CONTENTS

1.0 INTRODUCTION

Data link level

The communication protocol used is MODBUS / JBUS compatible.
Up to 255 different instruments can be managed by the protocol.
Data are transmitted in messages and are checked by mean of a CRC16 WORD
There are no limitations to the number of possible retries done by the master.

Physical level

The physical communication line respects the EIA-RS485 standard in half-duplex modality.
In this case, as only two wires are used, only one instrument at a time can engage the line; this means that there must be a master polling the slave instruments and waiting for the answers.

On the same physical line only 32 instruments can be attached (master included). In order to increase the number of the slave instrument, the necessary repeaters must be used.

The communication parameters are :

speed : programmable
19200, 9600, 4800 Baud
bit n. : 8
stop bit : 1
parity : programmable

2.0 DATA MESSAGE DESCRIPTION

The generic data message is composed as following :

Instrument address	Functional code	Data	CRC word

Two answers are possible :

Answer containing data

Instrument address	Functional code	Data	CRC word

Error answer

Instrument address	Functional code + 0x80	Error code	CRC word

2.1 Data field description

Instrument address : instrument identification number in the network
It must be the same for the demand and the answer.
Format : 1 BYTE from 0 to 0xff - 0 is for broadcast messages with no answer (not used)

Functional code : command code
Used functional code :
Format : 1 BYTE
0x03 : reading of consecutive words
0x10 : writing of consecutive words

Data : they can be :
- the address and the number of the required words (in the demand)
- the data (in the answer)

CRC word : it is the result of the calculation made on all the bytes in the message

2.2 Data format

Three types of format are used for the data :

* BYTE
* WORD : two BYTES
* long : two WORDS

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* BYTE
* WORD : two BYTES
* long : two WORDS

The base data format is the WORD.
If the required data is in a BYTE format, a WORD with the MSB (Most Significant Byte) set to 0 is anyway transmitted and this BYTE comes before the LSB (Least Significant Byte).
If the required data is in a long format, 2 WORDS are transmitted and the MSW comes before the LSW.

MSB	LSB	MSB	LSB
Most Significant WORD		Least Significant WORD	

Example : 1000 = 0x 03 e8 or
0x 00 00 03 e8 (if long)

MSB	LSB	MSB	LSB
0x00	0x00	0x03	0xe8

All data are positive and the sign indications are readable in other variables.

2.3 Description of CRC calculation

The following is an example of the CRC calculation in C language.

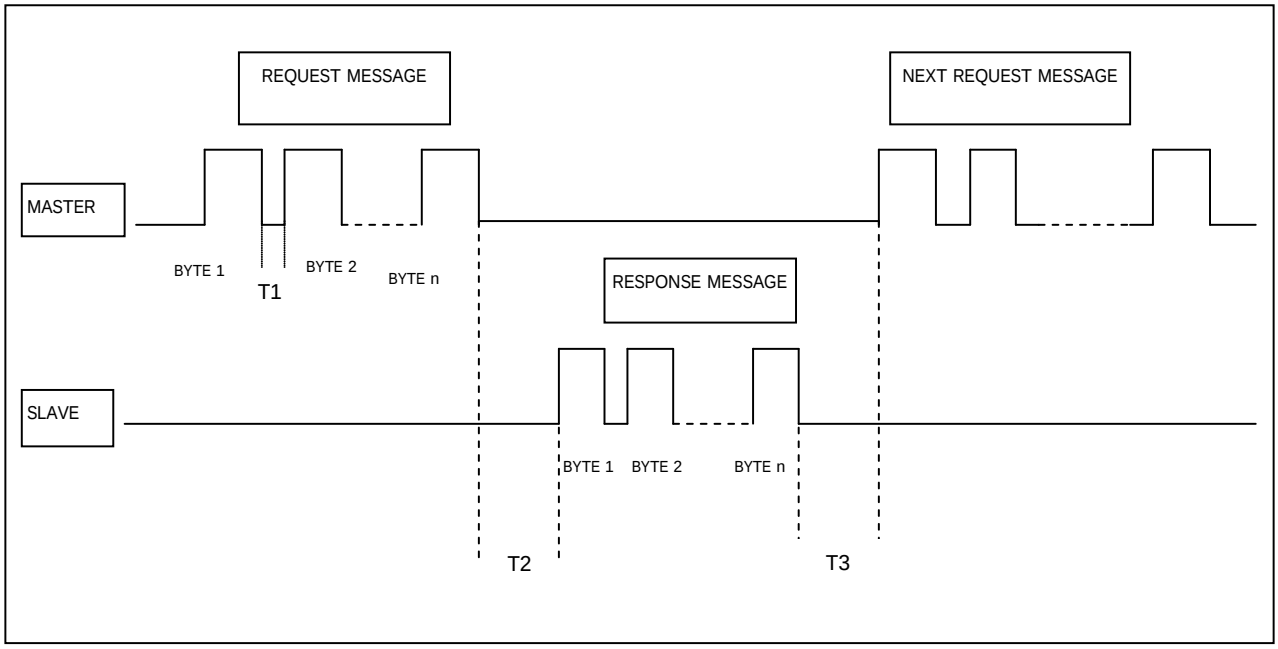
```
unsigned int calc_crc (char *ptbuf, unsigned int num)
/*    ************************************************************
 *    Descrizione : calculates a data buffer CRC WORD
 *    Input       : ptbuf = pointer to the first byte of the buffer
 *                  num   = number of bytes
 *    Output      : //
 *    Return      :
**    ************************************************************/
 {
  unsigned int crc16;
  unsigned int temp;
  unsigned char c, flag;


  crc16 = 0xffff;                              /* init the CRC WORD */
  for (num; num>0; num--) {
        temp = (unsigned int) *ptbuf;          /* temp has the first byte */
        temp &= 0x00ff;                        /* mask the MSB */
        crc16 = crc16 ^ temp;                  /* crc16 XOR with temp */
        for (c=0; c<8; c++) {
              flag = crc16 & 0x01;             /* LSBit di crc16 is kept */
              crc16 = crc16 >> 1;              /* LSBit di crc16 is lost */
              if (flag != 0)
                   crc16 = crc16 ^ 0x0a001;    /* crc16 XOR with 0x0a001 */
        }
        ptbuf++;                               /* points the next byte */
  }

  crc16 = (crc16 >> 8) | (crc16 << 8);         /* LSB is exchanged with MSB */

  return (crc16);

} /* calc_crc */
```

