Contents

Rev	DESCRIPTION	Date	Sw
B	Formal revision	10/05/2016	➢ 1.00

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

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

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.

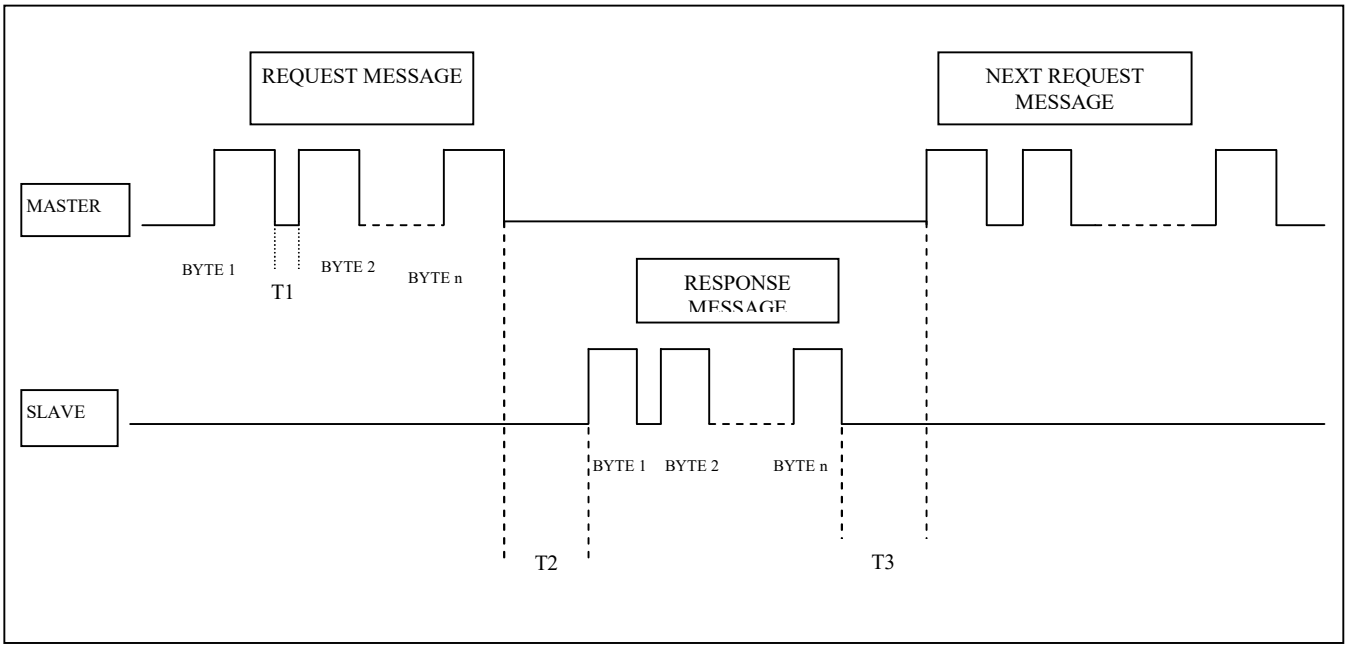
```
unsigned int calc_crc (char *ptbuf, unsigned int num)
/*     ************************************************************
 *     Descrizione : calculates a data buffer CRC WORD
 *     Input       :       ptbuf = pointer to the first byte of the buffer
 *                  num    = number of bytes
 *     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

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	Byte n.	**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