

**CARLO GAVAZZI
CONTROLS**

WM12
Serial protocol
V1 R3

SERIAL COMMUNICATION PROTOCOL

WM12

Ver. 1 Rev. 3

10th August 2005

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1 COMMUNICATION PROTOCOL

1.1 INTRODUCTION

WM12 is provided with a RS485 serial interface. The serial communication protocol is MODBUS/JBUS.

The data format is fixed:

- 1 start bit
- 8 data bit
- 1 stop bit
- 9600 baud
- Parity: none

The host starts the communication, by sending the frame relevant to the query. Each frame is composed of 4 types of information:

- **slave address**: it is a number within the range from 1 to 255, which identifies each instrument connected to the network.
- **function code** (command): it defines the control type (reading of n words, writing of one word)
- **data field**: it defines the function parameters (e.g. address of the word to write, value of this word, etc.)
- **control word** (CRC): it is used to detect transmission errors that may occur.

The master calculates the CRC after defining address, function number and data field. When the slave receives the query, it stores it in a temporary buffer. After that, the CRC is calculated and compared with the one received. If the two CRC values are the same and the address is correct, the slave carries out the command and then sends back its reply.

The frame synchronisation is forced after a minimum time of 3 msec without communicating.

1.2 FUNCTIONS

Three functions are available on the WM12:

- Reading of n words (**function 03**)
- Reading of n words (**function 04**)
- Writing of one word (function 06) (**available only for C.G. Controls, except for the reset instructions**)

Note: The functions 03 and 04 have exactly the same effect.

The user is allowed to reset the peak values (Wdmd, Amax) and to reset the latch alarm. To carry out the reset a write command must be sent.

Pay attention to follow scrupulously the reset instructions and to send the exact frame, because a different write command could modify some calibration parameters, invalidating the accuracy of the measurements.

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1.2.1 FUNCTIONS 03 AND 04

Query

Address	Function *	Word address		n° of words **		CRC	
1 byte	1 byte	2 bytes		2 bytes		2 bytes	
from 1 to 255	04 *	MSB	LSB	MSB	LSB	MSB	LSB

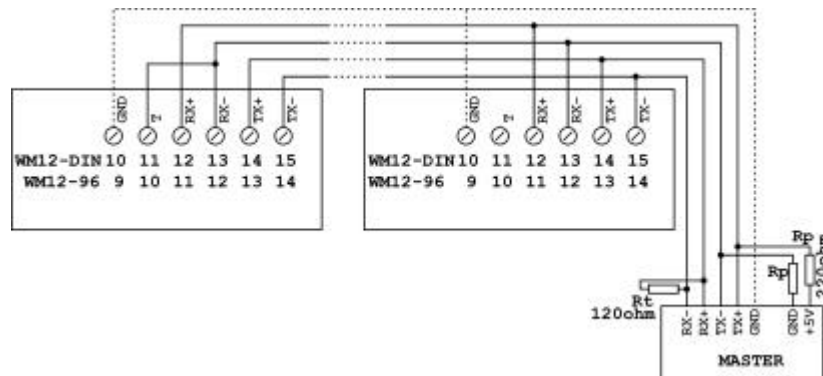
Note: * The function code can be either 04 or 03

