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1.0 ABSTRACT

Phisical level

The physical communication line complies with 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 which polls the slave instruments so the demand and the request are alternated.

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

The communication parameters are :

Baud rate : programmable
Data bit number : 8
Stop bit : 1
Parity : programmable

Data link level

After each command, a response telegram must follow.
The data are transmitted in packets and are checked by a CRC word.

Application level

The communication protocol used is MODBUS / JBUS compatible.
Up to 255 different instruments can be managed by the protocol.
There are no limitations to the number of possible retries done by the master.

2.0 DATA MESSAGE DESCRIPTION

The generic data message is composed as the 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 Parameters 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

2.3 Description of CRC calculation

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

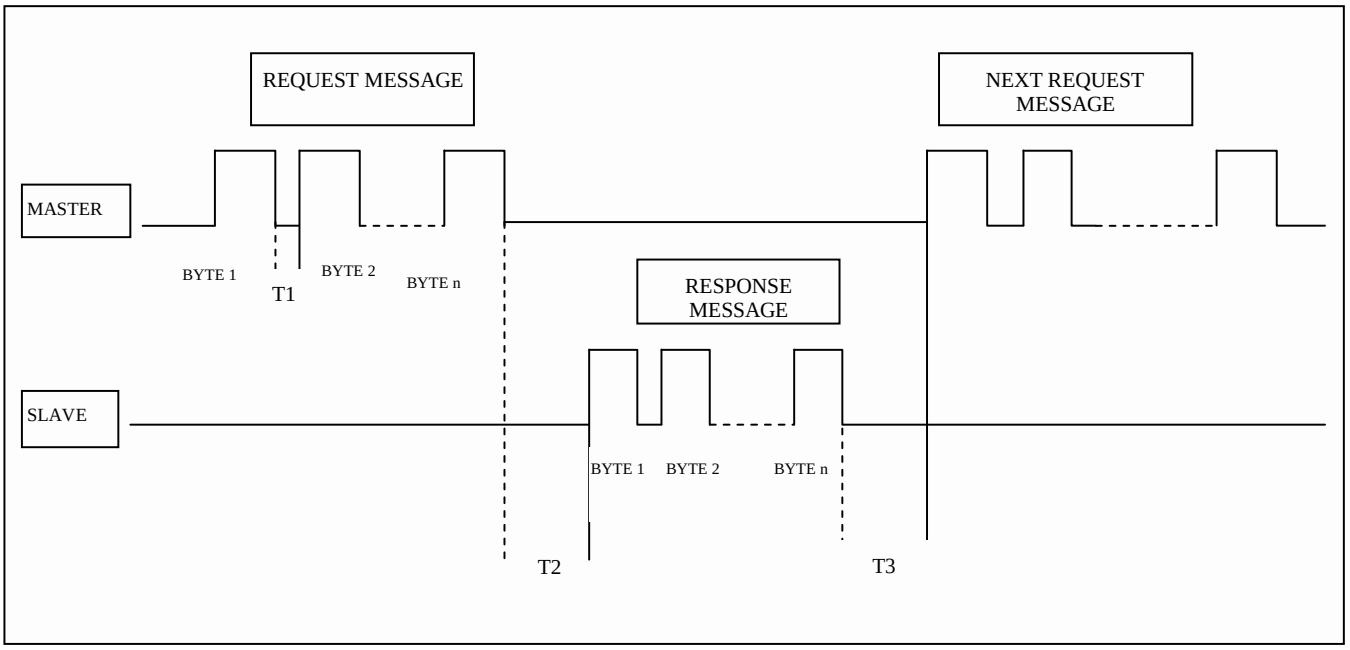
```
unsigned int calc_crc (char *ptbuf, unsigned int num)
/*     ************************************************************
 *     Descrizione : calculates a data buffer CRC WORD
 *     Input       :       ptbuf = pointer to the first byte of the buffer
 *                  num   = number of bytes
 *     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 mantained */
              crc16 = crc16 >> 1;              /* Lsbit di crc16 is lost */
              if (flag != 0)
                   crc16 = crc16 ^ 0x0a001;    /* crc16 XOR with 0x0a001 */
        }
        ptbuf++;                               /* pointer to 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) it can't be accepted, so the slave answers with an error message.

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

2.5 Timing



TIME	DESCRIPTION	VALUES	
T1	**Time between characters.** If this time exceeds the max. time allowed, the message is not considered by device.	Modbus standard	
T2	**Slave response time** Minimum and maximum response time of device to the Master request.	Min = 20 ms. Max = 300ms.	
T3	**Delay time** Time before a new message request from the Master	Min = 20 ms.	

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 (the demand was wrong) :

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 (the demand was wrong) :

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

Variables or groups of variables may be required up to 32 BYTES.

Address	Byte n.	Description	Unit
0x1000	4	Voltage	mV
0x1002	4	Current	mA
0x1004	4	Signed power	(*)
0x1006	4	Positive Energy	Wh
0x1008	4	Negative Energy	Wh
0x100A	4	Time	seconds
0x100C	4	Average Power	(*)
0x100E	4	Maximum Power Demand	(*)
0x1010	2	Minutes elapsed durino the average calculation	
0x1012	4	Positive Amperehours	Ah
0x1014	4	Negative Amperehours	Ah
0x1201	WORD	Current transformer ratio (KTA)	integer
0x1202	WORD	Voltage transformer ratio (KTV)	1/10
0x1203	WORD	Device identifier	0x14

(*) ----------

W/100 if Primary current < 6000 A
W if Primary current >= 6000 A

Example

Demand of 4 WORDS (8 BYTES – 2 variables) starting from the address 0x1006 :

BYTE	BYTE	MSB | LSB	MSB | LSB	MSB | LSB
Device address 0x07	F.code 0x03	1st WORD address 0x10 | 0x06	WORDS number 0x00 | 0x04	CRC16 0xA0 | 0xAE

Answer

BYTE	BYTE	BYTE	MSB | LSB	MSB | LSB	MSB | LSB	MSB | LSB	MSB | LSB
0x07	0x03	BYTES number 0x08	WORD 1 0x00 | 0x00	WORD 2 0x09 | 0x45	WORD 3 0x00 | 0x00	WORD 4 0x02 | 0x0C	CRC16 0x47 | 0x6C

In the above case, the information is :

WORD 1 ,WORD 2 : Positive energy 0x00000945 = 2373 Wh

WORD 3 ,WORD 4 : Negative energy 0x0000020C = 524 Wh