2.4 Error management

If the received message is incorrect (CRC16 is wrong) the polled slave doesn't answer.
If the message is correct but there are errors (wrong functional code or data) so it can't be accepted, the slave answers with an error message.

The error codes are defined in the following part of the document.

2.5 Timing



Values :

T1 (time between characters) = 25 msec (max)
T2 (slave response time) = 100 msec (max)
T3 (delay time) = 25 msec (min)

3.0 COMMANDS

Code 0x03 : reading of one or more consecutive WORDS

Command format :

BYTE	BYTE	MSB LSB	MSB LSB	MSB LSB
Instrument Address	Funct. Code	First WORD address	WORDS number	CRC16

Answer format (containing data) :

BYTE	BYTE	BYTE	MSB LSB	MSB LSB	MSB LSB
Instrument Address	Funct. Code	BYTES number	WORD 1	WORD N.	CRC16

The BYTES number must always match the WORDS number (in the demand) * 2.

Answer format (wrong request) :

BYTE	BYTE	BYTE	MSB LSB
Instrument Address	Funct. Code + 0x80	Error code	CRC16

Error codes :
* 0x01 : incorrect functional code
* 0x02 : wrong first WORD address
* 0x03 : incorrect data

Code 0x10 : writing of more consecutive WORDS

Command format :

BYTE	BYTE	MSB LSB	MSB LSB	BYTE	MSB LSB MSB LSB	MSB LSB
Instr. address	Funct. Code	First WORD address	WORDS number	BYTE numbers	Word Value	CRC16

Answer format (containing data) :

BYTE	BYTE	BYTE	MSB LSB	MSB LSB	MSB LSB
Instrument Address	Funct. Code	BYTES number	First WORD address	00 00	CRC16

The BYTES number must always match the WORDS number (in the demand) * 2.

Answer format (wrong request) :

BYTE	BYTE	BYTE	MSB LSB
Instrument Address	Funct. Code + 0x80	Error code	CRC16

Error codes :
* 0x01 : wrong functional code
* 0x02 : wrong first WORD address
* 0x03 : wrong data

4.0 VARIABLES

4.1 Data addresses

The following table must be used to retrieve all information of the real time measurements.
The user can poll on both tables without any more operation, just change the Modbus address in the protocol data message.

