB, byte-wise addressable data array. The database allows data to be routed from any supported network to any other supported network. Data may be stored into the database in either big-endian style (meaning that if a 16-bit or 32-bit value is stored in the database, the most significant byte will start at the lowest address) or little-endian style (meaning that if a 16-bit or 32-bit value is stored in the database, the least significant byte will start at the lowest address).

The other fundamental aspect of the Millennium Series is the concept of a configurable "service object". A service object is used for any master/client protocol to describe what service (read or write) is to be requested on the network. The gateway will cycle through the defined service objects in a round-robin fashion; however, the gateway does implement a "write first" approach. This means that the gateway will perform any outstanding write services before resuming its round-robin, read request cycle.

Additionally, the database and service objects provide the added benefit of "data mirroring", whereby current copies of data values (populated by a service object) are maintained locally within the gateway itself. This greatly reduces the request-to-response latency times on the various networks, as requests (read or write) can be entirely serviced locally, thereby eliminating the time required to execute a secondary transaction on a different network.

Regardless of their network representation, all data values are stored in the gateway's internal database as integer values (either 8-, 16- or 32-bits in length, depending on the protocol and/or object configuration). This means that even if a network variable is accessed by the gateway as a 32-bit floating-point number, this native representation will always be converted to an equivalent integer representation prior to being stored in the database. Once in the database, this value will then be accessible to the network operating on the other port of the gateway, which may then impose its own conversion process on the data. A port's conversion may be implicit (e.g. all Modbus holding registers are interpreted by the protocol as 16-bit unsigned integers) or explicit (as configured in a BACnet service object).

In order to facilitate the free scaling and conversion of native data values, a user-configurable "multiplier" and "data type" exist for some network configurations. All network values are scaled by a multiplier prior to being stored into the database or after being retrieved from the database. The data type is used to determine how many bytes are allocated for the value in the database and whether or not to interpret the number as signed or unsigned upon retrieval from the database.

A typical use of the multiplier feature is to preserve the fractional components of a network value for insertion into the database. For example, if the floating-point value “3.19” is read by the gateway from a remote BACnet device, then we could use a multiplier value of 0.01 to preserve all of the significant digits of this value: the network representation (3.19) will be divided by the multiplier value (0.01) to obtain a resultant value of 319, which will then be inserted into the database. Similarly, when a value in the database corresponding to a specific service object is changed (which therefore requires that this updated value be written to the associated remote device on the network), the service object’s multiplier value will first be multiplied by the database value in order to obtain the resultant network value. For example, if 3000 is written to the database at a location corresponding to a certain service object on the other port, and that service object’s multiplier value is 0.1, then the database value (3000) will be multiplied by the multiplier value (0.1) to obtain the resultant network value of 300.0, which will then be written to the network as a native floating point value.

An appropriate data type should be selected based on the range of the network data values. For example, if the value of an Analog Output on a remote BACnet device can vary from –500 to 500, a 16-bit signed data type should be used. If the value can only vary from 0 to 150, for example, an 8-bit unsigned data type may be used. Care must be taken so that a signed data type is selected if network data values can be negative. For example, if 0xFF is written to the database at a location corresponding to a service object with an 8-bit unsigned data type, the resultant network value will be 255_{10} (assuming a multiplier of 1). However, if 0xFF is written to the database at a location corresponding to a service object with an 8-bit signed data type, the resultant network value will be -1_{10} (again, assuming a multiplier of 1). It is also important to select a data type large enough to represent the network data values. For example, if a value of 257 is read by the gateway from a remote device and the data type corresponding to that service object is 8-bit unsigned, the value that actually will be stored is 1 (assuming a multiplier of 1). This is because the maximum value that can be stored in 8-bits is 255. Any value higher than this therefore results in overflow.

The Millennium Series gateways also provide a powerful data-monitoring feature that allows the user to view and edit the database in real time, as well as view the status of service objects via the ICC Gateway Configuration Utility’s Monitor tab when connected via USB to a PC.

When properly configured, the gateway will become essentially “transparent” on the networks, and the various network devices can engage in seamless dialogs with each other.

4. Precautions and Specifications

DANGER!

Rotating shafts and electrical equipment can be hazardous. Installation, operation, and maintenance of the gateway shall be performed by **Qualified Personnel** only.

Qualified Personnel shall be:

- Familiar with the construction and function of the gateway, the equipment being driven, and the hazards involved.
- Trained and authorized to safely clear faults, ground and tag circuits, energize and de-energize circuits in accordance with established safety practices.
- Trained in the proper care and use of protective equipment in accordance with established safety practices.

Installation of the gateway should conform to all applicable **National Electrical Code** (NEC) *Requirements For Electrical Installation*s, all regulations of the **Occupational Safety and Health Administration**, and any other applicable national, regional, or industry codes and standards.

DO NOT install, operate, perform maintenance, or dispose of this equipment until you have read and understood all of the following product warnings and user directions. Failure to do so may result in equipment damage, operator injury, or death.

4.1 Installation Precautions

DANGER!

- Avoid installation in areas where vibration, heat, humidity, dust, metal particles, or high levels of electrical noise (EMI) are present.
- Do not install the gateway where it may be exposed to flammable chemicals or gasses, water, solvents, or other fluids.
- Where applicable, always ground the gateway to prevent electrical shock to personnel and to help reduce electrical noise.

  Note: *Conduit is not an acceptable ground.*
- Follow all warnings and precautions and do not exceed equipment ratings.

4.2 Maintenance Precautions

DANGER!

- **Do Not** attempt to disassemble, modify, or repair the gateway. Contact your ICC sales representative for repair or service information.
- If the gateway should emit smoke or an unusual odor or sound, turn the power off immediately.
- The system should be inspected periodically for damaged or improperly functioning parts, cleanliness, and to determine that all connectors are tightened securely.

4.3 Inspection

Upon receipt, perform the following checks:

- Inspect the unit for shipping damage.
- Check for loose, broken, damaged or missing parts.

Report any discrepancies to your ICC sales representative.

4.4 Maintenance and Inspection Procedure

Preventive maintenance and inspection is required to maintain the gateway in its optimal condition, and to ensure a long operational lifetime. Depending on usage and operating conditions, perform a periodic inspection once every three to six months.

<u>Inspection Points</u>

- Check that there are no defects in any attached wire terminal crimp points. Visually check that the crimp points are not scarred by overheating.
- Visually check all wiring and cables for damage. Replace as necessary.
- Clean off any accumulated dust and dirt.
- If use of the interface is discontinued for extended periods of time, apply power at least once every two years and confirm that the unit still functions properly.
- Do not perform hi-pot tests on the interface, as they may damage the unit.

Please pay close attention to all periodic inspection points and maintain a good operating environment.

4.5 Storage

- Store the device in a well ventilated location (in its shipping carton, if possible).
- Avoid storage locations with extreme temperatures, high humidity, dust, or metal particles.

4.6 Warranty

This gateway is covered under warranty by ICC, Inc. for a period of 12 months from the date of installation, but not to exceed 18 months from the date of shipment from the factory. For further warranty or service information, please contact Industrial Control Communications, Inc. or your local distributor.

4.7 Disposal

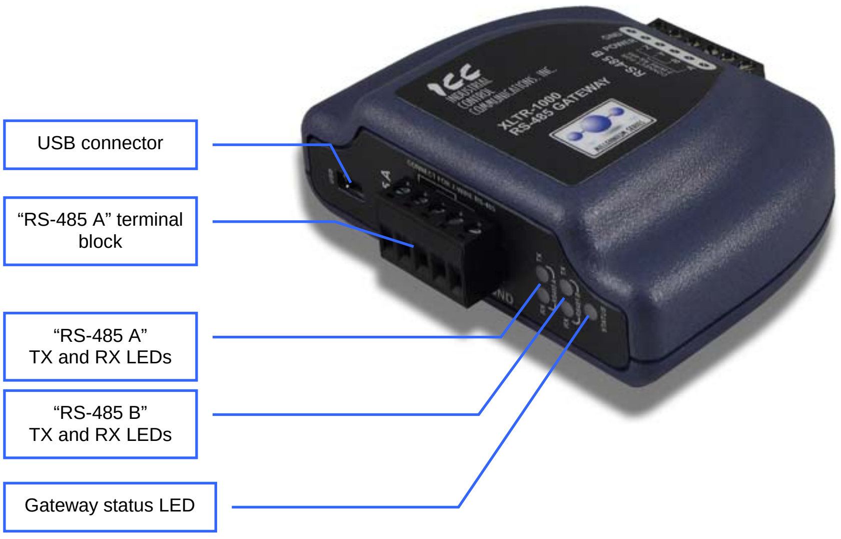
- Contact the local or state environmental agency in your area for details on the proper disposal of electrical components and packaging.
- Do not dispose of the unit via incineration.

4.8 Environmental Specifications

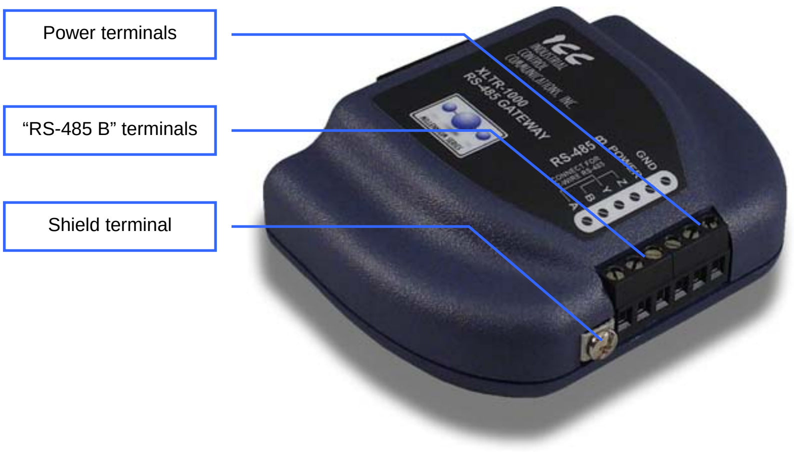
Item	Specification
Operating Environment	Indoors, less than 1000m above sea level, do not expose to direct sunlight or corrosive / explosive gasses
Operating Temperature	-10 ~ +50°C (+14 ~ +122°F)
Storage Temperature	-40 ~ +85°C (-40 ~ +185°F)
Relative Humidity	20% ~ 90% (without condensation)
Vibration	5.9m/s^2 {0.6G} or less (10 ~ 55Hz)
Grounding	Non-isolated, referenced to power ground
Cooling Method	Self-cooled

This device is lead-free / RoHS-compliant.

5. Gateway Overview


USB connector
"RS-485 A" terminal block
"RS-485 A" TX and RX LEDs
"RS-485 B" TX and RX LEDs
Gateway status LED

Gateway Overview (Front)



Gateway Overview (Back)

5.1 Power Supply Electrical Interface

When the gateway is not plugged into a PC via the USB cable, it must be powered by an external power source. Ensure that the power supply adheres to the following specifications:

Voltage rating	7 - 24VDC
Minimum Current rating..........	50mA (@24VDC)

- Typical current consumption of the XLTR-1000 when powered from a 24V supply is approximately 15mA.
- ICC offers an optional 120VAC/12VDC power supply (ICC part number 10755) that can be used to power the gateway from a standard wall outlet.
- The power supply must be connected to the gateway's "RS-485 B" terminal block at terminals #5 (POWER) and #6 (GND) as highlighted in Figure 1.

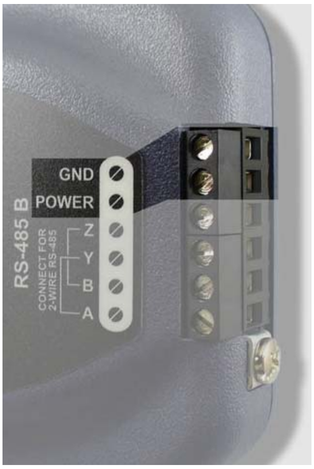


Figure 1: "RS-485 B" Terminal Block Power Supply Connections

5.2 RS-485 Port Electrical Interface

In order to ensure appropriate network conditions (signal voltage levels, etc.) when using the gateway's RS-485 ports, some knowledge of the network interface circuitry is required. Refer to Figure 2 for a simplified network schematic of the RS-485 interface circuitry. Both the "RS-485 A" and "RS-485 B" ports have 4 terminals for four-wire communication. For two-wire communication, connect a jumper wire between TB:1 (A / RXD+) and TB:3 (Y / TXD+) and a wire between TB:2 (B / RXD-) and TB:4 (Z / TXD-).

The GND terminals (terminal #5 on port "RS-485 A" and terminal #6 on port "RS-485 B") are internally connected.

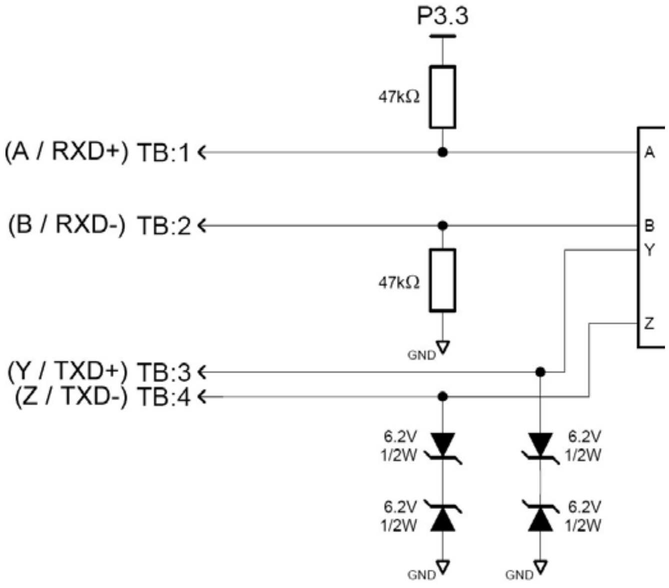


Figure 2: RS-485 Interface Circuitry Schematic

Figure 3 highlights the terminals on the gateway's "RS-485 B" terminal block that are specific to RS-485 network connections. Equivalent terminals exist on the "RS-485 A" terminal block for connection to that separate subnet.

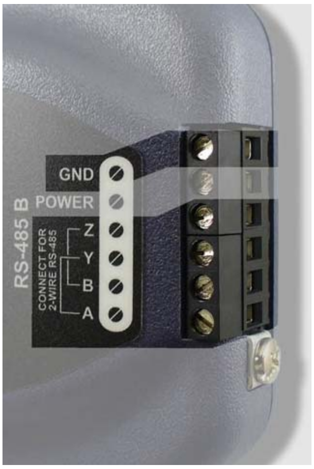


Figure 3: "RS-485 B" Terminal Block Network Connections

6. Installation

The gateway's installation procedure will vary slightly depending on the mounting method used. Before mounting the gateway, install the 4 black rubber feet (Figure 4) onto the bottom of the enclosure.

Figure 4: Rubber Feet

6.1 Mounting the Gateway

The gateway may be mounted on a panel, a wall or a DIN rail. In all cases, the gateway is mounted using the two keyhole-shaped screw holes on the bottom of the enclosure. A DIN rail adapter with two pre-mounted screws is provided for mounting the gateway on a DIN rail. The user must choose the appropriate hardware for mounting the gateway on a panel or wall. When choosing screws for panel or wall mounting, ensure the head size matches the keyhole screw holes on the back of the enclosure. The following describes the method for the two mounting options.

6.1.1 Panel / Wall Mounting

To mount the gateway on a panel or wall, drill two holes 25mm apart vertically. Screw two #6 pan head screws (or equivalent) into the holes and mount the gateway onto the screws. Several test-fitting iterations may be required in order to arrive at the proper screw height adjustment.

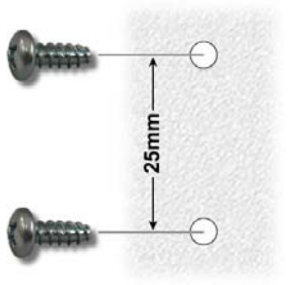


Figure 5: Panel / Wall Mounting Diagram

6.1.2 DIN Rail Mounting

The DIN rail adapter (Figure 6) can clip onto 35mm and G-type rails. To mount the gateway to a DIN rail, clip the DIN rail adapter onto the DIN rail and mount the gateway on the screws (the screws should already be seated into the adapter at the proper height). Refer to Figure 7, Figure 8, and Figure 9.

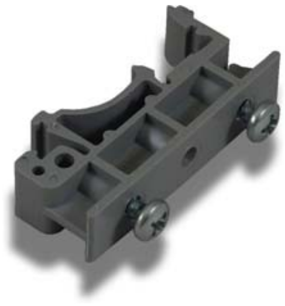


Figure 6: DIN Rail Adapter

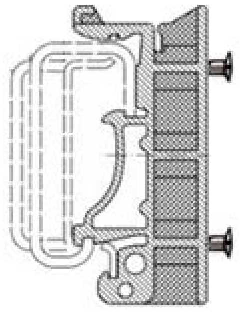


Figure 7: DIN Rail Adapter Attachment

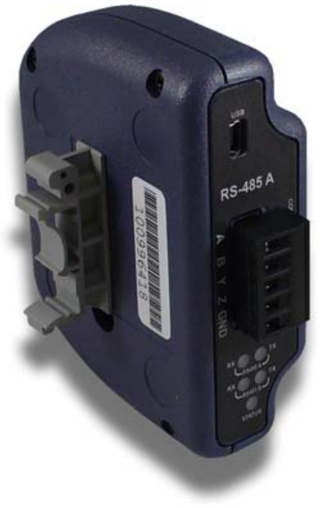


Figure 8: Unit with Attached DIN Rail Adapter

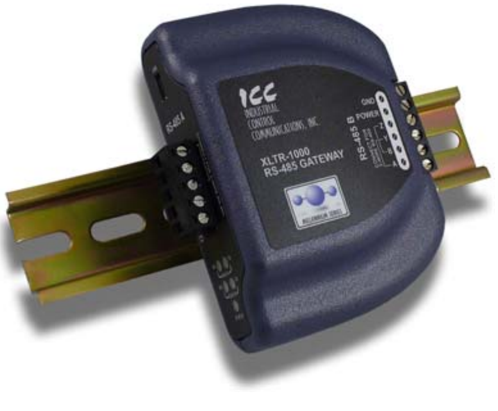


Figure 9: Example Installation

6.2 Wiring Connections

Note that in order to power the unit, a power supply must also be installed. Refer to section 5.1 for more information.

1. Mount the unit via the desired method (refer to section 6.1).
2. Connect the various networks to their respective plugs/terminal blocks. Ensure that any wires are fully seated into their respective terminal blocks, and route the network cables such that they are located well away from any electrical noise sources, such as adjustable-speed drive input power or motor wiring. Also take care to route all cables away from any sharp edges or positions where they may be pinched.
3. Take a moment to verify that the gateway and all network cables have sufficient clearance from electrical noise sources such as drives, motors, or power-carrying electrical wiring.
4. Connect the power supply to the gateway's "RS-485 B" terminal block on the terminals labeled POWER and GND. Pay particular attention to the proper polarity.

6.3 Grounding

Grounding is of particular importance for reliable, stable operation. Communication system characteristics may vary from system to system, depending on the system environment and grounding method used. The gateway has two logic ground terminals (terminal #5 on port "RS-485 A" and terminal #6 on port "RS-485 B") that are internally connected. These ground terminals serve as the ground reference for both power and RS-485 communication signals.

The gateway is also provided with a "Shield" terminal adjacent to the "RS-485 B" terminal block. This shield terminal has no internal connection: its purpose is simply to provide a cable shield chaining location between devices. The shield is then typically connected to ground at one location only.

Please be sure to consider the following general points for making proper ground connections:

Grounding method checkpoints

1. Make all ground connections such that no ground current flows through the case or heatsink of a connected electrical device.
2. Do not connect the Shield terminal to a power ground or any other potential noise-producing ground connection (such as a drive's "E" terminal).
3. Do not make connections to unstable grounds (paint-coated screw heads, grounds that are subjected to inductive noise, etc.)

7. LED Indicators

The gateway contains several different LED indicators, each of which conveys important information about the status of the unit and connected networks. These LEDs and their functions are summarized here.

