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Energy for Peace & Prosperity

Industrial Communication Protocol II: Modbus

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9 December 2021

Profile

- Researcher
  - Motor system energy efficiency
  - Appliance energy efficiency standards and labels
  - Cooling efficiency
  - Industrial IoT standardization
- **Programmer**
  - Embedded device and system
  - IoT cloud OPC UA server
  - Web application
  - Web crawling
- Coordinator
  - International cooperation
  - Technology transfer

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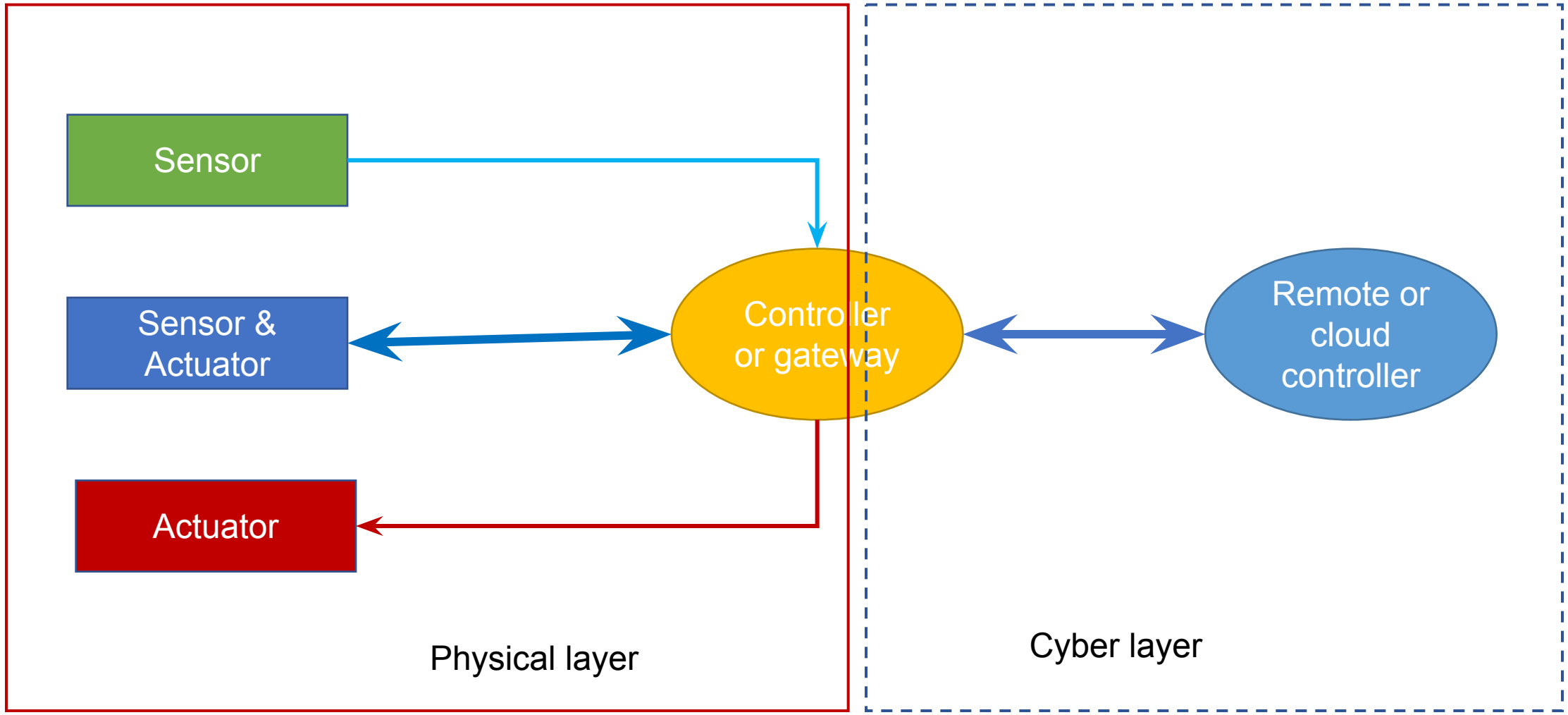
How machines to “talk” with each other?



