Contents

Rev	DESCRIPTION	Date	Sw
B	Formal revision	10/05/2016	➢ 2.90

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 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.

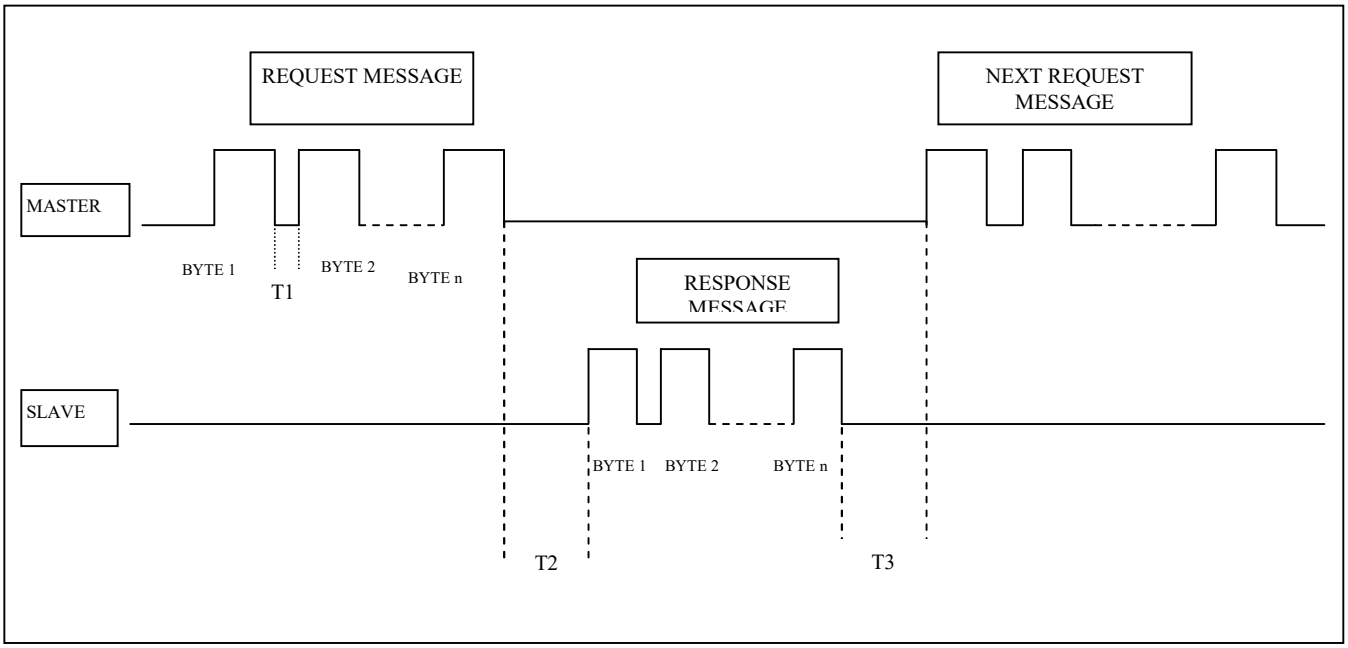
```
unsigned int calc_crc (char *ptbuf, unsigned int num)
/*     ************************************************************
 *     Descrizione : calculates a data buffer CRC WORD
 *     Input       :       ptbuf = pointer to the first byte of the buffer
 *                  num    = number of bytes
 *     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.	Min = 3 msec Max = 99 msec
T2	**Slave response time** Minimum response delay to Master request.	Min = 10 ms
T3	Time before a new message request from the Master can be issued	Min = 1 ms

Be careful : among the setup parameters there is a timeout value that may be programmed
The value of 20 msec is suggested to keep compatibility with older IME devices.
The minimum value is 3 msec.

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

4.1 Data addresses

Both variables and groups of variables can be required.
All the variables with consecutive addresses can be required at one time.
The following is the table with the addresses and the meaning of the variables.

Address		Read/Write	Format	Description
HEX	DEC			
				Energy
0x325	805	R	UD WORD	3-phase : Total positive active energy
0x329	809	R	UD WORD	3-phase : Total positive reactive energy
0x32d	813	R	UD WORD	3-phase : Partial positive active energy
0x331	817	R	UD WORD	3-phase : Partial positive reactive energy

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	UD_WORD	Phase 1 : phase voltage	mV
0x1002	UD_WORD	Phase 2 : phase voltage	mV
0x1004	UD_WORD	Phase 3 : phase voltage	mV
0x1006	UD_WORD	Phase 1 : current	mA
0x1008	UD_WORD	Phase 2 : current	mA
0x100a	UD_WORD	Phase 3 : current	mA
0x100c	UD_WORD	0	
0x100e	UD_WORD	Chained voltage : L1-L2	mV
0x1010	UD_WORD	Chained voltage : L2-L3	mV
0x1012	UD_WORD	Chained voltage : L3-L1	mV
0x1014	UD_WORD	3-phase : active power	W/100
0x1016	UD_WORD	3-phase : reactive power	W/100
0x1018	UD_WORD	3-phase : apparent power	W/100