7.1 Gateway Status

The gateway has one dichromatic LED to indicate the status of the device. On startup, the LED blinks a startup sequence: Green, Red, Green, Red. Always confirm this sequence upon powering the gateway to ensure the device is functioning properly.

Solid green	The status LED lights solid green when the gateway has power and is functioning normally.
Flashing green........	The status LED flashes green when the gateway is connected to a PC via a USB cable.
Flashing red............	If a fatal error occurs, the status LED will flash a red error code. The number of sequential blinks (followed by 2 seconds of OFF time) indicates the error code.

7.2 RS-485 Network Status LEDs

The gateway has one red and one green LED for each of the two RS-485 ports to indicate the status of that RS-485 network.

Green (TX) LED	Lights when the gateway is transmitting data on that RS-485 port.
Red (RX) LED	Lights when the gateway is receiving data on that RS-485 port. Note that this does not indicate the validity of the data with respect to a particular protocol: only that data exists and is being detected. Also note that if a 2-wire RS-485 network is in use, that the corresponding RX LED will light in conjunction with the TX LED (as transmitting devices on 2-wire RS-485 networks also receive their own transmissions).

8. Configuration Concepts

8.1 USB Configuration Utility

The gateway can be configured by a PC via a USB mini type-B cable. This connection provides power to the device, so there is no need for any external power supply while the gateway is attached to the PC.

The gateway is configured by the ICC Gateway Configuration Utility PC application. For information on how to install the utility, refer to the ICC Gateway Configuration Utility User's Manual.

The following will briefly describe how to configure the gateway using the configuration utility. For more information, refer to the ICC Gateway Configuration Utility User's Manual.

Manually Selecting a Device

Select the XLTR-1000 from the device menu: click **Device→Select Device→XLTR-1000**.

Note that when a device is selected, the utility will then automatically attempt to locate any connected devices of that type.

Automatically Connecting To a Device

If a device is already connected to the PC, you can click the **Auto Connect** button and the utility will automatically select the correct device and upload the current configuration from the connected device.

General Configuration

To configure the gateway, select the desired protocol, baud rate, parity, address, timeout, and scan rate/response delay for both RS-485 ports, and configure any objects associated with the designated protocols (refer to section 8.6 for more information). For more information on configuring ports, refer to section 8.3.

Note that all numbers can be entered in not only decimal but also in hexadecimal by including "0x" before the hexadecimal number.

Database Endianness Selection

Select the desired endianness for how data will be stored in the database: click **Device→Database Endianness→Big Endian** to use big endian style or click **Device→Database Endianness→Little Endian** to use little endian style. Note that this is part of the configuration and therefore does not take effect until the configuration is downloaded to the device. For more information on the database endianness, refer to Appendix A: Database Endianness.

Loading a Configuration from an XML File

To load a configuration from an XML file stored on the PC, click **File→Load Configuration…** (or click the **Load Configuration** button on the toolbar).

Saving a Configuration to an XML File

To save the configuration to an XML file on the PC, click **File→Save Configuration…** (or click the **Save Configuration** button on the toolbar).

Downloading a Configuration to a Device

To download the configuration to the gateway, click **Device→Download Configuration To Device** (or click the **Download Configuration To Device** button on the toolbar).

Note that because there is a different driver firmware for each protocol, the correct firmware may not be installed on the device corresponding to your configuration. The utility may need to update the firmware on the device before the configuration can be loaded.

Updating Firmware

To update firmware on the gateway, click **Device→Update Firmware** (or click the **Update Firmware** button on the toolbar).

Note that if a newer version exists for the firmware installed on the device, a message will be displayed in the **Status** box indicating an update is available.

Resetting the Device

To reset the gateway, click **Device→Reset Device** (or click the **Reset Device** button on the toolbar).

Monitoring the Database

To monitor the gateway's database in real time, select the **Monitor** tab. Data is updated automatically to reflect the actual values in the database. Values can be edited by double clicking the data in the database. The status of service objects can also be added and viewed in this tab in the **Status** list. Section 8.4.2 describes how to view the status of a service object. For more information, refer to the ICC Gateway Configuration Utility User's Manual.

8.2 Timeout Configuration Tab

The gateway can be configured to perform a specific set of actions when network communications are lost. This allows each address in the database to have its own unique "fail-safe" condition in the event of network interruption. Support for this feature varies depending on the protocol: refer to the protocol-specific section of this manual for further information.

Note that this feature is only used with slave/server protocols. This is not the same as the timeout value used for master/client protocols. For more information, refer to section 8.3.

There are two separate elements that comprise the timeout configuration:

- The timeout time
- Timeout Object configuration

8.2.1 Timeout Time

The timeout time is the maximum number of milliseconds for a break in network communications before a timeout will be triggered. This timeout setting is configured at the protocol level as part of the port configuration, and used by the protocol drivers themselves to determine abnormal loss-of-communications conditions and, optionally, trigger a gateway-wide timeout processing event. If it is not desired to have a certain protocol trigger a timeout processing event, then the protocol's timeout time may be set to 0 (the default value) to disable this feature. Refer to section 8.3 for details.

8.2.2 Timeout Object Configuration

A timeout object is used by the gateway as part of the timeout processing to set certain addresses of the database to "fail-safe" values. When a timeout event is triggered by a protocol, the timeout objects are parsed and the configured 8-bit, 16-bit, or 32-bit value is written to the corresponding address(es). The following describes the configurable fields of a timeout object:

Database Addr

This field is the starting address in the database where the first data element of this timeout object will begin. Depending on the designated Data Type, the maximum allowable database address is 4095, 4094, or 4092 for 8-bit, 16-bit, or 32-bit sized objects, respectively.

Data Type

This field selects the size and range of valid values for each data element in this timeout object. For instance, selecting 16-bit unsigned allows for a range of values between 0 and 65535, using 2 bytes in the database. Whereas selecting 16-bit signed allows for a range of values between -32768 and 32767, also using 2 bytes in the database. Select the desired data type from this dropdown.

Value

This is the "fail-safe" timeout value that every data element in this timeout object will be automatically written to upon processing of a timeout event triggered by a protocol.

Length

This field is the number of data elements for this timeout object. The total number of bytes modified by this timeout object is determined by the length multiplied by the number of bytes in the data type selected (1, 2 or 4).

8.3 Port Configuration Tabs Protocol Selection Group

This section describes each available field in the Protocol Selection group of the port configuration tabs. Note that support of these fields will vary by protocol, and that unsupported fields will automatically be made non-selectable within the configuration utility.

Protocol

Select the desired protocol for the port.

Baud Rate

Select the network baud rate for the port.

Parity

Select the network parity for the port.

Address

Select the network address at which the gateway will reside.

Timeout

For master/client protocols, enter the request timeout in milliseconds. This setting is the maximum amount of time that the gateway will wait for a response from a remote device after sending a request.

For slave/server protocols, this value is the maximum amount of time the protocol driver will wait in between received packets before triggering a timeout event (for network loss detection). For further timeout processing details, refer to section 8.2.

Scan Rate / Response Delay

For master/client protocols, the scan rate is the number of milliseconds the device will wait between sending requests. This is a useful feature for certain devices or infrastructure components (such as radio modems) that may not be capable of sustaining the maximum packet rates that the gateway is capable of producing. The start time for this delay is taken with respect to the moment at which the gateway is capable of sending the next packet (due to either reception or timeout of the previous request). The default setting of 0 means that the gateway will send its next request packet as soon as possible.

For slave/server protocols, the response delay is the number of milliseconds the device will wait before responding to a request. This is a useful feature for certain master devices or infrastructure components (such as radio modems) that may require a given amount of time to place themselves into a "receiving mode" where they are capable of listening for slave responses. The default setting of 0 means that the gateway will send its responses as soon as possible.

8.4 Service Object Configuration

A service object is used by the gateway to make requests on a network when a master/client protocol is enabled. Each service object defines the services (read or write) that should be performed on a range of network objects of a common type. The data from read requests is mirrored in the database starting at a user-defined address (if a read function is enabled). When a value within that address range in the database changes, a write request is generated on the network (if a write function is enabled). Depending on the protocol selected, service objects will vary slightly. Refer to section 8.6 for specific examples.

8.4.1 Description of Common Fields

This section contains general descriptions of the common service object fields, regardless of which protocol is selected. Each protocol has its own additional fields, as well as a more specific implementation of the common fields. These are discussed in section 8.6.

Description

This field is a description of the service object. It is not used by the gateway, but serves as a reference for the user.

Destination Address

This field is the network node address of the device that the gateway will send a request to.

Type

This selects the object type to use in the service object. All objects in the service object will be of this type.

Start Object

This field specifies the first instance number of the service object range.

Number of Objects

This field specifies the number of objects the service object contains in its range.

Database Address

This is the starting address in the gateway's database that is used to mirror the data on the network. The number of bytes allocated for the service object data is determined by the data type and the number of objects in the service object.

Data Type

This field specifies how many bytes are used to store each object in the service object. The data type also specifies whether the value should be treated as signed or unsigned when converting it to a real number to send over the network.

Note that each data type has its own range limitations for what can be stored in the database: 8 bits can store values up to 255, 16 bits can store values up to 65,535, and 32 bits can store values up to 4,294,967,295.

Multiplier

This field is the amount that associated network values are scaled by prior to being stored into the database or after being retrieved from the database. Upon retrieval from the database, the data is multiplied by the multiplier to produce a network value. Similarly, network values are divided by the multiplier before being stored into the database.

Note that the multiplier, coupled with the data type, imposes range limitations on network data values. For example, if the data type is 8-bit and the multiplier is 0.5, then the network data can achieve a maximum value of only 127 (since 255 is the maximum value that can be stored in 8 bits in the database).

Function Codes

This field allows you to select which function code to use for a read or write. You may also specify a read-only or a write-only service object by unchecking the checkbox next to the write or the read function, respectively.

Note that some protocols only support one read and one write function code.

8.4.2 Viewing the Status of a Service Object

The gateway provides the user the ability to debug the configured service objects while the device is running. When defining a service object, check the **Reflect Status** checkbox and enter the database address to store the status information. The status information is a 16-byte structure containing a transmission counter, a receive counter, a receive error counter, the current status, and the last error of the defined service object. This information is detailed in Appendix B: Status Information. The data contained in the status information may be viewed over the network on the other port of the gateway by mapping objects to the same database address where the status information is stored.

Alternatively, the status can be viewed in the **Monitor** tab in the **Status** list of the configuration utility. When a configuration that contains a service object status is downloaded to the device, or uploaded from the device, that address is automatically added into the **Status** list in the **Monitor** tab (status addresses can also be added manually in the **Monitor** tab by typing the address and clicking **Add Status Address**). This window will show the value of each of the counters and a translation of the current status and last error. In addition, the counters can be reset by selecting one or more entries in the **Status** list and clicking **Reset Counters**. Status addresses can also be deleted by selecting one or more entries in the **Status** list and clicking **Delete Status Address**, or all of the entries can be deleted by clicking **Delete All Status Addresses**.

8.5 General Object Editing Options

The following editing options apply for all types of configuration objects including, but not limited to, Connection Objects, Service Objects, Register Remap Objects, Timeout Objects and BACnet Objects.

Creating an Object

To create an object, populate all the fields with valid values and click the **Create** button.

Viewing an Object

Objects are listed in the object window located at the bottom of the configuration utility. To view an object, select that object's entry in the object window. This will cause all of the object configuration fields to be populated with the object's current settings.

Updating an Object

To update an object, select the object's entry in the object window, make any required changes, and then click the **Update** button.

Copying an Object

To copy an object, select the entry you wish to copy in the object window, make any required changes, and then click the **Create** button. This may be a useful feature for situations in which many objects must be configured, but only a few fields (such as the database address and type) are different.

Deleting an Object

To delete an object, select the entry you wish to delete in the object window and click the **Delete** button. Note that this action cannot be undone.

Deleting all Objects

To delete all the objects in the object window, click the **Delete All** button. Note that this action cannot be undone.

8.6 Protocol Configuration

The following section describes how to configure protocols on the gateway with the configuration utility. As a rule, the two RS-485 ports on the gateway are equivalent to each other. During configuration, it therefore makes no difference whether port A or port B is assigned to each specific network in use. For more details on how to use the configuration utility, refer to the ICC Gateway Configuration Utility User's Manual.

8.6.1 Modbus RTU Master

Modbus RTU Master can be configured on either RS-485 port by selecting **Modbus RTU Master** from the protocol dropdown menu. The Modbus RTU Master protocol uses service objects to make requests. For more information on service objects, refer to section 8.4. Each register (input or holding) in a service object is mapped to 2 bytes in the database (the data type is fixed at 16-bit). Each discrete (input or coil) is mapped starting at the least-significant bit of the byte specified by the database address and at each consecutive bit thereafter. For more information on register and discrete mapping, refer to section 9.1.1.3.

8.6.1.1 Protocol Selection Group

Protocol

Select **Modbus RTU Master** from this dropdown menu.

Baud Rate

Select the desired network baud rate from this dropdown menu.

Parity

Select the desired network parity and number of stop bits from this dropdown menu.

Timeout

This is the time in milliseconds that the device will wait for a response from a remote slave after sending a request.

Scan Rate

This is the time the device will wait between sending requests. This may be useful if slave devices require additional time between requests. If no additional delay time is needed, set this field to 0. For more information, refer to section 8.3.

8.6.1.2 Modbus Service Object Configuration

This section describes the configurable fields for a Modbus service object. For more information on Modbus service object editing options, refer to section 8.5.

Type

This group designates the Modbus data type that this service object will access. Choose from Holding Register, Input Register, Coil Status, or Input Status.

Description

This field is a description of the service object. It is not used on the gateway, but serves as a reference for the user. Enter a string of up to 16 characters in length.

Dest Address

This field indicates the destination address of the remote slave device on the network that will be accessed by this service object. Enter a value between 0 and 247. Note that address 0 is defined by Modbus as the broadcast address: if this address is used, the **Read** function checkbox must be unchecked, as attempts to read a service object targeting destination address 0 will invariably time out.

Start Reg / Start Discrete

For holding register and input register types: this field defines the starting register number for a range of registers associated with this service object. Enter a value between 1 and 65535.

For coil status and input status types: this field defines the starting discrete number for a range of discretes associated with this service object. Enter a value between 1 and 65535.

Num Regs / Num Discretes

For holding register and input register types: This field defines the number of registers associated with this service object. Enter a value between 1 and 125.

For coil status and input status types: This field defines the number of discretes associated with this service object. Enter a value between 1 and 2000.

Database Addr

This field defines the database address where the first register/discrete of this service object will be mapped. Enter a value between 0 and 4095. Note that the configuration utility will not allow entry of a starting database address that will cause the service object to run past the end of the database. The highest valid database address, therefore, will depend on the targeted data type, as well as the number of items to be accessed.

Multiplier

Applies to register types only. This field is the amount that associated network values are scaled by prior to being stored into the database or after being retrieved from the database. Upon retrieval from the database, raw data is multiplied by the multiplier to produce a network value. Similarly, network values are divided by the multiplier before being stored into the database.

Note that the multiplier imposes range limitations on network data values. For example, if the multiplier is 0.01, then the network data can achieve a maximum value of only 655 (since 65535 is the maximum value that can be stored in 16 bits in the database).

Read Enable and Function Code Selection

Check **Read** to enable reading (the service object will continuously read from the slave unless a pending **Write** exists). When reads are enabled, the desired read **Function Code** can be selected in the drop-down box.

Write Enable and Function Code Selection

Applies to holding register and coil status types only. Check **Write** to enable writing (when values encompassed by this service object change in the gateway's database, these changes will be written down to the targeted slave). When writes are enabled, the desired write **Function Code** can be selected in the drop-down box.

Group Multiple Writes

Applies to holding register and coil status types with writes enabled only. This checkbox is used to indicate whether the gateway should group writes to multiple holding registers or coils into one packet, or send separate write packets for each one. Check this box to enable the grouping of multiple writes into one write packet.

For holding register types: note that this feature is only available with function code **16 (Preset Multiple Registers)**.

For coil status types: note that this feature is always enabled with function code **15 (Force Multiple Coils)**.

Service Object Status

If it is desired to reflect the status of this service object, check the **Reflect Status** checkbox and enter a database **address** between 0 and 4080 (0x0 – 0xFF0) at which to store the status information. For more information on reflecting the status of service objects, refer to section 8.4.2.

8.6.1.2.1 32-Bit Extension Options

Applies to register types only. If the target registers are associated with the Enron/Daniel extension to the Modbus specification, or are represented by 32-bit values, check the **Enable Enron/Daniel** checkbox to enable the 32-bit extension option. The following describes each of the extension options:

Floating Point

Enable **Floating Point** if the transmitted values are encoded in IEEE 754 floating point format.

Big Endian

Enable **Big Endian** if the transmitted values are encoded in big-endian, 16-bit word order, i.e. the most significant 16-bit word is before the least significant 16-bit word.

Word-Size Reg

Enable **Word-Size Reg** if each target register is 16-bits wide, but two 16-bit registers comprise one 32-bit value. If not enabled, each of the target registers is assumed to be 32-bits wide.

Note that when **Word-Size Reg** is enabled, the **Num Regs** field name changes to **Num Reg Pairs**, indicating the number of pairs of 16-bit wide registers to address. When enabled, each register pair will use two register addresses and the selected **Data Type** will be applicable for the register pair, not the individual registers. For example, if the **Start Reg** is 100, **Num Reg Pairs** is 2, and **Data Type** is 32-bit Unsigned, then register numbers 100 – 103 will be accessed by the service object, with registers 100 and 101 stored as the first 32-bit Unsigned value and registers 102 and 103 stored as the next 32-bit Unsigned value in the gateway's database.

Word Count

Enable **Word Count** to encode the number of 16-bit words to be transferred in the Modbus "quantity of registers" field. If not enabled, the number of 32-bit registers will be used in the "quantity of registers" field.

Data Type

This field specifies how many bytes are used to store data for each register (or register pair) in this service object, as well as whether the value should be treated as signed or unsigned when converted to a floating point number for transmission over the network. Select the desired data type from this dropdown menu.

Note that each data type has different range limitations: 16-bit data types can represent values up to 65,535, and 32-bit data types can represent values up to 4,294,967,295.

8.6.1.3 Configuration Example

This example will configure one port of the gateway (port B) for communication using the Modbus RTU master driver. This example will only detail the configuration of the Modbus master driver and related service objects, with the goal of mapping data on the remote Modbus slaves into the gateway's database. Once this data is mapped into the gateway's database, it is then accessible for reading and writing via any other supported network connected to the other gateway port (port A).

Say, for instance, we wish to communicate to an adjustable-speed drive that supports Modbus. We wish to monitor the output frequency, output current, and output voltage of the drive, located at input registers 201, 202, and 203, respectively. We'd also like to monitor the running, forward/stop, and reverse/stop bits, located at input statuses 9, 10, and 11, respectively. To run the drive, we need to be able to command the frequency command at register 14, the command forward/stop bit at coil 21, and command reverse/stop bit at coil 22.

<u>Configure the RS-485 B port using the above requirements</u>

- Connect the gateway to the PC via a USB mini type-B cable.
- Open the configuration utility and select the XLTR-1000 (see section 8.1 for more information on selecting a device).
- Click on the **RS-485 B Configuration** tab.
- Select **Modbus RTU Master** from the protocol dropdown menu.
- Enter the **Baud Rate** and **Parity** settings to match that of the drive.
- Create Service Objects to read and write the desired registers and discretes:
    - We can create one service object to monitor the output frequency, output current and output voltage.
        - Select **Input Register** from the **Type** selection.
        - Enter the address of the drive into the **Dest Address** field.
        - Enter "201" into the **Start Reg** field.
        - Enter "3" into the **Num Regs** field.
        - Enter "0" into the **Database Addr** field.
        - Click **Create**.
    - Similarly, we can create one service object to monitor the running, forward/stop, and reverse/stop status bits.
        - Select **Input Status** from the **Type** selection.
        - Enter the address of the drive into the **Dest Address** field.
        - Enter "9" into the **Start Discrete** field.
        - Enter "3" into the **Num Discretes** field.
        - Enter "6" into the **Database Addr** field.
        - Click **Create**.
    - To command the frequency command, we must create a service object for that register.
        - Select **Holding Register** from the **Type** selection.
        - Enter the address of the drive into the **Dest Address** field.
        - Enter "14" into the **Start Reg** field.
        - Enter "1" into the **Num Regs** field.
        - Enter "16" into the **Database Addr** field.
        - Select the desired **Write Function Code** depending on what the drive supports. Say, for instance, our drive only supports function code **6 (Preset Single Register)**. Select this from the dropdown menu.
        - Click **Create**.
    - To command the forward/stop and reverse/stop command bits, one last service object must be created.
        - Select **Coil Status** from the **Type** selection.
        - Enter the address of the drive into the **Dest Address** field.

