EMS

MODBUS COMMUNICATION PROTOCOL

Version 1.0

October 16, 2025

1 Introduction

The RS485 serial interface supports the MODBUS (RTU) protocol. In this document only the information necessary to read/write from/to EM500 has been reported (not all the parts of the protocol have been implemented).
For a complete description of the MODBUS protocol, please refer to the latest revision of the "Modbus_Application_Protocol" document that is downloadable from the www.modbus.org web site.

2 Modbus functions

These functions are available on EMS series:

- Reading of n "Holding Registers" (code 03h)
- Reading of n "Input Register" (code 04h)
- Writing of one "Single Registers" (code 06h)
- Writing of one "Holding Registers" (code 10h)
- Broadcast mode (writing instruction on address 00h)

IMPORTANT:

1) In this document the "Modbus address" field is indicated in two modes:
   1.1) "**Modicon address**": it is the "6-digit Modicon" representation with Modbus function code 04 (Read Input Registers). It is possible to read the same values with function code 03 (Read Holding Registers) replacing the first digit ("3") with the number "4".
   1.2) "**Physical address**": it is the "word address" value to be included in the communication frame.
2) The functions 03h and 04h have exactly the same effect and can be used indifferently.
3) The communication parameters are to be set according to the configuration of the instrument

2.1 *Function 03h (Read Holding Registers)*

This function is used to read the contents of a contiguous block of holding registers (word). The Request frame specifies the starting register address and the number of registers to be read. It is possible to read maximum 125 registers (words) [250 bytes] with a single request.
The register data in the response message are packed as two bytes per register (word), with the binary contents right justified within each byte. For each register, the first byte contains the high order bits (MSB) and the second contains the low order bits (LSB).

Request frame

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	
Function code	1 byte	03h	
Starting address	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
Quantity of registers (**N** word)	2 bytes	1 to 14h (1 to 20)	Byte order: MSB, LSB
CRC	2 bytes		

Response frame (correct action)

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	
Function code	1 byte	03h	
Quantity of requested bytes	1 byte	**N** word * 2	
Register value	**N***2 bytes		Byte order: MSB, LSB
CRC	2 bytes		

Response frame (incorrect action)

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	Possible exception : 01h: illegal function 02h: illegal data address 03h: illegal data value 04h: slave device failure
Function code	1 byte	83h	
Exception code	1 byte	01h, 02h, 03h, 04h (see note)	
CRC	2 bytes		

2.2 *Function 04h (Read Input Registers)*

This function code is used to read the contents of a contiguous block of input registers (word). The Request frame specifies the starting register address and the number of registers to be read. It is possible to read maximum 125 register (word) [250 bytes] with a single request.
The register data in the response message are packed as two bytes per register (word), with the binary contents right justified within each byte. For each register, the first byte contains the high order bits (MSB) and the second contains the low order bits (LSB).

Request frame

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	
Function code	1 byte	04h	
Starting address	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
Quantity of registers (**N** word)	2 bytes	1 to 14h (1 to 20)	Byte order: MSB, LSB
CRC	2 bytes		

Response frame (correct action)

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	
Function code	1 byte	04h	
Quantity of requested bytes	1 byte	**N** word * 2	
Register value	**N***2 bytes		Byte order: MSB, LSB
CRC	2 bytes		

Response frame (incorrect action)

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	Possible exception : 01h: illegal function 02h: illegal data address 03h: illegal data value 04h: slave device failure
Function code	1 byte	84h	
Exception code	1 byte	01h, 02h, 03h, 04h	
CRC	2 bytes		

2.3 *Function 06h (Write Single Holding Register)*

This function code is used to write a single holding register. The Request frame specifies the address of the register (word) to be written and its content.
The correct response is an echo of the request, returned after the register content has been written.

Request frame

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	
Function code	1 byte	06h	
Starting address	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
Register value	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
CRC	2 bytes		

Response frame (correct action)

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	
Function code	1 byte	06h	
Starting address	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
Register value	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
CRC	2 bytes		

Response frame (incorrect action)

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	Possible exception : 01h: illegal function 02h: illegal data address 03h: illegal data value 04h: slave device failure
Function code	1 byte	86h	
Exception code	1 byte	01h, 02h, 03h, 04h	
CRC	2 bytes		

2.4 *Function 10h (Write multiple registers)*

This function code is used to write a block of contiguous registers (maximum 123 word [246 bytes]). The requested values to be written are specified in the request data field. Data is packed as two bytes per register.
The correct response returns the function code, starting address, and the quantity of written registers.

Request frame

Description	Length	Value	Note
Physical Address	1 byte	1 to F7 (1 to 247)	
Function code	1 byte	10h	
Starting Address	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
Quantity of Registers (**N** word)	2 bytes	0001h to 0078h	Byte order: MSB, LSB
Byte count	1 byte	**N** word * 2	
Register value	**N** * 2 bytes	value	Byte order: MSB, LSB
CRC	2 bytes		

Response frame (correct action)

Description	Length	Value	Note
Physical Address	1 byte	1 to F7 (1 to 247)	
Function code	1 byte	10h	
Starting Address	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
Quantity of Registers (**N** word)	2 bytes	0001h to 0078h	Byte order: MSB, LSB
CRC	2 bytes		

Response frame (incorrect action)

Description	Length	Value	Note
Physical Address	1 byte	1 to F7 (1 to 247)	Possible exception: 01h: illegal function 02h: illegal data address 03h: illegal data value 04h: slave device failure
Function code	1 byte	90h	
Exception code	1 byte	01h, 02h, 03h, 04h	
CRC	2 bytes		

2.5 *Broadcast mode*

In broadcast mode the master can send a request (command) to all the slaves. No response is returned to broadcast requests sent by the master. It is possible to send the broadcast message only with function code 06h and 10h using address 00h.