** The maximum number of words is 12

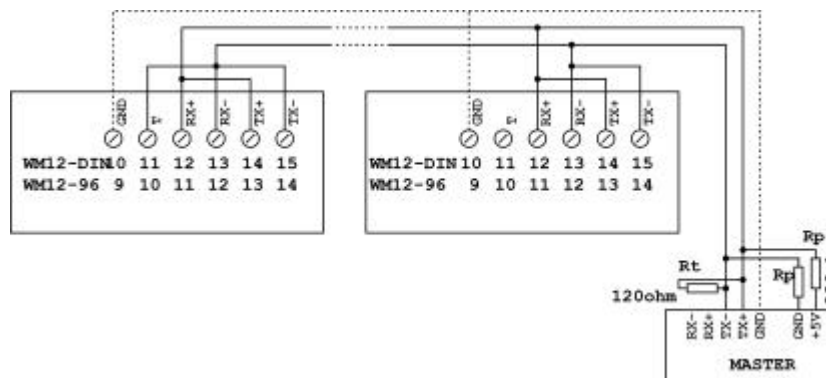
Reply

Address	Function	n° bytes	Values	CRC	
1 byte	1 byte	1 byte	n° bytes	2 bytes	
from 1 to 255	04 *		LSB-MSB format	MSB	LSB

1.3 FOUR-WIRE CONNECTION



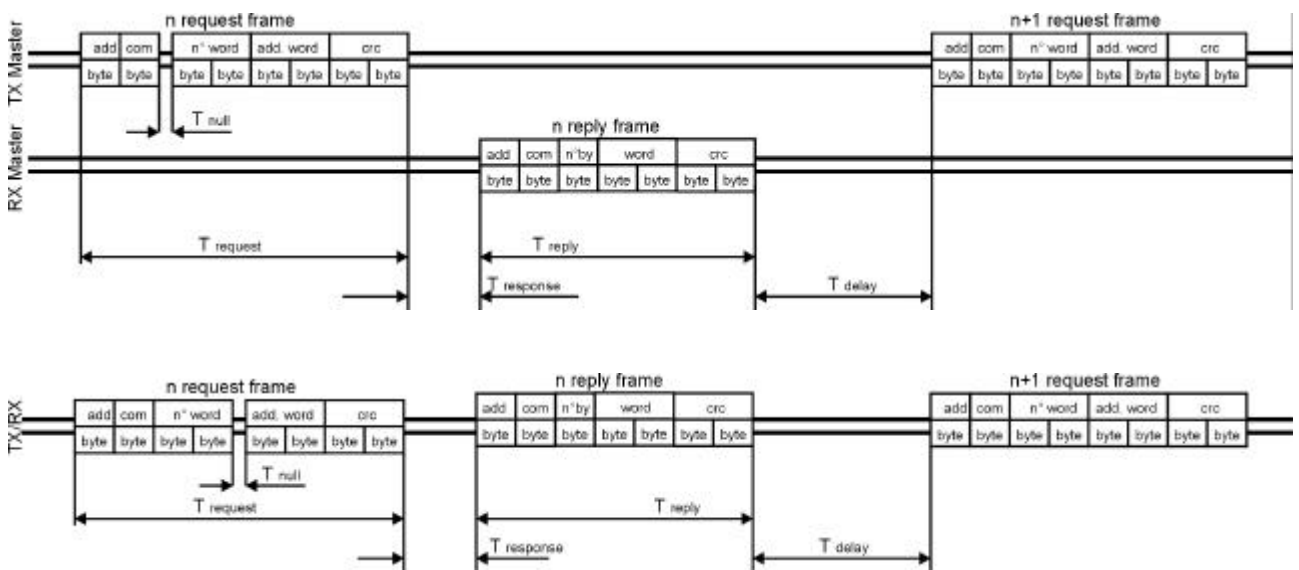
1.3.1 TWO-WIRE CONNECTION



Notes:

1. To avoid errors due to the signal reflections or line coupling, it is necessary to terminate the input of the last instrument on the network, and also the reception of the Host. If this is not enough, it is also possible to bias the Host transmission (in case of 2-wire connection, it is only possible to either terminate or bias the Host, not both). The termination on both the instrument and the host is necessary even in case of point-to-point connection, within short distances.
2. The GND connection is optional if a shielded cable is used.
3. For connections longer than 1200m, a line amplifier is necessary.

