



ICx Gateway

Protocol Implementation Details

<u>Protocol:</u>	MODBUS (TCP / RTU)
<u>Implementation:</u>	Master / Slave
Document Version:	1.0

Solutions for SCADA communications and
protocol translation

1. Introduction

1.1. Introduction

This document provides the details of MODBUS Master / Slave implementation within ICx Gateway (PC based and Embedded System). This document includes interoperability, system specific, configuration and maintenance details.

1.2. SCOPE

1.2.1. Interoperability

List the supported features of MODBUS Protocol within ICx Gateway.

1.2.2. System Details

This section defines the implementation details of the ICx Gateway over a specified platform. This includes details about design, characteristics and performance details of the ICx Gateway.

1.2.3. Configuration

ICx Gateways comes bundled with WINDOWS based Configuration Tool that allows easy data points (tags) configuration and mapping yet allowing full control over the application and protocol. ICx allows direct integration of MS Excel sheet, enabling faster and easy parameter configuration (basic as well as advanced). All protocol mappings and communication related parameters are comprehensively covered in Excel Sheets thus allowing complete and user friendly management of data points.

1.2.4. Maintenance

- ICx Gateways has inbuilt Maintenance and Diagnosis Capabilities. It includes:
 - Protocol Analyzer: Featuring protocol packet capturing & analysis, and Error Logging
 - Gateway Start / Stop
- Database Management: Database Downloading and Switching, Protocol selection and configuration settings

2. Interoperability

2.1. MODBUS INTEROPERABILITY SHEET

- Features / Applications supported
- Features / Applications not implemented
- Not Applicable

2.2. MODBUS Configuration

2.2.1. MODBUS RTU

Two implementation classes are proposed as in MODBUS specifications.

- Basic
- Regular

The regular class must provide configuration capabilities.

	Basic		Regular	Default
Addressing	Slave: Configurable Address from 1 to 247	Master: Configurable Address from 1 to 247	Configurable Address from 1 - 247	1
Broadcast	Yes		Yes	Yes
Baud Rate	9600		All (19200 Default)	19200
Parity	Even		EVEN + possibility to configure NO and	EVEN
Mode	RTU		RTU	RTU
Electrical Interface	RS 485 or RS 232		RS 485 or RS 232	RS 485
Connector Type	RJ 45		RJ 45 and DB9	DB9

2.2.2. MODBUS TCP

	Supported		Future	Default
Connection	Slave: Maximum 64 Slaves supported	Master: Maximum 8 Master Supported	Can be extended to 255 Devices	Not Applicable
Broadcast	Not Applicable		Not Applicable	Not Applicable
Network Speed	10/100 Mbps		10/100 Mbps	100 Mbps
Mode	TCP		TCP	TCP
Electrical Interface	Ethernet		Ethernet	Ethernet
Connector Type	RJ 45		RJ45	RJ45

2.3. Function Support

Function Code	Description	Implementation TCP	Implementation RTU
1	Read Coil status	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	Discrete inputs	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Read Input Registers	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	Read Holding Registers	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	Write single coil	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
6	Write single register	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
7	Read Exception Status	<input type="checkbox"/>	<input checked="" type="checkbox"/>
8	Diagnostics	<input type="checkbox"/>	<input checked="" type="checkbox"/>
11	Get Comm Event Counter	<input type="checkbox"/>	<input checked="" type="checkbox"/>
12	Get Comm Event Log	<input type="checkbox"/>	<input checked="" type="checkbox"/>
15	Write Multiple Coils	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
16	Write Multiple registers	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
17	Report Slave ID (Serial Line only)	<input type="checkbox"/>	<input checked="" type="checkbox"/>
20	Read File Record	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
21	Write File Record	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
22	Mask Write Register	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
23	Read/Write Multiple registers	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
24	Read FIFO Queue	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

3. System Details

3.1. Introduction

This section describes the System details and requirements for ICx gateway implementation. ICx Gateway is available in two variants:

- Personal Computers: ICx Gateway can be implemented on any WINDOWS 2000 / XP based computers provided with necessary serial and Ethernet ports.
- Embedded Systems: ICx Gateway supports WINDOWS CE based devices. ICx gateway is successfully deployed over ADVANTECH UNO 1019 Embedded Computer (WIN CE based).

3.2. PC based ICx Gateway

3.2.1. Data points

- Maximum Data points: 65535 (As permitted by Protocol).
- There is no limitation from the view point of ICx Gateway regarding support for data points. It may be restricted as per the hardware over which it is installed.