2.6 *Application notes*

2.6.1 *RS485 general considerations*

1. To avoid errors due to the signal reflections or line coupling, it is necessary to terminate the bus at the beginning (master side, if not already embedded, by inserting a 120 ohm 1/2W 5% resistor between line B and A) and at the end (in EMS interface by connecting the terminal B+ with the terminal T in the last instrument).
2. The network termination is necessary even in case of point-to-point connection and/or of short distances.
3. For connections longer than 1000m or if in the network there are more than 160 instruments (with 1/5 unit load as used in EMS interface), a signal repeater is necessary.
4. For bus connection it is suggested to use an AWG24 balanced pair cable and to add a third wire for GND connection. If a shielded cable is used, connect the shield to GND.
5. The GND should be connected to ground only at the host side.
6. If an instrument does not answer within the “max answering time”, it is necessary to repeat the query. If the instrument does not answer after 2 or 3 consecutive queries, it is to be considered as not connected, faulty or reached with a wrong address. The same consideration is valid in case of CRC errors or incomplete response frames.

2.6.2 *Modbus timing*

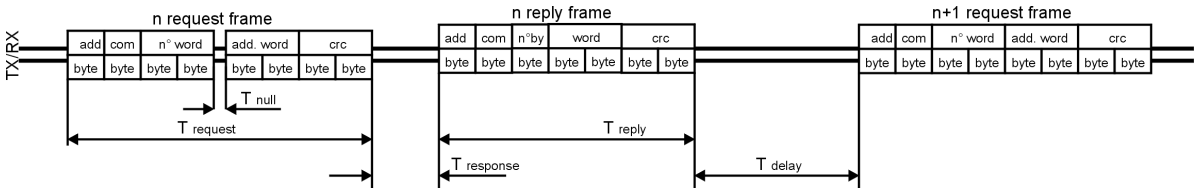


Fig. 1 : 2-wire timing diagram

TIMING CHARACTERISTICS OF READING FUNCTION:	**ms**
T response: Max answering time	500 ms
T response: Typical answering time	60 ms
T delay: Minimum time before a new query	3,5 char
T null: Max interruption time during the request frame	2,5 char

3 Data Format, Variables and parameters

3.1 Data format representation

The variables are represented by integers or floating numbers, with 2's complement notation in case of "signed" format, using the following:

Format	IEC data type	Description	Bits	Range
INT16	INT	Integer	16	-32768 .. 32767
UINT16	UINT	Unsigned integer	16	0 .. 65535
INT32	DINT	Double integer	32	-2^{31} .. 2^{31}
UINT32	UDINT	Unsigned double integer	32	0 .. $2^{32}-1$
UINT64	ULINT	Unsigned long integer	64	0 .. $2^{64}-1$
IEEE754 SP		Single-precision floating-point	32	$-(1+[1-2^{-23}])x2^{127}$ .. 2^{128}

For all the formats the byte order (inside the single word) is MSB->LSB. In INT32, UINT32 and UINT64 formats, the word order is LSW-> MSW.
For IEEE754 floating point format used for Sunspec map, the order is MSW->LSW.

3.2 Not available electrical values or invalid data

Unhandled Variables (by the system or the meter for a given system type):

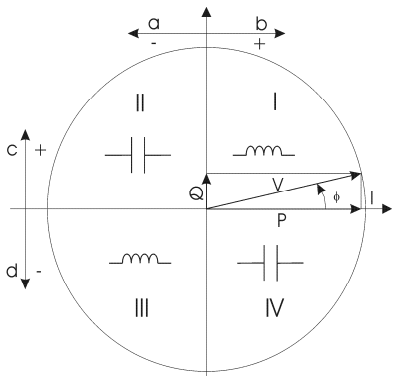
- All counters that are not handled, regardless of whether it is due to the system type or because the meter does not support them, must be set to **0** (in SunSpec: **NaN, not implemented**).
- All instantaneous variables not defined by the system type must be forced to **0** (in SunSpec: **NaN, not implemented**).
- All instantaneous variables defined by the system type but not supported by the meter must be forced to the value **"not available": 0x7FFD (0xFFFF)** (in SunSpec: **NaN, not implemented**).

Variables defined by the system type but in an error condition:

- Must be forced to the value **"invalid/error": 0x7FFF (0xFFFF)** (in SunSpec: **signaling NaN**).

3.3 Geometric representation

According to the signs of the power factor, the active power P and the reactive power Q, it is possible to obtain a geometric representation of the power vector, as indicated in the drawing below, according to EN 60253-23:



a = Exported active power

b = Imported active power

c = Imported reactive power

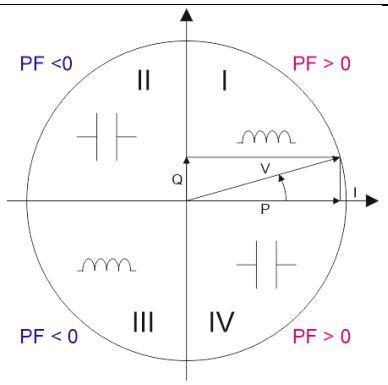
d = Exported reactive power

Fig. 2 : Geometric Representation

3.4 *Power Factor conventions*

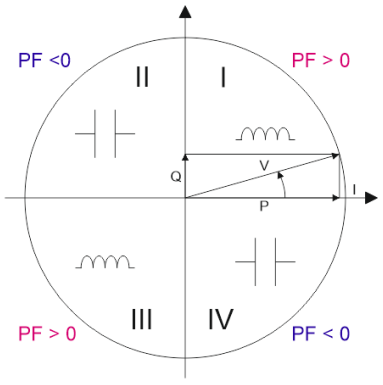
The Power Factor values are provided in different registers according to the following conventions:

- IEC convention (Modbus)
- L/C convention (Modbus)
- IEEE convention (Sunspec)



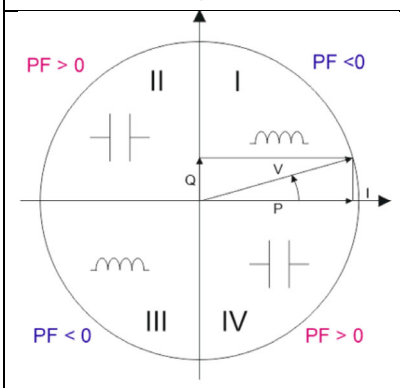
IEC convention

- when the active power is positive (consumption), the power factor is positive.
- when the active power is negative (generation), the power factor is negative.