- Enter “21” into the **Start Discrete** field.
- Enter “2” into the **Num Discretes** field.
- Enter “18” into the **Database Addr** field.
- Click **Create**.

Finishing Up

- Configure the RS-485 A port for the other protocol to be used in accessing the drive through the gateway.
- Download the configuration to the gateway (see section 8.1 for more information on downloading a configuration to a device).

Where are the monitor and command values?

Modbus Register	Database Address
Output Frequency (Input Register 201)	0 (upper byte) & 1 (lower byte)
Output Current (Input Register 202)	2 (upper byte) & 3 (lower byte)
Output Voltage (Input Register 203)	4 (upper byte) & 5 (lower byte)
Running (Input Status 9)	6 / bit 0
Forward/Stop (Input Status 10)	6 / bit 1
Reverse/Stop (Input Status 11)	6 / bit 2
Frequency Command (Holding Register 14)	16 (upper byte) & 17 (lower byte)
Command Forward/Stop (Coil Status 21)	18 / bit 0
Command Reverse/Stop (Coil Status 22)	18 / bit 1

Note that the database is assumed to be big endian in this example.

8.6.2 Modbus RTU Slave

Modbus RTU Slave can be configured on either RS-485 port by selecting **Modbus RTU Slave** from the protocol dropdown menu. By default, the gateway's entire database is accessible via the register mapping mechanism discussed in section 9.1.2.2.

8.6.2.1 Protocol Selection Group

Protocol

Select **Modbus RTU Slave** from this dropdown menu.

Baud Rate

Select the desired network baud rate from this dropdown menu.

Parity

Select the desired network parity and number of stop bits from this dropdown menu.

Address

This field is the slave address at which the device will reside on the network. Enter a value between 1 and 247.

Timeout Time

Refer to section 8.2.1.

Response Delay

This field is used to set the time, in milliseconds, the device waits before responding to master requests. This may be useful if the Modbus master communicating to the gateway requires additional time before it can process a response to its request. If no delay is required, set this field to 0.

8.6.2.2 Register Remap Object

Optionally, registers can be remapped to different database addresses from their default mapping using a register remap object. It also allows the user to map a register that is not mapped into the database by default (any register above 2048) to an address in the database. The register remap object can remap a range of consecutive registers to any starting address in the database (as long as the entire range is within the database).

Note that registers can be accessed as either holding registers or input registers. Accessing either type refers to the same register on the gateway.

The following describes the configurable fields for a register remap object. For more information on register remap object editing options, refer to section 8.5.

Type

This group designates the Modbus register type(s) that this object will remap. Choose Holding Register and/or Input Register to assign which register type(s) to remap.

Description

This field is a description of the register remap object. It is not used on the gateway, but serves as a reference for the user. Enter a string of up to 16 characters in length.

Start Reg

This field is the starting register number for a range of registers to be remapped. Enter a value between 1 and 65535 (0x1 – 0xFFFF).

Num Regs

This field is the number of registers to remap. Enter a value of 1 or more.

Database Addr

This field is the database address where the remapping begins. Enter a value between 0 and 4094 (0x0 – 0xFFE).

Multiplier

This field is the amount that associated network values are scaled by prior to being stored into the database or after being retrieved from the database. Upon retrieval from the database, raw data is multiplied by the multiplier to produce a network value. Similarly, network values are divided by the multiplier before being stored into the database.

Note that the multiplier imposes range limitations on network data values. For example, if the multiplier is 0.01, then the network data can achieve a maximum value of only 655 (since 65535 is the maximum value that can be stored in 16 bits in the database).

8.6.2.2.1   32-Bit Extension Options

If the target registers are associated with the Enron/Daniel extension to the Modbus specification, or are represented by 32-bit values, check the **Enable Enron/Daniel** checkbox to enable the 32-bit extension option. The following describes each of the extension options:

Floating Point

Enable **Floating Point** if the transmitted values are to be encoded in IEEE 754 floating point format.

Big Endian

Enable **Big Endian** if the transmitted values are to be encoded in big-endian, 16-bit word order, i.e. the most significant 16-bit word is before the least significant 16-bit word.

Word-Size Register

Enable **Word-Size Register** if each target register is 16-bits wide, but two 16-bit registers are to comprise one 32-bit value. If not enabled, each of the target registers is assumed to be 32-bits wide.

Note that when **Word-Size Register** is enabled, the **Num Regs** field name changes to **Num Reg Pairs**, indicating the number of pairs of 16-bit wide registers to be addressed. When enabled, each register pair will use two register addresses and the selected **Data Type** will be applicable for the register pair, not the individual registers. For example, if the **Start Reg** is 100, **Num Reg Pairs** is 2, and **Data Type** is 32-bit Unsigned, then register numbers 100 – 103 will be remapped, with registers 100 and 101 representing the first 32-bit Unsigned value and registers 102 and 103 representing the next 32-bit Unsigned value in the gateway's database.

Word Count

Enable **Word Count** to interpret the Modbus "quantity of registers" field as the number of 16-bit words to be transferred. If not enabled, the "quantity of registers" field will be interpreted as the number of 32-bit registers to be transferred.

Data Type

This field specifies how many bytes are used to store data for each register (or register pair), as well as whether the internal value should be treated as signed or unsigned when converted to a floating point number for transmission over the network. Select the desired data type from this dropdown menu.

Note that each data type has different range limitations: 16-bit data types can represent values up to 65,535, and 32-bit data types can represent values up to 4,294,967,295.

8.6.2.3 Configuration Example

This example will configure one port of the gateway (port A) for communication using the Modbus RTU slave driver. This example will only detail the configuration of the Modbus slave driver and related register remap objects, with the goal of mapping data from the Modbus master into the gateway's database. Once this data is mapped into the gateway's database, it is then accessible for reading and writing via any other supported network connected to the other gateway port (port B).

Assume that we have a PLC that can act as a Modbus master connected to the gateway's RS-485 A port. The PLC exchanges information (through the gateway) with different floors of a building. There are 3 floors. Floor #1 has 3 registers at addresses 1000, 1001, and 1002 for monitoring the floor status and 3 registers at addresses 1003, 1004, and 1005 for executing commands on the floor. Similarly floors #2 and #3 have the same registers for monitoring and commanding, starting at register 2000 for floor #2 and starting at 3000 for floor #3.

<u>Configure the RS-485 A port using the above requirements</u>

- Connect the gateway to the PC via a USB mini type-B cable.
- Open the configuration utility and select the XLTR-1000 (see section 8.1 for more information on selecting a device).
- Click on the **RS-485 A Configuration** tab.
- Select **Modbus RTU Slave** from the protocol dropdown menu.
- Enter the **Baud Rate** and **Parity** settings to match that of the PLC.
- Enter the **Address** for the gateway to reside at on the network.
- Create Register Remap Objects to map the registers into the gateway's database. The monitor registers will start at database address 0 and the command registers will start at database address 100.

    - Remap floor 1's monitor data registers:
        - Enter "1000" into the **Start Reg** field.
        - Enter "3" into the **Num Regs** field.
        - Enter "0" into the **Database Addr** field.
        - Click **Create**.

    - Remap floor 1's command data registers:
        - Enter "1003" into the **Start Reg** field.
        - Enter "3" into the **Num Regs** field.
        - Enter "100" into the **Database Addr** field.
        - Click **Create**.

    - Remap floor 2's monitor data registers:
        - Enter "2000" into the **Start Reg** field.
        - Enter "3" into the **Num Regs** field.
        - Enter "6" into the **Database Addr** field.
        - Click **Create**.

    - Remap floor 2's command data registers:
        - Enter "2003" into the **Start Reg** field.
        - Enter "3" into the **Num Regs** field.
        - Enter "106" into the **Database Addr** field.
        - Click **Create**.

    - Remap floor 3's monitor data registers:
        - Enter "3000" into the **Start Reg** field.
        - Enter "3" into the **Num Regs** field.
        - Enter "12" into the **Database Addr** field.
        - Click **Create**.

- Remap floor 1’s command data registers:
    - Enter “3003” into the **Start Reg** field.
    - Enter “3” into the **Num Regs** field.
    - Enter “112” into the **Database Addr** field.
    - Click **Create**.

Finishing Up

- Configure the RS-485 B port for the other protocol to be used in accessing the floors of the building.
- Download the configuration to the gateway (see section 8.1 for more information on downloading a configuration to a device).

Where are the monitor and command values?

Modbus Register	Database Address
Floor 1 Monitor Data 1 (Register 1000)	0 (upper byte) & 1 (lower byte)
Floor 1 Monitor Data 2 (Register 1001)	2 (upper byte) & 3 (lower byte)
Floor 1 Monitor Data 3 (Register 1002)	4 (upper byte) & 5 (lower byte)
Floor 2 Monitor Data 1 (Register 2000)	6 (upper byte) & 7 (lower byte)
Floor 2 Monitor Data 2 (Register 2001)	8 (upper byte) & 9 (lower byte)
Floor 2 Monitor Data 3 (Register 2002)	10 (upper byte) & 11 (lower byte)
Floor 3 Monitor Data 1 (Register 3000)	12 (upper byte) & 13 (lower byte)
Floor 3 Monitor Data 2 (Register 3001)	14 (upper byte) & 15 (lower byte)
Floor 3 Monitor Data 3 (Register 3002)	16 (upper byte) & 17 (lower byte)
Floor 1 Command Data 1 (Register 1003)	100 (upper byte) & 101 (lower byte)
Floor 1 Command Data 2 (Register 1004)	102 (upper byte) & 103 (lower byte)
Floor 1 Command Data 3 (Register 1005)	104 (upper byte) & 105 (lower byte)
Floor 2 Command Data 1 (Register 2003)	106 (upper byte) & 107 (lower byte)
Floor 2 Command Data 2 (Register 2004)	108 (upper byte) & 109 (lower byte)
Floor 2 Command Data 3 (Register 2005)	110 (upper byte) & 111 (lower byte)
Floor 3 Command Data 1 (Register 3003)	112 (upper byte) & 113 (lower byte)
Floor 3 Command Data 2 (Register 3004)	114 (upper byte) & 115 (lower byte)
Floor 3 Command Data 3 (Register 3005)	116 (upper byte) & 117 (lower byte)

Note that the database is assumed to be big endian in this example.

8.6.3 Modbus RTU Sniffer

The Modbus RTU Sniffer driver can be configured on either RS-485 port by selecting **Modbus RTU Sniffer** from the protocol dropdown menu. The Modbus RTU Sniffer driver is passive (listen only), and uses service objects to define what registers to log values for from the network traffic. For more information on service objects, refer to section 8.4. Each register (input or holding) in a service object is mapped to 2 bytes in the database (the data type is fixed at 16-bit). For more information on register mapping, refer to section 9.1.1.3.

8.6.3.1 Protocol Selection Group

Protocol

Select **Modbus RTU Sniffer** from this dropdown menu.

Baud Rate

Select the desired network baud rate from this dropdown menu.

Parity

Select the desired network parity and number of stop bits from this dropdown menu.

8.6.3.2 Modbus Sniffer Service Object Configuration

This section describes the configurable fields for a Modbus sniffer service object. For more information on Modbus service object editing options, refer to section 8.5.

Type

This group designates the Modbus register type that this service object will log (capture data for). Choose from Holding Register or Input Register.

Description

This field is a description of the service object. It is not used on the gateway, but serves as a reference for the user. Enter a string of up to 16 characters in length.

Dest Address

This field indicates the node address of the remote slave device on the network that contains the register(s) to be logged by this service object. Enter a value between 0 and 247. Note that address 0 is defined by Modbus as the broadcast address: if this address is used, the **Read** function checkbox must be unchecked, since slaves cannot respond to broadcast messages.

Note that using a destination address of 0 will configure the service object to only log broadcast messages; however, if a destination address other than 0 is used, broadcast messages will also be logged for that service object as well as requests targeted specifically at the defined destination address.

Start Reg

This field defines the starting register number for a range of registers associated with this service object. Enter a value between 1 and 65535.

Num Regs

This field defines the number of registers associated with this service object. Enter a value between 1 and 125.

Database Addr

This field defines the database address where the first register of this service object will be mapped. Enter a value between 0 and 4095. Note that the configuration utility will not allow entry of a starting database address that will cause the service object to run past the end of the database. The highest valid database address, therefore, will depend on the targeted data type, as well as the number of items to be accessed.

Multiplier

This field is the amount that associated network values are scaled by prior to being stored into the database. Network values are divided by the multiplier before being stored into the database.

Note that the multiplier imposes range limitations on network data values. For example, if the multiplier is 0.01, then the network data can achieve a maximum value of only 655 (since 65535 is the maximum value that can be stored in 16 bits in the database).

Read Enable and Function Code Selection

Check **Read** to enable read function logging (the service object will log reads from the master to the slave). When reads are enabled, the desired read **Function Code** can be selected in the drop-down box.

Write Enable and Function Code Selection

Applies to holding register only. Check **Write** to enable write function logging (the service object will log writes from the master to the slave). When writes are enabled, the desired write **Function Code** can be selected in the drop-down box.

Note that the Modbus sniffer driver allows for both function codes 6 and 16 to be logged simultaneously so that if a register is written using either of these two function codes, it will be logged into the gateway’s database.

Service Object Status

If it is desired to reflect the status of this service object, check the **Reflect Status** checkbox and enter a database **address** between 0 and 4080 (0x0 – 0xFF0) at which to store the status information. For more information on reflecting the status of service objects, refer to section 8.4.2.

Note that the reflect status information for the Modbus sniffer driver is slightly different than that of the Modbus RTU master driver, because the sniffer driver does not actually transmit any requests itself. The status information should be interpreted from the perspective of the network master (as if the master were updating the status information). For example, when the master transmits a request to read a register, the TX Counter is incremented, and when the slave responds, the RX Counter is incremented.

8.6.3.3 Configuration Example

This example will configure the gateway for communication using the Modbus RTU Sniffer driver.

Say, for instance, we wish to monitor the communication between an adjustable-speed drive (the slave) and a PLC (the master), storing the transferred data values in the gateway's database for access by another network on the gateway. This scenario allows the gateway to expose data values on the Modbus network in a non-intrusive manner, which simplifies installation and nearly eliminates integration effort when applied to an already-functioning Modbus network. In this case, we wish to monitor the drive's output frequency, output current and output voltage, located at input registers 201, 202, and 203, respectively. We'd also like to monitor the frequency command (as commanded by the master) at holding register 14.

<u>Configure the gateway using the above requirements</u>

- Connect the gateway to the PC via a USB mini type-B cable.
- Open the configuration utility and select the XLTR-1000 (see section 8.1 for more information on selecting a device).

<u>Configure the RS-485 B port using the above requirements</u>

- Click on the **RS-485 B Configuration** tab.
- Select **Modbus RTU Sniffer** from the protocol dropdown menu.
- Enter the **Baud Rate** and **Parity** settings to match that of the Modbus network.
- Create Service Objects to log data from the desired registers:

    - We can create one service object to monitor the output frequency, output current and output voltage.
        - Select **Input Register** from the **Type** selection group.
        - Enter the address of the drive into the **Dest Address** field.
        - Enter "201" into the **Start Reg** field.
        - Enter "3" into the **Num Regs** field.
        - Enter "0" into the **Database Addr** field.
        - Click **Create**.

    - To monitor the drive's frequency command, we must create a second service object for that register.
        - Select **Holding Register** from the **Type** selection.
        - Enter the address of the drive into the **Dest Address** field.

- Enter “14” into the **Start Reg** field.
- Enter “1” into the **Num Regs** field.
- Enter “6” into the **Database Addr** field.
- Click **Create**.

Finishing Up

- Download the configuration to the gateway (see section 8.1 for more information on downloading a configuration to a device).
- Connect to the gateway to the Modbus network.

Where are the monitor values?

Drive’s Modbus Register	Database Address
output frequency (input register 201)	0 & 1
output current (input register 202)	2 & 3
output voltage (input register 203)	4 & 5
frequency command (holding register 14)	6 & 7

8.6.4 BACnet MS/TP Client

BACnet MS/TP Client can be configured on either RS-485 port by selecting **BACnet MS/TP Client** from the protocol dropdown menu. The gateway can read and write the present value property of BACnet objects hosted by other devices on the network. This behavior is defined by configuring BACnet service objects. For more information on service objects, refer to section 8.4. Whenever the BACnet MS/TP client driver is enabled, the BACnet device object is always present and must be properly configured. Note that BACnet MS/TP (client or server) may only be enabled on one port of the gateway. This section will discuss how to configure the BACnet MS/TP client.

8.6.4.1 Protocol Selection Group

This section describes the fields that must be configured on the RS-485 port.

Protocol

Select **BACnet MS/TP Client** from this dropdown menu.

Baud Rate

Select the network baud rate from this dropdown menu.

Address

This field is the node address that the gateway will reside at on the network. Enter a value between 0 and 127.

Scan Rate

This is the time the device will wait between sending requests. This may be useful if BACnet devices that the gateway is communicating with require additional time between requests. If no additional time is required, set this field to 0.

8.6.4.2 Device Object Configuration Group

The Device Object Configuration group contains several fields that must be appropriately set for each device residing on a BACnet network.

Device Name

This field is the BACnet Device Object's name. The device name must be unique across the entire BACnet network. Enter a string of between 1 and 16 characters in length.

Instance Number

This field is the BACnet Device Object's instance number. The instance number must be unique across the entire BACnet network. Enter a value between 0 and 4194302 (0x0 – 0x3FFFFE).

Max Master

This field is the highest allowable address for MS/TP master nodes on the network. Any address higher than this will not receive the token from the gateway. Enter a value between 0 and 127. Note that this value must be greater than or equal to the configured Address for the gateway. If the highest address on the network is unknown, set this field to 127.

Configuration tip: The Address and Max Master fields greatly affect network performance. For best results, set all device addresses consecutively, starting with address 0, ending with a device with a configurable Max Master field at the highest address. Then set that device's Max Master field to its network address. This will prevent any unnecessary poll for master packets on the network and thereby maximize efficiency.

8.6.4.3 BACnet Service Object Configuration

The following describes the configurable fields for a BACnet service object. For more information on BACnet service object editing options, refer to section 8.5.

Type

The radio buttons in this group select the BACnet object type. Choose from Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, or Binary Value.

Description

This field is a description of the service object. It is not used on the gateway, but serves as a reference for the user. Enter a string of between 1 and 16 characters in length.

Dest Dev Inst ("Destination Device Instance")

This field is the destination device instance of the BACnet device the gateway should send requests to for this service object. Enter a value between 0 and 4194302 (0x0 – 0x3FFFFE).

Note that the gateway uses this value for dynamic device binding to determine the address of the destination device. If the destination device does not support dynamic device binding, then static device binding must be used. For more information on device binding, refer to section 9.2.2.3.

Use Static Device Binding

This checkbox is used to manually define the destination device network address. This feature must be used for all MS/TP slave devices, and for any MS/TP master devices that do not support dynamic device binding. For more information on device binding, refer to section 9.2.2.3.

Dest Address

*Note that this field is available only when the **Use Static Device Binding** checkbox is checked.* This field is used to manually define the address of the BACnet device that the gateway should target for this service object. Enter a value between 0 and 127.

Start Inst

This field is the starting instance number for a range of BACnet objects for this service object. Enter a value between 0 and 4194302 (0x0 – 0x3FFFFE).

Num Insts

This field is the number of BACnet objects in this service object. Enter a value of 1 or more.

Database Addr

This field is the database address where the first BACnet object of this service object will be mapped. Enter a value between 0 and 4095 (0x0 – 0xFFF).

Note that the configuration utility will not allow entry of a starting database address that will cause the service object to run past the end of the database. The highest valid database address, therefore, will depend on the targeted data type, as well as the number of items to be accessed.

