046 86
ENERGY METER
4 module

CONTENTS

1.0 ABSTRACT

Phisical level

The phisical 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 phisical 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
bit n. : 8
stop bit : 1

Data link level

After each command, a response telegram must follow, unless the command was a broadcast one.
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 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.

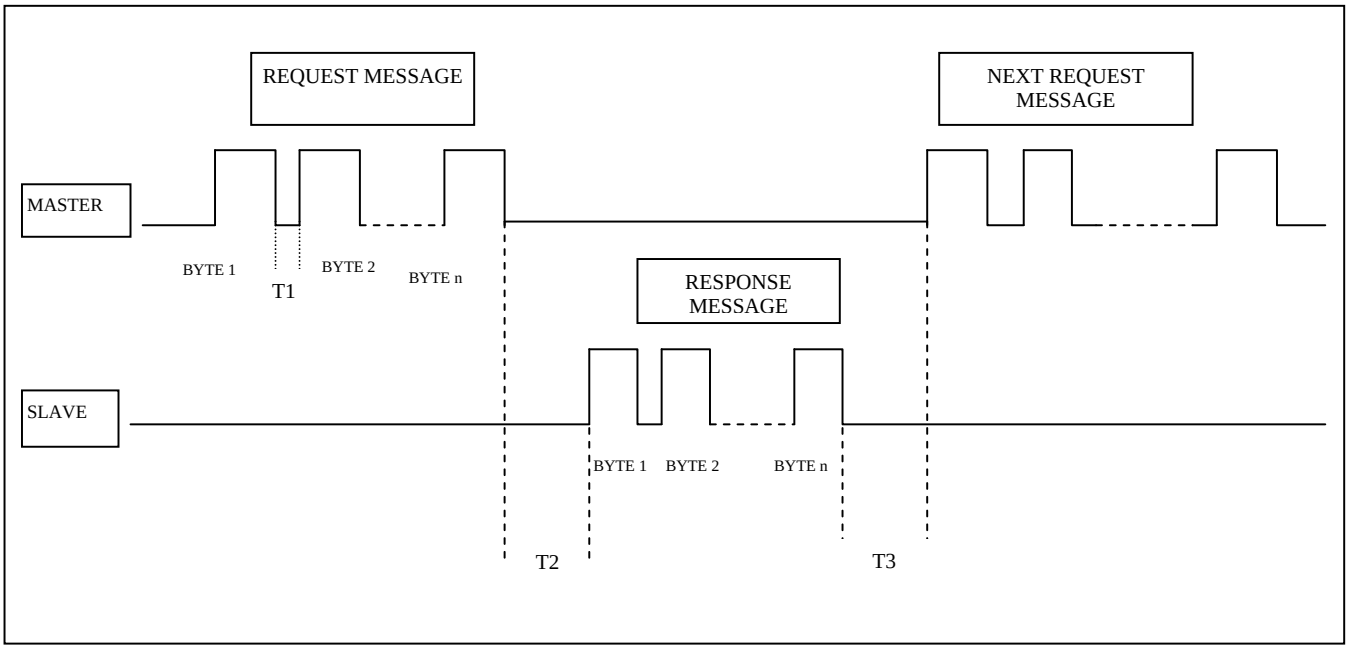
```
unsigned int calc_crc (char *ptbuf, unsigned int num)
/*     ************************************************************
 *     Descrizione : calculates a data buffer CRC WORD
 *     Input       :       ptbuf = pointer to the first byte of the buffer
 *                  num    = number of bytes
 *     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.	25 ms.	
T2	**Slave response time** Minimum and maximum response time of device to the Master request.	Min = 25 ms. Max = 100ms.	
T3	**Delay time** Time before a new message request from the Master	Min = 25 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 100 BYTES.

Address	Byte n.	Description	Unit	Soft. Vers.
0x301	Long	Phase 1 : phase voltage	mV	All
0x305	Long	Phase 2 : phase voltage	mV	All
0x309	Long	Phase 3 : phase voltage	mV	All
0x30d	Long	Phase 1 : current	mA	All
0x311	Long	Phase 2 : current	mA	All
0x315	Long	Phase 3 : current	mA	All
0x319	Long	3-phase : active power	(3)	All
0x31d	Long	3-phase : reactive power	(3)	All
0x321	Long	3-phase : apparent power	(3)	All
0x325	Long	3-phase : indirect positive active energy	(4)	All
0x329	Long	Chained voltage : L1-L2	mV	All
0x32d	Long	Chained voltage : L2-L3	mV	All
0x331	Long	Chained voltage : L3-L1	mV	All
0x335	Long	3-phase : direct positive active energy	(4)	All
0x339	WORD	Frequency	Hz/10	All
0x33b	WORD	0	-	
0x33d	BYTE	3-phase : power factor	1/100	All
0x33f	BYTE	3-phase : sector of power factor (cap or ind)	(1)	All
0x340	BYTE	Reserved	-	All
0x341	WORD	CRC of the software	-	All
0x343	Long	3-phase : direct positive reactive energy	(4)	All
0x347	BYTE	3-phase : sign of active power	(5)	All
0x348	Long	Operating time counter	sec.	All
0x34c	BYTE	3-phase : sign of reactive power	(5)	All
0x34d	BYTE	Reserved	-	All
0x34e	BYTE	0		
0x34f	BYTE	0		
0x350	Long	3-phase : average power	(3)	All
0x354	Long	3-phase : peak maximum demand	(3)	All
0x358	BYTE	Time counter for average power	minutes	All
0x359	Long	Neutral current	mA	All
0x35d	Long	Phase 1 : active power	(3)	All
0x361	Long	Phase 2 : active power	(3)	All
0x365	Long	Phase 3 : active power	(3)	All
0x369	BYTE	Phase 1 : sign of active power	(5)	All
0x36a	BYTE	Phase 2 : sign of active power	(5)	All
0x36b	BYTE	Phase 3 : sign of active power	(5)	All
0x36c	Long	Phase 1 : reactive power	(3)	All
0x370	Long	Phase 2 : reactive power	(3)	All
0x374	Long	Phase 3 : reactive power	(3)	All
0x378	BYTE	Phase 1 : sign of reactive power	(5)	All
0x379	BYTE	Phase 2 : sign of reactive power	(5)	All
