CAEL Modbus Protocol

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

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Compatible FW version: v7.1.0 and newer

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

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
- 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

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

Register size	value	
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	0x0020	Model Name	R	16 bytes	ASCII	
2	40049	0x0030	Serial Number	R	16 bytes	ASCII	
3	40065	0x0040	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	0x0050	Slave ID	R/W	1 byte	unsigned Integer	1 … 247
2	40083	0x0052	Baud rate	R/W	1 byte	unsigned Integer	0: 9600 1: 19200 2: 38400 3: 57600 4: 115200
3	40085	0x0054	Data type	R/W	1 byte	unsigned Integer	0: N81 1: N82 2: E81 3: E82 4: O81 5: O82
4	4087	0x0056	Unit	R/W	1 byte	unsigned Integer	0: Metric 1: Imperial

6-3 Temperature and relative humidity offset

Values are stored with a scaling of 1:100

No.	Register Address	Starting Address	Content	R/W	Register	Data Type	Value/ Unit
1	40261	0x0104	Temperature offset	R/W	1	Integer	±300 (±3℃)
2	40265	0x0108	Relative Humidity offset	R/W	1	Integer	±1,000 (±10%RH)

6-4 Alarm settings

No.	Register Address	Starting Address	Content	R/W	Register	Data Type	Value/ Unit
1	40515	0x0202	Mode	R/W	1	unsigned Integer	0: Single, 1: Dual
2	40517	0x0204	Logic	R/W	1	unsigned Integer	0: AND, 1: OR
3	40137	0x0088	Delay	R/W	1	unsigned Integer	0…3600 second
4	40139	0x008A	Latch	R/W	1	unsigned Integer	0: Off, 1: On
5	40125	0x007C	1st quantity	R/W	1	unsigned Integer	0: T, 1: RH, 2: Td, 3: Tf, 4: Tw, 5: E, 6: R, 7: A, 8: S
6	40523	0x020A	1st H-setpoint enable	R/W	1	unsigned Integer	0: Disable, 1: Enable
7	40529	0x0210	1st L-setpoint enable	R/W	1	unsigned Integer	0: Disable, 1: Enable
8	40519	0x0206	1st H-setpoint	R/W	2	Floating Pt.	-9999… 9999
9	40525	0x020C	1st L-setpoint	R/W	2	Floating Pt.	-9999… 9999
10	40133	0x0084	1st hysteresis	R/W	2	Floating Pt.	0… 9999
11	40513	0x0200	2nd quantity	R/W	1	unsigned Integer	0: T, 1: RH, 2: Td, 3: Tf, 4: Tw, 5: E, 6: R, 7: A, 8: S
12	40535	0x0216	2st H-setpoint enable	R/W	1	unsigned Integer	0: Disable, 1: Enable
13	40541	0x021C	2st L-setpoint enable	R/W	1	unsigned Integer	0: Disable, 1: Enable
14	40531	0x0212	2st H-setpoint	R/W	2	Floating Pt.	-9999… 9999
15	40537	0x0218	2st L-setpoint	R/W	2	Floating Pt.	-9999… 9999
16	40543	0x021E	2st hysteresis	R/W	2	Floating Pt.	0… 9999

Note:

1. (T) temperature, (RH) relative humidity, (Td) dew point temperature, (Tf) frost/dew point temperature, (Tw) wet bulb temperature, (E) water vapor pressure, (R) mixing ratio, (A) absolute humidity, (S) enthalpy,
2. 2:Td, 3: Tf, 4: Tw, 5: E, 6: R, 7: A, 8: S theses are only supported for option-M *Psychrometric calculations*

6-5 Physical Quantities (IEEE 754 Floating Pt)

