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# VMU-E

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## COMMUNICATION PROTOCOL

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## 1.1 Introduction

The RS485 serial interface supports the MODBUS/JBUS (RTU) protocol. In this document only the information necessary to read/write from/to EM21 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 "Modbus\_Application\_Protocol\_V1\_1a.pdf" document that is downloadable from the [www.modbus.org](http://www.modbus.org) web site.

## 1.2 MODBUS functions

These functions are available on EM21:

- Reading of n "Holding Registers" (code 03h)
- Reading of n "Input Register" (code 04h)
- Writing of one "Holding Registers" (code 06h)
- Diagnostic (code 08h with sub-function code 00h)
- Broadcast mode (writing instruction on address 00h)

### IMPORTANT:

- 1) In this document the "Modbus address" field is indicated in two modes:
  - 1.1) "**Modicom address**": it is the "6-digit Modicom" 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 (refer to EM21 instruction manual)

### 1.2.1 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 11 registers (words) with a single request, when not differently specified.

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 10h (1 to 11)	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		

## 1.2.2 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 11 register (word) with a single request, when not differently specified. 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 10h (1 to 11)	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		

## 1.2.3 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		

### 1.2.4 Function 08h (Diagnostic with sub-function code 00h)

MODBUS function 08h provides a series of tests to check the communication system between a client (Master) device and a server (Slave), or to check various internal error conditions in a server.

EM24-DIN supports only 0000h sub-function code (Return Query Data). With this sub-function the data passed in the request data field is to be returned (looped back) in the response. The entire response message should be identical to the request.

### Request frame

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	
Function code	1 byte	08h	
Sub-function	2 bytes	0000h	
Data (N word)	N *2 bytes	Data	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	08h	
Sub-function	2 bytes	0000h	
Data (N word)	N *2 bytes	Data	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	88h	
Exception code	1 byte	01h, 02h, 03h, 04h	
CRC	2 bytes		

### 1.2.5 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 using address 00h.

## 1.3 Application notes

### 1.3.1 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 and at the end (inserting a 120 ohm 1/2W 5% resistor between line B and A in the last instrument and in the Host interface).
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 EM21 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. Connect GND to the shield if a shielded cable is used.
5. The GND is to 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.

### 1.3.2 MODBUS timing

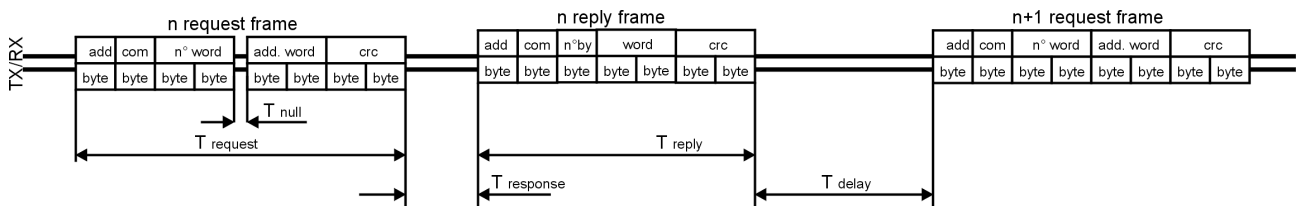


Fig. 1 : 2-wire timing diagram

Timing characteristics of reading function:	msec
T response: Max answering time	500ms
T response: Typical answering time	40ms
T delay: Minimum time before a new query	3,5char
T null: Max interruption time during the request frame	2,5char

## 2 TABLES

### 2.1 Data format representation In Carlo Gavazzi instruments

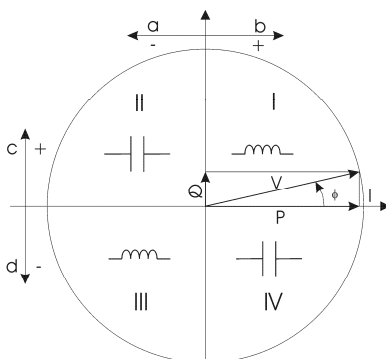
The variables are represented by integers or floating numbers, with 2's complement notation in case of "signed" format, using the following:

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 int	32	$0 .. 2^{32}-1$
UINT64	ULINT	Unsigned long integer	64	$0 .. 2^{64}-1$
IEEE754 SP		Single-precision floating-point	32	$-(1+[1 - 2^{-23}]) \times 2^{127} .. 2^{128}$

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.

#### 2.1.1 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

### 2.2 Maximum and minimum electrical values in EM20

The maximum electrical input values are reported in the following table. If the input is above the maximum value the display shows "EEE".

Table 2.1-1

	Min value	Max value
V	0VDC	500VDC
Adirect	0ADC	22ADC
Vshunt	0mVDC	130mVDC
Ishunt	0.0DGT	999.9DGT

The overflow indication "EEE" is displayed when the MSB value of the relevant variable is 7FFFh.

