Modbus Router/B

Datasheet

A-MBR/B

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1. PREFACE

1.1. ABOUT THIS DOCUMENT

This document contains the technical data for the Modbus Router/B.

1.2. INTRODUCTION TO THE MODBUS ROUTER

The Modbus Router provides intelligent data routing between EtherNet/IP and Modbus (serial Modbus-RTU232, Modbus-RTU485, and Ethernet Modbus-TCP). The Modbus Router allows the user to integrate Modbus devices into a Rockwell Automation Logix platform (ControlLogix or CompactLogix) or PLC (SLC or MicroLogix) with minimal effort.

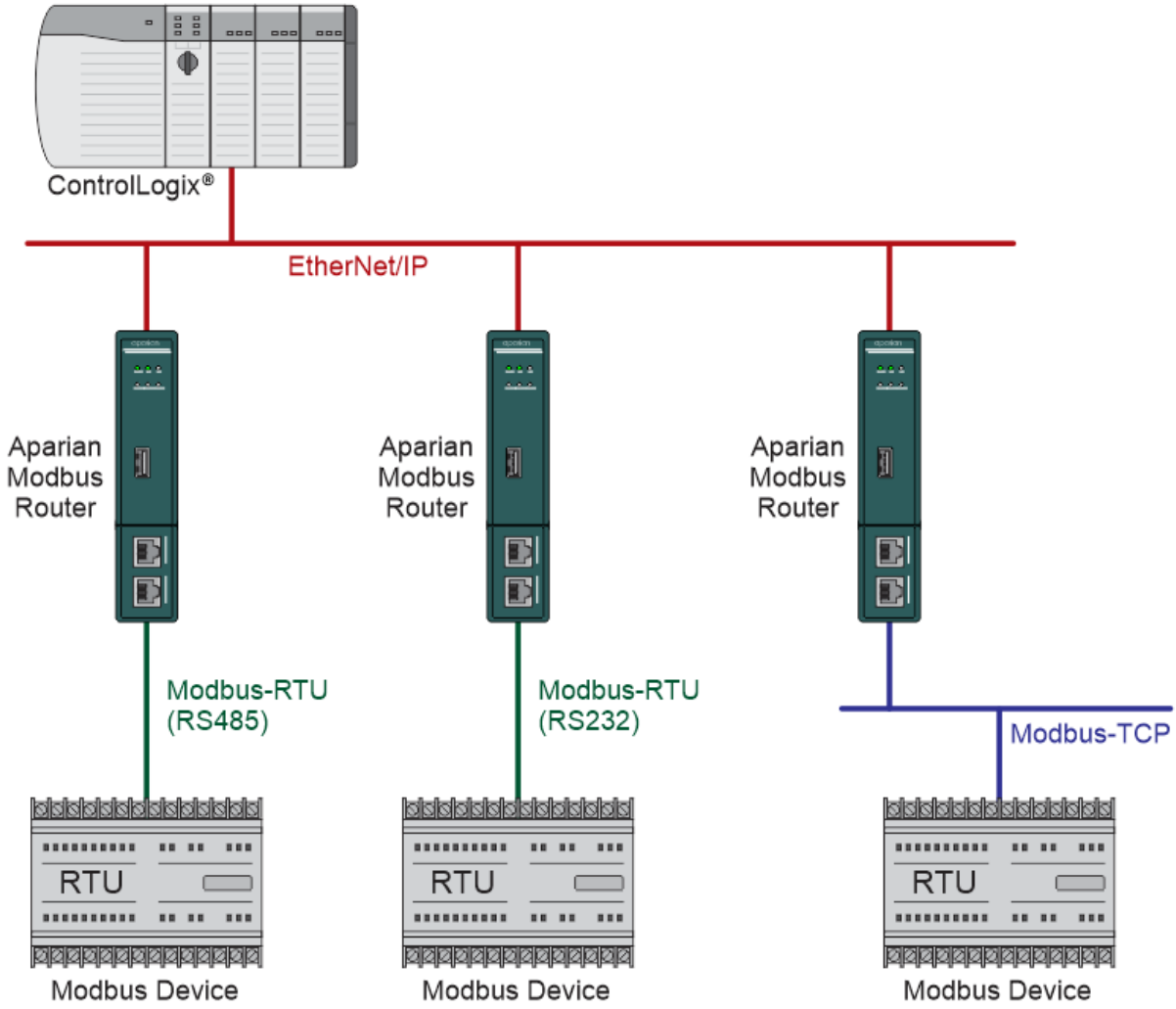


Figure 1.1 – Typical Setup

The module can be configured in one of six router modes:

Scheduled Tag
The MBR/B operates as a **Modbus Client** and transfers data between a Modbus device and a number of Logix tags, using a preconfigured scheduled. No Logix or remote device configuration is required. The MBR/B can execute up to 100 Modbus message instructions (e.g., Modbus Holding Register Read) and exchange the Modbus data with Logix tags in up to three Logix Controllers. Each Modbus Message instruction is executed at one of four configured rates. The Modbus data is exchanged using only one of the available ports (Ethernet TCP, RTU232, or RTU485).

Reactive Tag
The MBR/B operates as a **Modbus Server** and transfers data between Modbus Clients and a number of Logix tags, using a preconfigured tag map. No Logix or remote device configuration is required. The MBR/B can map up to 100 Modbus message instructions (e.g., Modbus Holding Register Read) and exchange the Modbus data with Logix tags in up to three Logix Controllers. The Modbus data is exchanged using only one of the available ports (Ethernet TCP, RTU232, or RTU485).

Unscheduled
The MBR/B operates as a **Modbus Client** and sends Modbus messages to Modbus devices when receiving a Logix Message Instruction. This provides the user with complete control (from Logix) of which Modbus instructions must be sent and at which frequency. The Modbus data is exchanged using only one of the available ports (Ethernet TCP, RTU232, or RTU485).

Enhanced
The user can decide if the MBR/B is operating as a Modbus Client or Server as well as if the MBR/B is operating as an EtherNet/IP Target or EtherNet/IP Originator.

In Enhanced Mode the MBR/B can be configured in any one of the four combinations:

Modbus	EtherNet/IP
Client	Target
Client	Originator
Server	Target
Server	Originator

Table 1.1 – Enhanced Mode Operating Combinations

Modbus Mode

Modbus Server

The data from the configured EtherNet/IP devices (using either Class 1 Assemblies, Explicit messaging or Logix Direct-to-Tag reads/writes) will be written to, or read from, the module's internal Modbus Registers using the Internal Map. These registers can be accessed by a remote Modbus Client using either Modbus TCP, Modbus RTU232, Modbus RTU485, or any simultaneous combination of these.