Data Type

Applies to analog objects only. This field specifies how many bytes are used to store present value data for each BACnet object in this service object, as well as whether the value should be treated as signed or unsigned when converted to a real number for transmission over the network. Select the desired data type from this dropdown menu.

Note that each data type has its own range limitations: 8-bit can have values up to 255, 16-bit can have values up to 65,535, and 32-bit can have values up to 4,294,967,295.

Multiplier

Applies to analog objects only. This field is the amount that associated network values are scaled by prior to being stored into the database or after being retrieved from the database. Upon retrieval from the database, the data is multiplied by the multiplier to produce a network value. Similarly, the network values are divided by the multiplier before being stored into the database.

Note that the multiplier, coupled with the data type, imposes range limitations on the network data value. For example, if the data type is 8-bit and the multiplier is 0.5, then the network data can have values only up to 127 (since 255 is the maximum value that can be stored in 8 bits).

Read Enable and Function Code Selection

Check **Read** to enable reading (the service object will continuously read from the remote device unless a pending **Write** exists). When reads are enabled, the desired read **Function Code** can be selected in the drop-down box.

Write Enable and Function Code Selection

Does not apply to input objects. Check **Write** to enable writing (when values encompassed by this service object change in the gateway's database, these changes will be written down to the targeted remote device). When writes are enabled, the desired write **Function Code** can be selected in the drop-down box.

Priority

This field is used to specify the priority associated with writes for this service object. Select the desired priority from the dropdown menu.

Service Object Status

If it is desired to reflect the status of this service object, check the **Reflect Status** checkbox and enter a database **address** between 0 and 4080 (0x0 – 0xFF0) at which to store the status information. For more information on reflecting the status of service objects, refer to section 8.4.2.

8.6.4.4 Configuration Example

This example will configure the gateway for end-to-end communication using BACnet MS/TP client and Modbus RTU slave.

Say, for instance, we wish to communicate to an adjustable-speed drive that supports BACnet MS/TP from a PLC that supports Modbus RTU. We wish to monitor the output frequency, output current, and output voltage of the drive, located at analog input objects 1, 2 and 3, with multipliers of 0.01, 0.01, and 0.1 respectively. We'd also like to monitor the running, forward/stop, and reverse/stop bits, located at binary input objects 1, 2 and 3, respectively. To run the drive, we need to be able to command the frequency command at analog output object 2 with a multiplier of 0.01, the command forward/stop bit at binary output object 2, and command reverse/stop bit at binary output object 3.

Configure the RS-485 A port (Modbus slave) using the above requirements

- Connect the gateway to the PC via a USB mini type-B cable.
- Open the configuration utility and select the XLTR-1000 (see section 8.1 for more information on selecting a device).
- Click on the **RS-485 A Configuration** tab.
- Select **Modbus RTU Slave** from the protocol dropdown menu.
- Enter the **Baud Rate** and **Parity** settings to match that of the PLC.
- Enter the slave address that your PLC is configured to communicate with into the **Address** field.
- The default mapping of the gateway's database into the Modbus register space will be used, so no register remap objects need to be created.

Configure the RS-485 B port (BACnet client) using the above requirements

- Click on the **RS-485 B Configuration** tab.
- Select **BACnet MS/TP Client** from the protocol dropdown menu.
- Enter the **Baud Rate** settings to match that of the drive.
- Enter the **Address** for the gateway to reside at on the network.
- Enter a **Device Name,** device **Instance Number**, and the **Max Master** for the gateway.
- Create Service Objects to read and write the desired BACnet objects:
    - We can create one service object to monitor the output frequency and output current since they are the same type and have the same multiplier value.
        - Select **Analog Input** from the **Type** selection group.
        - Enter the device instance of the drive into the **Dest Dev Inst** field.
        - Enter "1" into the **Start Inst** field.
        - Enter "2" into the **Num Insts** field.
        - Enter "0" into the **Database Addr** field.
        - Select **32-bit Unsigned** from the **Data Type** dropdown menu.
        - Enter "0.01" into the **Multiplier** field.
        - Click **Create**.

    - Since the output voltage has a different multiplier than the other two analog inputs, it must be defined as a separate service object.
        - Select **Analog Input** from the **Type** selection group.
        - Enter the device instance of the drive into the **Dest Dev Inst** field.
        - Enter "3" into the **Start Inst** field.
        - Enter "1" into the **Num Insts** field.
        - Enter "8" into the **Database Addr** field.
        - Select **32-bit Unsigned** from the **Data Type** dropdown menu.
        - Enter "0.1" into the **Multiplier** field.
        - Click **Create**.

    - Now we must create a service object to monitor the running, forward/stop, and reverse/stop bits.
        - Select **Binary Input** from the **Type** selection group.
        - Enter the device instance of the drive into the **Dest Dev Inst** field.
        - Enter "1" into the **Start Inst** field.
        - Enter "3" into the **Num Insts** field.
        - Enter "12" into the **Database Addr** field.
        - Click **Create**.

    - To command the frequency command, we must create a service object for that analog output.
        - Select **Analog Output** from the **Type** selection group.

- Enter the device instance of the drive into the **Dest Dev Inst** field.
- Enter "2" into the **Start Inst** field.
- Enter "1" into the **Num Insts** field.
- Enter "16" into the **Database Addr** field.
- Select **32-bit Unsigned** from the **Data Type** dropdown menu.
- Enter "0.01" into the **Multiplier** field.
- Click **Create**.

o To command the forward/stop and reverse/stop command bits, one last service object must be created.
  - Select **Binary Output** from the **Type** selection group.
  - Enter the address of the drive into the **Dest Address** field.
  - Enter "2" into the **Start Inst** field.
  - Enter "2" into the **Num Insts** field.
  - Enter "20" into the **Database Addr** field.
  - Click **Create**.

Finishing Up

- Download the configuration to the gateway (see section 8.1 for more information on downloading a configuration to a device).
- Connect to the gateway with your PLC.

Where are the monitor and command values?

Database Address	BACnet Object	Modbus Discrete / Register
0 & 1	Output Frequency (Analog Input 1)	Register 1 – lower 16 bits
2 & 3		Register 2 – upper 16 bits
4 & 5	Output Current (Analog Input 2)	Register 3 – lower 16 bits
6 & 7		Register 4 – upper 16 bits
8 & 9	Output Voltage (Analog Input 3)	Register 5 – lower 16 bits
10 & 11		Register 6 – upper 16 bits
12	Running (Binary Input 1)	Discrete 97 / Register 7 – bit 0
	Forward/Stop (Binary Input 2)	Discrete 98 / Register 7 – bit 1
	Reverse/Stop (Binary Input 3)	Discrete 99 / Register 7 – bit 2
13..15	Unused	
16 & 17	Frequency Command (Analog Output 2)	Register 9 – Lower 16 bits
18 & 19		Register 10 – Upper 16 bits
20	Command Forward/Stop (Binary Output 2)	Discrete 161 / Register 11 – bit 0
	Command Reverse/Stop (Binary Output 3)	Discrete 162 / Register 11 – bit 1

Note that the database is assumed to be little endian in this example. Also note that the bit-access variables (Running, Command Forward/Stop, etc.) can be simultaneously accessed from the Modbus network as either bits within a register, or as individual discretes (refer to section 9.1.2.3).

8.6.5 BACnet MS/TP Server

BACnet MS/TP Server can be configured on either RS-485 port by selecting **BACnet MS/TP Server** from the protocol dropdown menu. The BACnet MS/TP server can host a wide variety of user-defined BACnet objects. Whenever the BACnet MS/TP server is enabled, the BACnet device object is always present and must be properly configured. Note that BACnet MS/TP (client or server) may only be enabled on one port of the gateway. This section will discuss how to configure the BACnet MS/TP server.

8.6.5.1 Protocol Selection Group

This section describes the fields that must be configured on the RS-485 port.

Protocol

Select **BACnet MS/TP Server** from this dropdown menu.

Baud Rate

Select the network baud rate from this dropdown menu.

Address

This field is the node address that the gateway will reside at on the network. Enter a value between 0 and 127.

8.6.5.2 Device Object Configuration Group

The Device Object Configuration group contains several fields that must be appropriately set for each device residing on a BACnet network.

Device Name

This field is the BACnet Device Object's name. The device name must be unique across the entire BACnet network. Enter a string of between 1 and 16 characters in length.

Instance Number

This field is the BACnet Device Object's instance number. The instance number must be unique across the entire BACnet network. Enter a value between 0 and 4194302 (0x0 – 0x3FFFFE).

Max Master

This field is the highest allowable address for master nodes on the network. Any address higher than this will not receive the token from the gateway. Enter a value between 0 and 127. Note that this value must be greater than or equal to the configured Address for the gateway. If the highest address on the network is unknown, set this field to 127.

Configuration tip: The Address and Max Master fields greatly affect network performance. For best results, set all device addresses consecutively, starting with address 0, ending with a device with a configurable Max Master field at the highest address. Then set that device's Max Master field to its address. This will prevent any unnecessary poll for master packets on the network and thereby maximize efficiency.

8.6.5.3 BACnet Object Common Configurable Fields

This section describes the common configurable fields for all BACnet objects. For more information on BACnet object editing options, refer to section 8.5.

Type

The radio buttons in this group select the BACnet object type. Choose from Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, or Binary Value.

Object Name

This field is the name of the BACnet object. Enter a string of between 1 and 16 characters in length. All object names must be unique within the gateway.

Instance

This field is the BACnet Object's instance number. Enter a value between 0 and 4194302 (0x0 – 0x3FFFFE).

Database Addr

This field is the database address where the BACnet object's present value will reside. Enter a value between 0 and 4095 (0x0 – 0xFFF).

A note for analog objects: Depending on the designated Data Type, the maximum allowable database address is 4095, 4094, or 4092 for 8-bit, 16-bit, or 32-bit sized objects, respectively.

Multiplier

Applies to analog objects only. This field is the amount that associated network values are scaled by prior to being stored into the database or after being retrieved from the database. Upon retrieval from the database, the data is multiplied by the multiplier to produce a network value. Similarly, the network values are divided by the multiplier before being stored into the database.

Note that the multiplier, coupled with the data type, imposes range limitations on the network data value. For example, if the data type is 8-bit and the multiplier is 0.5, then the network data can have values only up to 127 (since 255 is the maximum value that can be stored in 8 bits).

Units

Applies to analog objects only. Select the desired units from this dropdown menu. If the desired units are not available in the dropdown menu, select **Other Units** and enter the enumerated value (as defined by the BACnet Specification) in the **Unit Value** field.

Bitmask

Applies to binary objects only. This 8-bit field specifies which bit(s) in the byte designated by the **Database Addr** that the binary object will map to. This allows up to 8 binary objects to be simultaneously assigned to one database address (each binary object mapping to a single bit of that byte in the database). It is possible to map binary objects to multiple bits within the designated database location. Such a configuration allows (for example) the modification of multiple selected database bits via a single binary output.

<u>The effect of the **Bitmask** field when writing:</u> When the present value property of a binary output object or binary value object is set to "active" by a BACnet client, then the bit(s) in the designated **Database Addr** indicated by a "1" in the bitmask are set. Similarly, when the present value property of the object is set to "inactive", then the bit(s) in the designated **Database Addr** indicated by a "1" in the bitmask are cleared. For binary output objects, this setting/clearing behavior is reversed if the object's **Polarity** is set to "Reversed".

<u>The effect of the **Bitmask** field when reading:</u> When the present value property of a binary object is read by a BACnet client, the **Bitmask** is used to determine the active/inactive state of the object by inspecting the value in the designated database address at the bit location(s) indicated in the **Bitmask**. If <u>all</u> of the bit locations at the designated database address indicated by a "1" in the **Bitmask** are set, then the object's state will be returned as "active". Else, the object's state will be returned as "inactive". For binary input and binary output objects, the resultant state is reversed just prior to being placed on the network if the object's **Polarity** is set to "Reversed".

Active Text

Applies to binary objects only. This field specifies the description of the object's "active" state. Enter a string of up to 8 characters in length. This field is optional and may be left blank.

Inactive Text

Applies to binary objects only. This field specifies the description of the object's "inactive" state. Enter a string of up to 8 characters in length. This field is optional and may be left blank.

Polarity

Applies to binary input and binary output objects only. This field indicates the relationship between the physical state of the object (as stored in the gateway's database) and the logical state represented by the object's present value property. If the physical state is active high, select **Normal** from this dropdown menu. If the physical state is active low, select **Reverse** from this dropdown menu. For further detail, refer to the **Bitmask** behavioral description above.

Data Type

Applies to analog objects only. This field specifies how many bytes are allocated for the present value data, as well as whether the value should be treated as signed or unsigned when converting it to a real number to send over the network. Select the desired data type from this dropdown menu.

Note that each data type has its own range limitations: 8-bit data types can have values up to 255, 16-bit data types can have values up to 65,535, and 32-bit data types can have values up to 4,294,967,295.

Relinquish Def

This field is the default value to be used for an object's present value property when all command priority values in the object's priority array are NULL. Note that this property only exists for those objects that implement a priority array (analog output, analog value, binary output and binary value objects).

8.6.5.4 Configuration Example

This example will configure one port of the gateway (port A) for communication using the BACnet MS/TP server driver. This example will only detail the configuration of the BACnet server driver and related objects, with the goal of mapping data from the BACnet MS/TP network into the gateway's database. Once this data is mapped into the gateway's database, it is then accessible for reading and writing via any other supported network connected to the other gateway port (port B).

Assume that we have a building automation system (BAS) that can act as a BACnet MS/TP client connected to the gateway's RS-485 A port. The BAS exchanges information (through the gateway) with different floors of a building. There are 3 floors; floor #1 has 3 analog values at instances 1000, 1001, and 1002 for monitoring the floor status and 3 analog values at instances 1003, 1004, and 1005 for executing commands on the floor. Similarly, floors #2 and #3 have the same analog values for monitoring and commanding starting at instance 2000 for floor #2, and starting at instance 3000 for floor #3.

Configure the RS-485 A port using the above requirements

- Connect the gateway to the PC via a USB mini type-B cable.
- Open the configuration utility and select the XLTR-1000 (see section 8.1 for more information on selecting a device).
- Click on the **RS-485 A Configuration** tab.
- Select **BACnet MS/TP Server** from the protocol dropdown menu.
- Enter the **Baud Rate** settings to match that of the BAS.
- Enter the **Address** at which the gateway will reside on the network.
- Enter a **Device Name,** device **Instance Number**, and the **Max Master** for the gateway.

- Create BACnet objects to map the data from the BAS into the gateway's database. The monitor object data will start at database address 0 and the command object data will start at database address 100.

  - Create objects for floor #1's monitor data
    For the first object, enter the following:
    - Select **Analog Value** from the **Type** selection group.
    - Enter "F1 Mon Data 1" into the **Object Name** field.
    - Enter "1000" into the **Instance** field.
    - Enter "0" into the **Database Addr** field.
    - Select **32-bit Unsigned** from the **Data Type** dropdown menu.
    - Enter "1" into the **Multiplier** field.
    - Select **No Units (95)** from the **Units** dropdown menu.
    - Click **Create**.

    Repeat these steps for the other two objects, increasing the **Object Name** by 1, **Instance** by 1, and **Database Addr** by 4 each time.

  - Create objects for floor #1's command data
    For the first object, enter the following:
    - Select **Analog Value** from the **Type** selection group.
    - Enter "F1 Cmd Data 1" into the **Object Name** field.
    - Enter "1003" into the **Instance** field.
    - Enter "100" into the **Database Addr** field.
    - Select **32-bit Unsigned** from the **Data Type** dropdown menu.
    - Enter "1" into the **Multiplier** field.
    - Select **No Units (95)** from the **Units** dropdown menu.
    - Click **Create**.

    Repeat these steps for the other two objects, increasing the **Object Name** by 1, **Instance** by 1, and **Database Addr** by 4 each time.

  - Create objects for floor #2's monitor data
    For the first object, enter the following:
    - Select **Analog Value** from the **Type** selection group.
    - Enter "F2 Mon Data 1" into the **Object Name** field.
    - Enter "2000" into the **Instance** field.
    - Enter "12" into the **Database Addr** field.
    - Select **32-bit Unsigned** from the **Data Type** dropdown menu.
    - Enter "1" into the **Multiplier** field.
    - Select **No Units (95)** from the **Units** dropdown menu.
    - Click **Create**.

    Repeat these steps for the other two objects, increasing the **Object Name** by 1, **Instance** by 1, and **Database Addr** by 4 each time.

- Create objects for floor #2's command data
  For the first object, enter the following:
  - Select **Analog Value** from the **Type** selection group.
  - Enter "F2 Cmd Data 1" into the **Object Name** field.
  - Enter "2003" into the **Instance** field.
  - Enter "112" into the **Database Addr** field.
  - Select **32-bit Unsigned** from the **Data Type** dropdown menu.
  - Enter "1" into the **Multiplier** field.
  - Select **No Units (95)** from the **Units** dropdown menu.
  - Click **Create**.

  Repeat these steps for the other two objects, increasing the **Object Name** by 1, **Instance** by 1, and **Database Addr** by 4 each time.

- Create objects for floor #3's monitor data
  For the first object, enter the following:
  - Select **Analog Value** from the **Type** selection group.
  - Enter "F3 Mon Data 1" into the **Object Name** field.
  - Enter "3000" into the **Instance** field.
  - Enter "24" into the **Database Addr** field.
  - Select **32-bit Unsigned** from the **Data Type** dropdown menu.
  - Enter "1" into the **Multiplier** field.
  - Select **No Units (95)** from the **Units** dropdown menu.
  - Click **Create**.

  Repeat these steps for the other two objects, increasing the **Object Name** by 1, **Instance** by 1, and **Database Addr** by 4 each time.

- Create objects for floor #3's command data:
  For the first object, enter the following:
  - Select **Analog Value** from the **Type** selection group.
  - Enter "F3 Cmd Data 1" into the **Object Name** field.
  - Enter "3003" into the **Instance** field.
  - Enter "124" into the **Database Addr** field.
  - Select **32-bit Unsigned** from the **Data Type** dropdown menu.
  - Enter "1" into the **Multiplier** field.
  - Select **No Units (95)** from the **Units** dropdown menu.
  - Click **Create**.

  Repeat these steps for the other two objects, increasing the **Object Name** by 1, **Instance** by 1, and **Database Addr** by 4 each time.

Finishing Up

- Configure the RS-485 B port for the other protocol to be used in accessing the floors of the building.
- Download the configuration to the gateway (see section 8.1 for more information on downloading a configuration to a device).

Where are the monitor and command values?

BACnet Object	Database Addresses
Floor #1 Monitor Data 1 (AV1000)	0 (upper byte)..3(lower byte)
Floor #1 Monitor Data 2 (AV1001)	4 (upper byte)..7(lower byte)
Floor #1 Monitor Data 3 (AV1002)	8 (upper byte)..11(lower byte)
Floor #2 Monitor Data 1 (AV2000)	12 (upper byte)..15(lower byte)
Floor #2 Monitor Data 2 (AV2001)	16 (upper byte)..19(lower byte)
Floor #2 Monitor Data 3 (AV2002)	20 (upper byte)..23(lower byte)
Floor #3 Monitor Data 1 (AV3000)	24 (upper byte)..27(lower byte)
Floor #3 Monitor Data 2 (AV3001)	28 (upper byte)..31(lower byte)
Floor #3 Monitor Data 3 (AV3002)	32 (upper byte)..35(lower byte)
Floor #1 Command Data 1 (AV1003)	100 (upper byte)..103(lower byte)
Floor #1 Command Data 2 (AV1004)	104 (upper byte)..107(lower byte)
Floor #1 Command Data 3 (AV1005)	108 (upper byte)..111(lower byte)
Floor #2 Command Data 1 (AV2003)	112 (upper byte)..115(lower byte)
Floor #2 Command Data 2 (AV2004)	116 (upper byte)..119(lower byte)
Floor #2 Command Data 3 (AV2005)	120 (upper byte)..123(lower byte)
Floor #3 Command Data 1 (AV3003)	124 (upper byte)..127(lower byte)
Floor #3 Command Data 2 (AV3004)	128 (upper byte)..131(lower byte)
Floor #3 Command Data 3 (AV3005)	132 (upper byte)..135(lower byte)

Note that the database is assumed to be big endian in this example.