1.3.2 TIMING



Timing characteristics of reading function, 4-wires/2-wires connections	msec
T response: Max answering time	300ms
T response: Typical answering time	40ms
T delay: Minimum time for a new query	10ms
T null: Max interruption time on the request frame	2ms

1.3.3 APPLICATION NOTES

1. 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 must be considered as not connected, faulty or with wrong address. The same consideration is valid in case of CRC errors or incomplete frames.
2. By entering the programming mode (by pushing the “S” key) the communication is interrupted. Any data received during the programming mode are ignored.
3. The writing is allowed only for C.G. Controls internal and service use (except for the reset instructions).
4. For the timing calculation, please refer to the following formulae:

$$T_{request} = \frac{N^{\circ} bit}{Baud_rate} * 8$$

$$T_{reply} = \frac{N^{\circ} bit}{Baud_rate} * N^{\circ} char$$

$$TS = T_request + T_response + T_reply + T_delay1$$

$$TA = TS * N^{\circ} request$$

$$TM = (TS + Tdelay2) * N^{\circ} instruments$$

N°bit	10
N°char	5+N° Word*2 if function 04 o 03, 8 if function 06
N°word	Number of words to be read in an instrument
TS	Execution time of one reading
Tdelay1	Minimum time for new query on the same address
TA	Data acquiring time from one instrument
TM	Monitoring time of all the instruments
N°instruments	Number of instruments connected to the network.
Tdelay2	Minimum time for new query on a different address

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2 VARIABLE MAPPING

2.1 RAM MEMORY MAPPING

ADDRESS	BYTES	VARIABLE	Type	ADDRESS	BYTES	VARIABLE	Type
0280h	2	V L1-N	VN	02A0h	2	VA L1	P
0282h	2	A L1	A	02A2h	2	VA L2	P
0284h	2	W L1	P	02A4h	2	VA L3	P
0286h	2	V L2-N	V	02A6h	2	VA Σ	P Σ
0288h	2	A L2	A	02A8h	2	var L1	P
028Ah	2	W L2	P	02AAh	2	var L2	P
028Ch	2	V L3-N	V	02ACh	2	var L3	P
028Eh	2	A L3	A	02AEh	2	var Σ	P Σ
0290h	2	W L3	P	02B0h	2	W dmd	P Σ
0292h	2	V L1-L2	VC	02B2h	2	VA dmd	P Σ
0294h	2	V L2-L3	VC	02B4h	2	W dmd MAX	P Σ
0296h	2	V L3-L1	VC	02B6h	2		
0298h	2	VL-L Σ	VC	02B8h	2	Hz	H
029Ah	2	A max	A	02BAh	2		
029Ch	2	A n	A	02BCh	1+1	PF L1/PF L2	PF
029Eh	2	W Σ	P Σ	02BEh	1+1	PF L3/ PF Σ	PF

Note: the word 2BCh contains the PF L1 value on its LSB and the PF L2 value on its MSB (most significant byte); the word 2BEh contains the PF L3 value on its LSB and the PF Σ value on its MSB. For each byte related to the power-factor variables, the most significant bit indicates the sign, in the following way:

- msb=0 L (inductive) type
- msb=1 C (capacitive) type.

2.1.1 VARIABLE REPRESENTATION

All the variables, except for the PF values, are represented as **signed two's complement integers**, by using the number of bytes specified in the memory-mapping table. For the correct interpretation, it is necessary to consider also the decimal point and the engineering unit, according to the following table, and multiply the value by the relevant CT and VT ratios:

INF	d.p	ENG. Unit
VN	111.1	V
VC	111	V
A	111	mA
P Σ	111	W, VA, VAR
P	111.1	W, VA, VAR
H	111.1	HZ
PF	1.11	PF

The format of the single variables is referred to the electrical input of the instrument and it does not depend on the setting of the CT and VT values.

