

KOSMOS SERIE

CODE: 30727419 EDITION: 24.01.2012



INSTRUCTIONS MANUAL
PROTOCOL MODBUS-RTU

MICRA-D

CE



INDEX

1.	MODBUS-RTU PROTOCOL	3
2.	CALCULATION OF CRC	4
3.	TIMING	4
4.	MODBUS FUNCTIONS.....	5
5.	DATA TYPE AND MEMORY LOCATIONS	6
	5.1 Reading variables programming	7
	5.2 Writing variables programming	8
	5.3 Reading dynamic variables.....	9
6.	FORMAT OF ERROR CODES	11
7.	USE STANDART PROGRAMS	13
8.	ADDRESS OF THE MEMORY VARIABLES	14

1. MODBUS RTU PROTOCOL

The modbus RTU protocol is a serial data transmission format widely used in communications with PLC's but easy adaptable to other types of remote units thanks to its particular message structure (it doesn't operate with variables but with memory addresses).

The implementation of a universal standard protocol such as modbus allows the instrument be connected to existing systems without need for creating specific communication logic programs.

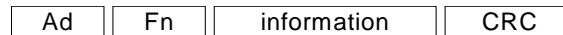
Moreover, the quantity and variety of processable data can be infinite since it is no more necessary to specify the desired parameter or parameters but only the first memory address and the quantity to transmit.

The following definitions of modbus protocol are given adapted to the KOSMOS SERIES instruments.

The MODBUS RTU protocol has no delimiter character at the beginning and the end of a message.

Each frame must be preceded by a silent interval of at least 3, 5 character times and must be finished with a silent of the same duration.

The first character of a frame is the slave address, followed by the function number, the information field and two bytes of error check code (CRC).



One character is composed of 10 bits: 1 start bit, 8 data bits and 1 stop bit.

2. CRC GENERATION *(according to modbus RTU)*

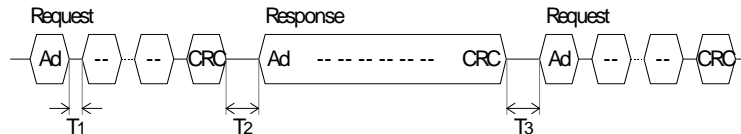
1. Load a 16-bit register with H'FFFF (all '1'). Call it CRC.
2. Exclusive OR the first message byte with the low-order byte of the CRC register and put the result in CRC.
3. Shift the CRC register 1 bit towards the right (to the LSB) writing a '0' in the MSB.
4. If the new LSB is '0' repeat from point 3. If the LSB is '1', exclusive OR the CRC register with the 16-bit value H'A001 (1010 0000 0000 0001).
5. Repeat points 3 and 4 until completing a total of 8 shifts, after what the first byte has been processed.
6. Repeat points 2 to 5 with the second byte and continue these operations until all bytes on the message are processed.
7. Append the obtained CRC to the message so that the low order byte is transmitted first.

CRC Polynome: $2^{15} + 2^{13} + 2^0$
CRC Initial value: H'FFF

3. TIMING

The instrument detects the start of a message when receives a valid character (containing its address or the address 00) after a silent interval of at least 3,5 character times.

The end of a message is acknowledged by a silent interval of the same duration.



- T1:** time between two characters (min 0, max 3,5CT)
- T2:** time between query and response (min 3,5CT)
- T3:** time between response and next query (min 3,5CT)

CT = 1 character time

baud (bits/s)	3,5CT
1200	30ms
2400	15ms
4800	8ms
9600	4ms
19200	2ms

4. MODBUS FUNCTIONS

The modbus functions supported by the instrument are the following:

CODE	FUNCTION
03 (03H)	read n words
05 (05H)	force state
16 (10H)	write n words

- Function 03** Used to read, in floating point format, dynamic variables such as display value, peak, valley, tare..., depending on model.
- Function 05** Used to force the instrument to take an action such as 'make tare', 'reset tare', 'reset peak', 'reset latched setpoints'..., depending on model.
- Function 16** Used to write in the instrument memory, programming variable in word format.