L/C convention

- for an Inductive load the power factor is positive.
- for a Capacitive load, the power factor is negative.



IEEE convention

- for an Inductive load the power factor is negative.
- for a Capacitive load, the power factor is positive.

4 Carlo Gavazzi Modbus map

4.1 *Instantaneous variables: 3-Phase and 2-Phase Load types (2P, 3P and 3PN)*

MODBUS: read only mode with functions code 03 and 04

Modicon address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Load type			Notes
					2P	3P	3PN	
300001	0000h	2	V L1-N	INT32	Y	0	Y	Value weight: Volt*10
300003	0002h	2	V L2-N	INT32	Y	0	Y	
300005	0004h	2	V L3-N	INT32	0	0	Y	
300007	0006h	2	V L1-L2	INT32	Y	Y	Y	
300009	0008h	2	V L2-L3	INT32	0	Y	Y	
300011	000Ah	2	V L3-L1	INT32	0	Y	Y	
300013	000Ch	2	A L1	INT32	Y	Y	Y	Value weight: Ampere*1000
300015	000Eh	2	A L2	INT32	Y	Y	Y	
300017	0010h	2	A L3	INT32	0	Y	Y	
300019	0012h	2	W L1	INT32	Y	0	Y	Value weight: Watt*10
300021	0014h	2	W L2	INT32	Y	0	Y	
300023	0016h	2	W L3	INT32	0	0	Y	
300025	0018h	2	VA L1	INT32	Y	0	Y	Value weight: VA*10
300027	001Ah	2	VA L2	INT32	Y	0	Y	
300029	001Ch	2	VA L3	INT32	0	0	Y	
300031	001Eh	2	var L1	INT32	Y	0	Y	Value weight: var*10
300033	0020h	2	var L2	INT32	Y	0	Y	
300035	0022h	2	var L3	INT32	0	0	Y	
300037	0024h	2	V L-N sys	INT32	Y	0	Y	Value weight: Volt*10
300039	0026h	2	V L-L sys	INT32	Y	Y	Y	
300041	0028h	2	W sys	INT32	Y	Y	Y	Value weight: Watt*10
300043	002Ah	2	VA sys	INT32	Y	Y	Y	Value weight: VA*10

300045	002Ch	2	var sys	INT32	Y	Y	Y	Value weight: var*10
300047	002Eh	1	PF L1	INT16	Y	0	Y	Sign according to IEC convention (see Power Factor conventions) For L (inductive)/C (capacitive) load indications, see 76h to 79h registers) Value weight: PF*1000
300048	002Fh	1	PF L2	INT16	Y	0	Y	
300049	0030h	1	PF L3	INT16	0	0	Y	
300050	0031h	1	PF sys	INT16	Y	Y	Y	
300051	0032h	1	Phase sequence	INT16	0	Y	Y	The value –1 corresponds to L1-L3-L2 sequence, the value 1 corresponds to L1-L2-L3 sequence. The phase sequence value is meaningful only in a 3-phase system
300052	0033h	1	Hz	INT16	Y	Y	Y	Value weight: Hz*10
300053	0034h	2	kWh (+) TOT	INT32	Y	Y	Y	Value weight: kWh*10
300055	0036h	2	Kvarh (+) TOT	INT32	Y	Y	Y	Value weight: kvarh*10
300057	0038h	2	n.a.	INT32	n.a.	n.a.	n.a.	Not available, value =0
300059	003Ah	2	n.a.	INT32	n.a.	n.a.	n.a.	Not available, value =0
300061	003Ch	2	kWh (+) PARTIAL	INT32	Y	Y	Y	Value weight: kWh*10
300063	003Eh	2	Kvarh (+) PARTIAL	INT32	Y	Y	Y	Value weight: kvarh*10
300065	0040h	2	kWh (+) L1	INT32	Y	Y	Y	Value weight: kWh*10
300067	0042h	2	kWh (+) L2	INT32	Y	Y	Y	Value weight: kWh*10
300069	0044h	2	kWh (+) L3	INT32	0	Y	Y	Value weight: kWh*10
300071	0046h	2	kWh (+) t1.	INT32	Y	Y	Y	Value weight: kWh*10
300073	0048h	2	kWh (+) t2.	INT32	Y	Y	Y	Value weight: kWh*10
300075	004Ah	2	n.a.	INT32	n.a.	n.a.	n.a.	Not available, value =0
300077	004Ch	2	n.a.	INT32	n.a.	n.a.	n.a.	Not available, value =0
300079	004Eh	2	kWh (-) TOT	INT32	Y	Y	Y	Value weight: kWh*10
300081	0050h	2	kvarh (-) TOT	INT32	Y	Y	Y	Value weight: kvarh*10
300083	0052h	2	kWh (-) PARTIAL	INT32	Y	Y	Y	Value weight: kWh*10
300085	0054h	2	Kvarh (-) PARTIAL	INT32	Y	Y	Y	Value weight: kvarh*10
300087	0056h	2	kVAh TOT	INT32	Y	Y	Y	Value weight: kVAh*10
300089	0058h	2	kVAh PARTIAL	INT32	Y	Y	Y	Value weight: kVAh*10
300091	005Ah	2	Run hour meter	INT32	Y	Y	Y	Value weight: hours*100
300093	005Ch	2	Run hour meter kWh (-)	INT32	Y	Y	Y	Value weight: hours*100
300095	005Eh	2	n.a.	INT32	n.a.	n.a.	n.a.	Not available, value =0
300097	0060h	2	n.a.	INT32	n.a.	n.a.	n.a.	Not available, value =0
300099	0062h	2	n.a.	INT32	n.a.	n.a.	n.a.	Not available, value =0
300101	0064h	2	n.a.	INT32	n.a.	n.a.	n.a.	Not available, value =0
300103	0066h	2	n.a.	INT32	n.a.	n.a.	n.a.	Not available, value =0
300105	0068h	2	n.a.	INT32	n.a.	n.a.	n.a.	Not available, value =0
300107	006Ah	2	n.a.	INT32	n.a.	n.a.	n.a.	Not available, value =0
300109	006Ch	2	n.a.	INT32	n.a.	n.a.	n.a.	Not available, value =0
300111	006Eh	2	Run hour meter PARTIAL	INT32	Y	Y	Y	Value weight: hours*100
300113	0070h	2	Run hour meter kWh (-) PARTIAL	INT32	Y	Y	Y	Value weight: hours*100
300115	0072h	1	PF L1	INT16	Y	0	Y	Sign according to L/C convention (see Power Factor conventions) Value weight: PF*1000
300116	0073h	1	PF L2	INT16	Y	0	Y	
300117	0074h	1	PF L3	INT16	0	0	Y	
300118	0075h	1	PF sys	INT16	Y	Y	Y	
300119	0076h	1	Inductive/Capacitive Load phase 1	INT16	Y	0	Y	L (inductive)/C (capacitive) load indications: L=+1, C = -1
300120	0077h	1	Inductive/Capacitive Load phase 2	INT16	Y	0	Y	
300121	0078h	1	Inductive/Capacitive Load phase 3	INT16	0	0	Y	
300122	0079h	1	Inductive/Capacitive Load sys	INT16	Y	Y	Y	
300123	007Ah	2	n.a.	INT32	n.a.	n.a.	n.a.	Not available, value =0
300125	007Ch	2	n.a.	INT32	n.a.	n.a.	n.a.	Not available, value =0
300127	007Eh	2	n.a.	INT32	n.a.	n.a.	n.a.	Not available, value =0
300129	0080h	2	n.a.	INT32	n.a.	n.a.	n.a.	Not available, value =0
300131	0082h	2	THD A L1	INT32	Y	Y	Y	Value weight: %*100
300133	0084h	2	THD A L2	INT32	Y	Y	Y	Value weight: %*100
300135	0086h	2	THD A L3	INT32	0	Y	Y	Value weight: %*100
300137	0088h	2	n.a.	INT32	n.a.	n.a.	n.a.	Not available, value =0
300139	008Ah	2	THD V L1-N	INT32	Y	0	Y	Value weight: %*100
300141	008Ch	2	THD V L2-N	INT32	Y	0	Y	Value weight: %*100
300143	008Eh	2	THD V L3-N	INT32	0	0	Y	Value weight: %*100
300145	0090h	2	n.a.	INT32	n.a.	n.a.	n.a.	Not available, value =0
300147	0092h	2	THD V L1-L2	INT32	Y	Y	Y	Value weight: %*100
300149	0094h	2	THD V L2-L3	INT32	0	Y	Y	Value weight: %*100
300151	0096h	2	THD V L3-L1	INT32	0	Y	Y	Value weight: %*100
300153	0098h	2	An	INT32	Y	Y	Y	Value weight: Ampere*1000

