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# EM272

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## COMMUNICATION PROTOCOL

Version 1 Revision 0

June 6<sup>th</sup>, 2017

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# 1 Introduction

## 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 EM272 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 this EM272 model:

- 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 the EM272 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 18 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 18 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. EM272 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 (master side, if not already embedded, by inserting a 120 ohm 1/2W 5% resistor between line B and A) and at the end (by connecting the terminals B+ and 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 EM272 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

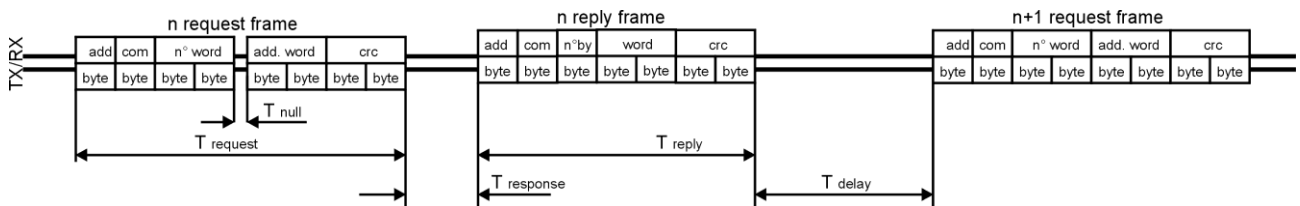


Fig. 1 : 2-wire timing diagram

Timing characteristics of reading function:	ms
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

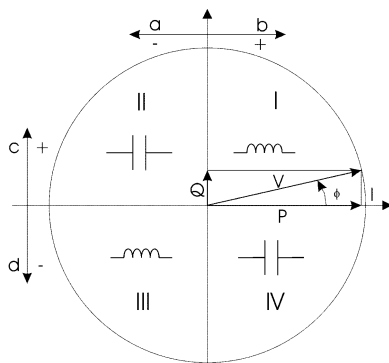
The variables are represented by integers or floating numbers, with 2's complement notation in case of "signed" format, using the following:

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.

### 2.2 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

### 2.3 Maximum electrical values in EM272

The maximum electrical input values are reported into the instrument data sheet. A variable being in overflow is represented by the number 7FFF FFFFh and displayed as "EEE".

2.4 Instantaneous variables and meters (grouped by phase)

MODBUS: read only mode with functions code 03 and 04

Table 2.4-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
<b>System variables</b>					
300259	0102h	2	V L-N sys (***)	INT32	Value weight: Volt*10
300261	0104h	2	V L-L sys (**)	INT32	
300263	0106h	2	kW sys (***)	INT32	Value weight: Watt*10
300265	0108h	2	kVA sys (***)	INT32	Value weight: VA*10
300267	010Ah	2	kvar sys (***)	INT32	Value weight: var*10
300269	010Ch	2	PF sys (***)	INT32	(*) Value weight: PF*1000
300271	010Eh	2	n.a.	INT32	Not available, value =0
300273	0110h	2	Hz	INT32	Value weight: Hz*10 (note: resolution = 1Hz)
<b>Total energies and dmd power</b>					
300275	0112h	2	kWh (+) TOT	INT32	Value weight: kWh*10
300277	0114h	2	Kvarh (+) TOT	INT32	Value weight: kvarh*10
300279	0116h	2	kWh (-) TOT	INT32	Value weight: kWh*10
300281	0118h	2	kvarh (-) TOT	INT32	Value weight: kvarh*10
300283	011Ah	2	W dmd	INT32	Value weight: Watt*10
300285	011Ch	2	W dmd peak	INT32	Value weight: Watt*10
<b>Phase 1 variables</b>					
300287	011Eh	2	V L1-L2 (**)	INT32	Value weight: Volt*10
300289	0120h	2	V L1-N	INT32	Value weight: Volt*10
300291	0122h	2	A L1	INT32	Value weight: Ampere*1000
300293	0124h	2	kW L1	INT32	Value weight: Watt*10
300295	0126h	2	kVA L1	INT32	Value weight: VA*10
300297	0128h	2	kvar L1	INT32	Value weight: var*10
300299	012Ah	2	PF L1	INT32	(*) Value weight: PF*1000
<b>Phase 2 variables</b>					
300301	012Ch	2	V L2-L3 (**)	INT32	Value weight: Volt*10
300303	012Eh	2	V L2-N (**)	INT32	Value weight: Volt*10
300305	0130h	2	A L2 (**)	INT32	Value weight: Ampere*1000
300307	0132h	2	kW L2 (**)	INT32	Value weight: Watt*10
300309	0134h	2	kVA L2 (**)	INT32	Value weight: VA*10
300311	0136h	2	kvar L2 (**)	INT32	Value weight: var*10
300313	0138h	2	PF L2 (**)	INT32	(*) Value weight: PF*1000
<b>Phase 3 variables</b>					
300315	013Ah	2	V L3-L1 (**)	INT32	Value weight: Volt*10
300317	013Ch	2	V L3-N (**)	INT32	Value weight: Volt*10
300319	013Eh	2	A L3 (**)	INT32	Value weight: Ampere*1000
300321	0140h	2	kW L3 (**)	INT32	Value weight: Watt*10
300323	0142h	2	kVA L3 (**)	INT32	Value weight: VA*10
300325	0144h	2	kvar L3 (**)	INT32	Value weight: var*10
300327	0146h	2	PF L3 (**)	INT32	(*) Value weight: PF*1000

(\*): Negative values correspond to exported active power; positive values correspond to imported active power.