5. DATA TYPE AND MEMORY LOCATIONS

The instrument manages different types of data which are accessible to the user by programming, display or through the serial channel RS232C or RS485.

The data is located depending on type, in specific memory areas with unique addresses incrementing in 1 per byte from the zero address.

The figure below shows the user accessible memory areas, with the data types and modbus functions to be used each zone.

PROGRAMMING DATA IN TABLE 4 <i>(READ AND WRITE)</i>	These are the data saved, in binary format in the instrument e2prom memory. Modbus function to used: <ul style="list-style-type: none">• Read: 03 (03H).• Write: 16(10H).
RESERVED	
FLOATING POINT VARIABLES IN TABLE 1 <i>(READ ONLY)</i>	These are measurement variables such as display, peak..., in floating point format (IEEE single precision). Modbus function to used: <ul style="list-style-type: none">• Read : 03 (03H).
RESERVED	

CONTROL VARIABLES are not located to specific memory addresses but they consist of internal flags that the instrument interprets to take an action, and then deactivate the flag (see chapter 5.4).

5.1. Reading programming variables

FUNCTION 03 (READ N WORDS))

Request frame

1 byte	1 byte	2 bytes	2 bytes	2 bytes
slave address	MODBUS function	1st byte address according to table	number of words (n° bytes / 2)	CRC

Response frame

1 byte	1 byte	1 byte	n bytes	2 bytes
address	function	n° bytes	information read	CRC

Examples (see addresses in chapter 8)

Request input type of instrument at address 01

H'01	H'03	H'00	H'00	H'00	H'01	H'84	H'0A
Slave address	modbus function	1er byte address (Dec. 0 according to table)		number of words =1		CRC	

Response

H'01	H'03	H'02	H'01	H'00	H'B9	H'D4
address	function	n° bytes	Magnetic Pickup		CRC	

5.2 Write programming variables

Data programming can be modified writing the wished direction using the function 10.

FUNCTION 10 (*WRITE N WORDS*)

Request frame

1 byte	1 byte	2 bytes	2 bytes	1 byte	n bytes	2 bytes
Slave address	MODBUS function	1st word address according to table	number of words (n° bytes / 2)	n° of bytes to write	Data to write	CRC

Response frame

1 byte	1 byte	2 bytes	2 bytes	2 bytes
address	function	1st address	number of words written	CRC

Examples (see addresses in chapter 8)

Programming of high level of brightness and 2 decimals for totalizer factor

H'01	H'10	H'00	H'4E	H'00	H'01	H'02	H'02	H'00
Slave address	function MODBUS	1st byte address (dec.12 according to table)		number of words =1		number of bytes=2	Dec Fact Tot=2	Bright Hi

H'A8	H'DE
CRC	

Response

H'01	H'10	H'00	H'4E	H'00	H'01	H'61	H'DE
address	function	1st byte address	number of words =1		CRC		

5.3 Reading dynamic variables

Dynamic variables are those that can vary based on the process without the user has access to modify them directly. The dynamic variables are normally the values of display, peak, valley.... Their positions in memory specify in the tables of chapter 8.

These variables are asked for by means of the function MODBUS like type variables integer of 4 bytes (2 words).

FUNCTION 03 (WRITE N WORDS))

Request frame

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Slave address	function MODBUS	1st word address according to the tables 1a and 1b	number of words (n° bytes / 2)	CRC

Response frame

1 byte	1 byte	1 byte	n bytes	2 bytes
address	function	n° bytes	Read Information	CRC

NOTE: In general these variables are transmitted without the decimal point of the display which is in other register.