Note: For 2-phase and 3-phase w/o neutral systems, the values relevant to phase 3 and/or line to neutral can still be read with a value equal to 0

4.2 *Instantaneous variables: 1-Phase Load types (AC and DC)*

MODBUS: read only mode with functions code 03 and 04

Modicon address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Load type		Notes
					1P AC	1P DC	
300001	0000h	2	V L-N	INT32	Y	Y	Value weight: Volt*10
300003	0002h	2	A	INT32	Y	Y	Value weight: Ampere*1000
300005	0004h	2	W	INT32	Y	Y	Value weight: Watt*10
300007	0006h	2	VA	INT32	Y	0	Value weight: VA*10
300009	0008h	2	Var	INT32	Y	0	Value weight: var*10
300011	000Ah	2	n.a.	INT32	n.a.	n.a.	Not available, value =0
300013	000Ch	2	n.a.	INT32	n.a.	n.a.	Not available, value =0
300015	000Eh	1	PF	INT16	Y	0	Sign according to IEC convention (see Power Factor conventions) For L (inductive)/C (capacitive) load indications, see 71h register) Value weight: PF*1000
300016	000Fh	1	Hz	INT16	Y	0	Value weight: Hz*10
300017	0010h	2	kWh (+) TOT	INT32	Y	Y	Value weight: kWh*10
300019	0012h	2	Kvarh (+) TOT	INT32	Y	0	Value weight: kvarh*10
300021	0014h	2	kWh (+) PARTIAL	INT32	Y	Y	Value weight: kWh*10
300023	0016h	2	Kvarh (+) PARTIAL	INT32	Y	0	Value weight: kvarh*10
300025	0018h	2	kWh (+) t1	INT32	Y	Y	Value weight: kWh*10
300027	001Ah	2	kWh (+) t2	INT32	Y	Y	Value weight: kWh*10
300029	001Ch	2	n.a.	INT32	n.a.	n.a.	Not available, value =0
300031	001Eh	2	n.a.	INT32	n.a.	n.a.	Not available, value =0
300033	0020h	2	kWh (-) TOT	INT32	Y	Y	Value weight: kWh*10
300035	0022h	2	kvarh (-) TOT	INT32	Y	0	Value weight: kvarh*10
300037	0024h	2	kWh (-) PARTIAL	INT32	Y	Y	Value weight: kWh*10
300039	0026h	2	kvarh (-) PARTIAL	INT32	Y	0	Value weight: kvarh*10
300041	0028h	2	kVAh TOT	INT32	Y	0	Value weight: kVAh*10
300043	002Ah	2	kVAh PARTIAL	INT32	Y	0	Value weight: kVAh*10
300045	002Ch	2	Hour counter	INT32	Y	Y	Value weight: hours*100
300047	002Eh	2	Hour counter Neg	INT32	Y	Y	Value weight: hours*100,
300049	0030h	2	Lifetime counter	INT32	Y	Y	Value weight: hours*100,
300051	0032h	2	THD A	INT32	Y	0	Value weight: %*100
300053	0034h	2	THD V L-N	INT32	Y	0	Value weight: %*100
300055	0036h	2	Hour counter PARTIAL	INT32	Y	Y	Value weight: hours*100
300057	0038h	2	Hour counter Neg PARTIAL	INT32	Y	Y	Value weight: hours*100,
300059	003Ah	2	n.a.	INT32	n.a.	n.a.	Not available, value =0
300061	003Ch	2	n.a.	INT32	n.a.	n.a.	Not available, value =0
300063	003Eh	2	n.a.	INT32	n.a.	n.a.	Not available, value =0
300065	0040h	2	n.a.	INT32	n.a.	n.a.	Not available, value =0
300067	0042h	2	n.a.	INT32	n.a.	n.a.	Not available, value =0
300069 to 300112	0044h to 006Fh		n.a.	INT32	n.a.	n.a.	Not available, value =0
300113	0070h	1	PF	INT16	Y	0	Sign according to L/C convention (see Power Factor conventions) Value weight: PF*1000
300114	0071h	1	Inductive/Capacitive Load	INT16	Y	0	L (inductive)/C (capacitive) load indications: L=+1, C = -1