(\*\*): Not available in case of 1P system type (values = 7FFD FFFFh)

(\*\*\*): In case of 1P system type, the system variables are a copy of the single-phase ones.

NOTE 1: in case of TCD missing the value of the related variables are forced to 7FFE FFFFh.

NOTE 2: the values in this table are relevant to the input A1 if ADD1 is used as instrument serial address, to the input A2 if ADD2 is used as instrument serial address (see [Serial port configuration menu](#)).

2.5 Firmware version and revision 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
300771	0302h	1	Major, Minor and Revision	UINT 16	MSB: Bit 0..3 = Minor Bit 4..7 = Major (e.g. 00010011b / 13h = 1.3) LSB: Revision
300772	0303h	1	n.a.	UINT 16	Not available, value =0 NOTE: keep for possible compatibility issues.

2.6 Program lock status

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

Table 2.6-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
300773	0304h	1	Status of the trimmer positioned on the rear of the removable unit display	UINT 16	Value=1: programming locked Value=0: programming unlocked



2.7 Carlo Gavazzi Controls identification code

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

Table 2.7-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
300012	000Bh	1	Carlo Gavazzi Controls identification code	UINT 16	Value=1632: EM27272DMV53X2SX Bit 15..4 = Family (102) Bit 3..0 = Subfamily (0)

2.8 Password configuration menu

MODBUS: read and write mode

Table 2.8-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
304097	1000h	1	Password	UINT 16	Minimum valid value: 0d Maximum valid value: 999d Any other value = 0d

2.9 System configuration menu

MODBUS: read only mode

Table 2.9-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes																														
304099	1002h	1	Measuring system	UINT 16	<p>The system is self-detected by the models of TCDxM connected: Value=0: "1P" system Value=1: "3P" system</p> <table border="1"> <thead> <tr> <th>TCD type Load A1</th> <th>TCD type Load A2</th> <th>System detected</th> </tr> </thead> <tbody> <tr> <td>3-Ph</td> <td>3-Ph</td> <td>3P</td> </tr> <tr> <td>3-Ph</td> <td>1-Ph</td> <td>3P</td> </tr> <tr> <td>1-Ph</td> <td>3-Ph</td> <td>3P</td> </tr> <tr> <td>1-Ph</td> <td>1-Ph</td> <td>1P</td> </tr> <tr> <td>3-Ph</td> <td>Missing</td> <td>3P</td> </tr> <tr> <td>Missing</td> <td>3-Ph</td> <td>3P</td> </tr> <tr> <td>Missing</td> <td>Missing</td> <td>3P</td> </tr> <tr> <td>1-Ph</td> <td>Missing</td> <td>1P</td> </tr> <tr> <td>Missing</td> <td>1-Ph</td> <td>1P</td> </tr> </tbody> </table>	TCD type Load A1	TCD type Load A2	System detected	3-Ph	3-Ph	3P	3-Ph	1-Ph	3P	1-Ph	3-Ph	3P	1-Ph	1-Ph	1P	3-Ph	Missing	3P	Missing	3-Ph	3P	Missing	Missing	3P	1-Ph	Missing	1P	Missing	1-Ph	1P
TCD type Load A1	TCD type Load A2	System detected																																	
3-Ph	3-Ph	3P																																	
3-Ph	1-Ph	3P																																	
1-Ph	3-Ph	3P																																	
1-Ph	1-Ph	1P																																	
3-Ph	Missing	3P																																	
Missing	3-Ph	3P																																	
Missing	Missing	3P																																	
1-Ph	Missing	1P																																	
Missing	1-Ph	1P																																	

2.10 Current transformer primary value

MODBUS: read only mode

Table 2.10-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
304100	1003h	1	TCDA1 current transformer primary value	UINT 16	Self-recognition (value in Ampere) in case of TCDxM connection. 65535d (FFFFh) means: no TCD detected 0d means: TCDMM detected (current transformer primary value to be set as per 2.14 paragraph)
304101	1004h	1	TCDA2 current transformer primary value	UINT 16	



2.11 VT menu

MODBUS: read and write mode

Table 2.11-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
304102	1005h	1	Voltage transformer ratio	UINT 16	Value min = 10 (VT=1.0) Value max = depends on the combinations of the used TCDs (see table below) Any other value = 10 (VT=1.0)