0x101a	U_WORD	3-phase : sign of active power	(2)
0x101b	U_WORD	3-phase : sign of reactive power	(2)
0x101c	UD_WORD	3-phase : total positive active energy	kWh/100
0x101e	UD_WORD	3-phase : total positive reactive energy	kvarh/100
0x1020	UD_WORD	For future use	
0x1022	UD_WORD	0	
0x1024	U_WORD	3-phase : power factor	1/100
0x1025	U_WORD	3-phase : sector of power factor (cap or ind)	(1)
0x1026	U_WORD	Frequency	Hz/10
0x1027	UD_WORD	3-phase : average power	W/100
0x1029	UD_WORD	3-phase : peak maximum demand	W/100
0x102b	U_WORD	Time counter for average power	minutes
0x102c	UD_WORD	Phase 1 : active power	W/100
0x102e	UD_WORD	Phase 2 : active power	W/100
0x1030	UD_WORD	Phase 3 : active power	W/100
0x1032	U_WORD	Phase 1 : sign of active power	(2)
0x1033	U_WORD	Phase 2 : sign of active power	(2)
0x1034	U_WORD	Phase 3 : sign of active power	(2)
0x1035	UD_WORD	Phase 1 : reactive power	var/100
0x1037	UD_WORD	Phase 2 : reactive power	var/100
0x1039	UD_WORD	Phase 3 : reactive power	var/100
0x103b	U_WORD	Phase 1 : sign of reactive power	(2)
0x103c	U_WORD	Phase 2 : sign of reactive power	(2)
0x103d	U_WORD	Phase 3 : sign of reactive power	(2)
0x103e	UD_WORD	3-phase : partial/second tariff positive active energy	kWh/100
0x1040	UD_WORD	3-phase : partial/second tariff positive reactive energy	kvarh/100
0x1042	UD_WORD	3-phase : second tariff peak maximum demand	W/100
0x1044	UD_WORD	0	
0x1046	UD_WORD	0	
0xC8	U_WORD	Parameter reset	(3)
0300	U_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
0x10 : reset Peak Maximum Demand tariff 1 (when selected)
0x20 : reset Peak Maximum Demand tariff 2 (when selected)

4.2 Variables description

Energy

Positive energy
Format : UD_WORD
Measurement unit : Hundreds of kWh/kvarh

Average power

Average power
This is the power calculated with the shifting average algorithm. It is updated every minute.
Format : UD_WORD
Measurement unit : W/100
Peak maximum demand
This is the power obtained as the maximum of the average powers and it is updated at the end of average period.
Format : UD_WORD
Measurement unit : W/100

Operating time counter

Format : UD_WORD
Measurement unit : min