Note: For meters DC systems, the values not managed can still be read with a valid equal to 0

4.3 *Other Instantaneous variables (read only, Only EMS main meter)*

Modicon address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
300769	0300h	1	Digital input status	INT16	0 = input open 1 = input closed ***NOTE: Only for EMS main meter***
300770	0301h	1	Active tariff	INT16	0 = no-one 1 = tariff 1 2 = tariff 2 ***NOTE: Only for EMS main meter***
300774	0305h	1	Reserved	UINT 16	
300775	0306h	1	Alarm status	INT16	0 = not active (including waiting for delay to elapse) 1 = active ***NOTE: Only for EMS main meter***

Note: If read by a meter different than EMS main meter an exception is generated.

4.4 *High resolution variables and energy counters (read only)*

MODBUS: read only mode with functions code 03 and 04

Modicon address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Load type					Notes
					2P	3P	3PN	1P AC	1P DC	
301281	0500h	4	kWh (+) TOT	INT64	Y	Y	Y	Y	Y	Value weight: Wh
301285	0504h	4	Kvarh (+) TOT	INT64	Y	Y	Y	Y	0	Value weight: VARh
301289	0508h	4	kWh (+) PARTIAL	INT64	Y	Y	Y	Y	Y	Value weight: Wh
301293	050Ch	4	Kvarh (+) PARTIAL	INT64	Y	Y	Y	Y	0	Value weight: VARh
301297	0510h	4	kWh (+) L1	INT64	Y	0	Y	0	0	Value weight: Wh
301301	0514h	4	kWh (+) L2	INT64	Y	0	Y	0	0	
301305	0518h	4	kWh (+) L3	INT64	0	0	Y	0	0	
301309	051Ch	4	kWh (-) TOT	INT64	Y	Y	Y	Y	Y	Value weight: Wh
301313	0520h	4	kWh (-) PARTIAL	INT64	Y	Y	Y	Y	Y	Value weight: Wh
301317	0524h	4	kvarh (-) TOT	INT64	Y	Y	Y	Y	0	Value weight: varh
301321	0528h	4	kvarh (-) Partial	INT64	Y	Y	Y	Y	0	Value weight: varh
301325	052Ch	4	kVAh TOT	INT64	Y	Y	Y	Y	0	Value weight: VAh
301329	0530h	4	kVAh PARTIAL	INT64	Y	Y	Y	Y	0	Value weight: VAh
301333	0534h	2	Run hour meter	INT32	Y	Y	Y	Y	Y	Value weight: hours*100
301335	0536h	2	Run hour meter kWh (-)	INT32	Y	Y	Y	Y	Y	Value weight: hours*100
301337	0538h	2	Run hour meter PARTIAL	INT32	Y	Y	Y	Y	Y	Value weight: hours*100
301339	053Ah	2	Run hour meter kWh (-) PARTIAL	INT32	Y	Y	Y	Y	Y	Value weight: hours*100
301341	053Ch	2	Hz	INT32	Y	Y	Y	Y	0	Value weight: Hz*1000
301343	053Eh	2	Run hour Life Counter	INT32	Y	Y	Y	Y	Y	Value weight: hours*100
301345	0540h	4	kWh (+) T1	INT64	Y	Y	Y	Y	Y	Value weight: Wh
301349	0544h	4	kWh (+) T2	INT64	Y	Y	Y	Y	Y	Value weight: Wh
301353	0548h	4	kWh (-) L1	INT64	Y	0	Y	0	0	Value weight: Wh
301357	054Ch	4	kWh (-) L2	INT64	Y	0	Y	0	0	Value weight: Wh
301361	0550h	4	kWh (-) L3	INT64	0	0	Y	0	0	Value weight: Wh
301365	0554h	4	kWh Quadrant I	INT64	Y	Y	Y	Y	0	Value weight: Wh
301369	0558h	4	kWh Quadrant II	INT64	Y	Y	Y	Y	0	Value weight: Wh
301373	055Ch	4	kWh Quadrant III	INT64	Y	Y	Y	Y	0	Value weight: Wh
301377	0560h	4	kWh Quadrant IV	INT64	Y	Y	Y	Y	0	Value weight: Wh
301381	0564h	4	kvarh Quadrant I	INT64	Y	Y	Y	Y	0	Value weight: VARh
301385	0568h	4	kvarh Quadrant II	INT64	Y	Y	Y	Y	0	Value weight: VARh
301389	056Ch	4	kvarh Quadrant III	INT64	Y	Y	Y	Y	0	Value weight: VARh
301393	0570h	4	kvarh Quadrant IV	INT64	Y	Y	Y	Y	0	Value weight: VARh
301397	0574h	4	kVAh Quadrant I	INT64	Y	Y	Y	Y	0	Value weight: VAh
301401	0578h	4	kVAh Quadrant II	INT64	Y	Y	Y	Y	0	Value weight: VAh
301405	057Ch	4	kVAh Quadrant III	INT64	Y	Y	Y	Y	0	Value weight: VAh
301409	0580h	4	kVAh Quadrant IV	INT64	Y	Y	Y	Y	0	Value weight: Vah
...										
301537	0600h	4	kWh (+) TOT	INT64	Y	Y	Y	Y	Y	Value weight: Wh*10
301541	0604h	4	kWh (-) TOT	INT64	Y	Y	Y	Y	Y	Value weight: Wh*10