TCDA2 \ TCDA1	60		100		200		400		800	
	MV5	MV6	MV5	MV6	MV5	MV6	MV5	MV6	MV5	MV6
60	999.0	999.0	999.0	999.0	764.6	999.0	432.1	744.3	231.1	398.1
100	999.0	999.0	994.0	999.0	662.6	999.0	397.6	684.7	220.8	380.4
200	764.6	999.0	662.6	999.0	497.0	855.9	331.3	570.6	198.8	342.3
400	432.1	744.3	397.6	684.7	331.3	570.6	248.5	427.9	165.6	285.3
800	231.1	398.1	220.8	380.4	198.8	342.3	165.6	285.3	124.2	213.9
2000	96	166	94	163	90	155	82	142	71	122
5000	39	67	38	67	38	65	36	63	34	59
10000 (NO TCD)	19	34	19	33	19	33	19	32	18	31

TCDA2 \ TCDA1	2000		5000		10000 (NO TCD)	
	MV5	MV6	MV5	MV6	MV5	MV6
60	96	166	39	67	19	34
100	94	163	38	67	19	33
200	90	155	38	65	19	33
400	82	142	36	63	19	32
800	71	122	34	59	18	31
2000	49	85	28	48	16	28
5000	28	48	19	34	13	22
10000 (NO TCD)	16	28	13	22	9	17

2.12 DMD integration time menu

MODBUS: read and write mode

Table 2.12-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
304113	1010h	1	Integration time for DMD power calculation	UINT 16	Minimum valid value: 1d Maximum valid value: 60d Any other value = 15d

2.13 Pulse output configuration menu

MODBUS: read and write mode

Table 2.13-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
304115	1012h	1	Ton time	UINT 16	Value 0: 40ms Value 1: 100ms Any other value = 1 (100ms)
304129	1020h	1	KWh per pulse relevant to the OUT1 (linked to TCDA1)	UINT 16	Min value = 1 (0.01 kWh/pulse) Max value = 999 (9.99 kWh/pulse) Any other value = 10 (0.1 kWh/pulse)
304131	1022h	1	KWh per pulse relevant to the OUT2 (linked to TCDA2)	UINT 16	Min value = 1 (0.01 kWh/pulse) Max value = 999 (9.99 kWh/pulse) Any other value = 10 (0.1 kWh/pulse)

2.14 Current transformer primary value TCDMM

MODBUS: read and write mode

Table 2.14-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
304132	1023h	1	TCDA1 current transformer primary value TCDMM	UINT 16	Min value = 10 (CT=10) Max value = 10000 (CT=10000)
304133	1024h	1	TCDA2 current transformer primary value TCDMM	UINT 16	Any other value = 10 (CT=10) Default value = 60 (CT=60)



### 2.15 “EC” menu

MODBUS: read and write mode

Table 2.15-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
304356	1103h	1	Easy connection mode enabling	UINT 16	Value=0: “EC” enabled Value=1: “EC” disabled Any other value: “EC” disabled

### 2.16 Serial port configuration menu

MODBUS: read and write mode

Table 2.16-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
308193	2000h	1	RS485 instrument address (ADD1)	UINT 16	Value min = 1 Value max = 246 Any other value = 1 NOTE: The instrument answers both to the set ADD1 Modbus address and to ADD2 = ADD1+1
308194	2001h	1	RS485 baud rate	UINT 16	Value 0 = 9.6 kbps Value 1 = 19.2 kbps Value 2 = 38.4 kbps Any other value = 9.6 kbps
308195	2002h	1	RS485 parity	UINT 16	Value 0 = no parity Value 1 = even parity Any other value = no parity

Note: The number of stop bits is fixed to “1”

### 2.17 Reset commands

MODBUS: read and write only mode

Table

2.17-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
316385	4000h	1	Reset of Energy meters, kWdmd and kWdmdm peak.	UINT 16	Value=1: Command is executed All other values produce no effects Note: Reset of Load 1 OR Load 2 related meters/dmd/dmd_peak (*)

NOTE (\*): the reset command is relevant to the input A1 if ADD1 is used as instrument serial address, to the input A2 if ADD2 is used as instrument serial address (see [Serial port configuration menu](#)).

### 2.18 Serial number

MODBUS: read only mode

Table 2.18-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
320481	5000h	1	Letter 1 (from SX) Letter 2 (from SX)	UINT 16	MSB: ASCII code LSB: ASCII code
320482	5001h	1	Letter 3 (from SX) Letter 4 (from SX)	UINT 16	MSB: ASCII code LSB: ASCII code
320483	5002h	1	Letter 5 (from SX) Letter 6 (from SX)	UINT 16	MSB: ASCII code LSB: ASCII code
320484	5003h	1	Letter 7 (from SX) Letter 8 (from SX)	UINT 16	MSB: ASCII code LSB: ASCII code
320485	5004h	1	Letter 9 (from SX) Letter 10 (from SX)	UINT 16	MSB: ASCII code LSB: ASCII code
320486	5005h	1	Letter 11 (from SX) Letter 12 (from SX)	UINT 16	MSB: ASCII code LSB: ASCII code
320487	5006h	1	Letter 13 (from SX)	UINT 16	MSB: ASCII code

### 2.19 Production year

MODBUS: read only mode

Table 2.19-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
320488	5007h	1	Instrument production year	UINT 16	

### 2.20 Reading and writing note

Unless differently indicated, both the reading and the writing function refers/has effect only to the instrument serial address adjusted as ADD1.



## **3 REVISIONS**

### **3.1 Version 1 Revision 0**

First release.