

# CAEL Modbus Protocol

Setup via Modbus RTU for SERIAL CAEL Transmitters. Supported function codes, Registers table and examples.

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## Introduction

This document describes how to set the address, baud rate, data format and read measured values from SERIAL devices with Modbus RTU interface.

Additionally it describes the data encoding of floating point values and the Modbus function codes supported by the SERIAL devices.

## Contents

<b>Introduction .....</b>	<b>1</b>
<b>1. Hardware interface.....</b>	<b>3</b>
<b>2. RS485 Slave ID, Baud rate, Data format .....</b>	<b>3</b>
<b>3. Modbus protocol.....</b>	<b>3</b>
<b>4. Supported function codes .....</b>	<b>4</b>
<b>5. Data Encoding.....</b>	<b>4</b>
<b>6. Holding Registers Table.....</b>	<b>5</b>
6-1 Device information.....	5
6-2 RS485 parameters.....	5
6-3 Physical Quantities (IEEE 754 Floating Pt) .....	6
6-4 Physical Quantities (16-bit integer).....	7
6-5 Physical Quantities (32-bit integer).....	8
<b>7. Data types.....</b>	<b>9</b>
7-1 ASCII format.....	9
7-2 IEEE 754 format.....	9
7-3 16-bit integer format.....	9
7-4 32-bit integer format.....	9
<b>8. Communication Examples .....</b>	<b>10</b>
8-1 Setting Slave ID.....	10
8-2 Setting Baud rate.....	10
8-3 Reading Temperature of floating point type .....	11
8-4 Reading Temperature of 16-bit integer type .....	11
8-5 Reading Temperature of 32-bit integer type .....	11
8-6 Reading Relativity Humidity of floating point type .....	12
8-7 Reading Relativity Humidity of 16-bit integer type.....	12
8-8 Reading Serial No. ....	13
<b>9. Revise history.....</b>	<b>14</b>

## 1. Hardware interface

- The hardware of digital interface for the transmitter is RS485.
- RS485 signal wires are named D+, D-
- RS485 signal is meet the standards TIA/EIA-485-A

## 2. RS485 Slave ID, Baud rate, Data format

- Support range of Slave ID: 1 ... 247
- Baud rate: 9600, 19200, 38400, 57600, 115200
- Parity: NONE, EVEN, ODD
- Data length: 8 bit
- Stop bit: 1, 2 bit
- Factory default is is ID 1, 9600 baud, none parity, 8 bit data length and 1 stop bit

## 3. Modbus protocol

- Modbus Protocol reference as below
  - [http://www.modbus.org/docs/Modbus\\_Application\\_Protocol\\_V1\\_1b3.pdf](http://www.modbus.org/docs/Modbus_Application_Protocol_V1_1b3.pdf)
- Modbus protocol structure:
  - 1st byte: Slave ID
  - 2nd byte: Function code
  - 3~Nth bytes: Data
  - last 2 bytes: CRC (Error check)
- Support MODBUS RTU mode
- Broadcast address = Slave ID 0
- Not implemented bit addressable items (i.e. Coils and Discrete inputs)
- Measured values are represented in 3 types
  - IEEE 754 single-precision 32-bit floating point type
  - 16-bit integer type, values are stored with a scaling of 1:100
  - 32-bit integer type, values are stored with a scaling of 1:100

## 4. Supported function codes

Following function codes are supported:

- 0x03 Read Holding Registers
- 0x06 Write Single Register
- 0x10 Write Multiple Registers

The measured values can be read by using 0x03 codes. The RS485 and unit can be set by using 0x06 or 0x10 code. The register numbers and the corresponding physical quantities are listed as below “Register Table”.