Note: If unmanaged, counters are forced to 0

4.5 *Firmware version and revision code (only main meter)*

MODBUS: read only mode with functions code 03 and 04 limited to a word at a time

Modicon address	Physical address	Length [word]	VARIABLE ENG. UNIT	Data Format	Notes	Default
300771	0302h	1	Major, Minor and Patch Number	UINT 16	MSB: Bit 0..3 = Minor Bit 4..7 = Major (e.g. 01000011b / 43h / 67d = 4.3) LSB: Patch Number	N/A
300772	0303h	1	Reserved	UINT 16		N/A
300785	0310h	1	Reserved	UINT 16		N/A

4.6 *Carlo Gavazzi Controls identification code*

MODBUS: read only mode with functions code 03 and 04 limited to a word

Modicon address	Physical address	Length [word]	VARIABLE ENG. UNIT	Data Format	Notes	Default
300012	000Bh	1	Carlo Gavazzi Controls identification code	UINT 16	Values: 2016d = EMS MV5 main meter - 1P load 2017d = EMS AV5 main meter - 1P load 2018d = EMS AV2 main meter - 1P load 2032d = EMS MV5 main meter - 2P/3P/3PN load 2033d = EMS AV5 main meter - 2P/3P/3PN load 2034d = EMS AV2 main meter - 2P/3P/3PN load 2048d = EMS - ESY/external meter - 1P load 2064d = EMS - ESY/external meter - 2P/3P/3PN load	N/A

4.7 *Output command (Only EMS main meter)*

MODBUS: write mode with function code 06

Modicon address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
316641	4100h	1	Digital output command	INT16	0 = output open 1 = output closed Other Values: no effect Notes: - a reading to this resister always returns 0 - if the output is not configured as "REMOTE" the command has no effect ***NOTE: Only for EMS main meter***

Note: If write to a meter different than EMS main meter an exception is generated.

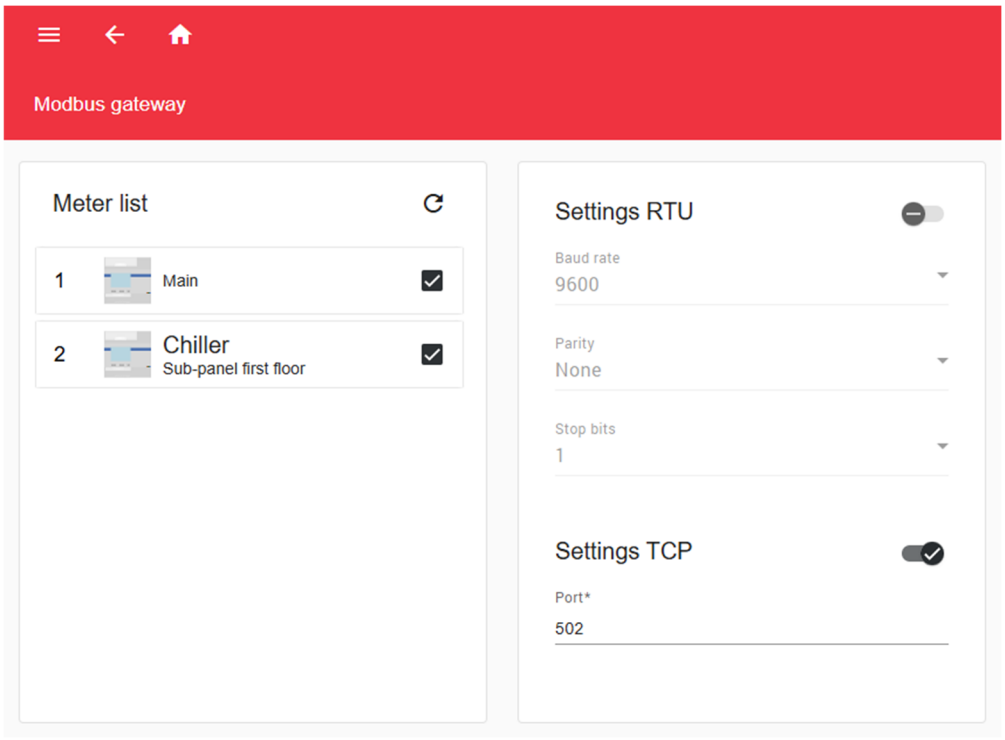
5 Multi- load management

When the EMS operates in multi-meter mode (i.e., acting as a concentrator for data received from external meters or ESY devices), the Modbus mapping of the variables coming from the other instruments follows the structure described in sections 4.1 and 4.2, while the Modbus ID is changed accordingly.

The main meter (EMS) is by default assigned Modbus ID = 1, but this value can be changed by the user. The other loads use the Modbus IDs assigned within the configuration window of the Modbus Gateway service (webApp).

In the following figure, the EMS reads data from an external meter that has been mapped with Modbus ID 2.

In this scenario, to retrieve the system power measured by the EMS (W sys), register 0028h must be read using Modbus ID=1. Conversely, to obtain the system power from the second external meter, the same register (0028h) must be accessed using Modbus ID=2.


Modbus gateway
Meter list
1
Main
2
Chiller
Sub-panel first floor
Settings RTU
Baud rate
9600
Parity
None
Stop bits
1
Settings TCP
Port*
502

6 SunSpec maps

EMS supports the following SunSpec model types, according to the Load Type:

Model	Description	Starting address	Applies to Meters with Load Type
1	Common	0x9C42	All
211	Single phase (AN or AB) meter	0x9C85	1P (both AC and DC)
212	Split single phase (ABN) meter	0x9C85	2P
213	Wye-connect three phase (abcn) meter	0x9C85	3PN
214	Delta-connect three phase (abc) meter	0x9C85	3P

In models 211, 212, 213 and 214:

- not implemented values are represented with a value 0x7FC00000 (quiet NaN or qNaN).
- implemented value that can't be provided for any reason (device internal problem, value not measurable because out of range, missing measuring sensor, etc.), is represented with a value 0x7FA00000 (signaling NaN or sNaN).

Evt field is always 0.

Only implemented values are reported in the maps in the next paragraphs.