0x37a	BYTE	Phase 3 : sign of reactive power	(5)	All

0x0c8	BYTE	Reset – bit to bit defined	(6)	All
0x100	WORD	Current transformer ratio (KTA)	integer	All
0x102	WORD	Voltage transformer ratio (KTV)	*10 always	All
0x300	BYTE	Device identifier	0x11	All

A second address table is implemented in the software and the user may decide freely which use.

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	Neutral current	mA
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	(3)
0x1016	Long	3-phase : reactive power	(3)
0x1018	Long	3-phase : apparent power	(3)
0x101a	WORD	3-phase : sign of active power	(5)
0x101b	WORD	3-phase : sign of reactive power	(5)
0x101c	Long	3-phase : indirect positive active energy	(4)
0x101e	Long	3-phase : direct positive reactive energy	(4)
0x1020	Long	3-phase : direct positive active energy	(4)
0x1022	Long	Operating time counter	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	(3)
0x1029	Long	3-phase : peak maximum demand	(3)
0x102b	WORD	Time counter for average power	minutes
0x102c	Long	Phase 1 : active power	(3)
0x102e	Long	Phase 2 : active power	(3)
0x1030	Long	Phase 3 : active power	(3)
0x1032	WORD	Phase 1 : sign of active power	(5)
0x1033	WORD	Phase 2 : sign of active power	(5)
0x1034	WORD	Phase 3 : sign of active power	(5)
0x1035	Long	Phase 1 : reactive power	(3)
0x1037	Long	Phase 2 : reactive power	(3)
0x1039	Long	Phase 3 : reactive power	(3)
0x103b	WORD	Phase 1 : sign of reactive power	(5)
0x103c	WORD	Phase 2 : sign of reactive power	(5)
0x103d	WORD	Phase 3 : sign of reactive power	(5)

0x1200	WORD	Current transformer ratio (KTA)	integer
0x1201	WORD	Voltage transformer ratio (KTV)	*10 always
0x1206	WORD	Device identifier	0x11

lx. ----------

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

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

W, var, VA / 100 if KTA*KTV < 6000
W, var, VA if KTA*KTV >= 6000

(4) ----------

For indirect positive active energy :

Format : xxxxxx.yy kWh always

Otherwise:

Transformer ratio	Measurement unit	Display Format	Protocol Format	
1 ≤ KTA*KTV < 10	Wh(varh) * 10	xxxxxx.yy k	xxxxxxyy	**
10 ≤ KTA*KTV < 100	Wh(varh) * 100	xxxxxxx.y k	xxxxxxxy	
100 ≤ KTA*KTV < 1000	kWh(kvarh)	Xxxxxxxx k	xxxxxxxx	
1000 ≤ KTA*KTV < 10000	kWh(kvarh) * 10	xxxxxx.yy M	xxxxxxyy	
10000 ≤ KTA*KTV < 100000	kWh(kvarh) * 100	xxxxxxx.y M	xxxxxxxy	
100000 ≤ KTA*KTV < 1000000	kWh(kvarh) * 1000	Xxxxxxxx M	xxxxxxxx	

** Positive active energy will have always the same format.

(5) ----------

0 : positive
1 : negative

(6) ----------

0x08 : operating time counter reset
0x010 : peak maximum demand reset

Example

Demand of 4 WORDS (8 BYTES – 2 variables) starting from the address 0x0325 :

BYTE	BYTE	MSB | LSB	MSB | LSB	MSB | LSB
Device address 0x01	F.code 0x03	1st WORD address 0x03 | 0x25	WORDS number 0x00 | 0x04	CRC16 0x55 | 0x86

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 : Total active energy 0x0000648C = 25740

WORD 3 ,WORD 4 : Total reactive energy 0x00003554 = 13652