## 2.3 Instantaneous variables and meters

MODBUS: read only mode with functions code 03 and 04

Table 2.3-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
300001	0000h	2	V	INT32	Value weight: Volt*10
300003	0002h	2	I (direct)	INT32	Value weight: Ampere*100
300005	0004h	2	I (shunt)	INT32	Value weight: Ampere*10
300007	0006h	2	W	INT32	Value weight: kWatt*100 (Idirect) Value weight: kWatt*10 (Ishunt)
300009	0008h	2	Vmin	INT32	Value weight: Volt*10
300011	000Ah	2	Vmax	INT32	Value weight: Volt*10
300013	000Ch	2	Imin (direct)	INT32	Value weight: Ampere*100
300015	000Eh	2	Imax (direct)	INT32	Value weight: Ampere*100
300017	0010h	2	Imin (shunt)	INT32	Value weight: Ampere*10
300019	0012h	2	Imax (shunt)	INT32	Value weight: Ampere*10
300021	0014h	2	Wmin	INT32	Value weight: kWatt*100 (Idirect) Value weight: kWatt*10 (Ishunt)
300023	0016h	2	Wmax	INT32	Value weight: kWatt*100 (Idirect) Value weight: kWatt*10 (Ishunt)
300025	0018h	2	kWh	INT32	Value weight: kWh*10 (Idirect) Value weight: kWh (Ishunt)
300027	001Ah	1	Alarm	INT16	=0 no alarm; <0 alarm

## 2.4 Firmware version and revision code

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

Table 2.4-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
300771	0302h	1	Version code	UINT 16	0: versione A 1: versione B ...
300772	0303h	1	Revision code	UINT 16	0: revisione 0 1: revisione 1 ...

## 2.5 Carlo Gavazzi Controls identification code

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

Table 2.5-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
300012	000Bh	1	Carlo Gavazzi Controls identification code	UINT 16	Value= 63

## 2.6 Programming parameter tables

NOTA: programmando lo strumento tramite la seriale RS485 i valori non appartenenti all'intervallo di validità di un parametro di programmazione numerico sono associati per default al valore massimo dell'intervallo mentre se il parametro è una selezione è associato il valore zero.

### 2.6.1 Password configuration menu

MODBUS: read and write mode

Table 2.6-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
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304097	1000h	1	PASSWORD	UINT 16	Minimum valid value: 0d Maximum valid value: 9999d
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## 2.6.2 Pulse output configuration menu

**MODBUS:** read and write mode

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
304098	1001h	1	Kwh per pulse relativi ad OUT	UINT 16	Value min = 1 (0.01Kwh) Value max = 1000 (10.00Kwh)

## 2.6.3 Pulse output configuration menu

**MODBUS:** read and write mode

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
304099	1002h	1	FUNZIONE DIGITAL OUTPUT	UINT 16	0 = PULSE 1 = ALARM

## 2.6.4 Alarm menu

**MODBUS:** read and write mode

Table 2.6-2

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
304100	1003h	1	Type of alarm	UINT 16	Value=0: none Value=1: "V" alarm Value=2: "A" alarm Value=3: "kW" alarm

## 2.6.5 Set point

**MODBUS:** read and write mode

Table 2.6-3

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
304101	1004h	1	Set point A	UINT 16	"V" alarm: value min = 0.0V value max = 999.9V
304102	1005h	1	Set point B	UINT 16	"I direct" alarm: value min = 0.00A value max = 99.99A "I shunt" alarm: value min = 0.0A value max = 999.9A "kW direct" alarm: value min = 0.00kW value max = 999.9kW "kW shunt" alarm: value min = 0.0kW value max = 999.9kW

## 2.6.6 Tempi di attivazione/disattivazione allarmi

**MODBUS:** read and write mode

Table

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
304103	1006h	1	Ritardo attivazione allarme	UINT 16	Value min = 0s Value max = 9999s



304104	1007h	1	Ritardo disattivazione allarme	UINT 16	Value min = 0s Value max = 9999s
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### 2.6.7 Tipo ingresso

**MODBUS:** read and write mode

Table

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
304105	1008h	1	Tipo ingresso in corrente	UINT 16	Value 0: direct Value 1: shunt

### 2.6.8 Parametri shunt

**MODBUS:** read and write mode

Table

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
304106	1009h	1	Input full-scale	UINT 16	Value min = 0.0 mV Value max = 120.0 mV
304107	100Ah	1	Display full-scale	UINT 16	Value min = 0.0 Value max = 999.9

### 2.6.9 Serial port configuration menu

**MODBUS:** read and write mode

Table 2.6-4

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
304108	100Bh	1	RS485 instrument address	UINT 16	Value min = 1 Value max = 247
304109	100Ch	1	Baud-rate	UINT 16	Value 0: 9600 Value 1: 19200 Value 2: 38400 Value 3: 115200

Note: The number of stop bits is fixed to "1" and the parity control is fixed to "none".

**Cambiando il baud-rate la risposta dello strumento avviene con il baud\_rate nuovo**

### Reset command

**MODBUS:** write only mode

Table

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
312289	3000h	1	Reset measure	UINT 16	Value=1: kWh reset Value=2: Vmin, Vmax, Imin, Imax, kWmin, kWmax reset