## 5. Data Encoding

SERIAL device uses a ‘big-Endian’ representation for addresses and data items. This means that when a numerical quantity larger than a single byte is transmitted, the most significant byte is sent first. So for example

<u>Register size</u>	<u>value</u>	
16 - bits	0x1234	the first byte sent is 0x12 then 0x34

<u>Register size</u>	<u>value</u>	
32 - bits	0x12345678	the first byte sent is 0x12 then 0x34, 0x56, 0x78

## 6. Holding Registers Table

### 6-1 Device information

No.	Register Address	Starting Address	Content	R/W	Data Bytes	Data Type	Value/ Unit
1	40033	0x20	Model Name	R	16 bytes	ASCII	
2	40049	0x30	Serial Number	R	16 bytes	ASCII	
3	40065	0x40	Firmware version	R	16 bytes	ASCII	

### 6-2 RS485 parameters

No.	Register Address	Starting Address	Content	R/W	Data Bytes	Data Type	Value/ Unit
1	40081	0x50	Slave ID	R/W	1 byte	unsigned Integer	1 ... 247
2	40083	0x52	Baud rate	R/W	1 byte	unsigned Integer	0: 9600 1: 19200 2: 38400 3: 57600 4: 115200
3	40085	0x54	Data type	R/W	1 byte	unsigned Integer	0: N81 1: N82 2: E81 3: E82 4: O81 5: O82
4	4087	0x56	Unit	R/W	1 byte	unsigned Integer	0: Metric 1: Imperial

### 6-3 Physical Quantities (IEEE 754 Floating Pt)

No.	Register Address	Starting Address	Content	R/W	Data Bytes	Data Type	Value/ Unit
1	41025	0x400	Temperature	R	4 bytes	Floating Pt.	°C, °F
2	41029	0x404	Relative Humidity	R	4 bytes	Floating Pt.	%
3	41033	0x408	Dew Point Temperature	R	4 bytes	Floating Pt.	°C, °F
4	41037	0x40C	*Dew/Frost Point Temperature	R	4 bytes	Floating Pt.	°C, °F
5	41041	0x410	Wet Bulb Temperature	R	4 bytes	Floating Pt.	°C, °F
6	41045	0x414	Vapor Pressure	R	4 bytes	Floating Pt.	mbar, psi
7	41049	0x418	Mixture Ratio	R	4 bytes	Floating Pt.	g/kg, gr/lb
8	41053	0x41C	Absolute Humidity	R	4 bytes	Floating Pt.	g/m <sup>3</sup> , gr/ft <sup>3</sup>
9	41057	0x420	Specific Enthalpy	R	4 bytes	Floating Pt.	kJ/kg, BTU/lb
10	41061	0x424	PPMv	R	4 bytes	Floating Pt.	ppm
11	41065	0x428	PPMw	R	4 bytes	Floating Pt.	ppm
12	41073	0x430	Dew/Frost Point Temperature, converted to atmospheric pressure	R	4 bytes	Floating Pt.	°C, °F
13	41077	0x434	Pressure, absolute	R	4 bytes	Floating Pt.	bar, psi

\*When the dew point is below 0 °C, the transmitter outputs frost point temperature

## 6-4 Physical Quantities (16-bit integer)

Values are stored with a scaling of 1:100 (e.g.: 2230 is equivalent to 22.3 °C)

If any value of reading is exceed 65535, please use 32-bit integer format

No.	Register Address	Starting Address	Content	R/W	Data Bytes	Data Type	Value/ Unit
1	41091	0x442	Temperature	R	2 bytes	16-bit integer	°C, °F
2	41095	0x446	Relative Humidity	R	2 bytes	16-bit integer	%
3	41099	0x44A	Dew Point Temperature	R	2 bytes	16-bit integer	°C, °F
4	41103	0x44E	*Dew/Frost Point Temperature	R	2 bytes	16-bit integer	°C, °F
5	41107	0x452	Wet Bulb Temperature	R	2 bytes	16-bit integer	°C, °F
6	41111	0x456	Vapor Pressure	R	2 bytes	16-bit integer	mbar, psi
7	41115	0x45A	Mixture Ratio	R	2 bytes	16-bit integer	g/kg, gr/lb
8	41119	0x45E	Absolute Humidity	R	2 bytes	16-bit integer	g/m <sup>3</sup> , gr/ft <sup>3</sup>
9	41123	0x462	Specific Enthalpy	R	2 bytes	16-bit integer	kJ/kg, BTU/lb
10	41127	0x466	PPMv	R	2 bytes	16-bit integer	ppm
11	41131	0x46A	PPMw	R	2 bytes	16-bit integer	ppm
12	41135	0x46E	Dew/Frost Point Temperature, converted to atmospheric pressure	R	2 bytes	16-bit integer	°C, °F
13	41139	0x472	Pressure, absolute	R	2 bytes	16-bit integer	bar, psi