6.1 *1 - Common model*

Modbus Address	Address Offset	Name	Value	Type	Size	Mandatory (M)	Static (S)	Label	Description
9C42h	0	ID	1	uint16		M	S	Model ID	Model identifier
9C43h	1	L	65	uint16		M	S	Model Length	Model length
9C44h	2	Mn	"CARLO-GAVAZZI-CONTROLS"	string	16	M	S	Manufacturer	Well known value registered with SunSpec for compliance
9C54h	18	Md	See Description	string	16	M	S	Model	EMS part number: "EMS10AV2O1X" "EMS10AV2S1X" "EMS10AV5O1X" "EMS10AV5S1X" "EMS10MV5O1X" "EMS10MV5S1X"
9C64h	34	Opt	""	string	8		S	Options	Not used
9C6Ch	42	Vr	See Description	string	8		S	Version	Major.Minor.PatchNumber Eg. "1.0.0."
9C74h	50	SN	See Description	string	16	M	S	Serial Number	Serial number (13 characters)
9C84h	66	DA		uint16				Device Address	Not used
9C85h	67	Pad	32768	pad			S		Force even alignment

6.2 *211 - Single phase (AN or AB) meter (1P Load Type)*

Modbus Address	Address Offset	Name	Value	Type	Units	Mandatory (M)	Static (S)	Label	Description
9C86h	0	ID	211	uint16		M	S	Model ID	Model identifier
9C87h	1	L	124	uint16		M	S	Model Length	Model length
9C88h	2	A		float32	A	M		Amps	Total AC Current
9C8Ah	4	AphA		float32	A	M		Amps PhaseA	Phase A Current
9C90h	10	PhV		float32	V			Voltage LN	Line to Neutral AC Voltage (average of active phases)
9CA0h	26	Hz		float32	Hz	M		Hz	Frequency
9CA2h	28	W		float32	W	M		Watts	Total Real Power
9CAAh	36	VA		float32	VA			VA	AC Apparent Power
9CB2h	44	VAR		float32	var			VAR	Reactive Power
9CBAh	52	PF		float32	PF			PF	Power Factor

9CC2h	60	TotWhExp		float32	Wh	M		Total Watt-hours Exported	Total Real Energy Exported
9CCAh	68	TotWhImp		float32	Wh	M		Total Watt-hours Imported	Total Real Energy Imported
9CE2h	92	TotVArhImpQ1		float32	varh			Total VAR-hours Imported Q1	Total Reactive Energy Imported Quadrant 1
9CEAh	100	TotVArhImpQ2		float32	varh			Total VAr-hours Imported Q2	Total Reactive Power Imported Quadrant 2
9CF2h	108	TotVArhExpQ3		float32	varh			Total VAr-hours Exported Q3	Total Reactive Power Exported Quadrant 3
9CFAh	116	TotVArhExpQ4		float32	varh			Total VAr-hours Exported Q4	Total Reactive Power Exported Quadrant 4
9D02h	124	Evt		bitfield32		M		Events	Meter Event Flags

6.3 *212 - split single phase (ABN) meter (3P Load Type)*

Modbus Address	Address Offset	Name	Value	Type	Units	Mandatory (M)	Static (S)	Label	Description
9C86	0	ID	212	uint16		M	S	Model ID	Model identifier
9C87	1	L	124	uint16		M	S	Model Length	Model length
9C88	2	A		float32	A	M		Amps	Total AC Current
9C8A	4	AphA		float32	A	M		Amps PhaseA	Phase A Current
9C8C	6	AphB		float32	A	M		Amps PhaseB	Phase B Current
9C90	10	PhV		float32	V	M		Voltage LN	Line to Neutral AC Voltage (average of active phases)
9C92	12	PhVphA		float32	V	M		Phase Voltage AN	Phase Voltage AN
9C94	14	PhVphB		float32	V	M		Phase Voltage BN	Phase Voltage BN
9C98	18	PPV		float32	V	M		Voltage LL	Line to Line AC Voltage (average of active phases)
9C9A	20	PPVphAB		float32	V	M		Phase Voltage AB	Phase Voltage AB
9CA0	26	Hz		float32	Hz	M		Hz	Frequency
9CA2	28	W		float32	W	M		Watts	Total Real Power
9CA4	30	WphA		float32	W			Watts phase A	
9CA6	32	WphB		float32	W			Watts phase B	
9CAA	36	VA		float32	VA			VA	AC Apparent Power
9CAC	38	VAphA		float32	VA			VA phase A	
9CAE	40	VAphB		float32	VA			VA phase B	
9CB2	44	VAR		float32	var			VAR	Reactive Power
9CB4	46	VARphA		float32	var			VAR phase A	
9CB6	48	VARphB		float32	var			VAR phase B	
9CBA	52	PF		float32	PF			PF	Power Factor
9CBC	54	PFphA		float32	PF			PF phase A	
9CBE	56	PFphB		float32	PF			PF phase B	
9CC2	60	TotWhExp		float32	Wh	M		Total Watt-hours Exported	Total Real Energy Exported
9CC4	62	TotWhExpPhA		float32	Wh			Total Watt-hours Exported phase A	
9CC6	64	TotWhExpPhB		float32	Wh			Total Watt-hours Exported phase B	
9CCA	68	TotWhImp		float32	Wh	M		Total Watt-hours Imported	Total Real Energy Imported
9CCC	70	TotWhImpPhA		float32	Wh			Total Watt-hours Imported phase A	
9CCE	72	TotWhImpPhB		float32	Wh			Total Watt-hours Imported phase B	
9CE2	92	TotVArhImpQ1		float32	varh			Total VAR-hours Imported Q1	Total Reactive Energy Imported Quadrant 1
9CEA	100	TotVArhImpQ2		float32	varh			Total VAr-hours Imported Q2	Total Reactive Power Imported Quadrant 2
9CF2	108	TotVArhExpQ3		float32	varh			Total VAr-hours Exported Q3	Total Reactive Power Exported Quadrant 3
9CFA	116	TotVArhExpQ4		float32	varh			Total VAr-hours Exported Q4	Total Reactive Power Exported Quadrant 4
9D02	124	Evt		bitfield32		M		Events	Meter Event Flags