3.2.2. Communication Channels

- Maximum Communication Ports: There is no limitation on the maximum number of ports supported from the ICx gateway software perspective, but limited by the hardware over which it is deployed
- ICx gateway (Master to Polled Slave Devices)
 - RTU Mode: ICx gateway (Master) has been successfully tested with 64 Slave devices over 8 Serial Ports simultaneously
 - TCP Mode: ICx gateway (Master) has been successfully tested with 64 Slave devices over 8 Ethernet Ports simultaneously
- ICx gateway (Slave to Polling Master)
 - TCP Mode: ICx gateway has been successfully tested with 8 Master Devices over 2 Port (Ethernet). ICx respond only to 1 master on which port is active.
 - RTU Mode: ICx gateway has been successfully tested with 8 Master Devices over 1 Port (RS 485) as well as 8 (RS 232) Serial Ports.

3.2.3. Redundancy

- Device Redundancy: Device redundancy is managed by the Master to ICx gateway. ICx can be configured to Poll the Slave only if the Master to ICx is polling the ICx Gateway.
 - Link Redundancy: Over a single ICx gateway, communication links (Serial / Ethernet) can be configured for redundancy, eliminating single point of failure. ICx initialize all redundant links at the startup and thus switching time of the link is reduced to minimum.
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3.2.4. Performance Characteristics

- Data Points:
 - Currently Managed: 20000
 - Maximum Can be Supported: 65535
- Communication Devices (Slave to ICx)
 - Currently Managed: 255
 - Maximum Can be Supported: 255
- Communication Devices (Master to ICx)
 - Currently Managed: 8
 - Maximum Can be Supported: 255
- Ports
 - TCP Mode
 - Currently Managed: 8
 - Maximum Can be Supported: Device Specific
 - RTU Mode
 - Currently Managed: 8
 - Maximum Can be Supported: Device Specific
- Device Redundancy Switchover time:
 - Currently Managed: By the Master to ICx Gateway
- Link Redundancy Switchover time:
 - Time depends upon the Timeout and number of retries. After timeout for the number of times as defined by user defined “**number of retries**”, the **next poll** to the slave device is send over the redundant link.
 - TCP Mode
 - ICx starts polling over the redundant link on socket break.
 - Typical switchover time is between 150ms - 250 ms.
 - RTU Mode
 - Typical switchover time is between 150ms - 250 ms.

3.2.5. Protocol Support

- One to One
- One to Many
- Protocols Matrix: ICx MOD can be mapped with following protocols
 - IEC 61850
 - IEC 60870 – 5 – 101
 - IEC 60870 – 5 – 104
 - IEC 60870 – 5 – 103
 - MODBUS (RTU / ASCII /TCP/AREVA MODBUS)
 - DNP 3
 - HNZ
 - Ethernet / IP
- **Delivery time**
 - 2 – 4 Weeks

3.3. ICx Gateway Embedded

3.3.1. Data points

- Maximum Data points: 50000 I/O Points

3.3.2. Communication Channels

- Maximum Communication Ports: There is no limitation on the maximum number of ports supported from the ICx gateway software perspective, but limited by the hardware over which it is deployed
- ICx gateway (Master) has been successfully tested with 32 Slave devices over 2 Ethernet Ports simultaneously
- ICx gateway (Slave to Polling Master) has been successfully tested with 2 Master Devices over 2 Ethernet Ports. ICx respond only to 1 master on which port is active.

3.3.3. Redundancy

- Device Redundancy: Device redundancy is managed by the Master to ICx gateway. ICx can be configured to Poll the Slave only if the Master to ICx is polling the ICx Gateway.
- Link Redundancy: Over a single ICx gateway, communication links (Serial / Ethernet) can be configured for redundancy, eliminating single point of failure. ICx initialize all redundant links at the startup and thus switching time of the link is reduced to minimum.

3.3.4. Performance Characteristics

3.3.5. Data points

- Maximum Data points: 65535 (As permitted by Protocol).
- There is no limitation from the view point of ICx Gateway regarding support for data points. It may be restricted as per the hardware over which it is installed.

3.3.6. Communication Channels

- Maximum Communication Ports: There is no limitation on the maximum number of ports supported from the ICx gateway software perspective, but limited by the hardware over which it is deployed
- ICx gateway (Master to Polled Slave Devices)
 - RTU Mode: ICx gateway (Master) has been successfully tested with 64 Slave devices over 8 Serial Ports simultaneously
 - TCP Mode: ICx gateway (Master) has been successfully tested with 64 Slave devices over 8 Ethernet Ports simultaneously
- ICx gateway (Slave to Polling Master)
 - TCP Mode: ICx gateway has been successfully tested with 8 Master Devices over 2 Port (Ethernet). ICx respond only to 1 master on which port is active.
 - RTU Mode: ICx gateway has been successfully tested with 8 Master Devices over 1 Port (RS 485) as well as 8 (RS 232) Serial Ports.

