An Introduction to Modbus® Communications
Webinar Organizers

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Agenda

1. What is Modbus?
2. Protocols, networks and terms
3. How does Modbus work?
4. When should I use Modbus?
5. Pros and Cons of Modbus
6. Practical cases
Takeaways

Understand the fundamentals of the terms and difference between a network and communication protocol

Learn how Modbus works and how it’s different from analog signals

Know the pros and cons of Modbus as a communication choice

Put it all together with a couple of real case scenarios
Getting to know you

• Where are you located?
• What is your industry?
• What is your experience with Modbus?
What is Modbus?

- Digital communication for 2 or more devices
- An application-layer protocol
- Open source code
- Published by Schneider Electric
Analog Signals

- Analog signals have an infinite number of possible values over time.
- Example:
  - 12.9 mA
  - 4.563 mA

Digital Signals

- Discrete number of values from 2 to billions determined by number of bits
- Vary with sample times
Digital Communication via Packets

- Digital signal communicated 1 and 0 values
- This code is read and interpreted by the Protocol
Protocols, networks, and terms

• RS232, RS485, USB, Ethernet are types of networks and used with Modbus.
  • Different transmission mediums to send the Modbus Protocol
    • Modbus is the language being spoken
    • RS232, RS485, Ethernet, etc. are the medium, such as phone, VOIP, fax, letter, etc.
    • Different methods of communicating the same core language between two devices.
Types of Networks

- **RS-485**
  - Full (5-wire) or half-duplex (3-wire)
  - Multi-drop
  - Up to 4,000 ft (1219 m).
  - Very common on industrial devices
  - Not common on computers
- **RS-232**
  - Usually 9-pin serial port
  - Usually only two devices
  - Up to 1,000 ft (305 m) are required.
  - Common on older desktop computers
Types of Networks (cont.)

• USB (Universal Serial Bus)
  • Various standard cables and connectors
    • Type A, Type B, mini, and micro
  • Less than 16 feet 5 inches (5 meters) without additional devices
  • Very common on computers

• Ethernet
  • Devices accessed anywhere on the network
  • Often everywhere in a facility
  • Web servers, virtual coms, etc. for global reach
  • Complicated to setup
  • Power over Ethernet options available
Questions?

- Please enter your questions in the ‘Questions’ window
Common specifications and settings

- Device address / Slave ID
- Baud rate
- Data format
- Parity
- Other
Device Address / Slave ID

- Programmable for 1 – 247 devices
- Each device on the Modbus network must have a unique identifier.
Baud rate

- Speed of communication in bits/second
- 300 – 19,200 bps
- Must be identical for all devices on the network
Data format

- Configures the Modbus data packet
- Start bits & Stop bits
- Must match on all devices on the network
Parity

- Even, odd or none
- Defines the data packet
- Should match on all devices
Other specifications

- Byte-to-byte timeout
- Transmit delays
- Other
### Registers & tables

<table>
<thead>
<tr>
<th>Register</th>
<th>Name</th>
<th>Access</th>
<th>Limits or Range</th>
<th>Units</th>
<th>Data Type</th>
<th>Function Code(s)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>40001 – 40002</td>
<td>PV1 Display value</td>
<td>Read Only</td>
<td>-99999 to 999999</td>
<td>User defined</td>
<td>Floating point</td>
<td>03, 04</td>
<td>Represents the PV1 display value including the decimal point. Under Range = -99999, Over Range = 999999, and Open = -99999</td>
</tr>
<tr>
<td>40003</td>
<td>Alarm and Relay status</td>
<td>Read Only</td>
<td>1 = In Alarm, 1 = relay energized</td>
<td>None</td>
<td>Word; Bits</td>
<td>03, 04</td>
<td>Read alarm status and energized/non-energized status of relays. Alm = Alarm, Rly = Relay.</td>
</tr>
<tr>
<td>40004</td>
<td>Digital Inputs and Outputs status</td>
<td>Read Only</td>
<td>1 = Input selected, 1 = Output active</td>
<td>None</td>
<td>Word; Bits</td>
<td>03, 04</td>
<td>Read the state of the digital inputs and outputs.</td>
</tr>
<tr>
<td>40005 – 40006</td>
<td>Maximum Display value</td>
<td>Read Only</td>
<td>-99999 to 999999</td>
<td>User defined</td>
<td>Floating point</td>
<td>03, 04</td>
<td>Represents the Maximum display value, including the decimal point, since last power up or Max Value reset.</td>
</tr>
</tbody>
</table>

- Tables are a tool for programming the master device.
- Each register will have type and number.
- Tables are charts used to define the registers.
How does Modbus work?