Examples (see addresses in chapter 8)

Request of the value of display of instrument at address 01 (format Long)

H'01	H'03	H'00	H'5A	H'00	H'02	H'E4	H'18
Slave address	function MODBUS	1st byte address (dec.62 according to table)		number of words =1		CRC	

Response (supposing display = +992)

H'01	H'03	H'04	H'00	H'00	H'03	H'E0	H'FB	H'4B
address	function	n° bytes	Datas Word 1		Datas Word 2		CRC	

Request of the values of peak and valley to the instrument to address 01 (format Long)

H'01	H'03	H'00	H'5E	H'00	H'04	H'25	H'DB
Slave address	function MODBUS	1st byte address (dec.94 according to table)		number of words =4		CRC	

Response (supposing peak= +1520, valley=-968)

H'01	H'03	H'08	00	00	H'05	H'F0
address	function	n° bytes	Peak: datas Word 1		Peak: datas Word 2	

00	00	H'FC	H'38	H'95	H'45
Valley: datas Word 1		Valley: datas Word 2		CRC	

6. FORMAT OF ERROR MESSAGES

Error Codes

CODE	ERROR TYPE
01	Illegal function or incompatible with data
02	Illegal data or invalid CRC

Error 01 :

- Error 01 is produced when the referenced address is outside the valid range or the allowable range for the requested function.
- Error 01 is produced when the function is not supported by the instrument (03H, 05H o 10H).

Error 02 :

- Error 02 is produced when the number of bytes in a 'write n bits' request frame exceeds from the maximum number of writable bytes or from the limit of 250.
- Error 02 is produced when the calculated CRC doesn't match the received message CRC.

Response Format

1 byte	1 byte	1 byte	2 bytes
Slave address	function +H'80	Code error	CRC

Example

Data Error (code 02) message from slave 01 as response to a function 03.

H'01	H'83	H'02	H'00	H'2C
address	H'03+H'80	code	CRC	

Example:

Request input type of instrument address 01

H'01	H'03	H'00	H'00	H'00	H'01	H'84	H'0B
Slave address	function MODBUS	1st byte address (d'0 According table)		number of words =1		CRC erroneous	

Message Error

H'01	H'83	H'02	H'00	H'F1
address	H'03+H'80	code	CRC	

7. USING STANDARD COMMUNICATIONS PROGRAMS

Introduction

It is found in the market a wide variety of standard programs that allow collecting data through the serial port of a computer to be used in a virtual control panel on the screen of the PC. The modbus communications protocol is used as a universal tool for connecting these programs with all types of remote instrumentation capable of managing this protocol.

In general, such programs continuously scan, at a fixed rate, the setup addresses according to the type of data inside. The type of the data depends on the modbus function used to request it.

The information is continuously updated in the data bus according to the frame format described in section 5. The program user only has to extract each variable from the frame to be represented on the PC screen in the desired format.

Due to that not always the standard modbus data formats match with those of most instrumentation units, in the case of KOSMOS instruments, the data extraction must be made under the following considerations.

3.2. COLLECTING FLOATING POINT VARIABLES USING FUNCTION 03

In modbus format, the variables by function 03 are represented by words (1 word=2 bytes) and they are contained in addresses that increment in 1 per word, that is, each address contains 2 bytes.

In the instrument, the addresses are incremented in 1 per byte that means that each address contains one byte. The result of this is that a floating point variable takes 4 addresses in the instrument and 2 addresses in modbus representation.

8. ADRESS OF VARIABLES MEMORY

Programming Data (Reading / Writing)

BYTE	MODBUS	Variable	Description
0	0	Input signal	0=10-30Vac, 1=Magnetic , 2=NAMUR, 3=PNP sensor, 4= NPN sensor, 5=TTL/24V Encoder, 6=Contact closure
1		Operation mode	0=Counter 1=Chronometer 2=Frequency meter 3=Tachometer
2	1	Counting direction	0=UP, 1=Down, 2= UP-Down
3		Unidirectional mode IN-A /IN A-B	0=IN-A, 1=IN-B
4	2	Bidirectional mode	0=Independent, 1=Directional, 2=Phase
5		Chronometer type	0=UP, 1=DOWn
6	3	Chronometer Scale	0=H.H, 1=H.MM, 2=M.SS, 3=0.01S
7		Tachymeter type	0=rPM 1=rAtE
8	4	Rate mode (Dir/inV)	0=dir 1=inV
9		Filter	ND
10	5	Frequency input	Digit 5
11			Digit 4
12	6		Digit 3
13			Digit 2
14	7		Digit 1
15			Frequency input decimal point