8.6.6 Metasys N2 Slave

Johnson Controls Metasys N2 slave can be configured on either RS-485 port by selecting **Metasys N2 Slave** from the protocol dropdown menu. The Metasys N2 slave driver can host a wide variety of user-defined N2 objects. This section will discuss how to configure the Metasys N2 driver.

8.6.6.1 Protocol Selection Group

This section describes the fields that must be configured on the RS-485 port.

Protocol

Select **Metasys N2 Slave** from this dropdown menu.

Address

This field is the station address that the gateway will reside at on the network. Enter a value between 1 and 255.

Timeout Time

Refer to section 8.2.1.

Response Delay

This field is used to set the time, in milliseconds, the device waits before responding to master requests. This may be useful if the Metasys master communicating to the gateway requires additional time before it can process a response to its request. If no delay is required, set this field to 0.

8.6.6.2 Metasys Object Common Configurable Fields

This section describes the common configurable fields for all Metasys objects. For more information on Metasys object editing options, refer to section 8.5.

Type

The radio buttons in this group select the Metasys object type. Choose from Analog Input, Analog Output, Binary Input, or Binary Output.

Object Name

This field is a description of the Metasys object. It is not used on the gateway, but serves as a reference for the user. Enter a string of up to 16 characters in length.

Instance

This field is the Metasys object's instance number. Metasys allows a maximum of 256 instances of each object type. Enter a value between 1 and 256 (0x1 – 0x100).

Database Addr

This field is the database address where the Metasys object's current value will reside. Enter a value between 0 and 4095 (0x0 – 0xFFF).

A note for analog objects: Depending on the designated Data Type, the maximum allowable database address is 4095, 4094, or 4092 for 8-bit, 16-bit, or 32-bit sized objects, respectively.

Multiplier

Applies to analog objects only. This field is the amount that associated network values are scaled by prior to being stored into the database or after being retrieved from the database. Upon retrieval from the database, the data is multiplied by the multiplier to produce a network value. Similarly, the network values are divided by the multiplier before being stored into the database.

Note that the multiplier, coupled with the data type, imposes range limitations on the network data value. For example, if the data type is 8-bit and the multiplier is 0.5, then the network data can have values only up to 127 (since 255 is the maximum value that can be stored in 8 bits).

Bitmask

Applies to binary objects only. This 8-bit field specifies which bit(s) in the byte designated by the **Database Addr** that the binary object will map to. This allows up to 8 binary objects to be simultaneously assigned to one database address (each binary object mapping to a single bit of that byte in the database). It is possible to map binary objects to multiple bits within the designated database location. Such a configuration allows (for example) the modification of multiple selected database bits via a single binary output.

<u>The effect of the **Bitmask** field when writing:</u> When the current state of a binary output object is overridden to "1" by a Metasys master, then the bit(s) in the designated **Database Addr** indicated by a "1" in the bitmask are set. Similarly, when the current state of the object is overridden to "0", then the bit(s) in the designated **Database Addr** indicated by a "1" in the bitmask are cleared.

<u>The effect of the **Bitmask** field when reading:</u> When the current state of a binary object is read by a Metasys master, the **Bitmask** is used to determine the state of the object by inspecting the value in the designated database address at the bit location(s) indicated in the **Bitmask**. If <u>all</u> of the bit locations at the designated database address indicated by a "1" in the **Bitmask** are set, then the object's state will be returned as "1". Else, the object's state will be returned as "0".

Data Type

Applies to analog objects only. This field specifies how many bytes are allocated for the object's current value, as well as whether the value should be treated as signed or unsigned when converting it to a real number to send over the network. Select the desired data type from this dropdown menu.

Note that each data type has its own range limitations: 8-bit data types can have values up to 255, 16-bit data types can have values up to 65,535, and 32-bit data types can have values up to 4,294,967,295.

8.6.6.3 Configuration Example

This example will configure one port of the gateway (port A) for communication using the Metasys N2 driver. This example will only detail the configuration of the N2 driver and related objects, with the goal of mapping data from the N2 network into the gateway's database. Once this data is mapped into the gateway's database, it is then accessible for reading and writing via any other supported network connected to the other gateway port (port B).

Assume that we have a building automation system (BAS) that can act as a Metasys N2 master connected to the gateway's RS-485 A port. The BAS exchanges information (through the gateway) with different floors of a building. There are 3 floors; floor #1 has 3 analog input object instances (AI1, AI2, and AI3) which the BAS reads to determine floor status information (perhaps actual temperatures), and 3 analog output object instances (AO1, AO2, and AO3) which the BAS writes with floor command values (perhaps thermostat setpoints). Similarly, floors #2 and #3 have the same analog objects for monitoring and commanding: AI4..AI6 and AO4..AO6 for floor #2, and AI7..AI9 and AO7..AO9 for floor #3.

<u>Configure the RS-485 A port using the above requirements</u>

- Connect the gateway to the PC via a USB mini type-B cable.
- Open the configuration utility and select the XLTR-1000 (see section 8.1 for more information on selecting a device).
- Click on the **RS-485 A Configuration** tab.
- Select **Metasys N2 Slave** from the protocol dropdown menu.
- Enter the **Address** at which the gateway will reside on the network.
- Create Metasys objects to map the data from the BAS into the gateway's database. The monitor object data will start at database address 0 and the command object data will start at database address 100.

    - Create input objects for floor #1's monitor data
      For the first object, enter the following:
        - Select **Analog Input** from the **Type** selection group.
        - Enter "F1 Mon Data 1" into the **Object Name** field.
        - Enter "1" into the **Instance** field.
        - Enter "0" into the **Database Addr** field.
        - Select **32-bit Unsigned** from the **Data Type** dropdown menu.
        - Enter "1" into the **Multiplier** field.
        - Click **Create**.

      Repeat these steps for the other two AI objects, increasing the **Object Name** by 1, **Instance** by 1, and **Database Addr** by 4 each time.

- Create output objects for floor #1's command data
  For the first object, enter the following:
    - Select **Analog Output** from the **Type** selection group.
    - Enter "F1 Cmd Data 1" into the **Object Name** field.
    - Enter "1" into the **Instance** field.
    - Enter "100" into the **Database Addr** field.
    - Select **32-bit Unsigned** from the **Data Type** dropdown menu.
    - Enter "1" into the **Multiplier** field.
    - Click **Create**.

  Repeat these steps for the other two AO objects, increasing the **Object Name** by 1, **Instance** by 1, and **Database Addr** by 4 each time.

- Create input objects for floor #2's monitor data
  For the first object, enter the following:
    - Select **Analog Input** from the **Type** selection group.
    - Enter "F2 Mon Data 1" into the **Object Name** field.
    - Enter "4" into the **Instance** field.
    - Enter "12" into the **Database Addr** field.
    - Select **32-bit Unsigned** from the **Data Type** dropdown menu.
    - Enter "1" into the **Multiplier** field.
    - Click **Create**.

  Repeat these steps for the other two AI objects, increasing the **Object Name** by 1, **Instance** by 1, and **Database Addr** by 4 each time.

- Create output objects for floor #2's command data
  For the first object, enter the following:
    - Select **Analog Output** from the **Type** selection group.
    - Enter "F2 Cmd Data 1" into the **Object Name** field.
    - Enter "4" into the **Instance** field.
    - Enter "112" into the **Database Addr** field.
    - Select **32-bit Unsigned** from the **Data Type** dropdown menu.
    - Enter "1" into the **Multiplier** field.
    - Click **Create**.

  Repeat these steps for the other two AO objects, increasing the **Object Name** by 1, **Instance** by 1, and **Database Addr** by 4 each time.

- Create input objects for floor #3's monitor data
  For the first object, enter the following:
    - Select **Analog Input** from the **Type** selection group.
    - Enter "F3 Mon Data 1" into the **Object Name** field.
    - Enter "7" into the **Instance** field.
    - Enter "24" into the **Database Addr** field.

- Select **32-bit Unsigned** from the **Data Type** dropdown menu.
- Enter “1” into the **Multiplier** field.
- Click **Create**.

Repeat these steps for the other two AI objects, increasing the **Object Name** by 1, **Instance** by 1, and **Database Addr** by 4 each time.

- Create output objects for floor #3’s command data:
  For the first object, enter the following:
  - Select **Analog Output** from the **Type** selection group.
  - Enter “F3 Cmd Data 1” into the **Object Name** field.
  - Enter “7” into the **Instance** field.
  - Enter “124” into the **Database Addr** field.
  - Select **32-bit Unsigned** from the **Data Type** dropdown menu.
  - Enter “1” into the **Multiplier** field.
  - Click **Create**.

  Repeat these steps for the other two AO objects, increasing the **Object Name** by 1, **Instance** by 1, and **Database Addr** by 4 each time.

Finishing Up

- Configure the RS-485 B port for the other protocol to be used in accessing the floors of the building.
- Download the configuration to the gateway (see section 8.1 for more information on downloading a configuration to a device).

Where are the monitor and command values?

Metasys Object	Database Addresses
Floor #1 Monitor Data 1 (AI1)	0 (upper byte)..3(lower byte)
Floor #1 Monitor Data 2 (AI2)	4 (upper byte)..7(lower byte)
Floor #1 Monitor Data 3 (AI3)	8 (upper byte)..11(lower byte)
Floor #2 Monitor Data 1 (AI4)	12 (upper byte)..15(lower byte)
Floor #2 Monitor Data 2 (AI5)	16 (upper byte)..19(lower byte)
Floor #2 Monitor Data 3 (AI6)	20 (upper byte)..23(lower byte)
Floor #3 Monitor Data 1 (AI7)	24 (upper byte)..27(lower byte)
Floor #3 Monitor Data 2 (AI8)	28 (upper byte)..31(lower byte)
Floor #3 Monitor Data 3 (AI9)	32 (upper byte)..35(lower byte)
Floor #1 Command Data 1 (AO1)	100 (upper byte)..103(lower byte)
Floor #1 Command Data 2 (AO2)	104 (upper byte)..107(lower byte)
Floor #1 Command Data 3 (AO3)	108 (upper byte)..111(lower byte)
Floor #2 Command Data 1 (AO4)	112 (upper byte)..115(lower byte)
Floor #2 Command Data 2 (AO5)	116 (upper byte)..119(lower byte)
Floor #2 Command Data 3 (AO6)	120 (upper byte)..123(lower byte)
Floor #3 Command Data 1 (AO7)	124 (upper byte)..127(lower byte)
Floor #3 Command Data 2 (AO8)	128 (upper byte)..131(lower byte)
Floor #3 Command Data 3 (AO9)	132 (upper byte)..135(lower byte)

Note that the database is assumed to be big endian in this example.

8.6.7 Toshiba ASD Master

Toshiba ASD Master can be configured on either RS-485 port by selecting **Toshiba ASD Master** from the protocol dropdown menu. The Toshiba ASD Master protocol uses service objects to make requests. For more information on service objects, refer to section 8.4. Each parameter in a service object is mapped to 2 bytes in the database (the data size is fixed at 16-bit, as this is the native data size of Toshiba ASD parameters). For more information on parameter mapping, refer to section 9.4.3.

8.6.7.1 Protocol Selection Group

Protocol

Select **Toshiba ASD Master** from this dropdown menu.

Baud Rate

Select the desired network baud rate from this dropdown menu.

Parity

Select the desired network parity and number of stop bits from this dropdown menu.

Timeout

This is the time in milliseconds that the device will wait for a response from a drive after sending a request.

Scan Rate

This is the time the device will wait between sending requests. This may be useful if drives require additional time between requests. If no additional delay time is needed, set this field to 0. For more information, refer to section 8.3.

8.6.7.2 Toshiba Service Object Configuration

This section describes the configurable fields for a Toshiba service object. For more information on Toshiba service object editing options, refer to section 8.5.

Description

This field is a description of the service object. It is not used on the gateway, but serves as a reference for the user. Enter a string of up to 16 characters in length.

Dest Address

This field indicates the destination address of the drive on the network that will be accessed by this service object. Enter a value between 0 and 63 to target a specific drive. A value of 255 (0xFF) can also be entered in this field. Address 255 designates the broadcast address in the Toshiba ASD protocol. If a broadcast service object is configured, then the **Read** function checkbox must be unchecked, as attempts to read a service object targeting destination address 255 will invariably time out.

Start Param

This field defines the starting parameter number for a range of drive parameters associated with this service object. Enter a value between 0 and FF99. For example, the drive's output frequency typically resides at parameter FE00.

For configuration parameters (i.e. those parameters which are not used for drive control or monitoring), do not include the leading "F" character which some documentation may include. If the leading "F" character is included in the string entered into the Start Param field, then the parameter can be read, but the drive will reject writing to the parameter. For example, some Toshiba documentation may indicate that the "deceleration time 1" configuration parameter is "F010". This should be entered into the Start Param field as "0010" (or just "10", as the configuration utility will automatically add "0" characters to the beginning of parameter numbers when necessary).

Num Params

This field defines the number of parameters associated with this service object. Enter a value between 1 and 125.

As an example, if you wish to access both "acceleration time 1" and "deceleration time 1" via a single service object, then enter "9" in the Start Param field and "2" in the Num Params field. This will cause the service object to access both parameters 0009 and 0010 (which some Toshiba documentation may describe as parameters F009 and F010, respectively).

Database Addr

This field defines the database address where the first parameter of this service object will be mapped. Enter a value between 0 and 4094. Note that the configuration utility will not allow entry of a starting database address that will cause the service object to run past the end of the database. The highest valid database address, therefore, depends on the number of parameters to be accessed.

Multiplier

This field is the amount that associated network values are scaled by prior to being stored into the database or after being retrieved from the database. Upon retrieval from the database, raw data is multiplied by the multiplier to produce a network value (to be sent to a drive). Similarly, network values (read from a drive) are divided by the multiplier before being stored into the database.

Note that the multiplier imposes range limitations on network data values. For example, if the multiplier is 0.01, then the network data can achieve a maximum value of only 655 (since 65535 is the maximum value that can be stored in 16 bits in the database).

Read Enable and Function Code Selection

Check **Read** to enable reading (the service object will continuously read from the drive unless a pending **Write** exists). When reads are enabled, the desired read **Function Code** can be selected in the drop-down box. When connected to the drives via a 2-wire RS-485 network, Toshiba recommends use of the “G” read function code. When connected to the drives via a 4-wire RS-485 network, either the “G” or “R” function codes can be used.

Write Enable and Function Code Selection

Check **Write** to enable writing (when values encompassed by this service object change in the gateway’s database, these changes will be written down to the targeted drive). When writes are enabled, the desired write **Function Code** can be selected in the drop-down box. The “P” function code writes to the drive’s volatile RAM memory only, and is typically used when frequently writing to configuration parameters in order to prevent damage to the drive’s EEPROM memory (which has a limited write count lifecycle). The “W” function code writes to both the drive’s volatile RAM memory as well as its non-volatile EEPROM memory. Drive command parameters (command word, frequency command etc.) exist in RAM only, so either write function code can be safely used when writing to them.

Service Object Status

If it is desired to reflect the status of this service object, check the **Reflect Status** checkbox and enter a database **address** between 0 and 4080 (0x0 – 0xFF0) at which to store the status information. For more information on reflecting the status of service objects, refer to section 8.4.2.

8.6.7.3 Configuration Example

This example will configure the gateway for end-to-end communication using Toshiba ASD Master and Modbus RTU slave.

Say, for instance, we wish to communicate to a Toshiba G7 adjustable-speed drive from a PLC that supports Modbus RTU. We wish to monitor the output frequency, status word, output current, and DC bus voltage of the drive, located at parameters FE00, FE01, FE03 and FE04, respectively. To run the drive, we need to be able to write to the RS-485 command word and frequency command, located at parameters FA04 and FA05, respectively.

Configure the RS-485 A port (Modbus slave) using the above requirements

- Connect the gateway to the PC via a USB mini type-B cable.
- Open the configuration utility and select the XLTR-1000 (see section 8.1 for more information on selecting a device).
- Click on the **RS-485 A Configuration** tab.
- Select **Modbus RTU Slave** from the protocol dropdown menu.
- Enter the **Baud Rate** and **Parity** settings to match that of the PLC.
- Enter the slave address that your PLC is configured to communicate with into the **Address** field.

- The default mapping of the gateway's database into the Modbus register space will be used in this example, so no register remap objects need to be created.

Configure the RS-485 B port (Toshiba ASD) using the above requirements

- Click on the **RS-485 B Configuration** tab.
- Select **Toshiba ASD Master** from the protocol dropdown menu.
- Enter the **Baud Rate** and **Parity** settings to match that of the drive.
- Create Service Objects to read and write the desired parameters. Because the drive status parameters are located at parameter numbers FE00, FE01, FE03 and FE04, we could decide to retrieve these by defining just one service object which reads a quantity of 5 parameters, starting with parameter FE00. Obviously, this would include parameter FE02, which we are not interested in. This unnecessary parameter in the gateway's database could just be ignored when read by the PLC. This approach results in a slightly faster and simpler configuration of the gateway, but at the expense of a slightly less efficient use of the RS-485 network bandwidth and special processing required in the PLC. For the purposes of this example, therefore, we will define two service objects for reading the drive status parameters: one which accesses parameters FE00 and FE01, and one which accesses parameters FE03 and FE04. These 4 parameters can then reside in a contiguous block of memory in the gateway's database, which means that they can be accessed via a single "read multiple registers" function code request on the Modbus network.

    - Create one service object to monitor the output frequency and drive status word.
        - Enter the address of the drive into the **Dest Address** field.
        - Enter "FE00" into the **Start Param** field.
        - Enter "2" into the **Num Params** field.
        - Enter "0" into the **Database Addr** field.
        - Uncheck the "write" function code check box (these are monitor-only parameters, so there will be no need to write to them)
        - Click **Create**.

    - Create a second service object to monitor the output current and DC bus voltage.
        - Enter the address of the drive into the **Dest Address** field.
        - Enter "FE03" into the **Start Param** field.
        - Enter "2" into the **Num Params** field.
        - Enter "4" into the **Database Addr** field.
        - Uncheck the "write" function code check box
        - Click **Create**.

    - Create a final service object for the RS-485 command word and frequency command.
        - Enter the address of the drive into the **Dest Address** field.
        - Enter "FA04" into the **Start Param** field.

- Enter “2” into the **Num Params** field.
- Enter “8” into the **Database Addr** field.
- Ensure that the “write” function code check box is checked, and then select the desired **Write Function Code**. Because this service object will be used to write to drive command registers (which exist only in RAM), either “P” or “W” will work fine: we will choose “P” from the dropdown menu.
- Click **Create**.

Finishing Up

- Download the configuration to the gateway (see section 8.1 for more information on downloading a configuration to a device).
- Connect the gateway to the drive and the PLC.

Where are the monitor and command values?

Database Addresses	**Drive Parameter**	**Modbus Register**
0 & 1	Output frequency (FE00)	Register 1
2 & 3	Drive status word (FE01)	Register 2
4 & 5	Output current (FE03)	Register 3
6 & 7	DC bus voltage (FE04)	Register 4
8 & 9	RS-485 command word (FA04)	Register 5
10 & 11	RS-485 frequency command (FA05)	Register 6

Note that the database endianness is arbitrary in this example, as both protocols will access the database uniformly regardless of whether big or little endian storage is selected.

8.6.8 Sullair Supervisor Master

Sullair Supervisor Master can be configured on either RS-485 port by selecting **Sullair Master** from the protocol dropdown menu. The Sullair Master protocol uses service objects to make requests. For more information on service objects, refer to section 8.4. Except for display parameters, each parameter in a Sullair supervisor service object is mapped to 2 bytes in the database (the data size is fixed at 16-bit). For more information on parameter mapping, refer to section 9.5.2.

8.6.8.1 Protocol Selection Group

Protocol

Select **Sullair Master** from this dropdown menu.

8.6.8.2 Sullair Service Object Configuration

This section describes the configurable fields for a Sullair service object. For more information on Sullair service object editing options, refer to section 8.5.

Description

This field is a description of the service object. It is not used on the gateway, but serves as a reference for the user. Enter a string of up to 16 characters in length.

Dest Address

This field indicates the destination address of the controller on the network that will be accessed by this service object. Enter a value between 1 and 16 to target a specific controller.

Start Param

This field defines the starting parameter number for a range of controller parameters associated with this service object. Enter a value between 0 and 124. For example, the controller's unload pressure value resides at parameter 5.