Address	Length	Description	Unit
0x1000	Long	Phase 1 : phase voltage	mV
0x1002	Long	Phase 2 : phase voltage	mV
0x1004	Long	Phase 3 : phase voltage	mV
0x1006	Long	Phase 1 : current	mA
0x1008	Long	Phase 2 : current	mA
0x100a	Long	Phase 3 : current	mA
0x100c	Long	0	
0x100e	Long	Chained voltage : L1-L2	mV
0x1010	Long	Chained voltage : L2-L3	mV
0x1012	Long	Chained voltage : L3-L1	mV
0x1014	Long	3-phase : active power	W/100
0x1016	Long	3-phase : reactive power	W/100
0x1018	Long	3-phase : apparent power	W/100
0x101a	WORD	3-phase : sign of active power	(2)
0x101b	WORD	3-phase : sign of reactive power	(2)
0x101c	Long	3-phase : total positive active energy	kWh/100 E.g. 123.45 kWh Value 12345
0x101e	Long	3-phase : total positive reactive energy	kvarh/100 E.g. 123.78 kWh Value 12378
0x1020	Long	For future use	
0x1022	Long	Operating timer	Sec.
0x1024	WORD	3-phase : power factor	1/100
0x1025	WORD	3-phase : sector of power factor (cap or ind)	(1)
0x1026	WORD	Frequency	Hz/10
0x1027	Long	3-phase : average power	W/100 E.g. 1.2 kW Value 120000
0x1029	Long	3-phase : peak maximum demand	W/100 E.g. 1.2 kW Value 120000
0x102b	WORD	Time counter for average power	Minutes
0x102c	Long	Phase 1 : active power	W/100 (see 1027)
0x102e	Long	Phase 2 : active power	W/100 (see 1027)
0x1030	Long	Phase 3 : active power	W/100 (see 1027)
0x1032	WORD	Phase 1 : sign of active power	(2)
0x1033	WORD	Phase 2 : sign of active power	(2)
0x1034	WORD	Phase 3 : sign of active power	(2)
0x1035	Long	Phase 1 : reactive power	var/100 (see 1027)
0x1037	Long	Phase 2 : reactive power	var/100 (see 1027)
0x1039	Long	Phase 3 : reactive power	var/100 (see 1027)
0x103b	WORD	Phase 1 : sign of reactive power	(2)
0x103c	WORD	Phase 2 : sign of reactive power	(2)
0x103d	WORD	Phase 3 : sign of reactive power	(2)
0x103e	Long	3-phase : partial positive active energy	kWh/100 (see 101c)
0x1040	Long	3-phase : partial positive reactive energy	kvarh/100 (see 101c)
0x1042	Long	0	W/100 (see 101c)
0x1044	Long	3-phase : negative active energy	kWh/100 (see 101c)

0x1046	Long	3-phase : negative reactive energy	kvarh/100 (see 101c)
0xc8	WORD	Parameter reset	(3)
0300	WORD	Device identifier	0x77

(1) ----------

0 : PF = 0 or 1
1 : ind
2 : cap

(2) ----------

0 : positive
1 : negative

(3) ----------

WRITABLE ONLY

0x01 : reset partial active energy
0x02 : reset partial reactive energy
0x08 : reset operating timer
0x10 : reset peak maximum demand

Example 1

Reading of 4 WORDS (8 BYTES – 2 variables) starting from the address 0x101c :

Request :

BYTE	BYTE	MSB | LSB	MSB | LSB	MSB | LSB
Device address	F. code	1st WORD address	WORDS number	CRC16
0x01	0x03	0x10 | 0x1c	0x00 | 0x04	0x81 | 0x0f

Answer :

BYTE	BYTE	BYTE	MSB | LSB	MSB | LSB	MSB | LSB	MSB | LSB	MSB | LSB
		BYTES number	WORD 1	WORD 2	WORD 3	WORD 4	CRC16
0x01	0x03	0x08	0x00 | 0x00	0x64 | 0x8c	0x00 | 0x00	0x35 | 0x54	0x9a | 0x83

In the above case, the information is :

WORD 1 ,WORD 2 : Total positive active energy 0x0000648C = 25740
WORD 3 ,WORD 4 : Total positive reactive energy 0x00003554 = 13652

Example 2

Writing of 1 WORD at address 0xc8 (reset of operating time counter) :

Command :

BYTE	BYTE	MSB | LSB	MSB | LSB		MSB | LSB	MSB | LSB
Device address	F. code	1st WORD address	WORDS number	BYTEs number	WORD	CRC16
0x01	0x10	0x00 | 0xc8	0x00 | 0x01	0x02	0x00 | 0x08	0xb7 | 0xde