• Master and Slave devices
  • Master polls multiple slave devices to gather information
  • Slave devices cannot transmit information without a request
  • The master keeps communication organized

• Data is sent in a series of 1s and 0s called bits in packets
  • Data content is identified in tables and registers

• Modbus Map
  • Defines the data
  • Tells the Master where the data is stored
  • Tells the Master how the data is stored
When should I use Modbus?

- When more than one piece of data is required from multiple field devices
- When a single field device gathers multiple useful PVs
- When adequate power is available
Pros and Cons of Modbus

**Pros**
- Ability to use multivariate transmitters
- Better accuracy from digital signals
- Easy to add devices
- High noise immunity
- Centralized SCADA
- Open source
- Network versatility

**Cons**
- More expensive than analog
- Complex to setup
- No way for slaves to report exceptions
- Limited to 247 devices
- No security of signal
Practical Case 1: Level Monitoring of Oil & Water in Storage Tanks

Problem: Operator monitoring of top levels, oil/water interface levels, and temperature in storage tanks.

- PD6830-AX0-I-2 Modbus scanner as the Modbus master
- (4) MTS M-Series multivariable tank level gauges as slaves
- 3-wire half-duplex RS-485 used for the connections
  - Easy to wire
  - Long distances OK
  - Multidrop (5 devices on the network)

This solution displays product level, interface level, and temperature for each tank.

<table>
<thead>
<tr>
<th>Fixed Serial Data Parameters</th>
<th>MTS M-Series Transmitter Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level Register</td>
<td>30001, 30002</td>
</tr>
<tr>
<td>Interface Register</td>
<td>30003, 30004</td>
</tr>
<tr>
<td>Ave Temp Register</td>
<td>30017, 30018</td>
</tr>
<tr>
<td>Data Type</td>
<td>Long Integer (2 registers), Binary, Signed</td>
</tr>
<tr>
<td>Byte Order</td>
<td>1234 (most significant digit register first)</td>
</tr>
</tbody>
</table>

The above parameters are taken from the MTS M-Series Modbus tables and used for programming the Scanner.

<table>
<thead>
<tr>
<th>Serial Comm Parameters</th>
<th>Scanner</th>
<th>Tank 1 Transmitter</th>
<th>Tank 2 Transmitter</th>
<th>Tank 3 Transmitter</th>
<th>Tank 4 Transmitter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address (Slave ID)</td>
<td>100</td>
<td>001</td>
<td>002</td>
<td>003</td>
<td>004</td>
</tr>
<tr>
<td>Baud Rate</td>
<td>4800 bps</td>
<td>4800 bps</td>
<td>4800 bps</td>
<td>4800 bps</td>
<td>4800 bps</td>
</tr>
<tr>
<td>Transmit Delay</td>
<td>50 ms</td>
<td>50 ms</td>
<td>50 ms</td>
<td>50 ms</td>
<td>50 ms</td>
</tr>
<tr>
<td>Parity/Stop Bits</td>
<td>None / 1</td>
<td>None / 1</td>
<td>None / 1</td>
<td>None / 1</td>
<td>None / 1</td>
</tr>
</tbody>
</table>
Practical Case 2: Using Modbus to Poll Data From the Field

Problem: How to get exact, accurate data from two flow meters mounted far from the control room.

- Modbus on PLC allows for error-free rate and total information from the flowmeters
- Ethernet used as a communication method
  - Remote location OK
  - Already present in control room
- Easy to add devices later

<table>
<thead>
<tr>
<th>Serial Comm Parameters</th>
<th>Flow Transmitter 1</th>
<th>Flow Transmitter 2</th>
<th>Control Room PLC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address (Slave ID)</td>
<td>100</td>
<td>200</td>
<td>001</td>
</tr>
<tr>
<td>Baud Rate</td>
<td>9600 bps</td>
<td>9600 bps</td>
<td>9600 bps</td>
</tr>
<tr>
<td>Transmit Delay</td>
<td>50 ms</td>
<td>50 ms</td>
<td>50 ms</td>
</tr>
<tr>
<td>Parity</td>
<td>Even, 1 Stop Bit</td>
<td>Even, 1 Stop Bit</td>
<td>Even, 1 Stop Bit</td>
</tr>
</tbody>
</table>

The above parameters are taken from the flowmeter Modbus tables and used for programming the PLC.
Summary

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• Please enter your questions in the ‘Questions’ window
• Apologies if we do not get to your question today. We’ll contact you offline with a response as soon as possible.
The Fundamentals of 4-20 mA Current Loops

• This webinar is designed as an introductory class for those who have to deal with 4-20 mA process signals but are not electrical engineers. This webinar will answer questions including:
  • What is a 4-20 mA current loop?
  • Why is this signal so popular?
  • How do I wire a 4-20 mA loop?
• Back by popular demand!

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