Physical layer communications

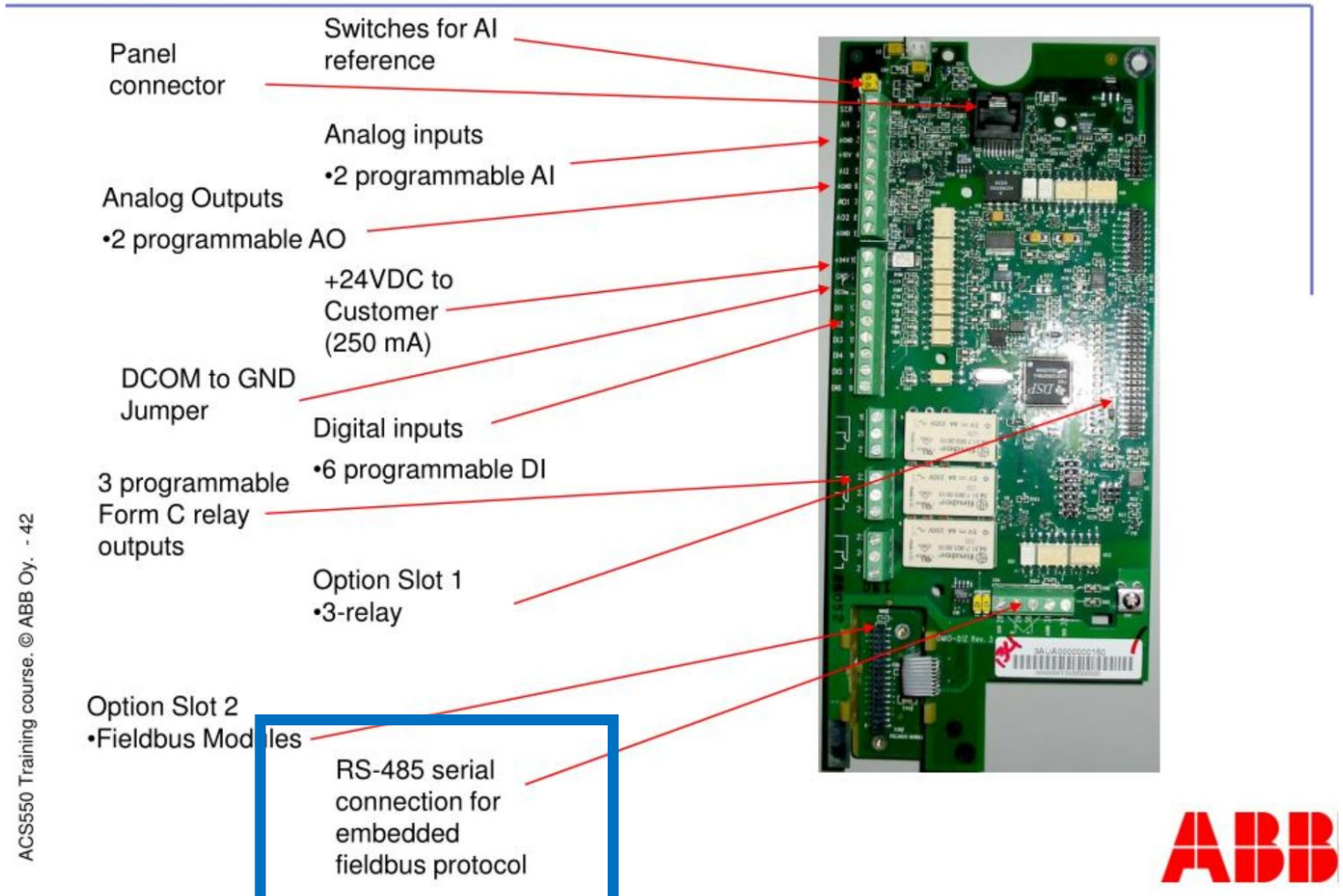
- Analog signals
  - Voltage: ±5V, ±10V
  - Current: 4-20mA
- Digital
  - Hart protocol: analog + digital
  - RS232
  - RS485
  - RS422
  - CAN
  - I2C
  - ……

Why Modbus?