No.	Register Address	Starting Address	Content	R/W	Register	Data Type	Value/ Unit
1	41537	0x600	Temperature	R	2	Floating Pt.	℃,°F
2	41539	0x602	Relative Humidity	R	2	Floating Pt.	%
3	41541	0x604	Dew Point Temperature	R	2	Floating Pt.	℃,°F
4	41543	0x606	*Dew/Frost Point Temperature	R	2	Floating Pt.	℃,°F
5	41545	0x608	Wet Bulb Temperature	R	2	Floating Pt.	℃,°F
6	41547	0x60A	Vapor Pressure	R	2	Floating Pt.	mbar, psi
7	41549	0x60C	Mixture Ratio	R	2	Floating Pt.	g/kg, gr/lb
8	41551	0x60E	Absolute Humidity	R	2	Floating Pt.	g/m^3 ,gr/ft^3
9	41553	0x610	Specific Enthalpy	R	2	Floating Pt.	kJ/kg, BTU/lb
10	41555	0x612	PPMv	R	2	Floating Pt.	ppm
11	41557	0x614	PPMw	R	2	Floating Pt.	ppm

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

6-6 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	Register	Data Type	Value/ Unit
1	41601	0x640	Temperature	R	2	32-bit integer	℃,°F
2	41603	0x642	Relative Humidity	R	2	32-bit integer	%
3	41605	0x644	Dew Point Temperature	R	2	32-bit integer	℃,°F
4	41607	0x646	*Dew/Frost Point Temperature	R	2	32-bit integer	℃,°F
5	41609	0x648	Wet Bulb Temperature	R	2	32-bit integer	℃,°F
6	41611	0x64A	Vapor Pressure	R	2	32-bit integer	mbar, psi
7	41613	0x64C	Mixture Ratio	R	2	32-bit integer	g/kg, gr/lb
8	41615	0x64E	Absolute Humidity	R	2	32-bit integer	g/m^3 ,gr/ft^3
9	41617	0x650	Specific Enthalpy	R	2	32-bit integer	kJ/kg, BTU/lb
10	41619	0x652	PPMv	R	2	32-bit integer	ppm
11	41621	0x654	PPMw	R	2	32-bit integer	ppm

*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
- https://www.h-schmidt.net/FloatConverter/IEEE754.html

7-3 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	0x08	0xB6

Number 22.3 is represented as <00><00><08><B6> in 32-bit integer type with scaling of 1:100

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	
1 … 247	03	06	00	00	02	CRC Lo	CRC Hi

*Address of Temperature floating type is 0x0600, 2 registers length

Response from the SERIAL devices

Slave ID	Function Code	Byte Count	2 Registers (4 bytes)				CRC	
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 32-bit integer type

Request from the host

Slave ID	Function Code	Register Address		Number Of Registers		CRC	
1 … 247	03	06	40	00	02	CRC Lo	CRC Hi

* Address of Temperature 32-bit integer type is 0x0640, 2 registers length

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> with scaling of 1:100

8-5 Reading Relativity Humidity of floating point type

Request from the host

Slave ID	Function Code	Register Address		Number Of Registers		CRC	
1 … 247	03	06	02	00	02	CRC Lo	CRC Hi

* Address of Relativity Humidity floating type is 0x0602, 2 registers length

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>

8-6 Reading Relativity Humidity of 32-bit integer type

Request from the host

Slave ID	Function Code	Register Address		Number Of Registers		CRC	
1 … 247	03	06	42	00	02	CRC Lo	CRC Hi

* Address of Relativity Humidity 32-bit integer type is 0x0642, 2 registers length

Response from the SERIAL devices

Slave ID	Function Code	Byte Count	2 Registers (4 bytes)				CRC	
1 … 247	03	04	00	00	11	12	CRC Lo	CRC Hi

* the 32-bit integer number 43.7 is represented as <00><00><11><12> with scaling of 1:100

8-7 Reading Serial No.

Request from the host

Slave ID	Function Code	Register Address		Number Of Registers		CRC	
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	
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 type
	Modify Frost point to Dew / frost point
-v2.1 20180523	Modify general descriptions
-v3.0 20210611	Modify register table, compatible FW version: v6.0.0 and newer
-v3.1 20221125	Add Offset & Alarm items
	Map to CAEL MODBUS v7.1.0