BYTE	MODBUS	Variable	Description
16	8	Display for input frequency	Digit 5
17			Digit 4
18	9		Digit 3
19			Digit 2
20	10		Digit 1
21		Totalizer	0=Yes, 1=No
22	11	Point decimal Display	0=no, 1=1 decimal, 2=2 decimals, 3=3 decimals, 4=4decimals
23		Totalizer decimal point	0=no, 1=1 decimal, 2=2 decimals, 3=3 decimals, 4=4decimals
24	12	Limit time (Tachymeter)	Digit 3
25			Digit 2
26	13	Average time (Tachymeter)	Digit 1
27			Digit 2
28	14	PPR (Pulse per revolution) (Tachymeter)	Digit 1
29			Digit 5
30	15	PPR (Pulse per revolution) (Tachymeter)	Digit 4
31			Digit 3
32	16		Digit 2
33			Digit 1
34	17		Offset
35		Digit 4	
36	18	Digit 3	
37		Digit 2	
38	19	Digit 1	
39		Display Multiplier Factor	Digit 5

BYTE	MODBUS	Variable	Description	
40	20		Digit 4	
41			Digit 3	
42	21		Digit 2	
43			Digit 1	
44	22		Decimal point of display multiplier factor	0=no, 1=1 decimal, 2=2 decimals, 3=3 decimals, 4=4 decimals
45			Totalizer Multiplier Factor	Digit 5
46	23			Digit 4
47				Digit 3
48	24			Digit 2
49				Digit 1
50	25	Color RUN		0=red, 1=green, 2=orange
51		Color PROG		0=red, 1=green, 2=orange
52	26	Color TOTAL		0=red, 1=green, 2=orange
53		Unused Variable		ND
54	27	SetPoint n°1 Value		Digit 8
55				Digit 7
56	28		Digit 6	
57			Digit 5	
58	29		Digit 4	
59			Digit 3	
60	30		Digit 2	
61			Digit 1	
62	31		SetPoint n°2 Value	Digit 8
63				Digit 7
64	32	Digit 6		
65		Digit 5		
66	33	Digit 4		
67		Digit 3		
68	34	Digit 2		
69		Digit 1		

BYTE	MODBUS	Variable	Description	
70	35	SetPoint n°3 Value	Digit 8	
71			Digit 7	
72	36		Digit 6	
73			Digit 5	
74	37		Digit 4	
75			Digit 3	
76	38		Digit 2	
77			Digit 1	
78	39		SetPoint n°4 Value	Digit 8
79				Digit 7
80	40	Digit 6		
81		Digit 5		
82	41	Digit 4		
83		Digit 3		
84	42	Digit 2		
85		Digit 1		
86	43	SetPoint n°1 Temporisation or Delay value		Digit 5
87				Digit 4
88	44		Digit 3	
89			Digit 2	
90	45		Digit 1	
91		SetPoint n°2 Temporisation or Delay value	Digit 5	
92	Digit 4			
93	Digit 3			
94	47		Digit 2	
95			Digit 1	
96	48	SetPoint n°3 Temporisation or Delay value	Digit 5	
97			Digit 4	
98	49		Digit 3	
99			Digit 2	