Modbus Client

The data from the configured EtherNet/IP devices (using either Class 1 Assemblies, Explicit messaging or Logix Direct-to-Tag reads/writes) will be written to, or read from, the module's internal Modbus Registers using the Internal Map. The Modbus Auxiliary Map can then be used to configure the Modbus data exchange between multiple remote Modbus Server devices and the module's internal Modbus registers. The Modbus communication can be via Modbus TCP, Modbus RTU232, Modbus RTU485, or any simultaneous combination of these.

EtherNet/IP Mode

EtherNet/IP Target

As an EtherNet/IP target, the module can exchange the Class 1 data with devices on the Modbus network:

- **EtherNet/IP Class 1 connection**

  Here a remote EtherNet/IP device (e.g. a Logix controller) establishes between 1 and 5 Class 1 connections to the module. Modbus data can be mapped into four separate input and output class 1 cyclic connections to the Logix controller (allowing up to 2KB input and 2KB output to be exchanged at the requested packet interval – RPI).

EtherNet/IP Originator

As an EtherNet/IP originator, the module can use one of two methods to read and write data to and from the Modbus network:

- **EtherNet/IP Explicit Messaging**

  This allows the MBR/B to exchange data with up to 10 EtherNet/IP devices. The module can use either Class 3 or Unconnected Messaging (UCMM) to Get and Set data in the remote EtherNet/IP devices.

- **Direct-To-Tag**

  This allows the MBR/B to exchange data with a Logix controller without the need to write any application code (e.g. ladder) in Studio 5000. The Modbus data is directly read from, or written to, Logix tags.

- **EtherNet/IP Class 1 connection**

  Modbus data can be mapped to a maximum of 10 EtherNet/IP devices using input and output class 1 cyclic connections. This will allow the

MBR/B to “own” the EtherNet/IP target device and exchange Modbus data using the EtherNet/IP device’s input and output assemblies.

Bridge
The MBR/B can operate as a transparent link for Modbus between different media (TCP, RTU232, and RTU485). This allows a Modbus client on Modbus TCP to communicate with Modbus devices on RS232 or RS485 and vice versa.

Concentrator
In Concentrator Mode, the MBR/B will collect data from a number of Modbus devices and provide the consolidated data to one or more Modbus Clients. The MBR/B will be a Modbus Server on one port, and Modbus Clients on the other ports. This will allow a Modbus SCADA to efficiently read the data from multiple Modbus devices, because the data from the various Modbus devices have been concentrated into the MBR/B.

The Modbus Router is configured using the Aparian Slate application. This program can be downloaded from www.aparian.com free of charge.

The module provides a range of statistics, a Modbus packet analyzer, and an Internal Modbus Register viewer to help fault find any problems.

The Modbus Router supports Modbus on three ports which can be configured from the Slate environment: Modbus-RTU232 (Serial), Modbus-RTU485 (Serial), and Modbus-TCP (Ethernet).

The Modbus Router uses isolated RS232 and isolated RS485 for Modbus serial communication providing better noise immunity. The RS232 and RS485 ports use a terminal block for convenient installation.

The MBR/B supports security services allowing the user to configure various levels of module security.

The module has two Ethernet ports and supports Device-Level-Ring (DLR) architectures.

A built-in webserver provides detailed diagnostics of system configuration and operation, including the display of Modbus operation and communication statistics, without the need for any additional software.

1.3. FEATURES

- MBR/B can operate as a Modbus Client or Modbus Server.
- Modbus Client mode can communicate with up to 100 Modbus Servers.
- Modbus Client requests can be sent in parallel increasing throughput performance.
- Supports Modbus passthrough messaging.
- Modbus Server mode supports full Modbus data range.
- Modbus Server mode supports emulating multiple Modbus nodes.
- Configurable Modbus TCP Port numbers.
- Supports EtherNet/IP Target and Originator modes:
    - EtherNet/IP Target (Class 1 connection)
    - EtherNet/IP Originator (Class 1 connection with up to 10 EtherNet/IP devices and Explicit Messaging, including Direct-To-Tag Logix tag access, with up to 10 EtherNet/IP devices).
- Supports CIP USB interface for Logix controllers.
- EtherNet/IP Class 1 target connections support 2kbyte input and 2kbyte output data to Logix input and output assemblies.
- Supports Modbus media conversion allowing for a transparent link from one media to another (e.g., Modbus TCP to Modbus RTU232).
- Support for PCCC Server emulation.
- Slate provides a Modbus packet capture utility for better diagnosis.
- Dual Ethernet ports which support Linear, Device-Level-Ring (DLR) or Split Dual-IP Modes.
- Network Time Protocol (NTP) supported for external time synchronization.
- Small form factor – DIN rail mounted.

The security services provide the following features:

- Configurable level of security
- Encrypted EtherNet/IP communication
- Fixed User Roles and Custom Users
- Configurable Password rules
- Login Expiry
- Failed Login Cool-off and Account Disable options
- Configurable Global Services and Custom Ports
- Optional IP Address Access Control List
- Optional MAC Access Control List
- Restrictions on Reset commands
- Restrictions on Device Flash options
- Security Audit trail in Event Log

1.4. ARCHITECTURE

The figures below provide an example of the typical network setup for connecting Modbus networks to either EtherNet/IP or PCCC networks.