3.3.7. Redundancy

- Device Redundancy: Device redundancy is managed by the Master to ICx gateway. ICx can be configured to Poll the Slave only if the Master to ICx is polling the ICx Gateway.
- Link Redundancy: Over a single ICx gateway, communication links (Serial / Ethernet) can be configured for redundancy, eliminating single point of failure. ICx initialize all redundant links at the startup and thus switching time of the link is reduced to minimum.

3.3.8. Performance Characteristics

- Data Points:
 - Currently Managed: 20000
 - Maximum Can be Supported: 50000
- Communication Devices (Slave to ICx)
 - Currently Managed: 128
 - Maximum Can be Supported: 128
- Communication Devices (Master to ICx)
 - Currently Managed: 8
 - Maximum Can be Supported: 8
- Ports
 - TCP Mode
 - Currently Managed: 2
 - Maximum Can be Supported: 4
 - RTU Mode
 - Currently Managed: 4
 - Maximum Can be Supported: 16
- Device Redundancy Switchover time:
 - Currently Managed: By the Master to ICx Gateway
- Link Redundancy Switchover time:
 - Time depends upon the Timeout and number of retries. After timeout for the number of times as defined by user defined “**number of retries**”, the **next poll** to the slave device is send over the redundant link.
 - TCP Mode
 - ICx starts polling over the redundant link on socket break.
 - Typical switchover time is between 50ms - 200 ms.
 - TCP Mode
 - Typical switchover time is between 50ms - 200 ms.
 -

3.3.9. Protocol Support

- One to One
 - One to Many
 - Protocols Matrix: ICx MOD can be mapped with following protocols
 - IEC 61850
 - IEC 60870 – 5 – 101
 - IEC 60870 – 5 – 104
 - IEC 60870 – 5 – 103
 - MODBUS (RTU / ASCII /TCP/AREVA MODBUS)
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- DNP 3
 - HNZ
 - Ethernet / IP
- **Delivery time**
 - 4 – 6 Weeks

4. Configuration / Maintenance / Diagnosis

4.1. Configuration Tool

ICx Gateways comes bundled with WINDOWS based Configuration Tool that allows easy data points (tags) configuration and mapping yet allowing full control over the application and protocol. Key Features are:

- Start / Stop of ICx Gateway
- Display of current status of ICx gateway
- Interface with MS Excel for Database Mapping
- Interface for Database Management
- Log File: Display contents of Gateway Error / Analysis Log
- ICx Gateway Embedded: Bundled with Internet Explorer based utility to change network parameters.
- Communication Port: Configuration utility only works over Ethernet (LAN). Serial Port based communication is under development

4.2. Database Management

ICx allows direct integration of MS Excel sheet, enabling faster and user friendly parameter configuration (basic as well as advanced). Key features are:

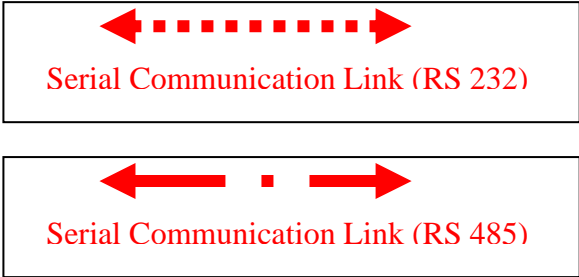
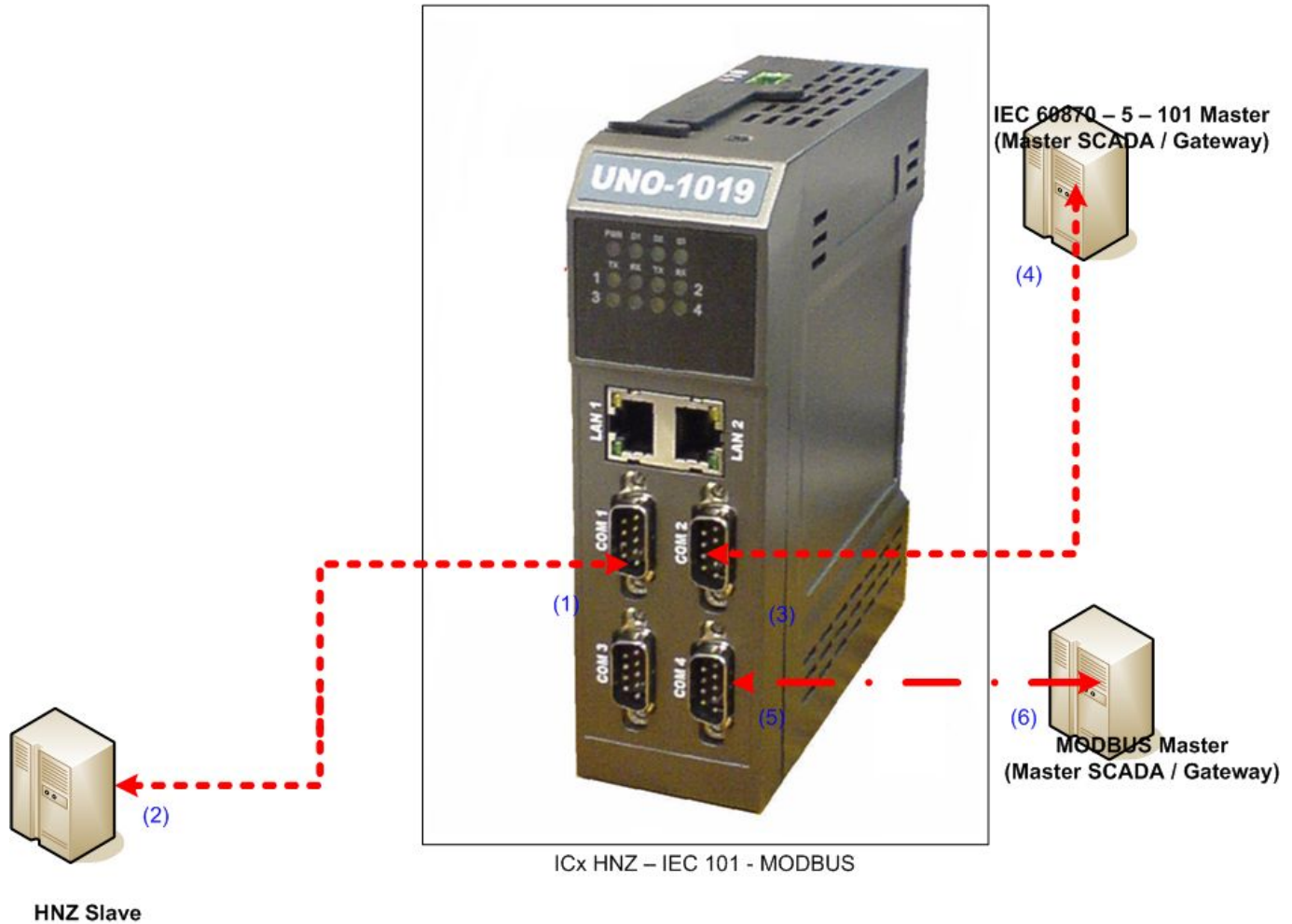
- All protocol mappings and communication related parameters are comprehensively covered in Excel Sheets thus allowing complete and user friendly management of data points.
- Version Management: ICx have inbuilt database versioning system. Before loading data to the ICx Gateway user must create the database (version) using Configuration tool. Each database creation is coded with Version Number "X.XX" and user comment.
- Database Loading: User created Database (versions) can be loaded to ICx gateway. User can switch to any version of database without limitation.

4.3. Diagnosis

- Visual Diagnosis:
 - Gateway configuration utility provides the status of the ICx Gateway.
 - ICx Gateway also has LED Indicators to show current activity status. Other than Power Indication LED, LED indications for Gateway Master / Slave Status and indication of the communication ports are also available.
- Gateway LOG: Gateway can be configured to provide following information in the LOG File:
 - Error Logs: This includes the Gateway error logs ranging from Protocol Translation / Mapping to communication error logs.
 - Protocol Analysis Logs: All protocol RAW Data transfer and translation analysis are contained in this log.
 - Embedded system: System resources information for the embedded device over which gateway is deployed.

5. Implementation Example

5.1. Architecture



5.2. Implementation Details

Item	Implementation	Description
1	HNZ Master	Gateway Act as Master to HNZ based RTU on Serial Port (RS 232) COM1. Master is responsible to acquire data from RTU and update the ICx Master Database
2	HNZ Slave	RTU providing field information as SLAVE for HNZ Network
3	IEC 60870-5-101 Slave	Gateway Act as Slave to Master devices on Serial Port (RS 232) COM2. The data collected from HNZ Slave (item No. 1) is converted into IEC 101 format.
4	IEC 60870-5-101 Master SCADA	Polls ICx gateway IEC 101 Slave implementation on COM 2.
5	MODBUS RTU Slave	Responds to the polling of MODBUS Master over Serial Port (RS 485) COM4. The data collected from HNZ Slave (item No. 1) is converted into MODBUS format.
6	MODBUS RTU Master / SCADA	Polls ICx gateway on COM 5 (RS485).