Num Params

This field defines the number of parameters associated with this service object. Enter a value between 1 and 125.

As an example, if you wish to access all the net status parameters via a single service object, then enter "100" in the Start Param field and "7" in the Num Params field. This will cause the service object to access all parameters that are updated via the net status message.

Database Addr

This field defines the database address where the first parameter of this service object will be mapped. Enter a value between 0 and 4094. Note that the configuration utility will not allow entry of a starting database address that will cause the service object to run past the end of the database. The highest valid database address, therefore, depends on the number of parameters to be accessed.

Multiplier

This field is the amount that associated network values are scaled by prior to being stored into the database or after being retrieved from the database. Upon retrieval from the database, raw data is multiplied by the multiplier to produce a network value (to be sent to a controller). Similarly, network values (read from a controller) are divided by the multiplier before being stored into the database. This value is ignored for display parameters.

Note that the multiplier imposes range limitations on network data values. For example, if the multiplier is 0.01, then the network data can achieve a maximum value of only 655 (since 65535 is the maximum value that can be stored in 16 bits in the database).

Read Enable and Function Code Selection

Check **Read** to enable reading (the service object will continuously read from the controller unless a pending **Write** exists). When reads are enabled, the desired read **Function Code** can be selected in the drop-down box.

Write Enable and Function Code Selection

Check **Write** to enable writing (when values encompassed by this service object change in the gateway's database, these changes will be written down to the targeted controller). When writes are enabled, the desired write **Function Code** can be selected in the drop-down box.

Service Object Status

If it is desired to reflect the status of this service object, check the **Reflect Status** checkbox and enter a database **address** between 0 and 4080 (0x0 – 0xFF0) at which to store the status information. For more information on reflecting the status of service objects, refer to section 8.4.2.

8.6.8.3 Configuration Example

This example will configure the gateway for accessing a Supervisor controller via the Sullair Master driver. Say, for instance, we wish to monitor P1 – P4, T1 – T5, and the run status. These data items are located at parameters 107 – 110, 111 – 115, and 103 respectively (refer to section 9.5 for a list of Supervisor parameters with indexes of 100+). We also wish to control the unload pressure, load pressure delta, and unload time, located at parameters 5, 6, and 7 respectively.

Configure the gateway using the above requirements

- Connect the gateway to the PC via a USB mini type-B cable.
- Open the configuration utility and select the XLTR-1000 (see section 8.1 for more information on selecting a device).

Configure the RS-485 B port using the above requirements

- Click on the **RS-485 B Configuration** tab.
- Select **Sullair Master** from the protocol dropdown menu.
- Create Service Objects to read and write the desired parameters. Because the pressure and temperature parameters are located at contiguous indexes (107 – 115), we can retrieve these by defining just one service object which reads a quantity of 9 parameters, starting with parameter 107. Similarly, the parameters we wish to control are also at contiguous indexes (5 – 7), enabling us to define a single service object for these parameters as well.

    - Create one service object to monitor the pressure and temperature parameters.
        - Enter the address of the controller into the **Dest Address** field.
        - Enter “107” into the **Start Param** field.
        - Enter “9” into the **Num Params** field.
        - Enter “0” into the **Database Addr** field.
        - Uncheck the “write” function code check box (these are monitor-only parameters, so there will be no need to write to them)
        - Click **Create**.

    - Create a second service object to monitor the run status of the controller.
        - Enter the address of the controller into the **Dest Address** field.
        - Enter “103” into the **Start Param** field.
        - Enter “1” into the **Num Params** field.
        - Enter “18” into the **Database Addr** field.
        - Uncheck the “write” function code check box
        - Click **Create**.

    - Create a final service object for the unload pressure, load pressure delta, and unload time.
        - Enter the address of the controller into the **Dest Address** field.
        - Enter “5” into the **Start Param** field.
        - Enter “3” into the **Num Params** field.
        - Enter “32” into the **Database Addr** field.
        - Ensure that the “write” function code check box is checked (as we do wish to modify these parameters over the network).
        - Click **Create**.

Finishing Up

- Download the configuration to the gateway (see section 8.1 for more information on downloading a configuration to a device).
- Connect the gateway to the Supervisor network.

Where are the monitor and command values?

Controller Parameter (Parameter Index)	Database Address
P1 (107)	0 & 1
P2 (108)	2 & 3
P3 (109)	4 & 5
P4 (110)	6 & 7
T1 (111)	8 & 9
T2 (112)	10 & 11
T3 (113)	12 & 13
T4 (114)	14 & 15
T5 (115)	16 & 17
run status (103)	18 & 19
unload pressure (5)	32 & 33
load pressure delta (6)	34 & 35
unload time (7)	36 & 37

9. Protocol-Specific Information

This section will discuss topics that are specific to each of the supported protocols.

9.1 Modbus RTU

9.1.1 Modbus RTU Master

9.1.1.1 Overview

The gateway supports the Modbus RTU master protocol on both of its RS-485 ports. Some notes of interest are:

- Supported Modbus master functions are indicated in Table 1.

Table 1: Supported Modbus RTU Master Functions

Function Code	Function
01	Read Coil Status
02	Read Input Status
03	Read Holding Registers
04	Read Input Registers
06	Preset Single Register
15	Force Multiple Coils
16	Force Multiple Registers

- Requests are fully configurable through service objects.
- 32-bit register accesses are supported in a variety of options and formats.
- The following point types are supported in Modbus Service Objects:
  - Holding Register
  - Input Register
  - Coil Status
  - Input Status

9.1.1.2 Modbus Service Objects

The Modbus RTU master driver uses service objects to describe what services the gateway should perform. For each service object, the gateway will continually read the registers or discretes defined within the service object from the designated slave, storing the value(s) in the database (if the read function is enabled). When data in the database changes where the registers or discretes are mapped, a write request is generated to the designated slave notifying it of the changed register or discrete value(s) (if the write function is enabled). For more information on configuring Modbus service objects, refer to section 8.6.1.2.

9.1.1.3 Register and Discrete Mapping

Holding and Input Registers

Modbus registers are mapped in the database as 2-byte values. This means that each register in a service object takes up two database addresses. For example if a service object's starting register is "1", the number of registers is "5", and the database address is "100", then registers 1 through 5 will be mapped at database addresses 100 through 109 (register 1 mapped at addresses 100 and 101, register 2 mapped at addresses 102 and 103, and so on).

Coils and Discrete Inputs

Coils and Discrete Inputs, from here on collectively referred to as "discretes", are mapped on a bit-by-bit basis in the database starting with the least significant bit of the database byte. For example, if a service object's starting discrete is "1", the number of discretes is "19", and the database address is "320", then discrete 1 through 8 will be mapped to bit 0 through 7, respectively, at address 320, discrete 9 through 16 will be mapped to bit 0 through 7, respectively, at address 321, and discrete 17 through 19 will be mapped to bit 0 through 2, respectively, at address 322. The remaining 5 bits in the byte at address 322 are unused.

9.1.2 Modbus RTU Slave

9.1.2.1 Overview

The gateway supports the Modbus RTU slave protocol on both of its RS-485 ports. Some notes of interest are:

- Supported Modbus slave functions are indicated in Table 2.

Table 2: Supported Modbus RTU Slave Functions

Function Code	Function
01	Read Coil Status
02	Read Input Status
03	Read Holding Registers
04	Read Input Registers
05	Force Single Coil
06	Preset Single Register
08	Diagnostics (Subfunction 0 only)
15	Force Multiple Coils
16	Force Multiple Registers

- Database data can be accessed as either holding registers (4X references) or input registers (3X references). For example, accessing database address 1300 involves accessing holding register 41301 or input register 31301 (i.e. offset 1301).
- Specific bits within the database can be accessed as either coils (0X references) or discrete inputs (1X references).
- 32-bit register accesses are supported in a variety of options and formats.
- Because the transaction is handled locally within the gateway, write data checking is not available. For example, if a write is performed to a register with a data value that is out-of-range of the corresponding data element, no Modbus exception will be immediately returned.
- Configuration tip: Improved network utilization may be obtained by appropriately grouping contiguous register assignments in the database. In this way, the “read multiple registers”, “read input registers” and “write multiple registers” functions can be used to perform transfers of larger blocks of registers using fewer Modbus transactions compared to a situation where the read/write registers were arranged in an alternating or scattered fashion.

9.1.2.2 Holding & Input Register Mappings

The Modbus RTU slave driver provides read/write support for holding registers (4X references) and read-only support for input registers (3X references). Both holding registers and input registers access the same data. For example, reading Holding Register 4 returns the same data as reading Input Register 4. By default, registers are mapped into the database using the following scheme:

Register 1 is mapped to address 0,
Register 2 is mapped to address 2,
Register 3 is mapped to address 4,
…

Arithmetically, the register-to-address relationship can be described via Equation 1:

$$address = 2 \times (register - 1) \qquad \textbf{Equation 1}$$

Additionally, a register remap object can be created to map a register to a different address in the database, or to map a register that is outside of the default mapping into the database. Refer to section 8.6.2.2 for more information on configuring register remap objects.

For clarity, let’s use Equation 1 in a calculation example with a remap object. Let’s assume we have defined a register remap object to remap register 25 to database address 62. This means that instead of register 25 mapping to address 48 (as it would with the default mapping), it will now map to address 62. Now say we wish to read registers 24 and 25. We already know that register 25 maps to database address 62, so we must use Equation 1 to calculate what address register 24 is mapped to. Using the equation, we can determine that register 24 is mapped to database address 46. So reading registers 24 and 25 will return data from addresses 46 and 62 in the database, respectively.

9.1.2.3 Coil & Discrete Input Mappings

The Modbus RTU slave driver provides read/write support for coils (0X references) and read-only support for discrete inputs (1X references). These will collectively be referred to from here on out as simply "discretes". Accessing discretes does not reference any new physical data: discretes are simply indexes into various bits of existing registers. What this means is that when a discrete is accessed, that discrete is resolved by the gateway into a specific register, and a specific bit within that register. The pattern of discrete-to-register/bit relationships can be described as follows:

Discrete 1...16 map to register #1, bit0...bit15 (bit0=LSB, bit15=MSB)
Discrete 17...32 map to register #2, bit0...bit15, and so on.

Arithmetically, the discrete-to-register/bit relationship can be described as follows: For any given discrete, the register in which that discrete resides can be determined by Equation 2:

$$register = \left\lfloor \frac{discrete + 15}{16} \right\rfloor$$ **Equation 2**

Where the bracket symbols "$\lfloor\ \rfloor$" indicate the "floor" function, which means that any fractional result (or "remainder") is to be discarded, with only the integer value being retained.

Also, for any given discrete, the targeted bit in the register in which that discrete resides can be determined by Equation 3:

$$bit = (discrete - 1)\ \%\ 16$$ **Equation 3**

Where "discrete" $\in$[1…65535], "bit" $\in$[0…15], and "%" is the modulus operator, which means that any fractional result (or "remainder") is to be retained, with the integer value being discarded (i.e. it is the opposite of the "floor" function).

Conversely, for any bit in a register, the targeted discrete corresponding to that bit can be calculated by Equation 4:

$$discrete = 16 \times (register - 1) + bit + 1$$ **Equation 4**

For clarity, let's use Equation 2 and Equation 3 in a calculation example. Say, for instance, that we are going to read coil #34. Using Equation 2, we can determine that coil #34 resides in register #3, as $\lfloor 3.0625 \rfloor$ = $\lfloor 3\ r1 \rfloor$ = 3. Then, using Equation 3, we can determine that the bit within register #3 that coil #34 targets is (34-1)%16 = 1, as 33%16 = mod(2 r1) = 1. Therefore, reading coil #34 will return the value of register #3, bit #1.

Note that discretes are mapped to registers, not database addresses. The location of a given register in the database determines what physical address the discrete will access. Because of this, it is possible to indirectly remap discretes using register remap objects. If a register has been remapped to an alternate database address, then the discretes that map to that register will also be remapped to that alternate address.

9.1.3 Modbus RTU Sniffer

9.1.3.1 Overview

The gateway supports a Modbus RTU sniffer driver on both of its RS-485 ports. This driver enables fully non-intrusive insight into any existing Modbus RTU network consisting of a master and at least one slave. The driver can be configured to "sniff" the requests of the master and log the responses of the slave(s) into the database. Some notes of interest are:

- Supported Modbus functions are indicated in Table 3.

Table 3: Supported Modbus RTU Sniffer Functions

Function Code	Function
03	Read Holding Registers
04	Read Input Registers
06	Preset Single Register
16	Force Multiple Registers

- The filtering of specific actions targeting registers of interest is fully configurable through service objects.
- Both Holding and Input Registers are supported in Modbus Service Objects.
- The Modbus Sniffer Service Objects are identical to those of the Modbus Master Service Objects with the exception that instead of the gateway itself generating requests, it must rely on the existing Modbus master to make requests on its behalf. Therefore, if the master never reads or writes a certain register that is configured in a service object on the gateway, the value of that register will never be updated. For more information on Modbus Service Objects, refer to section 9.1.1.2.
- The Modbus Sniffer driver never transmits on the Modbus network being sniffed.

9.2 BACnet MS/TP

The gateway supports both BACnet MS/TP client and server drivers on both of its RS-485 ports. Both client and server act as an MS/TP master on the network, meaning they are actively involved in token management.

9.2.1 Protocol Implementation Conformance Statement

BACnet Protocol

Date:	August 22, 2008
Vendor Name:	ICC, Inc.
Product Name:	Millennium Series Multiprotocol RS485 Gateway
Product Model Number:	XLTR-1000
Applications Software Version:	V2.100
Firmware Revision:	V2.100
BACnet Protocol Revision:	2

Product Description:

The XLTR-1000 is a multiprotocol RS-485 to RS-485 gateway. This product supports native BACnet, connecting directly to the MS/TP LAN using baud rates of 4800, 9600, 19200, 38400, 57600, 76800, and 115200. The device can be configured as a BACnet Client or as a BACnet Server.

BACnet Standard Device Profile (Annex L):

☐ BACnet Operator Workstation (B-OWS)
☐ BACnet Building Controller (B-BC)
☐ BACnet Advanced Application Controller (B-AAC)
☒ BACnet Application Specific Controller (B-ASC)
☐ BACnet Smart Sensor (B-SS)
☐ BACnet Smart Actuator (B-SA)

BACnet Interoperability Building Blocks Supported (Annex K):

☒ Data Sharing – ReadProperty-A (DS-RP-A)
☒ Data Sharing – ReadProperty-B (DS-RP-B)
☒ Data Sharing – ReadPropertyMultiple-B (DS-RPM-B)
☒ Data Sharing – WriteProperty-A (DS-WP-A)
☒ Data Sharing – WriteProperty-B (DS-WP-B)
☒ Data Sharing – WritePropertyMultiple-B (DS-WPM-B)
☒ Device Management – Dynamic Device Binding-A (DM-DDB-A)
☒ Device Management – Dynamic Device Binding-B (DM-DDB-B)
☒ Device Management – Dynamic Object Binding-B (DM-DOB-B)
☒ Device Management – DeviceCommunicationControl-B (DM-DCC-B)
☒ Device Management – ReinitializeDevice-B (DM-RD-B)

Segmentation Capability:

None

☐ Segmented requests supported Window Size ________
☐ Segmented responses supported Window Size ________

Standard Object Types Supported:

See "Object Types/Property Support Table" for object details.

Data Link Layer Options:

☐ BACnet IP, (Annex J)
☐ BACnet IP, (Annex J), Foreign Device
☐ ISO 8802-3, Ethernet (Clause 7)
☐ ANSI/ATA 878.1, 2.5 Mb. ARCNET (Clause 8)
☐ ANSI/ATA 878.1, RS-485 ARCNET (Clause 8), baud rate(s) ______
☒ MS/TP master (Clause 9), baud rate(s): 4800, 9600, 19200, 38400, 57600, 76800, 115200
☐ MS/TP slave (Clause 9), baud rate(s): ______
☐ Point-To-Point, EIA 232 (Clause 10), baud rate(s): ______
☐ Point-To-Point, modem, (Clause 10), baud rate(s): ______
☐ LonTalk, (Clause 11), medium: ______
☐ Other: ______

Device Address Binding:

Is static device binding supported? (This is currently for two-way communication with MS/TP slaves and certain other devices.) ☒ Yes ☐ No

Networking Options:

☐ Router, Clause 6 - List all routing configurations
☐ Annex H, BACnet Tunneling Router over IP
☐ BACnet/IP Broadcast Management Device (BBMD)
Does the BBMD support registrations by Foreign Devices? ☐ Yes ☐ No

Character Sets Supported:

Indicating support for multiple character sets does not imply that they can all be supported simultaneously.

☒ ANSI X3.4	☐ IBM™/Microsoft™ DBCS	☐ ISO 8859-1
☐ ISO 10646 (UCS-2)	☐ ISO 10646 (UCS-4)	☐ JIS C 6226

If this product is a communication gateway, describe the types of non-BACnet equipment/networks(s) that the gateway supports:

Refer to section 9 for other supported protocols.

Datatypes Supported:
The following table summarizes the datatypes that are accepted (in the case of a write property service) and returned (in the case of a read property service) when targeting the present value property of each supported object type.

Object Type	**Service**	
	Read Property	**Write Property**
Analog Output **Analog Value**	Real	Real, Unsigned, Integer, Null
Analog Input	Real	N/A
Binary Output **Binary Value**	Enumerated	Enumerated, Boolean, Real, Unsigned, Integer, Null
Binary Input	Enumerated	N/A

Object Types/Property Support Table

The following table summarizes the Object Types/Properties supported.

Property	Object Type						
	Device	Binary Input	Binary Output	Binary Value	Analog Input	Analog Output	Analog Value
Object Identifier	R	R	R	R	R	R	R
Object Name	R	R	R	R	R	R	R
Object Type	R	R	R	R	R	R	R
System Status	R						
Vendor Name	R						
Vendor Identifier	R						
Model Name	R						
Firmware Revision	R						
App Software Revision	R						
Protocol Version	R						
Protocol Revision	R						
Services Supported	R						
Object Types Supported	R						
Object List	R						
Max APDU Length	R						
Segmentation Support	R						
APDU Timeout	R						
Number APDU Retries	R						
Max Master	R						
Max Info Frames	R						
Device Address Binding	R						
Database Revision	R						
Present Value		R	W	W	R	W	W
Status Flags		R	R	R	R	R	R
Event State		R	R	R	R	R	R
Out-of-Service		R	R	R	R	R	R
Units					R	R	R
Priority Array			R	R		R	R
Relinquish Default			R	R		R	R
Polarity		R	R				
Inactive Text		R	R	R			
Active Text		R	R	R			

R – readable using BACnet services
W – readable and writable using BACnet services

9.2.2 BACnet MS/TP Client

9.2.2.1 Overview

The gateway supports BACnet MS/TP client on both of its RS-485 ports. Some notes of interest are:

- The gateway supports reading and writing the present value property of BACnet objects in devices on the network.
- Requests are fully configurable through service objects.
- Supported BACnet objects include:
    - Analog Input
    - Analog Output
    - Analog Value
    - Binary Input
    - Binary Output
    - Binary Value
- Supported baud rates include:
    - 4800
    - 9600
    - 19200
    - 38400
    - 57600
    - 76800
    - 115200
- Static device binding is supported.

9.2.2.2 BACnet Service Objects

The BACnet MS/TP Client protocol uses service objects to describe what services the gateway should perform. For each service object, the gateway will continually read the present value of the defined BACnet object within the service object from the designated device, storing the value(s) in the database (if the read function is enabled). When data in the database changes where the BACnet objects are mapped, a write request is generated to the designated device notifying it of the changed present value(s) of the BACnet object(s) (if the write function is enabled). For more information on configuring BACnet service objects, refer to section 8.6.4.3.

9.2.2.3 Device Binding

Dynamic Device Binding

In order for a BACnet client to request data from other devices, it must first learn what addresses those devices are located at on the network. BACnet client devices can use dynamic device binding to learn the addresses of other devices on the network. This is done by sending a Who-Is request on the network. Any devices whose device instance falls within the range of the Who-Is request will respond with an I-Am response, informing the client of what network address its device instance is associated with. By default, the gateway will use dynamic device binding if a service object is not configured to use static device binding.