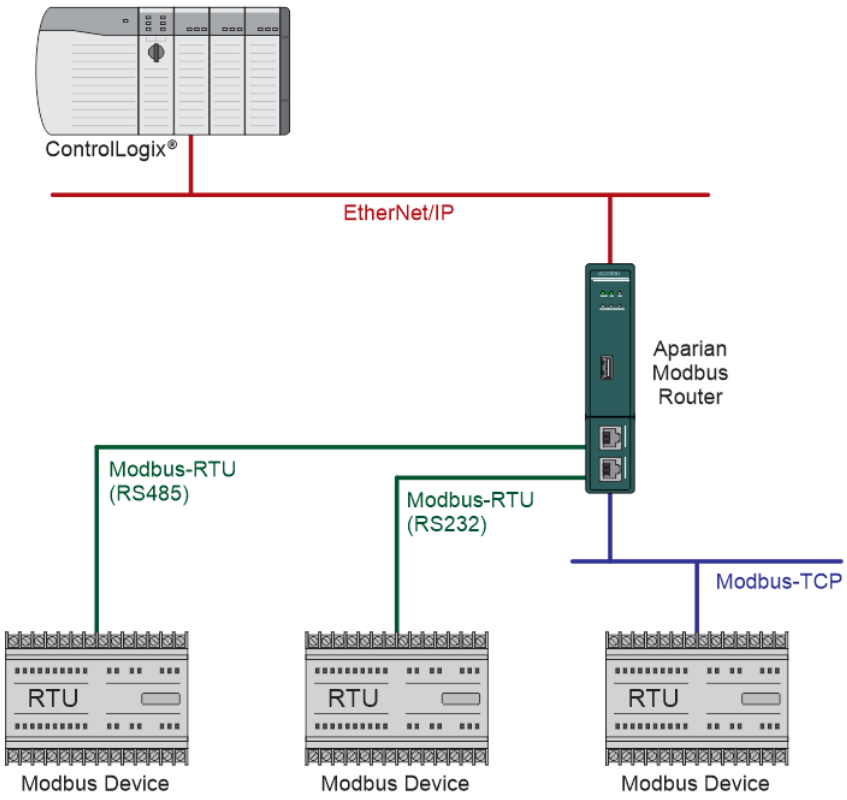


Figure 1.2 - Enhanced mode as a Modbus Client and EtherNet/IP Target.

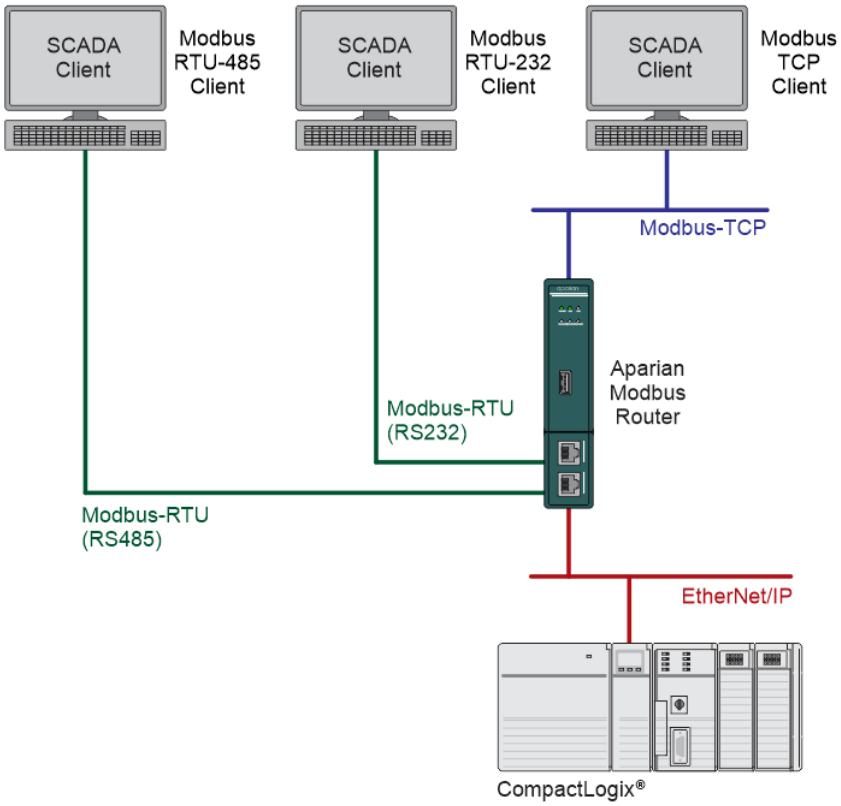


Figure 1.3 - Enhanced mode as a Modbus Server and EtherNet/IP Target.

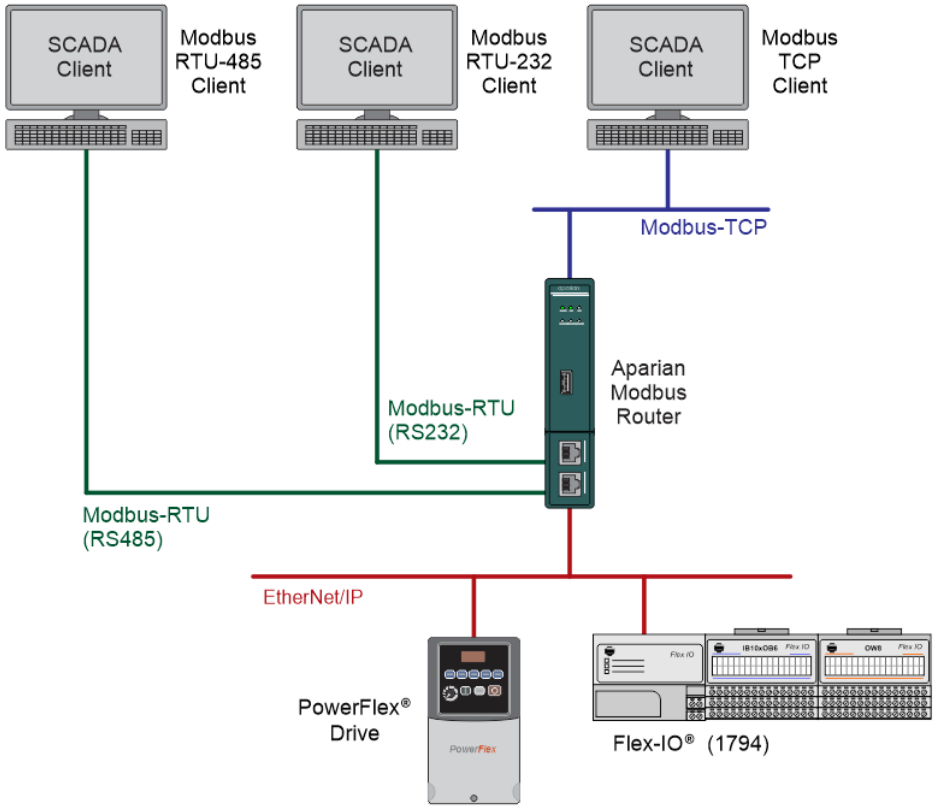


Figure 1.4 - Enhanced mode as a Modbus Server and EtherNet/IP Originator.