- Modbus is published in 1979 by Modicon
- Modbus is open and free
- Mainstream industrial devices support Modbus
- Modbus is device-to-device general international standard

All VFDs supports Modbus

ACS 550 Hardware



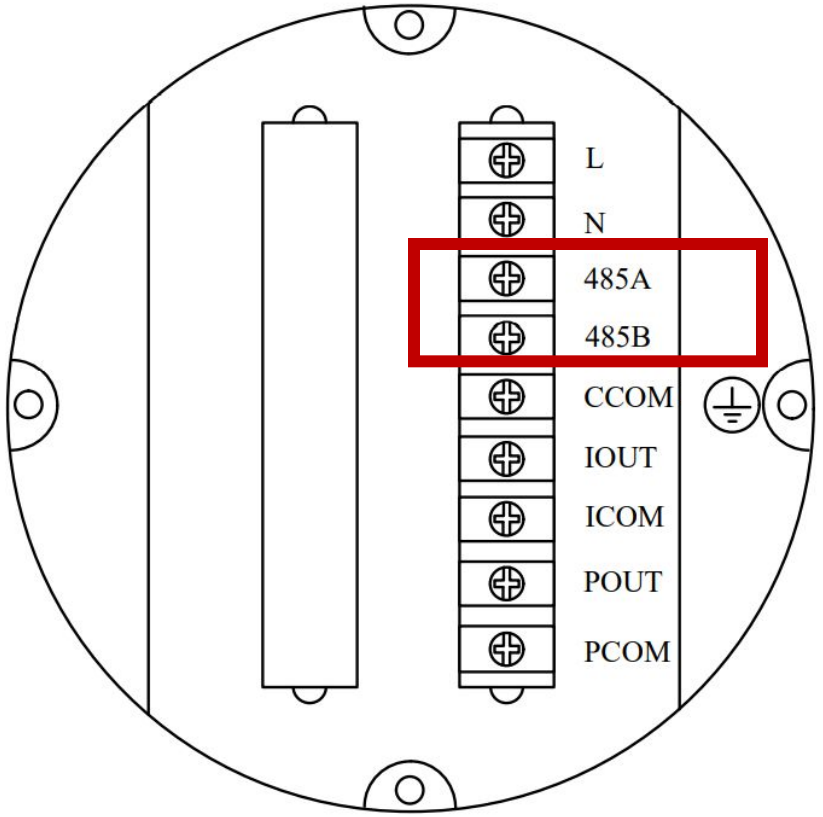
Technical manual

Code	Name	Range	Resolution	Default	User	S
Group 99: START-UP DATA						
9901	LANGUAGE	0…16 / 0…3	1	0 (ENGLISH)		
9902	APPLIC MACRO	-3…8, 31	1	1 (ABB STANDARD)		✓
9904	MOTOR CTRL MODE	1 = VECTOR:SPEED, 2 = VECTOR:TORQUE, 3 = SCALAR:FREQ	1	3 (SCALAR:FREQ)		✓
9905	MOTOR NOM VOLT	-01-yyyy-2: 115…345 V / -U1-yyyy-2: 115…345 V -01-yyyy-4: 200…600 V / -U1-yyyy-4: 230…690 V -U1-yyyy-6: 288…862 V	1 V	-01-yyyy-2: 230 V / -U1-yyyy-2: 230 V -01:-yyyy-4 400 V / -U1-yyyy-4: 460 V -U1-yyyy-6: 575 V		✓
9906	MOTOR NOM CURR	0.2 · I_{2hd} … 2.0 · I_{2hd}	0.1 A	1.0 · I_{2hd}		✓
9907	MOTOR NOM FREQ	10.0…500.0 Hz	0.1 Hz	-01: 50.0 Hz / -U1: 60.0 Hz		✓
9908	MOTOR NOM SPEED	50…30000 rpm	1 rpm	Size dependent		✓
9909	MOTOR NOM POWER	0.2…3.0 · P_{hd}	-01: 0.1 kW / -U1: 0.1 hp	1.0 · P_{hd}		✓
9910	ID RUN	0 = OFF/IDMAGN, 1 = ON	1	0 (OFF/IDMAGN)		✓
9915	MOTOR COSPHI	0 = IDENTIFIED, 0.01…0.97	0.01	0 (IDENTIFIED)		✓
Group 01: OPERATING DATA						
0101	SPEED & DIR	-30000…30000 rpm	1 rpm	-		
0102	SPEED	0…30000 rpm	1 rpm	-		
0103	OUTPUT FREQ	0.0…500.0 Hz	0.1 Hz	-		
0104	CURRENT	0.0…2.0 · I_{2hd}	0.1 A	-		
0105	TORQUE	-200.0…200.0%	0.1%	-		
0106	POWER	-2.0…2.0 · P_{hd}	0.1 kW	-		
0107	DC BUS VOLTAGE	0…2.5 · V_{dN}	1 V	-		
0109	OUTPUT VOLTAGE	0…2.0 · V_{dN}	1 V	-		
0110	DRIVE TEMP	0.0…150.0 °C	0.1 °C	-		
0111	EXTERNAL REF 1	0.0…500.0 Hz / 0…30000 rpm	0.1 Hz / 1 rpm	-		
0112	EXTERNAL REF 2	0.0…100.0% (0.0…600.0% for torque)	0.1%	-		
0113	CTRL LOCATION	0 = LOCAL, 1 = EXT1, 2 = EXT2	1	-		