BYTE	MODBUS	Variable	Description	
100	50	SetPoint n°4 Temporisation or Delay value	Digit 1	
101			Digit 5	
102			51	Digit 4
103				Digit 3
104				Digit 2
105	52	Digit 1		
106	53	SetPoint n°1 Pulse value	Digit 2	
107			Digit 1	
108	54	SetPoint n°2 Pulse value	Digit 2	
109			Digit 1	
110	55	SetPoint n°3 Pulse value	Digit 2	
111			Digit 1	
112	56	SetPoint n°4 Pulse value	Digit 2	
113			Digit 1	
114	57	SetPoint n°1 Activation mode (compteur, chronomètre)	0= PULSE,1=LATCH	
115		SetPoint n°2 Activation mode (compteur, chronomètre)	0= PULSE,1=LATCH	
116	58	SetPoint n°3 Activation mode (compteur, chronomètre)	0= PULSE,1=LATCH	
117		SetPoint n°4 Activation mode (compteur, chronomètre)	0= PULSE,1=LATCH	
118	59	SetPoint n°1 enable	0=OFF, 1=ON	
119		SetPoint n°2 enable	0=OFF, 1=ON	
120	60	SetPoint n°3 enable	0=OFF, 1=ON	
121		SetPoint n°4 enable	0=OFF, 1=ON	
122	61	SetPoint n°1 operation mode (Frequency meter, tachometer)	0=HI, 1=LO	
123		SetPoint n°2 operation mode (Frequency meter, tachometer)	0=HI, 1=LO	

BYTE	MODBUS	Variable	Description
124	62	SetPoint n°3 operation mode (Frequency meter, tachometer)	0=HI, 1=LO
125		SetPoint n°4 operation mode (Frequency meter, tachometer)	0=HI, 1=LO
126	63	SetPoint n° 1 Hysteresis or Delay (Frequency meter, tachometer)	0=Hys, 1=dLy
127		SetPoint n° 2 Hysteresis or Delay (Frequency meter, tachometer)	0=Hys, 1=dLy
128	64	SetPoint n° 3 Hysteresis or Delay (Frequency meter, tachometer)	0=Hys, 1=dLy
129		SetPoint n° 4 Hysteresis or Delay (Frequency meter, tachometer)	0=Hys, 1=dLy
130	65	SetPoint n°1 comparison value	0=Process, 1=Totaliizer
131		SetPoint n°2 comparison value	0=Process, 1=Totaliizer
132	66	SetPoint n°3 comparison value	0=Process, 1=Totaliizer
133		SetPoint n°4 comparison value	0=Process, 1=Totaliizer
134	67	SetPoint n°1 operation mode (counter,chronometer)	0=Mode 1 (Normal), 1=Mode 2 (Reset), 2=Mode 3 (Stop), 3=Mode 4 (Clear)
135		SetPoint n°2 (operation mode (counter,chronometer)	0=Mode 1 (Normal), 1=Mode 2 (Reset), 2=Mode 3 (Stop), 3=Mode 4 (Clear)
136	68	SetPoint n°3 operation mode (counter,chronometer)	0=Mode 1 (Normal), 1=Mode 2 (Reset), 2=Mode 3 (Stop), 3=Mode 4 (Clear)
137		SetPoint n°4 operation mode (counter,chronometer)	0=Mode 1 (Normal), 1=Mode 2 (Reset), 2=Mode 3 (Stop), 3=Mode 4 (Clear)
138	69	SetPoint n°1 Color	0=No change, 1=red, 2=green, 3=orange
139		SetPoint n°2 Color	0=No change, 1=red, 2=green, 3=orange