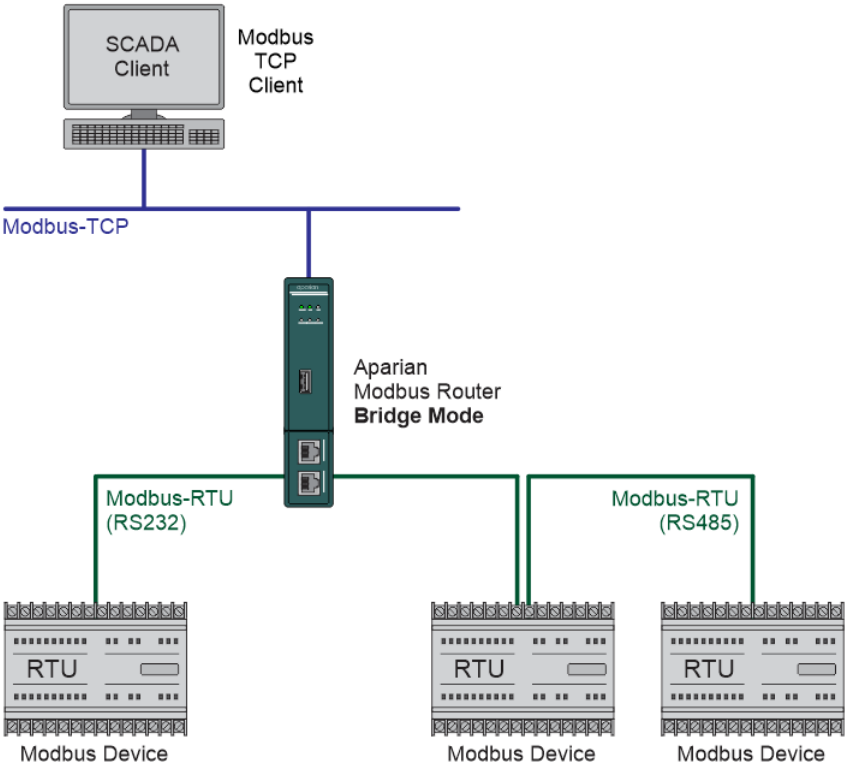


Figure 1.5 – Bridge Mode - from Modbus TCP to Modbus RTU232/RTU485.

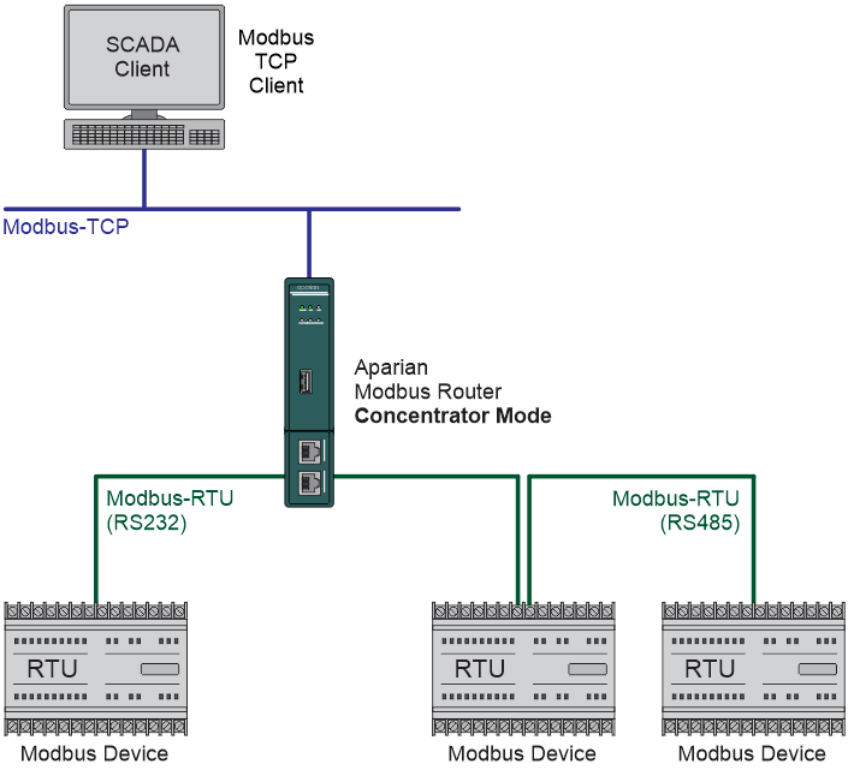


Figure 1.6 – Concentrator Mode – Modbus TCP SCADA interfacing with Modbus RTU devices.