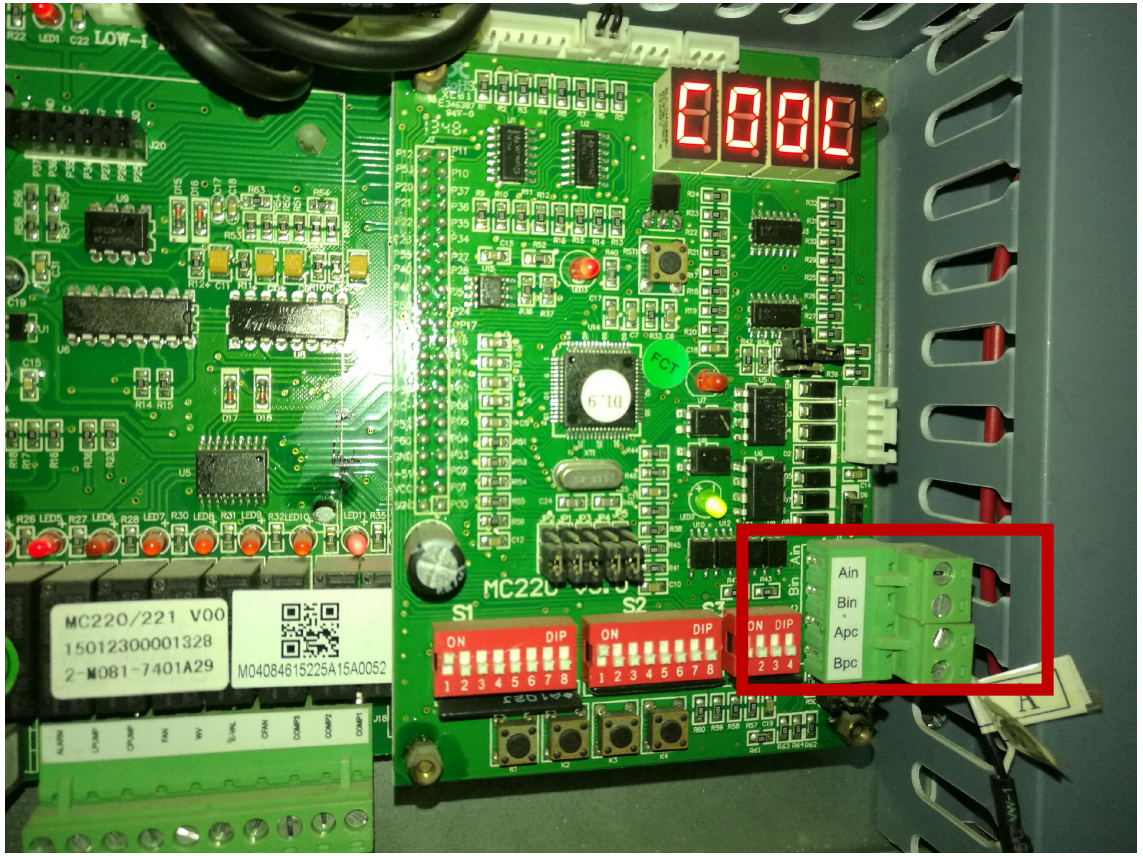
All PLCs support Modbus

- Modbus is a data communications protocol originally published by Modicon (now Schneider Electric) in 1979 for use with its programmable logic controllers (PLCs)