Static Device Binding

Not all BACnet devices support dynamic device binding. If the gateway needs to request data from an MS/TP slave, or an MS/TP master that doesn't support dynamic device binding, then static device binding must be used. Static device binding allows the user to manually define the information that the client would normally acquire using dynamic device binding. The only additional information the user must define is the network address of the destination device. This feature may also be useful if the destination device instance is unknown, but the network address of the device is known. In this case, an arbitrary device instance may be used (as long as it does not conflict with any other device instances in other defined service objects) and the destination address must be set to the network address of the device.

9.2.2.4 BACnet Object Mapping

Analog Objects

Analog objects are mapped in the database as either an 8-bit, 16-bit, or 32-bit value, depending on the data type selected. This means that each analog object in a service object consumes one, two, or four database addresses, respectively. For example, if a service object's starting analog output instance is "1", the number of instances is "5", the database address is "100", and the data type is "32-bit Unsigned", then AO 1 through 5 will be mapped at database addresses 100 through 119 (AO 1 is mapped at address 100 through 103, AO 2 is mapped at address 104 and 107, and so on).

Binary Objects

Binary objects are mapped on a bit-by-bit basis in the database starting with the least significant bit of the database byte. For example, if a service object's starting binary output instance is "1", the number of instances is "12", and the database address is "240", then BO 1 through 8 will be mapped to bit 0 through 7, respectively, at address 240, and BO 9 through 12 will be mapped to bit 0 through 3, respectively, at address 241. The remaining 4 bits in the byte at address 241 are unused.

9.2.3 BACnet MS/TP Server

9.2.3.1 Overview

The gateway supports BACnet MS/TP server on both of its RS-485 ports. Some notes of interest are:

- Fully configurable BACnet objects.
- Supported BACnet objects include:
    - Analog Input
    - Analog Output
    - Analog Value
    - Binary Input
    - Binary Output
    - Binary Value
- Supported baud rates include:
    - 4800
    - 9600
    - 19200
    - 38400
    - 57600
    - 76800
    - 115200
- Binary Objects support custom Active and Inactive Text.

9.2.3.2 BACnet Objects

The BACnet server hosts BACnet objects which contain many different properties for any BACnet client on the network to access. The gateway supports seven different BACnet objects: Device, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, and Binary Value. All supported properties of these objects are readable, while only the present value property is writable (for Outputs and Values only). Refer to section 9.2.1 for the list of properties each object supports. The objects and their properties are configured using the configuration utility. Refer to section 8.6.5 for more information on configuring BACnet objects.

9.2.3.3 Supported BACnet Services

This section details the BACnet services that are supported:

Read Property

This service is used to request data from the gateway about one of its BACnet object's properties.

Read Property Multiple

This service is used to request data from the gateway about several of its BACnet objects' properties.

Write Property

This service is used to send data to the gateway to change the value of one of its BACnet object's properties.

Note that write priorities are ignored by the gateway.

Write Property Multiple

This service is used to send data to the gateway to change the value of several of its BACnet objects' properties.

Note that write priorities are ignored by the gateway.

Dynamic Device Binding

This service is used to discover the gateway on the network. Upon receiving a Who-Is request on the network, the gateway will generate an I-Am response, if its instance number is included in the range of the request. This allows other devices to resolve the gateway's network address.

Dynamic Object Binding

This service is used to discover the gateway's objects on the network. Upon receiving a Who-Has request on the network, the gateway will generate an I-Have response, if that object exists on the device. This allows other devices to resolve which devices on the network have specific BACnet objects.

Device Communication Control

This service is used to halt responses to requests directed at the gateway for a defined amount of time or indefinitely. Once communication is disabled, until the defined amount of time has expired the device will only respond to a device communication control service that re-enables communication, or a reinitialize device service that resets the device. This service is generally only used for commissioning purposes.

Reinitialize Device

This service is used to reset the device. The gateway does not distinguish between a warm and cold restart. This service is password protected. To successfully reset the gateway, "icc" must be used as the password.

9.3 Metasys N2 Slave

The gateway supports the Johnson Controls Metasys N2 slave driver on both of its RS-485 ports, and supports N2 analog input, analog output, binary input and binary output object types.

9.3.1 Overview

Some notes of interest are:

- Fully configurable N2 objects.
- The Metasys device type for the gateway is VND.
- Network characteristics are fixed at 9600 baud, 8 data bits, 1 start bit, 1 stop bit and no parity according to the Metasys N2 specification.
- Connect the N2 bus wiring to the selected RS-485 port by using twisted-pair cable connected as shown in Figure 10 ("RS-485 B" port example shown). Connect the N2+ wire to terminal "A", the N2- wire to terminal "B", and the network ground wire to terminal "GND". Also install jumper wires connecting terminal "A" to terminal "Y", and terminal "B" to terminal "Z". Continue this connection scheme throughout the remainder of the network. Always connect each unit in a daisy-chain fashion, without drop lines, star configurations, etc. For further N2 network wiring requirements and procedures, please refer to the appropriate JCI network installation documentation.

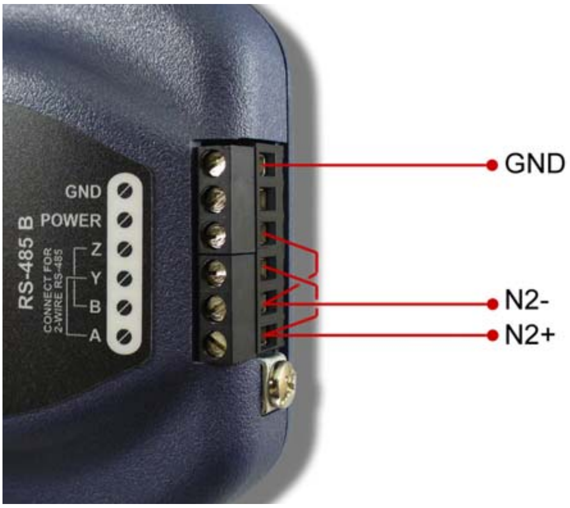


Figure 10: N2 Bus Cable Connection to "RS-485 B" Port

9.3.2 Metasys Objects

- **Analog input** (AI) objects are used for monitoring analog status items. AI objects support low alarm limits, low warning limits, high warning limits, high alarm limits and differential values. Change of state (COS), alarm and warning functions can also be enabled. An AI object will accept an override command, but will not change its actual value or indicate override active. A "multiplier value" is associated with the object, and is multiplied to the point's value to produce the floating-point AI value sent to the NCU (AI value = [database value] x multiplier).

- **Analog output** (AO) objects are used for setting and monitoring analog control and configuration items. An AO value can be modified by issuing an override command. Issuing a release command will not cause the AO to automatically return to its pre-override value, nor will the AO automatically return to its pre-override value after a certain time period of no communication. A "multiplier value" is associated with the object, and the floating-point AO value is divided by this multiplier to produce the result that is then stored in the gateway's database (database value = [AO value] / multiplier).

- **Binary input** (BI) objects are used for monitoring discrete (digital) status items. BI objects support COS, alarm enabling and normal/alarm status indications. A BI object will accept an override command, but will not change its actual value or indicate override active. A "bitmask" is associated with the object, and is used to determine the current state of the BI by inspecting the database data at the bit location(s) indicated in the bit mask. If <u>all</u> of the bit locations of the database data value indicated by a "1" in the bit mask are set, then the BI's current state is set to "1". Else, it is set to "0".

- **Binary output** (BO) points are used for setting and monitoring discrete control and configuration items. A BO value can be modified by issuing an override command. Issuing a release command will not cause the BO to automatically return to its pre-override value, nor will the BO return to its pre-override value after a certain time period of no communication. A "bitmask" is associated with the object, and is used to determine the current state of the BO by modifying the database at the bit location(s) indicated in the bit mask. When the BO's current state is set to "1" by the NCU, then the bit(s) of the database data value indicated by a "1" in the bit mask are set. Similarly, when the BO's current state is set to "0" by the NCU, then the bit(s) of the database data value indicated by a "1" in the bit mask are cleared.

9.4 Toshiba ASD Master

9.4.1 Overview

The gateway supports the Toshiba ASD Master protocol on both of its RS-485 ports. This protocol allows direct connection to Toshiba adjustable-speed drives with RS-485 ports that support the Toshiba protocol, such as the G7/Q7/H7 and AS1/FS1/G9/H9/Q9 families. Some notes of interest are:

- Supported function codes are indicated in Table 4.

Table 4: Supported Toshiba ASD Master Functions

Function Code	Function
R	RAM read for 4-wire RS-485 networks
G	RAM read for 2-wire RS-485 networks
W	RAM & EEPROM write
P	RAM-only write

- Requests are fully configurable through service objects.
- Up to 125 parameters can be requested per service object.
- Note that Toshiba 7-series drives (G7/Q7/H7 etc.) configured for 2-wire mode (F821=0) shipped prior to early 2006 may exhibit an issue that can cause their RS-485 ports to stop communicating after a certain amount of time. Please contact Toshiba technical support to confirm your configuration prior to using 2-wire RS-485 mode on these drives.
- If a 2-wire RS-485 drive network is desired, then the drive(s) must be properly configured for 2-wire RS-485. Note that this may involve hardware configuration in addition to parameter changes. For example, G7/Q7/H7-series drives have duplex selection jumpers located on the drive's control board near the communication ports. For these drives, both jumpers must be placed in the "HALF" position for successful 2-wire operation. Refer to Figure 11 for an example detailed view of correctly-positioned duplex selection jumpers.
- The Toshiba RS-485 terminal block connections for G7/Q7/H7/W7 drives are shown in Figure 12 for reference only. Because there are several possible

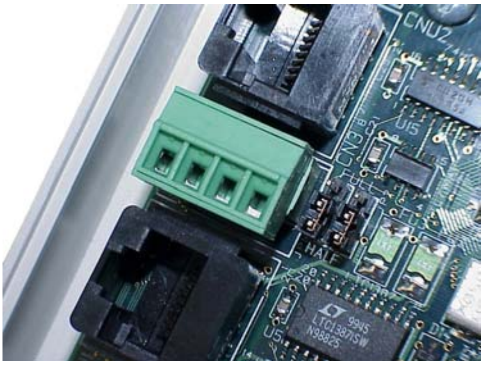


Figure 11: RS-485 Terminal Block (CN3) and Duplex Selection Jumpers

RS-485 port configurations & options available for the various Toshiba drives, please refer to the relevant Toshiba documentation for your drive.

- When using the "W" function code to write drive configuration parameters, be sure to follow Toshiba's guidelines regarding the number of times a specific parameter can be written without risk of EEPROM damage.

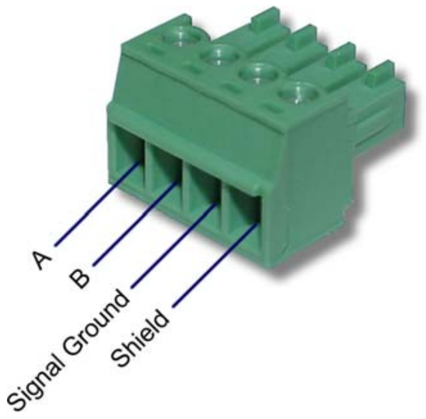


Figure 12: G7/Q7/H7/W7 RS-485 Terminal Block (CN3) Connections

9.4.2 Toshiba Service Objects

The Toshiba ASD master driver uses service objects to describe what services the gateway should perform. For each service object, the gateway will continually read the parameters defined within the service object from the designated drive, storing the value(s) in the database (if the read function is enabled). When data in the database changes where the parameters are mapped, a write request is generated to the designated drive notifying it of the changed parameter value(s) (if the write function is enabled). For more information on configuring Toshiba ASD service objects, refer to section 8.6.7.2.

9.4.3 Parameter Mapping

Drive parameters are mapped in the database as 2-byte values. This means that each parameter in a service object takes up two database addresses. For example, if a service object's starting parameter is "FE00", the number of parameters is "5", and the database address is "100", then parameters FE00 through FE04 will be mapped at database addresses 100 through 109 (parameter FE00 mapped at addresses 100 and 101, parameter FE01 mapped at addresses 102 and 103, and so on).

9.5 Sullair Supervisor Master

- The gateway acts as a Sullair Supervisor Protocol network monitor device (master) via either of its RS-485 ports. It can automatically adapt to the Supervisor network configuration (sequencing or non-sequencing/slave mode).
- Any numerically-addressed parameter defined by the Supervisor protocol is directly accessible (machine type = parameter #1, etc.). However, some Supervisor data objects are not natively numerically-addressed. For these data objects, the additional parameter numbers indicated in Table 5 have been assigned.

Table 5: Additional Supervisor Parameter Assignments

Parameter Number	Item	Note	Source
100	Capacity		Net / Quick Status
101	P2		
102	Sequence Hours		
103	Run Status	0 = E-stop 1 = Manual stop 2 = Remote stop 3 = Standby 4 = Starting 5 = Unloaded 6 = Loaded 7 = Trim 8 = Full load 9 = Remote disable	
104	Mode	0 = Auto 1 = Continuous	
105	Fault Status	0 = No Fault 1 = Faulted	
106	Sequencing Status	0 = Not Sequencing 1 = Sequencing	
107	P1		Info status
108	P2		
109	P3		
110	P4		
111	T1		
112	T2		
113	T3		
114	T4		
115	T5		
116	ID		
117	Analog Shutdown		
118	Relay Outputs		

Parameter Number	Item	Note	Source
119	Digital Shutdown		
120	Digital Inputs		
121	Run Time		
122	Load Time		
123	Display 1	1st Line of Display	
124	Display 2	2nd Line of Display	

- The baud rate is fixed at 9600 baud.
- The gateway Supervisor interface is primarily a system monitor and configuration device. As such, the following native Supervisor network commands are not accessible:

  S – Stop
  L – Load (modulate)
  T – Trim (modulate)
  D – Display message
  C – Cont run mode
  U – Unload
  F – Full load
  E – Emergency stop
  A – Auto run mode

- Requests are fully configurable through service objects.
- Up to 125 parameters can be requested per service object.

9.5.1 Sullair Service Objects

The Sullair Supervisor master driver uses service objects to describe what services the gateway should perform. For each service object, the gateway will continually read the parameters defined within the service object from the designated controller, storing the value(s) in the database (if the read function is enabled). When data in the database changes where the parameters are mapped, a write request is generated to the designated controller notifying it of the changed parameter value(s) (if the write function is enabled). For more information on configuring Sullair Supervisor service objects, refer to section 8.6.8.2.

9.5.2 Parameter Mapping

All but the two display parameters (indexes 123 & 124) are mapped in the database as 2-byte values. This means that each parameter in a service object takes up two database addresses. For example, if a service object's starting parameter is "10", the number of parameters is "5", and the database address is "100", then parameters 10 through 14 will be mapped at database addresses 100 through 109 (parameter 10 mapped at addresses 100 and 101, parameter 11 mapped at addresses 102 and 103, and so on). Each display parameter is mapped into the database as a 20-byte ASCII character array. In other words, each display parameter takes up 20 database addresses.

Note that because display parameters differ in size from all other parameters, a single service object cannot contain both types of parameters.

10. Troubleshooting

Although by no means exhaustive, the following table provides possible causes behind some of the most common errors experienced when using the gateway.

Problem	Symptom	Solution
The gateway will not turn on.	All LEDs are off and the gateway shows no activity.	• Confirm that power is connected to the correct inputs on the RS-485 B terminal block. • If firmware was being updated, it may have been corrupted. Unplug and reconnect the USB cable and run the configuration utility. Follow the utility instructions to restore the firmware.
No communications between an RS-485 network and the gateway.	The corresponding RS-485 TX and RX LEDs are blinking slowly, sporadically, or not at all.	• Check connections and orientation of wiring between the network and the gateway. • Confirm that the protocol, baud rate, parity, and address settings on the RS-485 port match your network configuration.
Firmware-generated error	The module status LED is flashing red. The number of times the LED flashes indicates an error code.	• 4 flashes indicate there is no more space left in Object Memory. Delete some configuration objects from the configuration utility. • Any other number of flashes indicates an internal device error. Please contact ICC for further assistance.
The device will not connect to the PC with the USB cable.	The USB cable is plugged into both the PC and the device, but the module status LED is not flashing green. The configuration utility may indicate a "Device Communication Error".	• Unplug and reconnect the USB cable. • Reinstall the ICC Gateway Configuration Utility. • Reinstall the ICC USB device drivers.

11. Appendix A: Database Endianness

A key feature of the Millennium Series gateways is the ability to change the byte order storage scheme for data in the database between big endian and little endian. The database endianness is the convention used to store multi-byte data to or retrieve multi-byte data from the database. The selected endianness affects the end-to-end consistency of multi-byte data between the two networks on the gateway.

To better understand how this byte-ordering scheme works, the following explains how the gateway stores and retrieves multi-byte data to and from the database. Data is stored into the database starting at the low address and filled to higher addresses. The endianness determines whether the most-significant or least-significant bytes are stored first.

Let's look at some examples that demonstrate this.

This example shows how the hex value 12345678 is stored into the database using a big endian byte order. Since the hex value 12 is the most significant byte, it is stored at address "a", the lowest address.

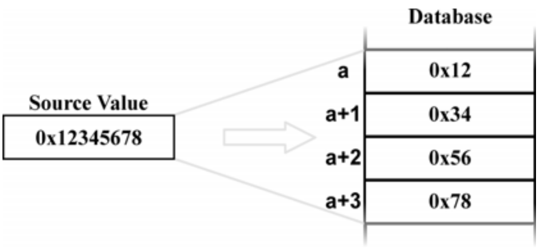


Figure 13: Big Endian Storage

This other example shows how the hex value 12345678 is stored into the database using a little endian byte order. Since the hex value 78 is the least significant byte, it is stored at the lowest address.

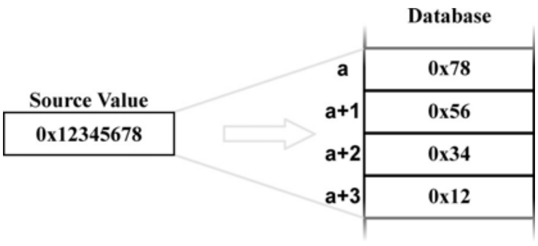


Figure 14: Little Endian Storage

Similarly, data is retrieved from the database starting at the low address. The endianness decides whether the first byte is the least-significant byte or the most-significant byte of the multi-byte number.

Here are some examples that demonstrate this.

This example shows how the hex value 12345678 is retrieved from the database using a big endian byte order. Since the hex value 12 is at address "a", the lowest address, it is the most significant byte.

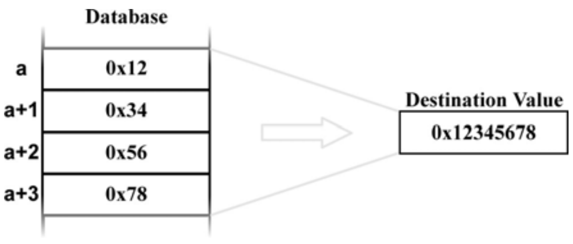


Figure 15: Big Endian Retrieval

This other example shows how the hex value 12345678 is retrieved from the database using a little endian byte order. Since the hex value 78 is at the lowest address, it is the least significant byte.

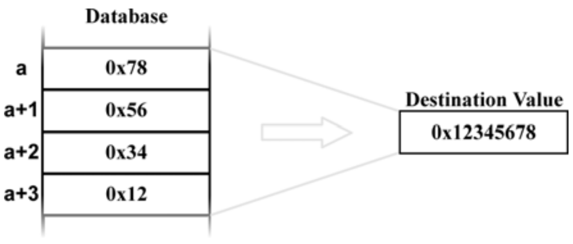


Figure 16: Little Endian Retrieval

The above examples illustrate the data movement to and from the gateway's internal database. This idea helps explain the data movement, as a whole, from one port to the other on the gateway between two different networks. Because networks vary in the manner that they exchange data, endianness selection must be part of the gateway's configuration in order to ensure coherent multi-byte data exchange. There are two data exchange methods used by the supported networks of the gateway.