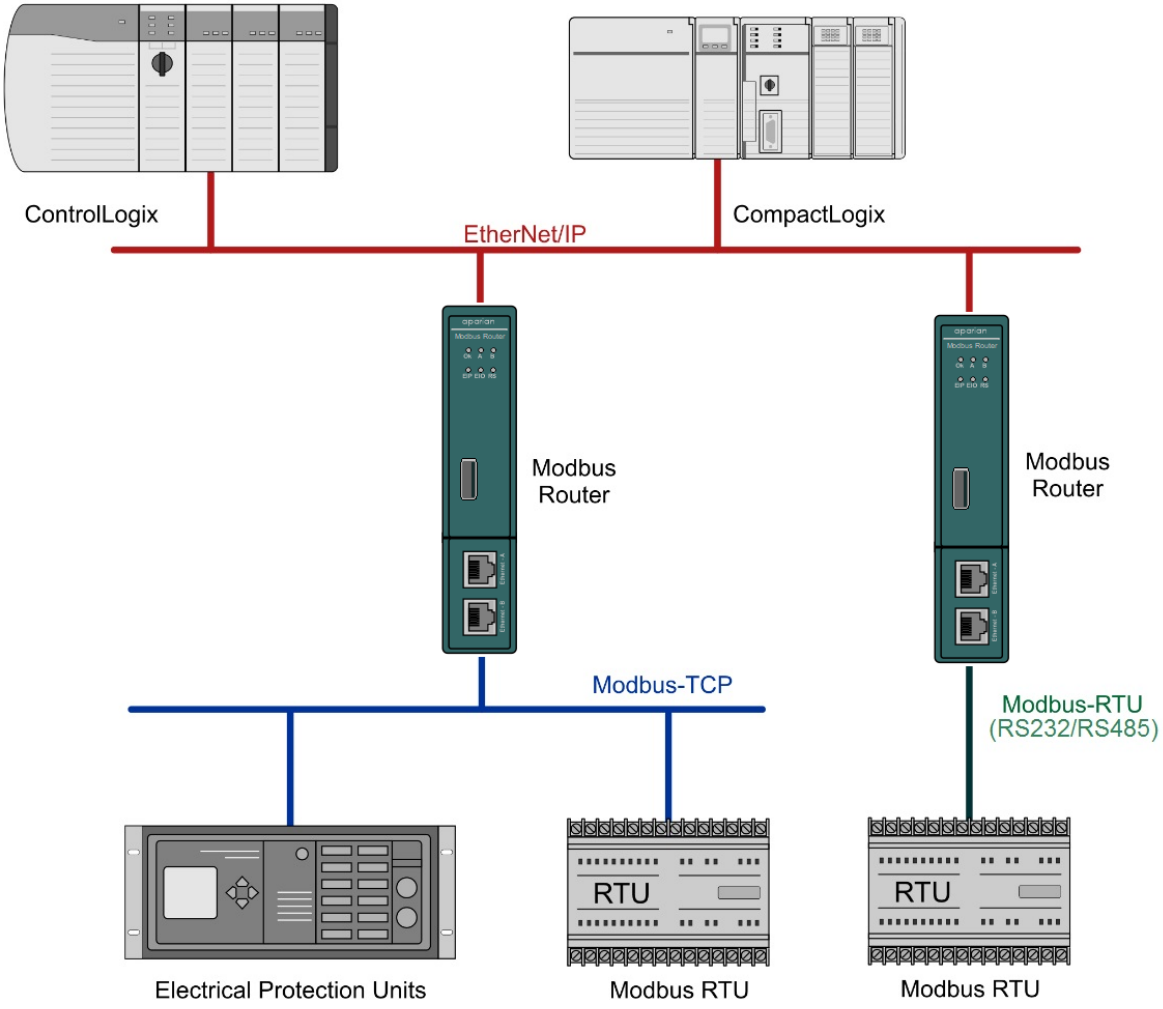


Figure 1.7 - Example of a typical network setup in scheduled/unscheduled mode.

Systems that rely on a central Logix Controller communicating to a number of remote Modbus devices, (e.g. Electrical Protection Units or Remote Terminal Units), may find the Modbus Router useful when operating in Scheduled Tag Mode as shown in the figure above. The module, acting as a Modbus client, will exchange data between the Modbus device and Logix platform at a configured interval without any need for additional coding or mapping.

The Modbus Router can also communicate with a Logix controller using the USB port on the front of the controller. This will allow the user to setup redundant Logix Controllers each with its own Modbus Router directly connected to the Logix Controller over USB. Only the Modbus Router connected to the Primary controller will be “active” with a configured Modbus TCP/IP address. When the primary and standby Logix Controllers swap the Modbus Routers will follow the primary controller and that specific Modbus Router will become active.

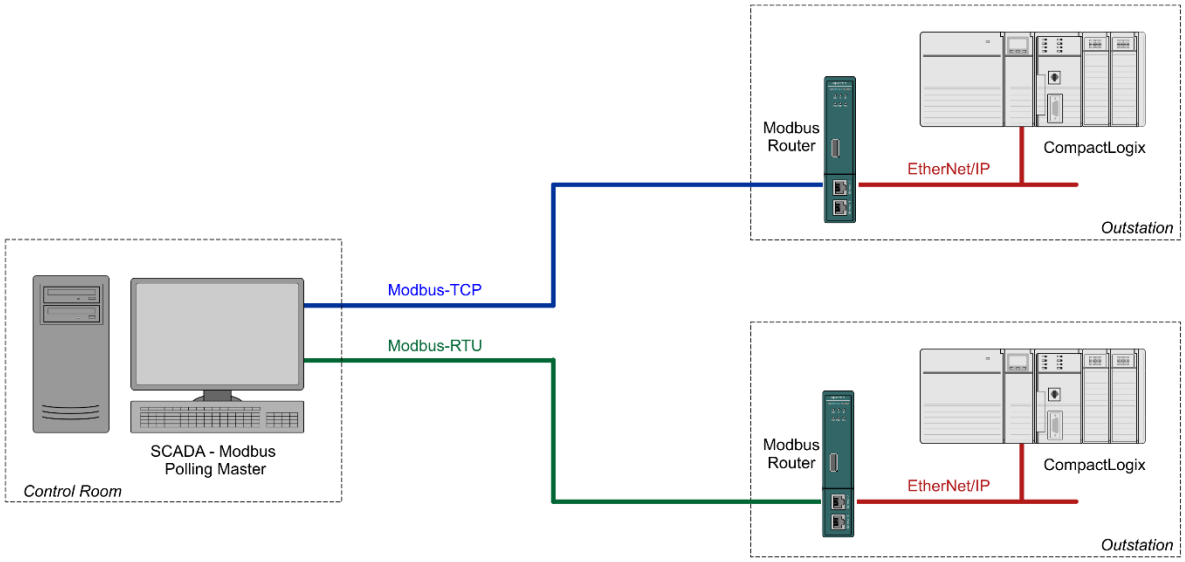


Figure 1.8 - Example of a typical network setup in reactive mode

By converting and redirecting serial Modbus messages from legacy devices to EtherNet/IP, the module provides an interface for data exchange to Allen-Bradley ControlLogix and CompactLogix platforms. This enables user to replace legacy devices and systems with minimal effort and downtime.

The Modbus Router allows a Logix platform to seamlessly integrate into a Modbus network with Reactive Tag Mode. The module will route Modbus messages directly to Logix tags with no need for additional ladder code.

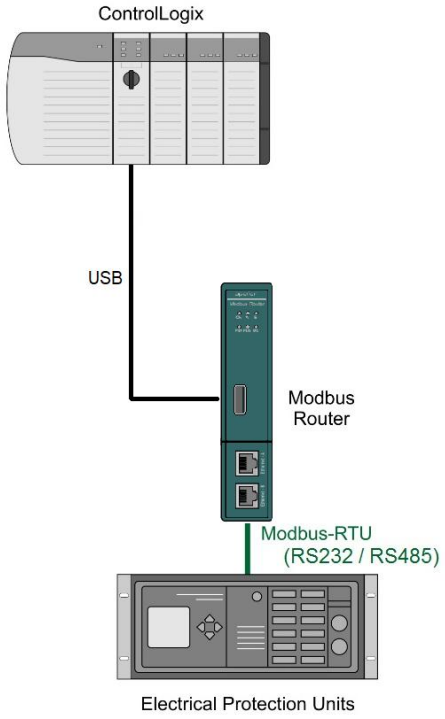


Figure 1.9 - Example of a typical network setup using the Logix Controller USB port.

