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1.0 ABSTRACT

Physical level

The electrical 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 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 :

Baud rate	: programmable (device dependant)
bit n.	: 8
stop bit	: 1
parity	: programmable (device dependant)

Data link level

The data are transmitted in a packet form (message) and are checked by a U_WORD (CRC). See the description of the data packet in the next paragraphs for more details.

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.

A delay between the response from the slave and the next command could be necessary and it is specified for each device (timing).

2.0 DATA MESSAGE DESCRIPTION

The generic data message is composed as following :

Device address	Functional code	Data	CRC word
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Two answers are possible :

Answer containing data

Device address	Functional code	Data	CRC word
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Error answer

Device address	Functional code + 0x80	Error code	CRC word
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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

The following types of format are used for the data values :

- * U_WORD : one WORD - unsigned
- * S_WORD : one WORD - signed
- * UD_WORD : two WORDS - unsigned
- * SD_WORD : two WORDS - signed

If the required data is in a D_WORD 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 UD_WORD)

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 */

```

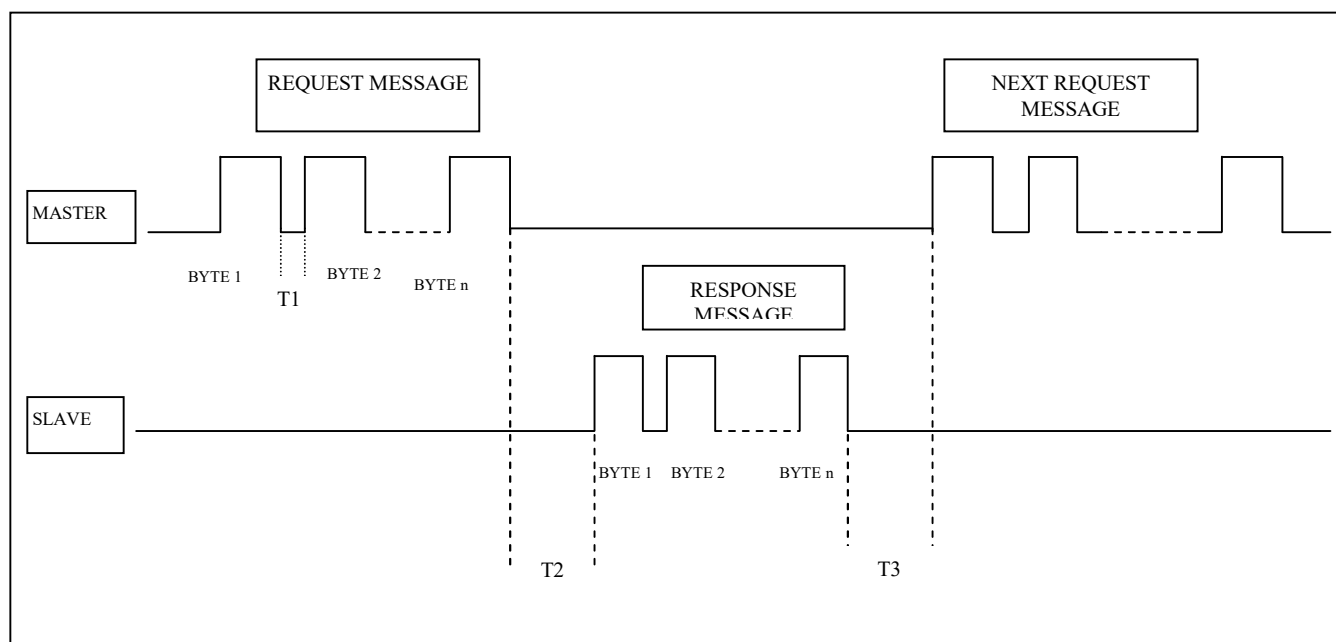
2.4 Error management

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	Min & Max VALUES
T1	Time between characters. If this time exceeds the max. time allowed, the message is not considered by device.	Typ. = 20 ms
T2	Slave response time Minimum response delay to Master request.	Min = 20 ms
T3	Time before a new message request from the Master can be issued	Min = 1 ms

3.0 COMMANDS

Code 0x03 : reading of one or more consecutive WORDS

Command format :

BYTE	BYTE	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		
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		
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		
Device address	Funct. Code	First WORD address		WORDS number		BYTE numbers	Word Value				CRC16	

Answer format (containing data) :

BYTE	BYTE	MSB	LSB	MSB	LSB		
Device address	Funct. Code	First WORD address		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		
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 14 BYTES

Address	Format	Description	Unit	Type
0x00	U WORD	Voltage	xxx, x V	Read
0x01	U WORD	Current	xxx, x A	Read
0x02	U WORD	Frequency	Xx, xx Hz	Read
0x03	U WORD	Active Power	Xxxx W	Read
0x04	U WORD	Reactive Power	Xxxx var	Read
0x05	U WORD	Apparent Power	Xxxx VA	Read
0x06	U WORD	Power Factor	-	-
0x07	U DWORD	Total Active Energy	Xxxxxx wh * 10	Read
0x11	U DWORD	Total Reactive Energy	Xxxxxx varh * 10	Read
0x2A	U WORD	Baud rate	-	Read/Write
0x2B	U WORD	Node Address	-	Read/Write

WRITE ADDRESS TABLE

Address	Format	Description	Value
0x2A	U WORD	Baud rate	1=1200/2=2400/3=4800/4=9600
0x2B	U WORD	Node address	1 .. 247