\*When the dew point is below 0 °C, the transmitter outputs frost point temperature

## 6-5 Physical Quantities (32-bit integer)

Values are stored with a scaling of 1:100 (e.g.: 2230 is equivalent to 22.3°C)

No.	Register Address	Starting Address	Content	R/W	Data Bytes	Data Type	Value/ Unit
1	41089	0x440	Temperature	R	4 bytes	32-bit integer	°C, °F
2	41093	0x444	Relative Humidity	R	4 bytes	32-bit integer	%
3	41097	0x448	Dew Point Temperature	R	4 bytes	32-bit integer	°C, °F
4	41101	0x44C	Dew/Frost Point Temperature	R	4 bytes	32-bit integer	°C, °F
5	41105	0x450	Wet Bulb Temperature	R	4 bytes	32-bit integer	°C, °F
6	41109	0x454	Vapor Pressure	R	4 bytes	32-bit integer	mbar, psi
7	41113	0x458	Mixture Ratio	R	4 bytes	32-bit integer	g/kg, gr/lb
8	41117	0x45C	Absolute Humidity	R	4 bytes	32-bit integer	g/m <sup>3</sup> , gr/ft <sup>3</sup>
9	41121	0x460	Specific Enthalpy	R	4 bytes	32-bit integer	kJ/kg, BTU/lb
10	41125	0x464	PPMv	R	4 bytes	32-bit integer	ppm
11	41129	0x468	PPMw	R	4 bytes	32-bit integer	ppm
12	41133	0x46C	Dew/Frost Point Temperature, converted to atmospheric pressure	R	4 bytes	32-bit integer	°C, °F
13	41137	0x470	Pressure, absolute	R	4 bytes	32-bit integer	bar, psi

\*When the dew point is below 0 °C, the transmitter outputs frost point temperature



## 7. Data types

### 7-1 ASCII format

ASCII reference as below

- <https://www.asciitable.com/>

### 7-2 IEEE 754 format

IEEE 754 reference as below

- [http://en.wikipedia.org/wiki/IEEE\\_754](http://en.wikipedia.org/wiki/IEEE_754)
- <https://www.h-schmidt.net/FloatConverter/IEEE754.html>

### 7-3 16-bit integer format

Data Hi Byte	Data Lo Byte
0x09	0x4F

Number 22.3 is represented as <09><4F> in 16-bit integer type

### 7-4 32-bit integer format

Data Hi Word, Hi Byte	Data Hi Word, Lo Byte	Data Lo Word, Hi Byte	Data Lo Word, Lo Byte
0x00	0x00	0x09	0x4F

Number 22.3 is represented as <00><00><09><4F> in 32-bit integer type

## 8. Communication Examples

### 8-1 Setting Slave ID

Request from the host

Slave ID	Function Code	Register Address		Register value		CRC	
1 ... 247	06	00	50	00	08	CRC Lo	CRC Hi

\*setting Slave ID as 8

Response from the SERIAL devices

Slave ID	Function Code	Register Address		Register value		CRC	
1 ... 247	06	00	50	00	08	CRC Lo	CRC Hi

\* setting done, new Slave ID is 8

### 8-2 Setting Baud rate

Request from the host

Slave ID	Function Code	Register Address		Register value		CRC	
1 ... 247	06	00	52	00	04	CRC Lo	CRC Hi

\*setting baud rate as 115200

Response from the SERIAL devices

Slave ID	Function Code	Register Address		Register value		CRC	
1 ... 247	06	00	52	00	04	CRC Lo	CRC Hi

\* setting done, new baud rate is 115200

### 8-3 Reading Temperature of floating point type

Request from the host

Slave ID	Function Code	Register Address		Number Of Registers		CRC	
						CRC Lo	CRC Hi
1 ... 247	03	04	00	00	02	CRC Lo	CRC Hi