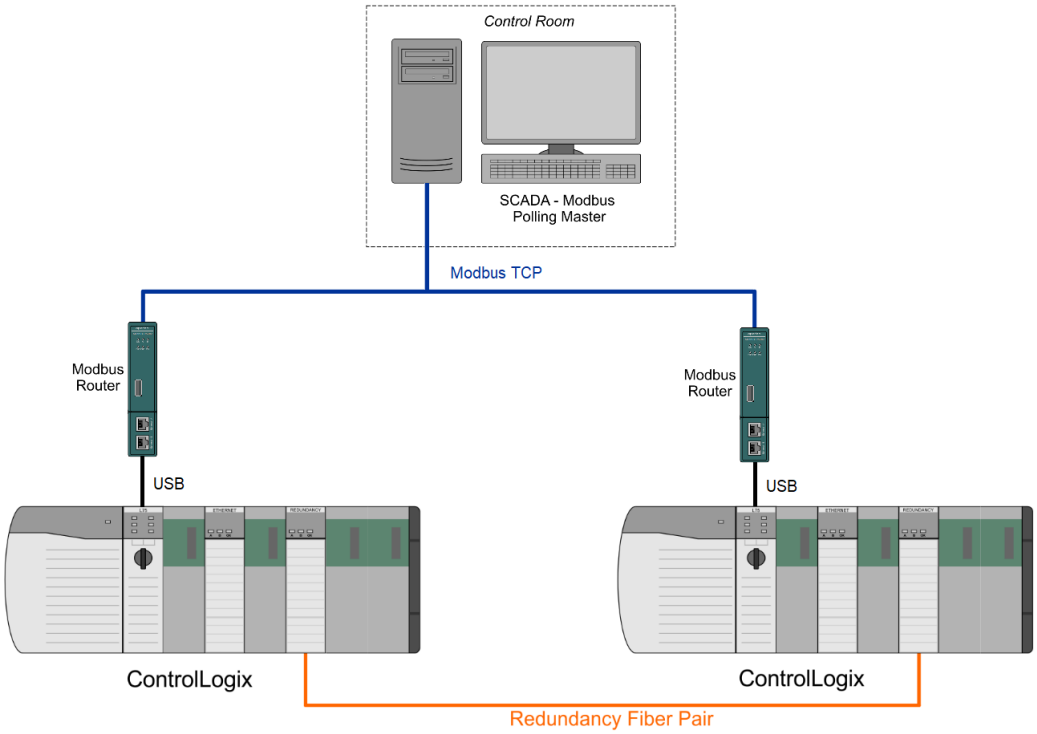


Figure 1.10 - Redundant Logix Controller communicating with Modbus Router over USB.

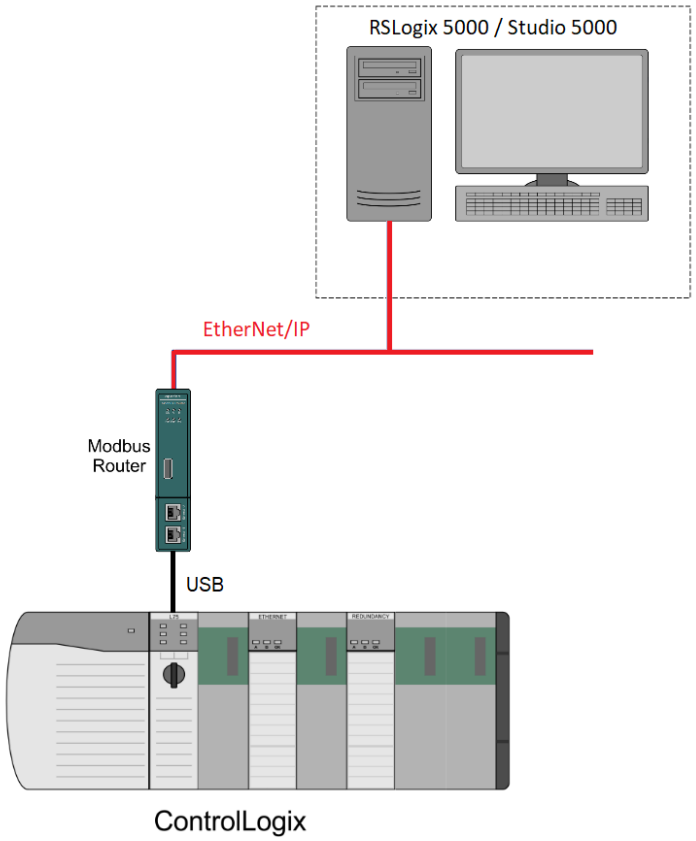


Figure 1.11 – Connect to Logix with Studio 5000 over USB.

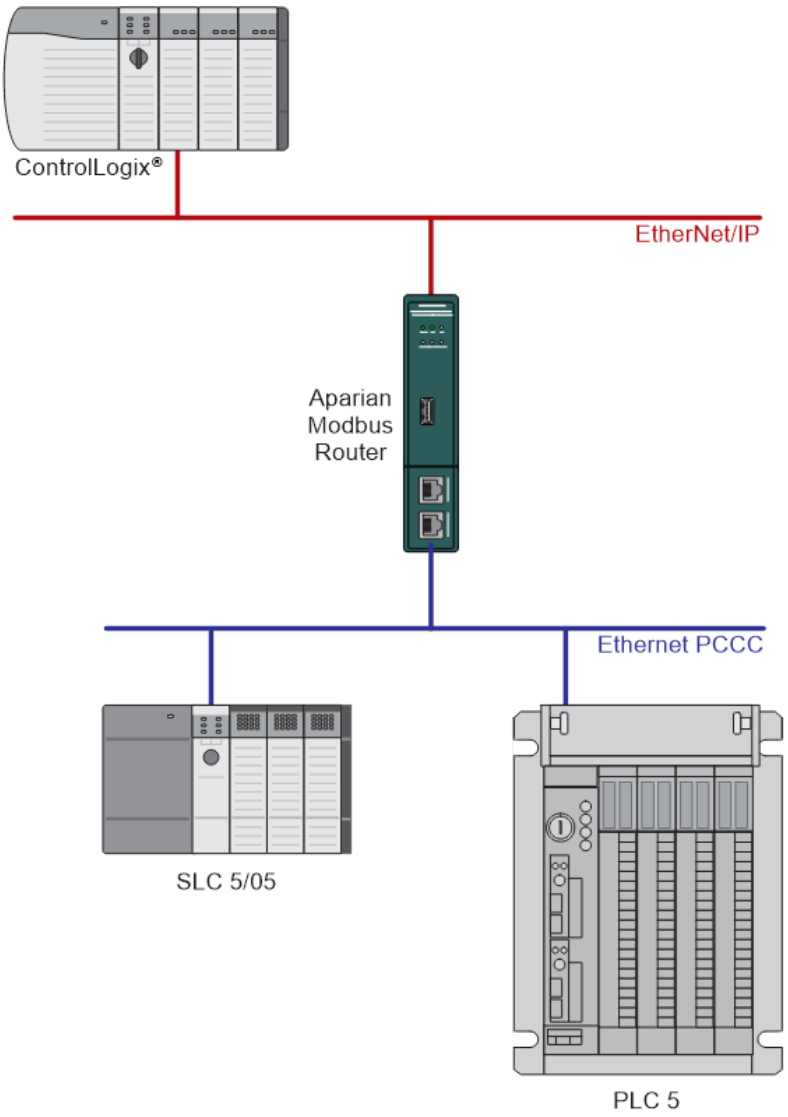


Figure 1.12 – PCCC Server Emulation

2. TECHNICAL SPECIFICATIONS

2.1. DIMENSIONS

Below are the enclosure dimensions as well as the required DIN rail dimensions. All dimensions are in millimeters.

