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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, 2400 Baud
bit n. : 8
stop bit : 1
parity : programmable

2.0 DATA MESSAGE DESCRIPTION

The generic data message is composed as following :

Device address	Functional code	Data	CRC word

Two answers are possible :

Answer containing data

Device address	Functional code	Data	CRC word

Error answer

Device address	Functional code + 0x80	Error code	CRC word

2.1 Data field description

Device address : device 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

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 of the required words (in the demand)
- the data (in the answer)

CRC word : it is the result of the calculation done 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

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.

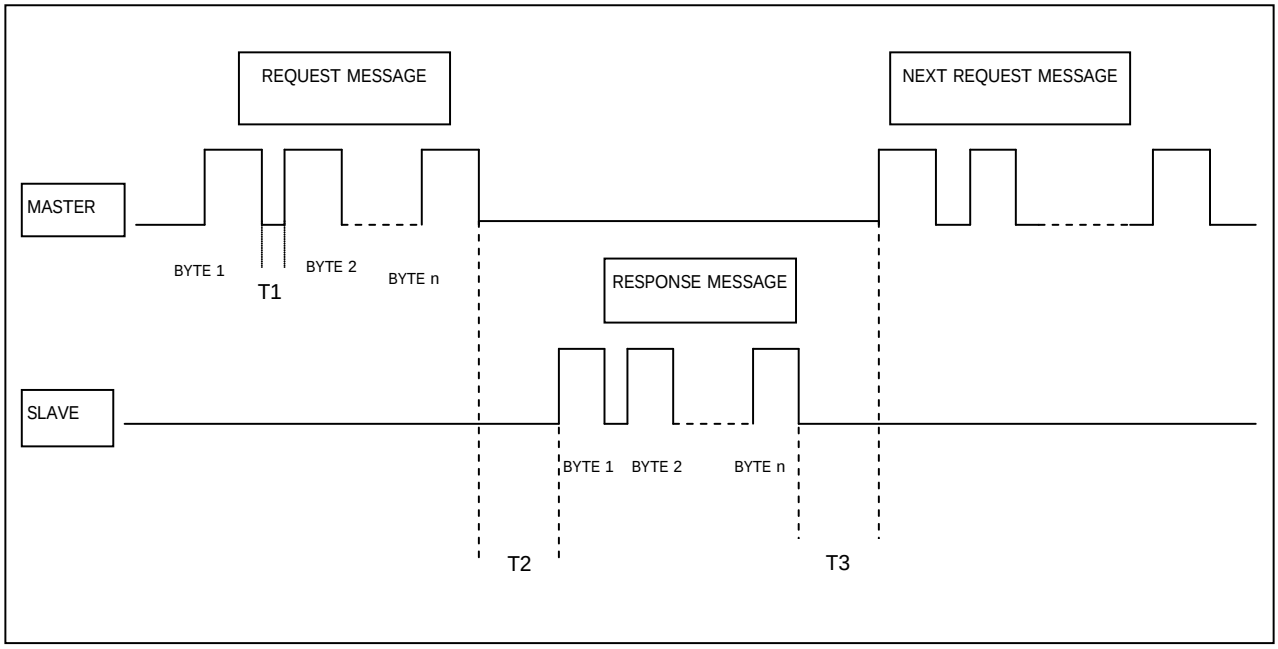
```
unsigned int calc_crc (char *ptbuf, unsigned int num)
/*     ************************************************************
 *     Descrizione : calculates a data buffer CRC WORD
 *     Input       :       ptbuf = pointer to the first byte of the buffer
 *                  num   = number of bytes
 *     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
Device address	Funct. Code	First WORD address	WORDS number	CRC16

Answer format (containing data) :

BYTE	BYTE	BYTE	MSB LSB	MSB LSB	MSB LSB
Device 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
Device 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
Device 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
Device 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
Device address	Funct. Code + 0x80	Error code	CRC16	

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

4.0 VARIABLES

Address	Length	Description	Unit
0x2000	Long	Voltage	mV
0x2002	Long	Current	mA
0x2004	Long	Active power	0.01 W (100.23 => 10023)
0x2006	WORD	Sign of active power	0 : pos 1 : neg
0x2007	WORD	Power factor	1/100
0x2008	WORD	Sector of power factor (cap or ind)	0 : PF = 0 or 1 1 : ind 2 : cap
0x2009	WORD	Frequency	0.1 Hz (50.0 => 500)
0x200a	Long	Positive active energy	0.1 kWh (100.2 => 1002)
0x200c	Long	Positive partial active energy	0.1 kWh (100.2 => 1002)
0x200e	Long	Operating time counter	sec.
0x0c8	WORD	Reset – bit to bit defined	(1)
0x300	WORD	Device identifier	0x13

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

WRITABLE ONLY

0x01 : partial active energy reset
0x08 : operating time counter reset

Example 1

Reading of 4 WORDS (8 BYTES – 2 variables) starting from the address 0x200a :

Request :

BYTE	BYTE	MSB | LSB	MSB | LSB	MSB | LSB
Device address 0x01	F. code 0x03	1st WORD address 0x20 | 0x0a	WORDS number 0x00 | 0x04	CRC16 0x6f | 0xcb

Answer :

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

In the above case, the information is :

WORD 1 ,WORD 2 : Positive active energy 0x0000648C = 25740
WORD 3 ,WORD 4 : Positive partial 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 0x01	F. code 0x10	1st WORD address 0x00 | 0xc8	WORDS number 0x00 | 0x01	BYTEs number 0x02	WORD 0x00 | 0x08	CRC16 0xb7 | 0xde