\*Registers of Temperature floating type are 0x0400 ~ 0x0403

Response from the SERIAL devices

Slave ID	Function Code	Byte Count	2 Registers (4 bytes)				CRC	
			41	B2	66	66	CRC Lo	CRC Hi
1 ... 247	03	04	41	B2	66	66	CRC Lo	CRC Hi

\* the floating point number 22.3 is represented as <41><B2><66><66>

### 8-4 Reading Temperature of 16-bit integer type

Request from the host

Slave ID	Function Code	Register Address		Number Of Registers		CRC	
						CRC Lo	CRC Hi
1 ... 247	03	04	42	00	01	CRC Lo	CRC Hi

\*Registers of Temperature 16-bit integer type are 0x0442 ~ 0x0443

Response from the SERIAL devices

Slave ID	Function Code	Byte Count	1 Registers (2 bytes)		CRC	
			08	B6	CRC Lo	CRC Hi
1 ... 247	03	02	08	B6	CRC Lo	CRC Hi

\* the 16-bit integer number 22.3 is represented as <08><B6>

### 8-5 Reading Temperature of 32-bit integer type

Request from the host

Slave ID	Function Code	Register Address		Number Of Registers		CRC	
						CRC Lo	CRC Hi
1 ... 247	03	04	40	00	02	CRC Lo	CRC Hi

\*Registers of Temperature 32-bit integer type are 0x0440 ~ 0x0443

## Response from the SERIAL devices

Slave ID	Function Code	Byte Count	2 Registers (4 bytes)				CRC	
1 ... 247	03	04	00	00	08	B6	CRC Lo	CRC Hi

\* the 32-bit integer number 22.3 is represented as <00><00><08><B6>

## 8-6 Reading Relativity Humidity of floating point type

### Request from the host

Slave ID	Function Code	Register Address		Number Of Registers		CRC	
1 ... 247	03	04	04	00	02	CRC Lo	CRC Hi

\*Registers of Relativity Humidity floating type are 0x0404 ~ 0x0407

## Response from the SERIAL devices

Slave ID	Function Code	Byte Count	2 Registers (4 bytes)				CRC	
1 ... 247	03	04	42	2E	CC	CD	CRC Lo	CRC Hi

\* the floating point number 43.7 is represented as <42><2E><CC><CD>:

## 8-7 Reading Relativity Humidity of 16-bit integer type

### Request from the host

Slave ID	Function Code	Register Address		Number Of Registers		CRC	
1 ... 247	03	04	46	00	01	CRC Lo	CRC Hi

\*Registers of Relativity Humidity 16-bit integer type are 0x0446 ~ 0x0447

## Response from the SERIAL devices

Slave ID	Function Code	Byte Count	1 Registers (2 bytes)		CRC	
1 ... 247	03	02	11	12	CRC Lo	CRC Hi

\* the 16-bit integer number 43.7 is represented as <11><12>

## 8-8 Reading Serial No.

Request from the host

Slave ID	Function Code	Register Address		Number Of Registers		CRC	
		00	30	00	06	CRC Lo	CRC Hi
1 ... 247	03	00	30	00	06	CRC Lo	CRC Hi

\*Registers of Serial No. are 0x30 ~ 0x3F

Response from the SERIAL devices

Slave ID	Function Code	Byte Count	6 Registers (12 bytes)												CRC	
			53	4E	30	31	32	33	34	35	36	37	38	39	CRC Lo	CRC Hi
1 ... 247	03	0C	53	4E	30	31	32	33	34	35	36	37	38	39	CRC Lo	CRC Hi

\*example of Serial No. is "SN0123456789"

## 9. Revise history

- v1.0 Step 2016 Initial edit
- v1.1 20170608 Add
  - PPMv\_float(0x0424)
  - PPMw\_float(0x0428)
  - PPMv\_int(0x0464)
  - PPMw\_int(0x0468)
- v2.0 20180130 Add
  - Dew/Frost Point Temperature, converted to atmospheric pressure
  - Pressure, absolute
  - 16-bit integer data typeModify
  - Frost point to Dew / frost point
- v2.1 20180523 Modify general descriptions