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2.2 ALARM MAPPING (READING ONLY)

ADDRESS	BYTE	CONSTANT	Description
027Eh	1	XXXXXXXX1 XXXXXXXX0	Voltage alarm ON Voltage alarm OFF
027Eh	1	XXXXXX1X XXXXXX0X	Current alarm ON Current alarm OFF

2.3 EEPROM MEMORY MAPPING

ADDRESS	BYTES	PARAMETER	DESCRIPTION	FORMAT
1080h	2	Password	Programming access password	111
1082h	2	vt_ratio	Voltage transformer ratio	11.1
1084h	2	ct_ratio	Current transformer ratio	111
1086h	2	p_int	Integration period (Wdmd)	111 [minutes]
1088h	2	filter_rng	Filter range	111 [% f.s.]
108ah	2	filter_coe	Filter coefficient	111
108ch	2	address	Instrument address	111
108eh	2	Set_vup	Upper voltage threshold	111 [V] ¹
1090h	2	Set_vdown	Lower voltage threshold	111 [V] ¹
1092h	2	Set_an	Neutral current threshold	1.11 [A] ²
1094h	2	system	System type (see 2.4)	111

¹ Value with voltage transformer ratio = 1

² Value with current transformer ratio = 1

2.4 SYSTEM CODE

Value	System type
0	3P
1	3P.n
2	2P
3	1P
4	3P.A

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2.5 RESET OF THE PEAK VALUES AND OF THE LATCH ALARM

Pay attention to follow scrupulously the reset instructions and to send the exact frame, because a different write command could modify some calibration parameters, invalidating the accuracy of the measurements.

The following frame must be sent:

Request frame

Address	Function	Data address		Value		CRC	
1 byte	1 byte	2 byte		2 byte		2 byte	
From 1 to 255	06h	33h	00h	00h	00h	MSB	LSB

Answer frame

Address	Function	Data address		Value		CRC	
1 byte	1 byte	2 byte		2 byte		2 byte	
From 1 to 255	06h	33h	00h	00h	00h	MSB	LSB

NOTE: the answer frame is an echo of the request frame, which confirm the execution of the command.

2.6 RESET OF THE LATCH ALARM ONLY

Pay attention to follow scrupulously the reset instructions and to send the exact frame, because a different write command could modify some calibration parameters, invalidating the accuracy of the measurements.

The following frame must be sent:

Request frame

Address	Function	Data address		Value		CRC	
1 byte	1 byte	2 byte		2 byte		2 byte	
From 1 to 255	06h	33h	01h	00h	00h	MSB	LSB

Answer frame

Address	Function	Data address		Value		CRC	
1 byte	1 byte	2 byte		2 byte		2 byte	
From 1 to 255	06h	33h	01h	00h	00h	MSB	LSB

NOTE: the answer frame is an echo of the request frame, which confirm the execution of the command.

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3 READ VARIABLES

3.1 INTRODUCTION

WM12 allows reading up to 12 consecutive words. A reading access is always possible: if the query is related to a non-existing variable, the WM12 replies with non-significant values.

The field "Word address" in the request frame must be exactly the physical memory address (not the register number). During a n-words reading, the answer contains the exact memory image. This means that the first byte is the content of the memory address specified in the request frame. The following bytes are the contents of the following addresses.

3.2 READING OF INSTANTANEOUS VARIABLES

To read all the variables, it is necessary to carry out at least three reading instructions as indicated below. If the values of current ratio and/or voltage ratio are different from 1, A, V and P values shall be calculated after the reading by multiplying the relevant values for CT and VT.