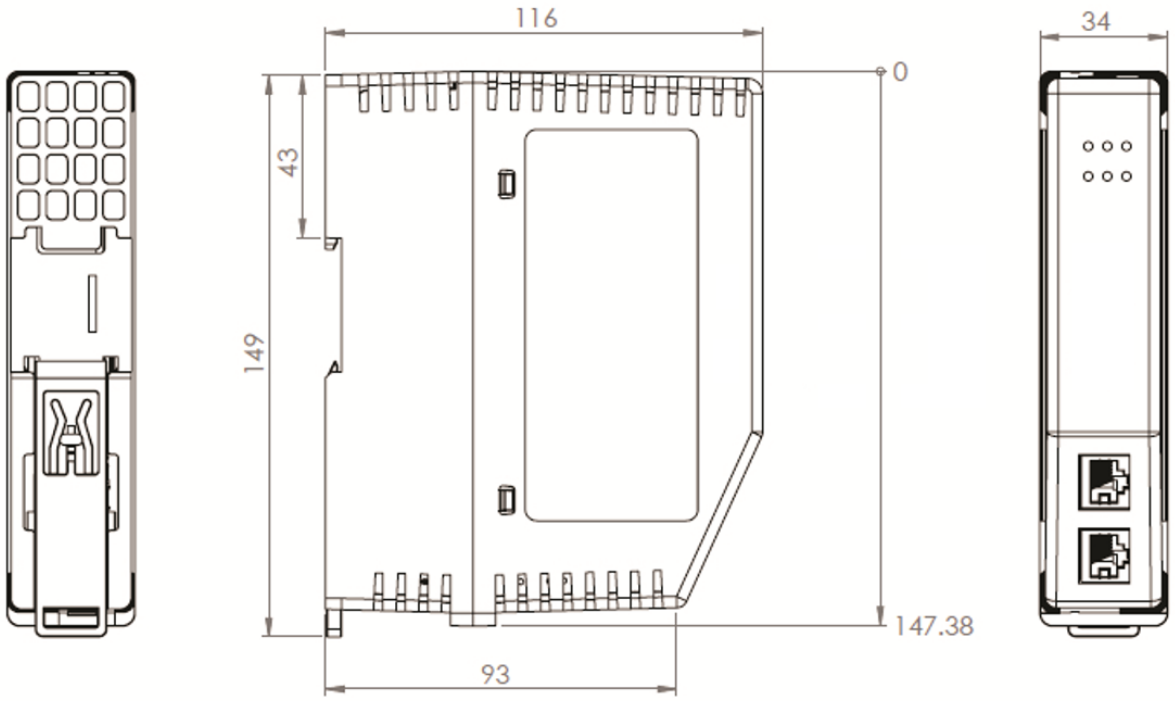


Figure 2.1 – Modbus Router enclosure dimensions

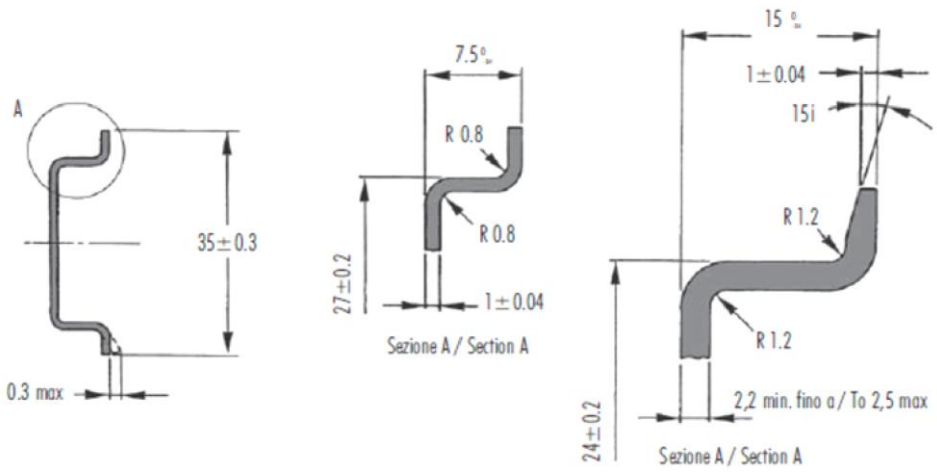


Figure 2.2 - Required DIN dimensions

2.2. ELECTRICAL

Specification	Rating
Power requirements	Input: 10 – 32V DC, (121 mA @ 24 VDC)
Voltage Fluctuations	Voltage fluctuations < ±10% Transient Over-voltages up to the levels of OVERVOLTAGE CATEGORY I
Power consumption	3.1 W (Including full load on USB of 200mA) 300 mA maximum
USB Power	5V, maximum load of 200 mA (1W).
Connector	3-way terminal
Conductors	24 – 18 AWG
Earth connection	Yes, terminal based
Emissions	IEC61000-6-4
ESD Immunity	EN 61000-4-2
Radiated RF Immunity	IEC 61000-4-3
EFT/B Immunity	EFT: IEC 61000-4-4
Surge Immunity	Surge: IEC 61000-4-5
Conducted RF Immunity	IEC 61000-4-6

Table 2.1 - Electrical specification

2.3. ENVIRONMENTAL

Specification	Rating
Enclosure rating	IP20, NEMA/UL Open Type Indoor use only
Temperature	-20 – 70 °C
Relative Humidity	5% to 90% - No condensation
Pollution Degree	2
Altitude	< 2000 m

Table 2.2 - Environmental specification

2.4. ETHERNET

Specification	Rating
Connector	RJ45
Conductors	CAT5 STP/UTP
ARP connections	Max 200
TCP connections	Max 200
CIP connections	Max 20
Communication rate	10/100Mbps
Duplex mode	Full/Half
Auto-MDIX support	Yes
Controller Support	ControlLogix, CompactLogix, MicroLogix, SLC
Embedded switch	Yes, 2 x Ethernet ports
Device Level Ring (DLR)	Supported
Network Time Protocol (NTP)	Supported