6.4 *213 - wye-connect three phase (abcn) meter (3PN Load Type)*

Modbus Address	Address Offset	Name	Value	Type	Units	Mandatory (M)	Static (S)	Label	Description
9C86	0	ID	213	uint16		M	S	Model ID	Model identifier
9C87	1	L	124	uint16		M	S	Model Length	Model length
9C88	2	A		float32	A	M		Amps	Total AC Current (nota: I1+I2+I3)
9C8A	4	AphA		float32	A	M		Amps PhaseA	Phase A Current
9C8C	6	AphB		float32	A	M		Amps PhaseB	Phase B Current
9C8E	8	AphC		float32	A	M		Amps PhaseC	Phase C Current
9C90	10	PhV		float32	V	M		Voltage LN	Line to Neutral AC Voltage (average of active phases)
9C92	12	PhVphA		float32	V	M		Phase Voltage AN	Phase Voltage AN
9C94	14	PhVphB		float32	V	M		Phase Voltage BN	Phase Voltage BN
9C96	16	PhVphC		float32	V	M		Phase Voltage CN	Phase Voltage CN
9C98	18	PPV		float32	V	M		Voltage LL	Line to Line AC Voltage (average of active phases)
9C9A	20	PPVphAB		float32	V	M		Phase Voltage AB	Phase Voltage AB
9C9C	22	PPVphBC		float32	V	M		Phase Voltage BC	Phase Voltage BC
9C9E	24	PPVphCA		float32	V	M		Phase Voltage CA	Phase Voltage CA
9CA0	26	Hz		float32	Hz	M		Hz	Frequency
9CA2	28	W		float32	W	M		Watts	Total Real Power
9CA4	30	WphA		float32	W			Watts phase A	
9CA6	32	WphB		float32	W			Watts phase B	
9CA8	34	WphC		float32	W			Watts phase C	
9CAA	36	VA		float32	VA			VA	AC Apparent Power
9CAC	38	VAphA		float32	VA			VA phase A	
9CAE	40	VAphB		float32	VA			VA phase B	
9CB0	42	VAphC		float32	VA			VA phase C	
9CB2	44	VAR		float32	var			VAR	Reactive Power
9CB4	46	VARphA		float32	var			VAR phase A	
9CB6	48	VARphB		float32	var			VAR phase B	
9CB8	50	VARphC		float32	var			VAR phase C	
9CBA	52	PF		float32	PF			PF	Power Factor
9CBC	54	PFphA		float32	PF			PF phase A	
9CBE	56	PFphB		float32	PF			PF phase B	
9CC0	58	PFphC		float32	PF			PF phase C	
9CC2	60	TotWhExp		float32	Wh	M		Total Watt-hours Exported	Total Real Energy Exported
9CC4	62	TotWhExpPhA		float32	Wh			Total Watt-hours Exported phase A	
9CC6	64	TotWhExpPhB		float32	Wh			Total Watt-hours Exported phase B	
9CC8	66	TotWhExpPhC		float32	Wh			Total Watt-hours Exported phase C	
9CCA	68	TotWhImp		float32	Wh	M		Total Watt-hours Imported	Total Real Energy Imported
9CCC	70	TotWhImpPhA		float32	Wh			Total Watt-hours Imported phase A	
9CCE	72	TotWhImpPhB		float32	Wh			Total Watt-hours Imported phase B	
9CD0	74	TotWhImpPhC		float32	Wh			Total Watt-hours Imported phase C	
9CE2	92	TotVArhImpQ1		float32	varh			Total VAR-hours Imported Q1	Total Reactive Energy Imported Quadrant 1
9CEA	100	TotVArhImpQ2		float32	varh			Total VAr-hours Imported Q2	Total Reactive Power Imported Quadrant 2
9CF2	108	TotVArhExpQ3		float32	varh			Total VAr-hours Exported Q3	Total Reactive Power Exported Quadrant 3
9CFA	116	TotVArhExpQ4		float32	varh			Total VAr-hours Exported Q4	Total Reactive Power Exported Quadrant 4
9D02	124	Evt		bitfield32		M		Events	Meter Event Flags

6.5 *214 - Delta-connect three phase (abc) meter (3P Load Type)*

Modbus Address	Address Offset	Name	Value	Type	Units	Mandatory (M)	Static (S)	Label	Description
9C86	0	ID	214	uint16		M	S	Model ID	Model identifier
9C87	1	L	124	uint16		M	S	Model Length	Model length
9C88	2	A		float32	A	M		Amps	Total AC Current (nota: I1+I2+I3)
9C8A	4	AphA		float32	A	M		Amps PhaseA	Phase A Current
9C8C	6	AphB		float32	A	M		Amps PhaseB	Phase B Current
9C8E	8	AphC		float32	A	M		Amps PhaseC	Phase C Current
9C98	18	PPV		float32	V	M		Voltage LL	Line to Line AC Voltage (average of active phases)
9C9A	20	PPVphAB		float32	V	M		Phase Voltage AB	Phase Voltage AB
9C9C	22	PPVphBC		float32	V	M		Phase Voltage BC	Phase Voltage BC
9C9E	24	PPVphCA		float32	V	M		Phase Voltage CA	Phase Voltage CA
9CA0	26	Hz		float32	Hz	M		Hz	Frequency
9CA2	28	W		float32	W	M		Watts	Total Real Power
9CAA	36	VA		float32	VA			VA	AC Apparent Power
9CB2	44	VAR		float32	var			VAR	Reactive Power
9CBA	52	PF		float32	PF			PF	Power Factor
9CC2	60	TotWhExp		float32	Wh	M		Total Watt-hours Exported	Total Real Energy Exported
9CCA	68	TotWhImp		float32	Wh	M		Total Watt-hours Imported	Total Real Energy Imported
9CE2	92	TotVArhImpQ1		float32	varh			Total VAR-hours Imported Q1	Total Reactive Energy Imported Quadrant 1
9CEA	100	TotVArhImpQ2		float32	varh			Total VAr-hours Imported Q2	Total Reactive Power Imported Quadrant 2
9CF2	108	TotVArhExpQ3		float32	varh			Total VAr-hours Exported Q3	Total Reactive Power Exported Quadrant 3
9CFA	116	TotVArhExpQ4		float32	varh			Total VAr-hours Exported Q4	Total Reactive Power Exported Quadrant 4
9D02	124	Evt		bitfield32		M		Events	Meter Event Flags