3.2.1 FIRST READING (FROM ADDRESS 0280H TO 0297H)

Request (8bytes)

1	4	2	80	0	C	F0	5F
---	---	---	----	---	---	----	----

Answer (29 bytes)

2	4	18	98	8	DF	5	C5	6F	97	8	DB	5	9C	6F	97	8	D9	5	4B	6F	BF	0	BF	0	BF	0	CRC	CRC
---	---	----	----	---	----	---	----	----	----	---	----	---	----	----	----	---	----	---	----	----	----	---	----	---	----	---	-----	-----

Example of interpretation

Variable	Value read(h)	Value converted (d)	Value formatted
V L1-N	0898	2200	220,0V
A L1	05DF	1503	1,503A
W L1	6FC5	28613	2861W
V L2-N	0897	2199	219,9V
A L2	05DB	1499	149,9A
W L2	6F9C	28572	2857W
V L3-N	0897	2199	219,9V
A L3	05D9	1497	1,497A
W L3	6F4B	28491	2849W
V L1-L2	00BF	191	191V
V L3-L1	00BF	191	191V
V L2-L3	00BF	191	191V

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3.2.2 SECOND READING (FROM ADDRESS 0298H TO 02AFH)

Request (8 bytes)

2	4	2	98	0	C	70	6B
---	---	---	----	---	---	----	----

Answer (29 bytes)

2	4	18	BF	0	E4	5	0	0	80	21	EF	C	E3	C	E3	C	B4	26	7B	6	71	6	76	6	62	13	D0	C3
---	---	----	----	---	----	---	---	---	----	----	----	---	----	---	----	---	----	----	----	---	----	---	----	---	----	----	----	----

Example of interpretation

Variable	Value read(h)	Value converted (d)	Value formatted
VL-L Σ	00BF	191	191V
A max	05E4	1508	1,508A
A n	0000	0	0A
W Σ	2180	8576	8576W
VA L1	0CEF	3311	3311VA
VA L2	0CE3	3299	3299VA
VA L3	0CE3	3299	3299VA
VA Σ	26B4	9908	9908VA
var L1	067B	1659	1659var
var L2	0671	1649	1649var
var L3	0676	1654	1654var
var Σ	1362	4926	4926var

3.2.3 THIRD READING (FROM ADDRESS 02B0H TO 02BFH)

Request (8 bytes)

2	4	2	B0	0	8	F1	A0
---	---	---	----	---	---	----	----

Answer (21 bytes)

2	4	10	5A	21	8A	26	82	21	0	0	F5	1	0	0	57	57	57	57	E2	53
---	---	----	----	----	----	----	----	----	---	---	----	---	---	---	----	----	----	----	----	----

Example of interpretation

Variable	Value read (h)	Value converted (d)	Value formatted
W dmd	215A	8538	8538W
VA dmd	268A	9866	9866VA
W dmd MAX	2182	8578	8578W
Hz	01F5	501	50,1HZ
PF L1	57	87	L.87
PF L2	57	87	L.87
PF L3	57	87	L.87
PF Σ	57	87	L.87

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3.3 READING OF CONFIGURATION PARAMETERS

Request (8 bytes)

1	4	10	80	0	B	B4	E5
---	---	----	----	---	---	----	----

Answer (21 bytes)

1	4	16	3	0	F	0	5	0	1	0	3	0	2	0	1	0	6E	0	64	0	64	0	1	0	FA	DE
---	---	----	---	---	---	---	---	---	---	---	---	---	---	---	---	---	----	---	----	---	----	---	---	---	----	----

Example of interpretation

Variable	Value read (h)	Value converted (d)	Value formatted
Password	0003	3	3
Tv	000F	15	1,5
Ta	0005	5	5
P.int	0001	1	1min
FiS	0003	3	3%
Fic	0002	2	2
Add	0001	1	1
AL_V up	006E	110	110V
AL_V down	0064	100	100V
AL_I	0064	100	1,00A
System	0001	1	3P.n

3.4 READING OF ALARM STATE

Request (8 bytes)

2	4	2	7E	0	1	50	59
---	---	---	----	---	---	----	----

Answer (7 bytes)

2	4	2	1	0	FC	A0
---	---	---	----------	---	----	----

To obtain the alarm representation, mask the not-significant bits of the byte indicated in bold (AND with the value 03h). In the example, the voltage alarm is ON.