Table 2.3 - Ethernet specification

2.5. SERIAL PORT (RS232)

Specification	Rating
RS232 Connector	9-way terminal (shared with RS485)
RS232 Conductor	24 – 18 AWG
Electrical Isolation	1000 Vdc
BAUD	1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200
Parity	None, Even, Odd
Data bits	8
Stop bits	1

Table 2.4 – RS232 Serial Port specification

2.6. SERIAL PORT (RS485)

Specification	Rating
RS485 Connector	9-way terminal (shared with RS485)
RS485 Conductor	24 – 18 AWG
Electrical Isolation	1500 Vrms for 1 minute.
BAUD	1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200
Parity	None, Even, Odd
Data bits	8
Stop bits	1

Table 2.5 – RS485 Serial Port specification

2.7. USB PORT

Specification	Rating
USB supported	USB2.0
Module USB Connector	Type-A
Recommended USB Cable	Type-A (male) to Type-B (male)

Table 2.6 – USB Port specification

2.8. MODBUS – REACTIVE / SCHEDULED MODE

Specification	Rating
Reactive Tag mode	Max 100 mapping items
Scheduled Tag mode	Max 100 mapping items
Application Functions Supported	Read Coil, Read Discrete Input, Read Holding Register, Read Input Register, Write Coil, Write Register
Maximum Logix Controller support	3 (when using Ethernet) 1 (when using USB)
Protocols	Modbus RTU (RS232 or RS485), Modbus TCP

Table 2.7 – Modbus specification

2.9. MODBUS CLIENT – ENHANCED MODE

Specification	Rating
Modes Supported	Modbus TCP, Modbus RTU232, Modbus RTU485
Modbus RTU485 Termination	125 Ω - Software Enabled
Max. Modbus Server Devices	100
Max. Modbus Mapping	100
Mapping Ranges	Holding Register 0 – 65535 Input Register 0 – 65535 Input Status 0 – 65535 Coil Status 0 – 65535
Base Offset	Modbus (Base 0) PLC (Base 1)
Configurable Modbus TCP Port	Yes
Supports Parallel Requests	Yes
Data Reformatting Supported	BB AA BB AA DD CC CC DD AA BB DD CC BB AA

Table 2.8 – Modbus Client specification

2.10. MODBUS SERVER – ENHANCED MODE

Specification	Rating
Modes Supported	Modbus TCP, Modbus RTU232, Modbus RTU485 (simultaneous)
Modbus RTU485 Termination	Software set
Mapping Ranges	Holding Register 0 – 65535 Input Register 0 – 65535 Input Status 0 – 65535 Coil Status 0 – 65535
Base Offset	Modbus (Base 0) PLC (Base 1)
Configurable Modbus TCP Port	Yes

Table 2.9 – Modbus Server specification

2.11. ETHERNET/IP TARGET

Specification	Rating
Class 1 Cyclic connection count	5
Logix Direct-to-Tag Supported	Yes

Table 2.10 – EtherNet/IP Target specification

2.12. ETHERNET/IP ORIGINATOR

Specification	Rating
Class 1 Cyclic Connections Supported	Yes
Class 3 / UCMM Connections Supported	Yes
Class 1 Connection Count	10
Class 3 / UCMM Target Device Count	10
Class 3 / UCMM Mapping Count	50

Table 2.11 – EtherNet/IP Originator specification

2.13. PCCC

Specification	Rating
Max PCCC Connections	20
Max PCCC Payload	1000 bytes
Max PLC Files	20
Supported PLC File Types	Integer Float Bit Status
Supported PCCC Requests	PLC5 Typed Read (CMD 0x0F; FNC 0x68) PLC5 Typed Write (CMD 0x0F; FNC 0x67) SLC Typed Read (CMD 0x0F; FNC 0xA2) SLC Typed Write (CMD 0x0F; FNC 0xAA) Word Range Read (CMD 0x0F; FNC 0x01) Word Range Write (CMD 0x0F; FNC 0x00) Read Modify Write (CMD 0x0F; FNC 0x26) Read Section Size (CMD 0x0F; FNC 0x29)

	Diagnostics Status (CMD 0x06; FNC 0x03)

Table 2.12 – PCCC specification.

2.14. CERTIFICATIONS

Certification	Mark
CE Mark	CE
RoHS2 Compliant	RoHS2
UL Mark File: E494895	c UL us LISTED CLASS 1, DIV 2, GROUPS A, B, C, D
ODVA Conformance	EtherNet/IP™
UKCA	UK CA

Table 2.13 – Certifications

3. APPENDIX

3.1. MODBUS CLIENT PERFORMANCE

The performance statistics below are an estimate and should be used as guidelines as many factors can influence the actual performance of Modbus communication (e.g., Server response time, network latency, switches, etc.).

NOTE: Once the Modbus exchange has complete, the data must still be exchanged with the EtherNet/IP interface (e.g., Logix Controller) which runs asynchronously to the Modbus Auxiliary Map execution.

For the below estimates, the following assumptions were made.

- The network latency is negligible.
- The Server response time is < 1ms.
- The Modbus Aux Map Item Count is how many Aux Map items there are per Modbus Server.
- Only Modbus TCP is being used as each Modbus RTU interface can only execute one transaction at a time (due to the serial communication).
- When Parallel Request has been disabled, then the Modbus Auxiliary Map will be executed one mapped item at a time. When Parallel Request has been enabled, a single request at a time will be sent simultaneously to each device.

NOTE: It is also important to note that, with parallel requests, the lower the Modbus Update Rate and the more the number of Auxiliary Mapped items, the less efficient the update rate becomes due to heavier processing loads. This is why when having many Modbus Servers with multiple requests, an update rate of, for example 10ms, can result in a higher update rate than when an update rate of 50ms is used.

Modbus Server Count	**Modbus Aux Map Count (per Modbus Server)**	**Modbus Update Rate**	**Update Time for all requests of all Modbus Servers**	
			Parallel Request **Disabled**	Parallel Request **Enabled**
10	4	10ms	400ms	40ms
10	4	50ms	2s	200ms
10	4	100ms	4s	400ms
30	4	10ms	1.2s	75ms
30	4	50ms	6s	200ms
30	4	100ms	12s	400ms
60	4	10ms	2.4s	180ms

60	4	50ms	12s	215ms
60	4	100ms	24s	420ms
100	2	10ms	2s	188ms
100	2	50ms	10s	165ms
100	2	100ms	20s	200ms

Table 3.1 – Modbus Client Performance