Smart meters support Modbus



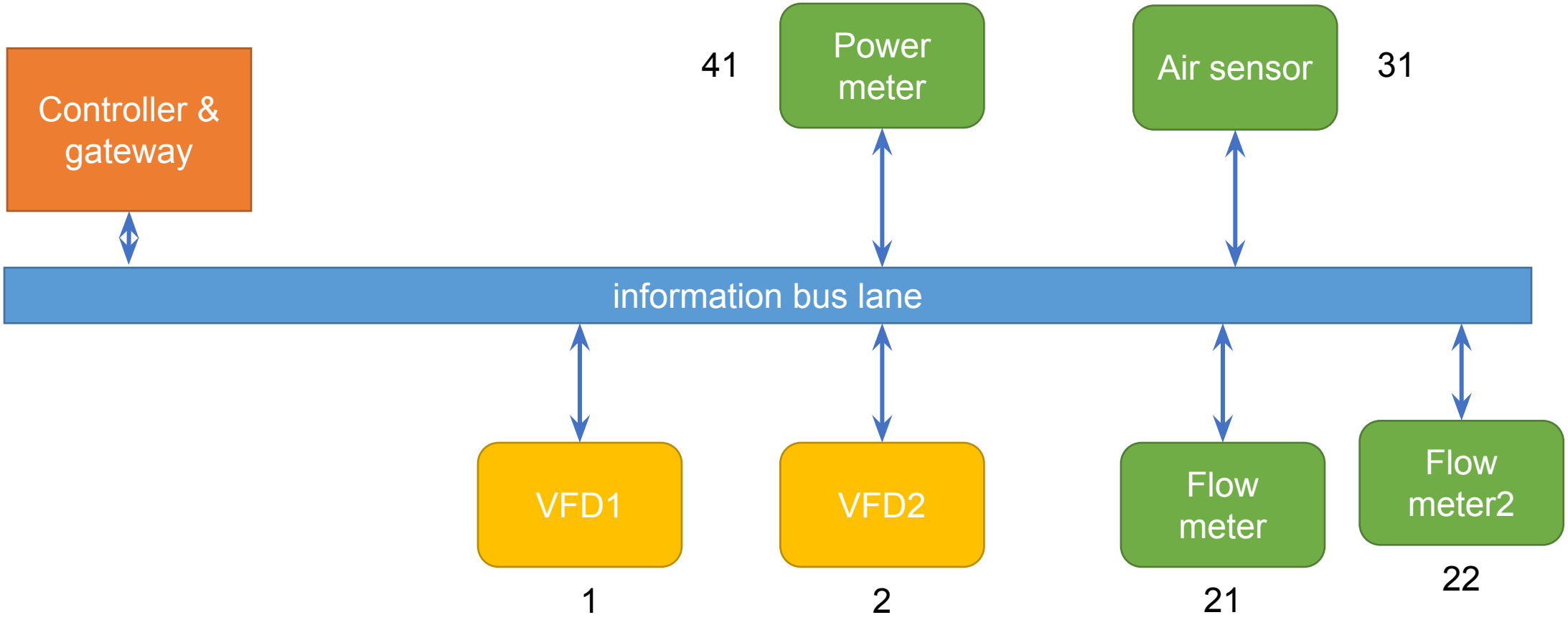
Other cases



AC system

Smart power meter

What is Modbus? – the concept of bus



What is Modbus?

- It is an open messaging protocol between master – slave devices
  - Request message from master and response from slaves
  - One master and maximum 247 slaves
- Modbus protocol defines standard messaging structure
- Modbus is independent of the underlying physical layer
  - RS422
  - RS232
  - RS485 (most widely applied)
- Two modes
  - RTU
  - ASCII

RS485 features

- Widely used in industrial equipments
- Easy to connect : A + B ports
- Reliable and stable communication
- Long distance communication : around 1000 meters
- One RS485 bus line can be connected with 32 receivers
- High communication speed : max to 10M/S

Common Modbus functions and codes

Function code	Function description
01	READ COIL STATUS
02	READ INPUT STATUS
03	READ HOLDING REGISTERS
04	READ INPUT REGISTERS
05	WRITE SINGLE COIL
06	WRITE SINGLE REGISTER
15	WRITE MULTIPLE COILS