The first method is used in those networks that define a byte order for how to interpret multi-byte data within an array of bytes. Profibus, for example, defines a big-endian order for multi-byte data, while DeviceNet defines a little-endian order for multi-byte data. These networks exchange I/O data by means of a "bag of bytes" approach, whereas the gateway need not concern itself with where individual values are delimited within the array of bytes itself (as this is determined by the sending or receiving nodes on the networks). The bytes are simply stored into the database in the order they were received. Gateway endianness selection therefore has no effect on data storage or retrieval with a "bag of bytes" protocol driver.

The other method is that used by networks that exchange data by means of an "object value" system, whereas data is exchanged by addressing a certain object to read or write data. Modbus for example, uses registers, while BACnet uses objects such as analog values to exchange data. When multi-byte values are received by the gateway, the bytes must be stored into the database in the order defined by the endianness selected. Likewise, when retrieving multi-byte values from the database for the gateway to transmit, the endianness selected will determine how the data is reconstructed when read from the database.

The selection of the correct byte ordering is crucial for coherent interaction between these two types of networks on the gateway. The following presents examples of how the database endianness affects end-to-end communication between networks and when each byte-ordering scheme should be used.

11.1 Ex: Modbus - Profibus

This example shows the interaction between a network using an object value method (Modbus) and one using a bag of bytes method (Profibus) to exchange data. The gateway reads holding registers 1 and 2 from the Modbus network, stores the data into the database, and then sends the 4 bytes of input data onto the Profibus network. Figure 17 shows this data movement for the gateway's database configured as big endian. Because the Profibus specification defines multi-byte values within the byte array to be interpreted as big endian, it is recommended that the database be configured for big-endian byte order when using Profibus. In the example, holding register 1 has a value of 0x1234 and holding register 2 has a value of 0x5678. When the Profibus device receiving the input data from the gateway recombines the two pairs of 2-byte values, the resulting data is 0x1234 and 0x5678, thus successfully receiving the correct values for holding registers 1 and 2.

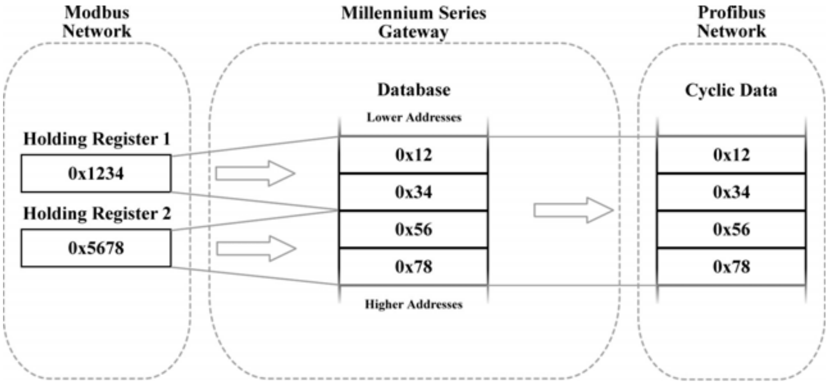


Figure 17: Modbus - Profibus Big Endian

In contrast, Figure 18 shows the effects of configuring the database for little-endian byte order. Holding registers 1 and 2 again have values of 0x1234 and 0x5678, respectively. However, when the Profibus device receiving the input data from the gateway interprets these values, the resulting pairs of 2-byte values become 0x3412 and 0x7856, thus receiving incorrect values for holding registers 1 and 2. Note that in both examples, the Profibus network data is always identical, byte-for-byte, to the gateway's database. For this reason it is important to configure gateways that use a bag-of-bytes style network, such as the PBDP-1000, to use the same endianness as defined for that network.

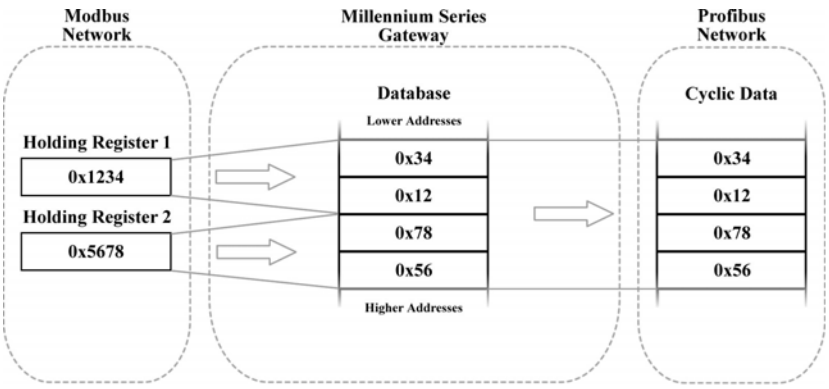


Figure 18: Modbus - Profibus Little Endian

11.2 Ex: Modbus - DeviceNet

This example shows the interaction between a network using an object value method (Modbus) and one using a bag of bytes method (DeviceNet) to exchange data. The gateway reads holding registers 1 and 2 from the Modbus network, stores the data into the database, and then sends the 4 bytes of input data onto the DeviceNet network. Figure 17 shows this data movement for the gateway's database configured as little endian. Because the DeviceNet specification defines multi-byte values within the byte array to be interpreted as little endian, it is recommended that the database be configured for little-endian byte order when using DeviceNet. In the example, holding register 1 has a value of 0x1234 and holding register 2 has a value of 0x5678. When the DeviceNet device receiving the input data from the gateway recombines the two pairs of 2-byte values, the resulting data is 0x1234 and 0x5678, thus successfully receiving the correct values for holding registers 1 and 2.

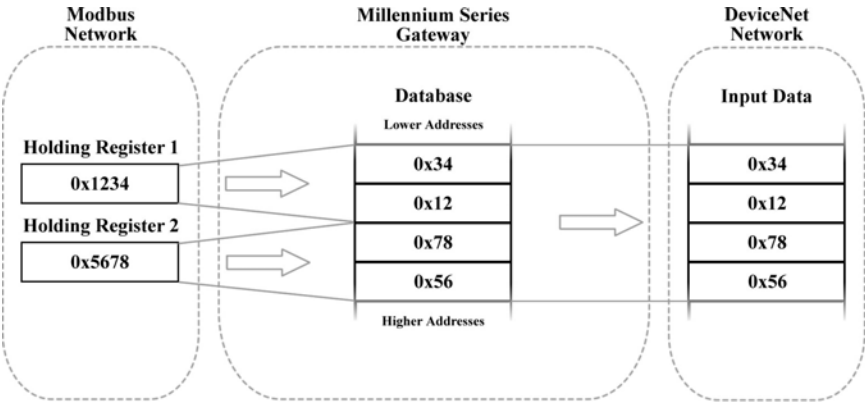


Figure 19: Modbus - DeviceNet Little Endian

In contrast, Figure 18 shows the effects of configuring the database for big-endian byte order. Holding registers 1 and 2 again have values of 0x1234 and 0x5678, respectively. However, when the DeviceNet device receiving the input data from the gateway interprets these values, the resulting pairs of 2-byte values become 0x3412 and 0x7856, thus receiving incorrect values for holding registers 1 and 2. Note that in both examples, the DeviceNet network data is always identical, byte-for-byte, to the gateway's database. For this reason it is important to configure gateways that use a bag-of-bytes style network, such as the DNET-1000, to use the same endianness as defined for that network.

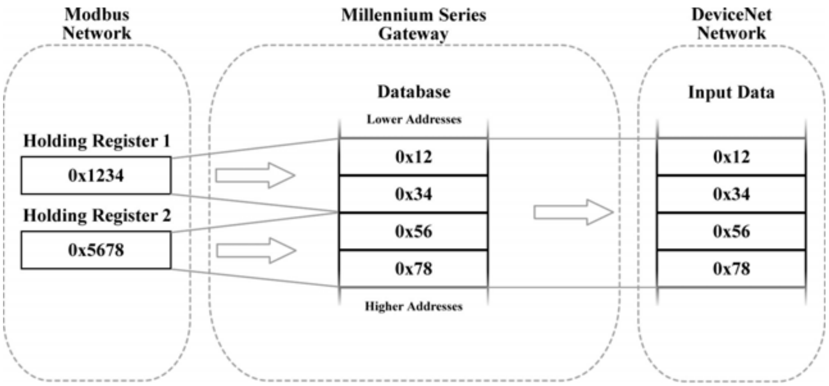


Figure 20: Modbus - DeviceNet Big Endian

11.3 Ex: BACnet - DeviceNet

This example is quite similar to the previous one as data is exchanged between an object-value style network (BACnet) and a bag-of-bytes style network (DeviceNet). The key difference is that in this example, BACnet Analog Value 0 is a 32-bit value, as apposed to two 16-bit Modbus registers. Here, the gateway reads analog value 0 from the BACnet network, stores the data into the database, and sends the input data onto the DeviceNet network. Figure 21 demonstrates the data flow from the BACnet network to the DeviceNet network through a gateway configured to use a little endian database. Because the DeviceNet specification defines multi-byte values within the byte array to be interpreted as little endian, it is recommended that the database be configured for little-endian byte order when using DeviceNet. In the example, analog value 0 has a value of 0x12345678. When the DeviceNet device receiving the input data from the gateway interprets the 4 bytes, the resulting 4-byte value will be 0x12345678, thus successfully receiving the original value of the BACnet analog value object.

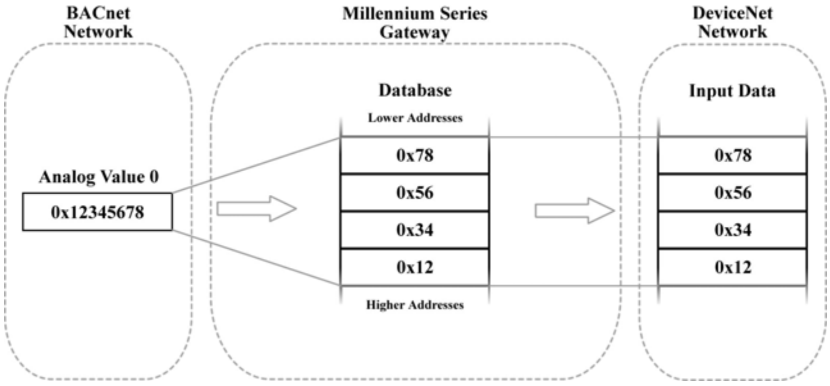


Figure 21: BACnet - DeviceNet Little Endian

Conversely, Figure 22 illustrates the consequences of configuring the database for big-endian byte order using this scenario. Once again, Analog Value 0 has a value of 0x12345678. But now, when the DeviceNet device interprets the 4 bytes of input data sent by the gateway, the resulting 4-byte value is 0x78563412, thus receiving an incorrect value for Analog Value 0. Note that in this example as well, the DeviceNet byte array is identical, byte-for-byte to the database. This example, in conjunction with the previous, demonstrates the dependence on the bag-of-bytes style networks for correct database endianness selection.

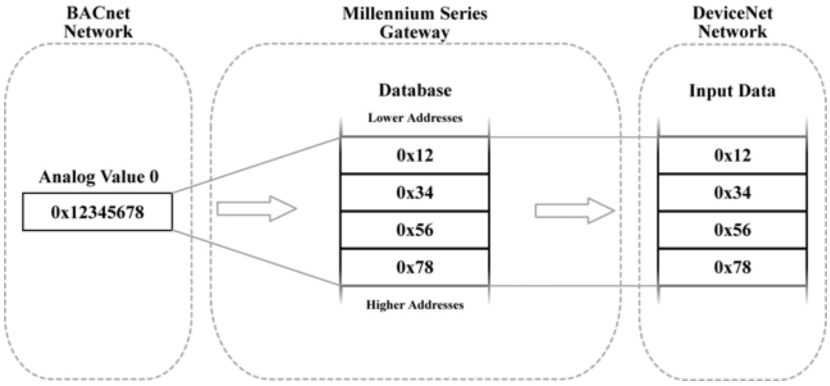


Figure 22: BACnet - DeviceNet Big Endian

11.4 Ex: BACnet - Modbus (Analog Objects-Registers)

This example exhibits two networks that both use an object value scheme to exchange data. In this scenario, the database endianness is irrelevant if the data types are the same for both networks. This example shows communication between a BACnet network and a Modbus network using two 16-bit analog value BACnet objects and two 16-bit Modbus holding registers. As shown in Figure 23, the values from the BACnet network are stored into the database with big-endian byte ordering. Figure 24 shows the values from the BACnet network being stored into the database with little-endian byte ordering. Regardless of the byte-ordering scheme used, the two holding registers on the Modbus network receive the same values. Notice that in both cases, analog values 1 and 2 have values of 0x1234 and 0x5678, respectively, while holding registers 1 and 2 also have values of 0x1234 and 0x5678, respectively. The only difference between the two cases is how the data is being stored internally on the gateway itself.

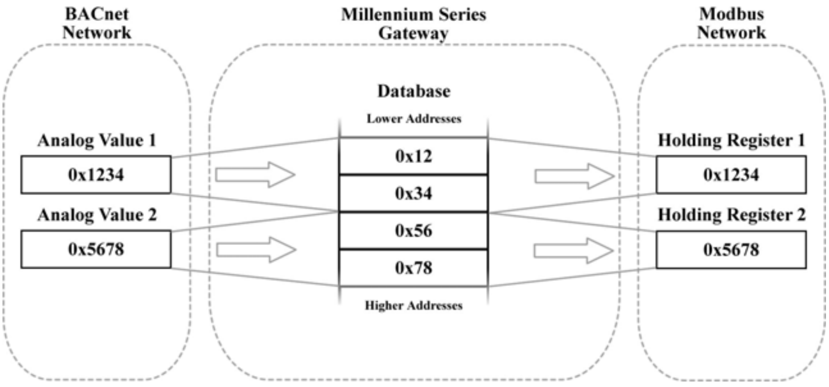


Figure 23: BACnet - Modbus (Analog Objects & Registers) Big Endian

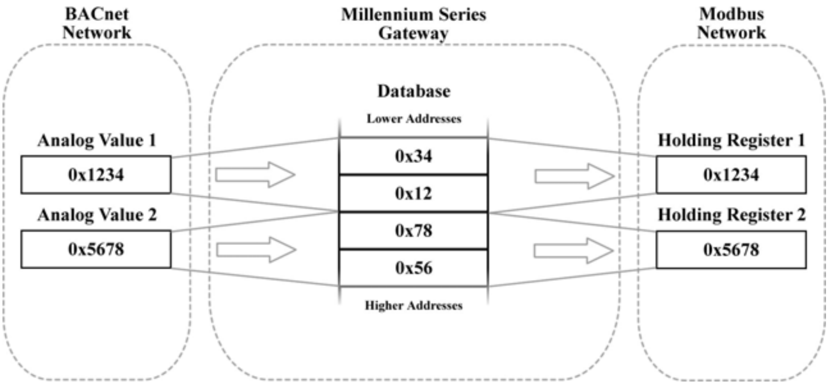


Figure 24: BACnet - Modbus (Analog Objects & Registers) Little Endian

11.5 Ex: BACnet - Modbus (Binary Objects-Discretes)

This example also contains two networks that both employ an object value method for exchanging data, but unlike the previous example, the database endianness affects the end-to-end alignment of the data. In this example, communication is taking place between a BACnet network and a Modbus network using single-bit data elements. The BACnet side is using binary values 1 through 32, while the Modbus side is using coil status 1 through 32. The byte ordering of the database is significant because of the manner in which Modbus coils are mapped in the gateway. Coils (and input statuses) are mapped to registers, not addresses (see Section 9.1.2.3 for more information). Since registers are 16-bit entities, the byte order of the registers (and by association, the coils), is affected by the endianness configured for the database. BACnet binary objects, however, are mapped on a byte-wise basis into the database.

When the database is configured for a little-endian byte order, binary value 1 – 8 corresponds to coil 1 – 8, binary value 9 – 16 corresponds to coil 9 – 16, and so on. This can be seen in Figure 25. Notice that the least significant bytes of the registers that the coils map to are placed in the lower memory addresses in the database. Because Modbus discretes are mapped to registers in a bit-wise little-endian fashion, it is recommended that the database be little endian in this scenario so that bit-wise data will align between networks.

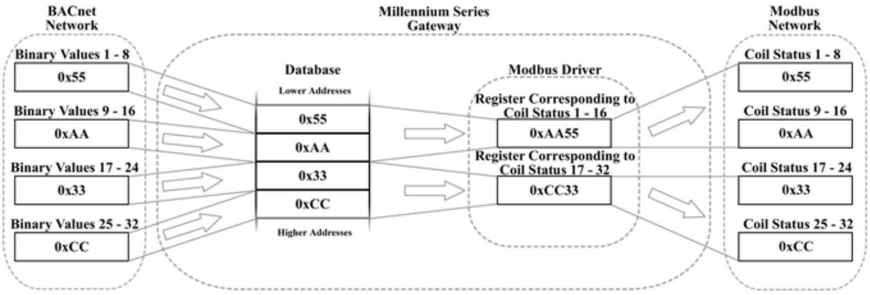


Figure 25: BACnet - Modbus (Binary Objects & Discretes) Little Endian

However, when the database is configured for a big-endian byte order, binary values 1 – 8 correspond to coils 9 – 16, binary values 9 – 16 correspond to coils 1 – 8, and so on. This can be seen in Figure 26. Since the most significant bytes of the Modbus registers that the coils map to are now mapped to lower addresses, the alignment between the two networks' bit-wise data is byte swapped. While this alignment can still be used, it is much more intuitive when the database is configured to be little endian.

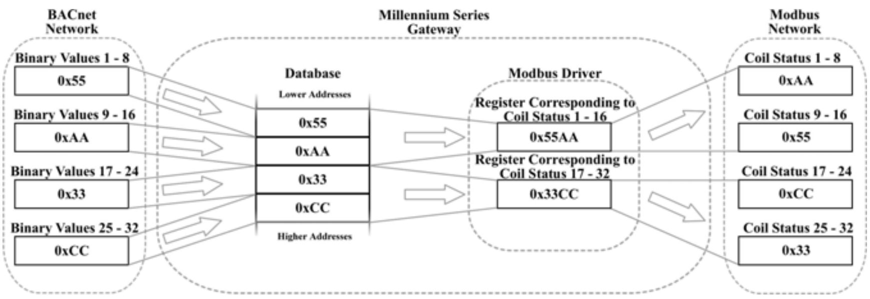


Figure 26: BACnet - Modbus (Binary Objects & Discretes) Big Endian

12. Appendix B: Status Information

This section details the information that is enabled by checking the **Reflect Status** checkbox while configuring a service object. Figure 27 diagrams the structure of this status information. Because this 16-byte structure resides in the database at a user-designated location, it can be accessed from the opposite port in order to continuously determine the performance of the corresponding service object.

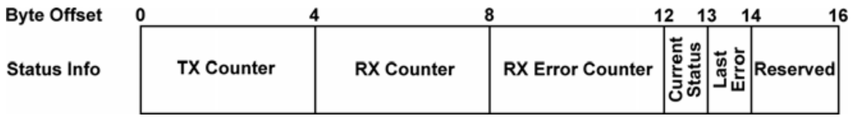


Figure 27: Service Object Status Format

<u>TX Counter</u>

This is a 32-bit counter that increments when a packet is transmitted from the gateway.

<u>RX Counter</u>

This is a 32-bit counter that increments when the gateway successfully receives a valid packet.

<u>RX Error Counter</u>

This is a 32-bit counter that increments when the gateway receives an error response packet or when an error occurs upon reception of a packet.

<u>Current Status</u>

This byte indicates the status of the most recently received packet. The status is updated each time the RX Counter or RX Error Counter increments. Refer to Table 6 for a list of currently used codes.

<u>Last Error</u>

This byte indicates the last reception error that occurred. The last error is updated each time the RX Error Counter increments. Refer to Table 6 for a list of currently used codes.

<u>Reserved</u>

These two bytes are currently unused but are reserved for future use.

Table 6: Status / Error Codes

Status / Error Code (Hex)	Description
0x00	No Error
0xF0	Invalid Data Address
0xF1	Data Error
0xF2	Write To Read-Only
0xF3	Read From Write-Only
0xF4	Target Busy
0xF5	Target Error
0xF6	Cannot Execute
0xF7	Mode Error
0xF8	Other Error
0xF9	Memory Error
0xFA	Receive Error
0xFB	Invalid Function
0xFC	Invalid Packet
0xFD	Security Error
0xFE	Checksum Error
0xFF	Timeout Error

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