3.5 READING OF C.G.C. INSTRUMENT CODE

Table of identification codes

Code	Model	Description
15h	WM12 AV5	400VL-L / 660VL-L 5A
16h	WM12 AV6	100VL-L / 208VL-L 5A

To read the identification code, send the following rigid-structure frame (the example is related to the address 2). The code is contained on the position 5 of the reply.

Request (8 bytes)

2	4	0	B	0	1	40	3B
---	---	---	---	---	---	----	----

Answer (21 bytes)

2	4	2	0	15	3C	FF
---	---	---	---	-----------	----	----

15h is the identification code of the WM12 AV5

4 CRC CALCULATION

4.1 EXAMPLE OF CRC CALCULATION

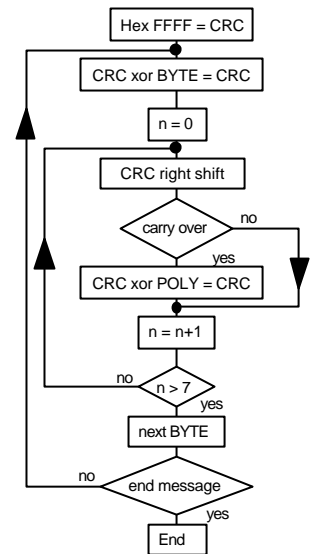
Frame = 0207h

Init CRC	1111 1111 1111 1111
Load first character	0000 0010
Execute the XOR with the first char. of the frame	1111 1111 1111 1101
Execute first Shift to the right	0111 1111 1111 1110 1
Carry = 1, load polynomial	1010 0000 0000 0001
Execute XOR with the polynomial	1101 1111 1111 1111
Execute 2° Shift to the right	0110 1111 1111 1111 1
Carry = 1, load polynomial	1010 0000 0000 0001
Execute XOR with the polynomial	1100 1111 1111 1110
Execute 3° Shift to the right	0110 0111 1111 1111 0
Execute 4° Shift to the right	0011 0011 1111 1111 1
Carry = 1, load polynomial	1010 0000 0000 0001
Execute XOR with the polynomial	1001 0011 1111 1110
Execute 5° Shift to the right	0100 1001 1111 1111 0
Execute 6° Shift to the right	0010 0100 1111 1111 1
Carry = 1, load polynomial	1010 0000 0000 0001
Execute XOR with the polynomial	1000 0100 1111 1110
Execute 7° Shift to the right	0100 0010 0111 1111 0
Execute 8° Shift to the right	0010 0001 0011 1111 1
Carry = 1, load polynomial	1010 0000 0000 0001
Execute XOR with the polynomial	1000 0001 0011 1110

Load second character of the frame	0000 0111
Execute XOR with the second character of the frame	1000 0001 0011 1001
Execute 1° Shift to the right	0100 0000 1001 1100 1
Carry = 1, load polynomial	1010 0000 0000 0001
Execute XOR with the polynomial	1110 0000 1001 1101
Execute 2° Shift to the right	0111 0000 0100 1110 1
Carry = 1, load polynomial	1010 0000 0000 0001
Execute XOR with the polynomial	1101 0000 0100 1111
Execute 3° Shift to the right	0110 1000 0010 0111 1
Carry = 1, load polynomial	1010 0000 0000 0001
Execute XOR with the polynomial	1100 1000 0010 0110
Execute 4° Shift to the right	0110 0100 0001 0011 0
Execute 5° Shift to the right	0011 0010 0000 1001 1
Carry = 1, load polynomial	1010 0000 0000 0001
Execute XOR with the polynomial	1001 0010 0000 1000
Execute 6° Shift to the right	0100 1001 0000 0100 0
Execute 7° Shift to the right	0010 0100 1000 0010 0
Execute 8° Shift to the right	0001 0010 0100 0001 0

CRC result	0001 0010 0100 0001
	12h 41h

Note: the byte 41h is sent first.



POLY = crc calculation polynomial: A001h