16	WRITE MULTIPLE REGISTERS

A Modbus message frame – read input register request

Data bytes index	1	2	3	4	5	6	7	8
RTU Data(hex)	1	4	0	0	0	2	71	CB
Field Name	Slave Address	Function	Starting Address Hi	Starting Address Lo	Quantity of Registers Hi	Quantity of Registers Lo	Error Check Lo	Error Check Hi

A Modbus message frame – read input register response

Data bytes index	1	2	3	4	5	6	7	8	9
RTU (hex)	1	4	4	0	6	0	5	DB	86
Field Name	Slave Address	Function	Byte Count	Data Hi	Data Lo	Data Hi	Data Lo	Error Check Lo	Error Check Hi

A Modbus message frame – write single coil request

Data bytes index	1	2	3	4	5	6	7	8
RTU Data(hex)	11	05	00	AC	FF	00	4E	8B
Field Name	Slave Address	Function	Coil Address Hi	Coil Address Lo	Write Data Hi	Write Data Lo	Error Check Lo	Error Check Hi

A Modbus message frame – write single coil response

Data bytes index	1	2	3	4	5	6	7	8
RTU Data(hex)	11	05	00	AC	FF	00	4E	8B
Field Name	Slave Address	Function	Coil Address Hi	Coil Address Lo	Write Data Hi	Write Data Lo	Error Check Lo	Error Check Hi