BYTE	MODBUS	Variable	Description	
140	70	SetPoint n°3 Color	0=No change, 1=red, 2=green, 3=orange	
141		SetPoint n°4 Color	0=No change, 1=red, 2=green, 3=orange	
142	71	Analog output: Display Value for 20mA or 10Vdc	Digit 5	
143			Digit 4	
144	72		Digit 3	
145			Digit 2	
146	73		Digit 1	
147	74	Analog output: Display Value for 0mA or 0Vcd	Digit 5	
148			Digit 4	
149			Digit 3	
150			75	Digit 2
151				Digit 1
152	76	Locking code	Digit 4	
153			Digit 3	
154	77		Digit 2	
155			Digit 1	
156	78		Decimal point of Totalizer multiplier factor	0=no, 1=1 decimal, 2=2 decimals, 3=3 decimals, 4=4décimales
157		Brightness	0= high, 1=low	
158	79	Programming Lock: Byte n°1	bit 0=Config. Set1 ,bit1=Config. Set2 ,bit2=Config. Set3 ,bit3=Config. Set4 ,bit4=Menu Input ,bit5=Menu Display	
159		Programming Lock: Byte n°2	bit0=Modif.Setpoints ,bit 1=Communication Menu ,bit2= Logics functions Menu ,bit3= Offset Key ,bit5= Analog ouput Menu	
160	80	Programming Lock: Byte n°3	bit 0= ND	
161		Logic Function n°1	N° Logic Function (see manual)	
162	81	Logic Function n°2	N° Logic Function (see manual)	
163		Logic Function n°3	N° Logic Function (see manual)	

BYTE	MODBUS	Variable	Description
164	82	Logics Functions n° 7,8,9	0= Print date 1= No Print date
165		Logic Function n°12	0=setpoint n°1, 1=setpoint n°2 ,2=setpoint n°3, 3=setpoint n°4 ,
166	83	ND	
167		COM: Baud Rate	0=1200 bds, 1=2400 bds, 2=4800 bds, 3=9600 bds ,4=19200 bds
168	84	COM: Unit Adress	Digit 2
169			Digit 1
170	85	COM: Protocol	0=ASCII, 1=ISO1745, 2=MODBUS-RTU
171		COM (RS485): Delay response	0=30ms ,1=60ms ,2=100ms
172 a 179	86 a 89	Reserved	ND

Dynamic Values (Only Reading)

180	90	Display Value	Long Format
181			
182			
183	91		
184	92	Totalizer Value	Long Format
185			
186	93		
187			
188	94	Peak Value	Long Format
189			
190	95		
191			
192	96	Valley Value	Long Format
193			
194	97		
195			

BYTE	MODBUS	Variable	Description
196	98	Setpoint n°1 Temporisation Value	Long Format
197			
198			
199			
200	100	Setpoint n°2 Temporisation Value	Long Format
201			
202			
203			
204	102	Setpoint n°3 Temporisation Value	Long Format
205			
206			
207			
208	104	Setpoint n°4 Temporisation Value	Long Format
209			
210			
211			
212	106	Setpoint n°1 Value	Long Format
213			
214			
215			
216	108	Setpoint n°2 Value	Long Format
217			
218			
219			
220	110	Setpoint n°3 Value	Long Format
221			
222			
223			
224	112	Setpoint n°4 Value	Long Format
225			

BYTE	MODBUS	Variable	Description
226	113		
227			
228	114	Relay n°4 State	0=ON ,1=OFF
229		Relay n°3 State	0=ON ,1=OFF
230	115	Relay n°2 State	0=ON ,1=OFF
231		Relay n°1 State	0=ON ,1=OFF
232	116	Offset	Long Format
233			
234	117		
235			
236	118	Display Multiplier Factor	Long Format
237			
238	119		
239			
240	120	Totalizer Multiplier Factor	Long Format
241			
242	121		
243			
244	122	Analog Output: Display Value for 20mA or 10Vdc	Long Format
245			
246	123		
247			
248	124	Analog Output: Display Value for 0mA or 0Vcd	Long Format
249			
250	125		
251			
252	126	Totalizer overflow sign	0=positive ,1=negative
253		Display overflow sign	0=positive ,1=negative
254	127	Display overflow state	0= OK ,1=Overflow
255		Totalizer overflow state	0= OK ,1=Overflow

DISEÑOS Y TECNOLOGIA, S.A.

Polígono Industrial Les Guixeres

C/ Xarol 8 C

08915 BADALONA-SPAIN

Tel : +34 - 93 339 47 58

Fax : +34 - 93 490 31 45

E-mail : dtl@ditel.es