A Modbus message frame – write single hold register request

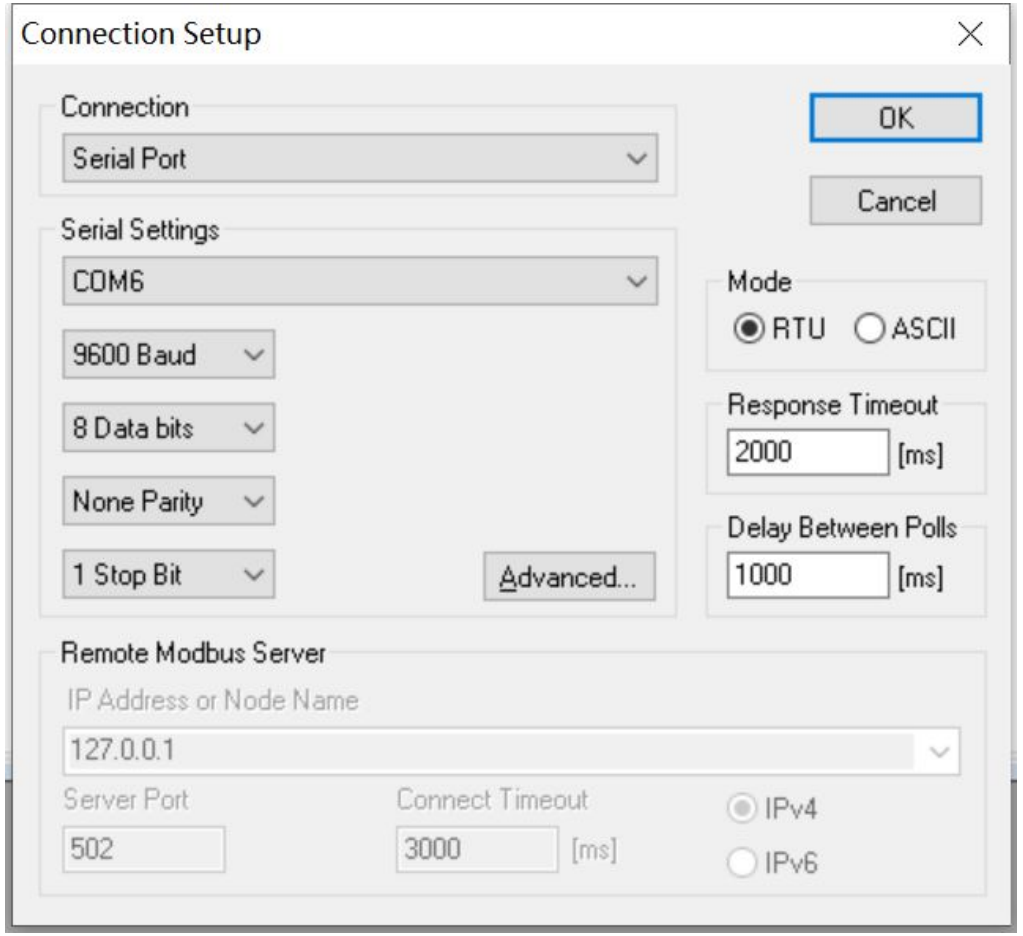
Data bytes index	1	2	3	4	5	6	7	8
RTU Data(hex)	11	06	00	01	00	03	9A	9B
Field Name	Slave Address	Function	Register Address Hi	Register Address Lo	Write Data Hi	Write Data Lo	Error Check Lo	Error Check Hi

A Modbus message frame – write single hold register response

Data bytes index	1	2	3	4	5	6	7	8
RTU Data(hex)	11	06	00	01	00	03	9A	9B
Field Name	Slave Address	Function	Register Address Hi	Register Address Lo	Write Data Hi	Write Data Lo	Error Check Lo	Error Check Hi

How to connect to a Modbus supported device?

- Select connection type
- Select serial port: at computer
- Select baud rate
- Select data bits
- Select parity mode
- Select stop bits



Where can we find connection info? – from user technical manual

通讯地址：1-247。 Slave address

默认地址：8 Default slave address : 8

波特率：1200、2400、4800、9600、19200、38400、57600； Baud rate

默认波特率：9600。 Default baud rate : 9600

校验：无校验、奇校验、偶校验； Parity options

默认无校验。 Default parity option : none parity

Practice

Thank You !

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