CONTENTS

1.0 ABSTRACT

Physical 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 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 DWORD format, 2 WORDS are transmitted and the MSW comes before the LSW (depending on the setting in the NEMO 96 : **big endian / little endian / swap WORDS**

MSB	LSB	MSB	LSB
Most Significant WORD		Least Significant WORD	

Example : 1000 = 0x 03 e8 or
0x 00 00 03 e8 (if UDWORD)

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.

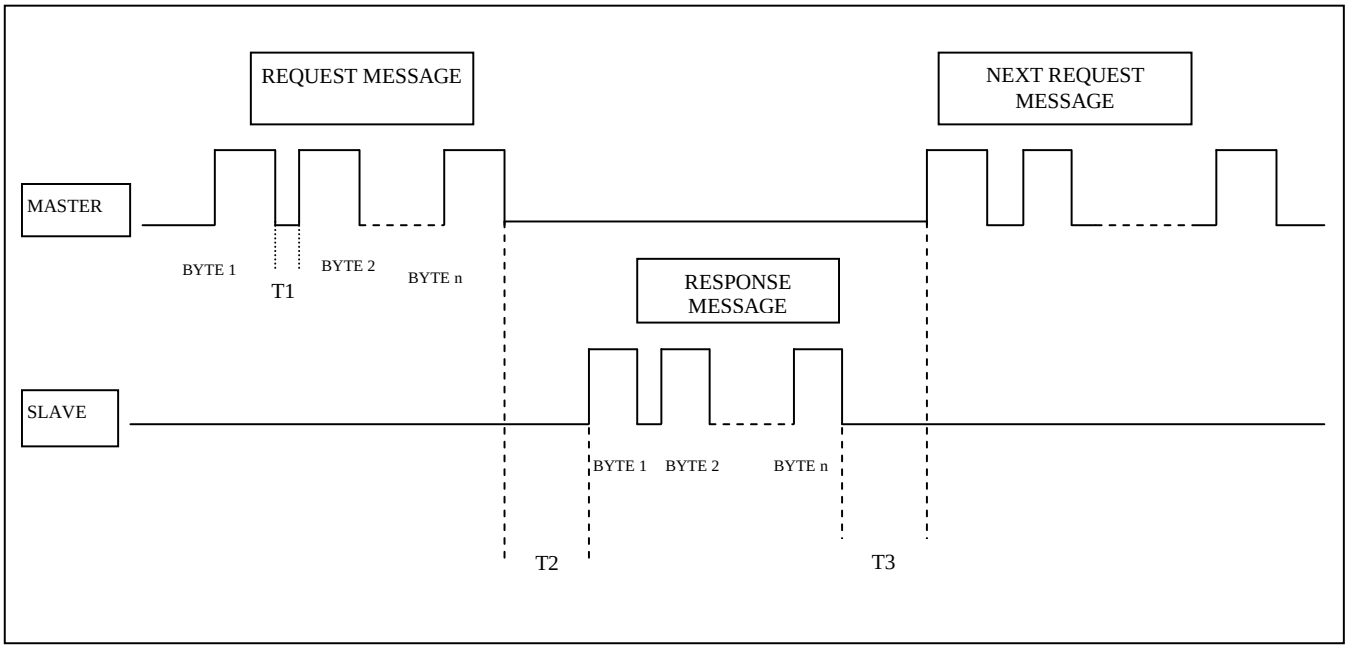
```
unsigned int calc_crc (char *ptbuf, unsigned int num)
/*     ************************************************************
 *     Descrizione : calculates a data buffer CRC WORD
 *     Input       :       ptbuf = pointer to the first byte of the buffer
 *                  num    = number of bytes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



Be careful : among the setup parameters there is a timeout value that may be programmed.
This is the inter-characters timeout and implicitly is the timeout to detect the end of a message.
The value of 20 msec is suggested to keep compatibility with older IME devices.
The minimum value is 3 msec.

TIME	DESCRIPTION	Min & Max VALUES
T1	**Time between characters.** If this time exceeds the programmed timeout, the message is considered closed by the device	Min = 3 msec Max <= 99 msec
T2	**Slave response time** Minimum and maximum response time of device to the Master request after a message has been detected valid	Max = 20 ms.
T3	Time before a new message request from the Master	Min = 1 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

Variables or groups of variables may be required up to 240 BYTES

0x100	**U_WORD**	Current transformer ratio (KTA)	No unit
0x102	**U_WORD**	Voltage transformer ratio (KTV)	1/100 (hundredths)
0x300	**U_WORD**	Device identifier	0x72
0x325	**UD_WORD**	3-phase : Tariff 1 "SUN indicator" positive active energy	(2)
0x329	**UD_WORD**	3-phase : Tariff 1 "SUN indicator" positive reactive energy	(2)
0x32d	**UD_WORD**	3-phase : Tariff 2 "MOON indicator" positive active energy	(2)
0x331	**UD_WORD**	3-phase : Tariff 2 "MOON indicator" positive reactive energy	(2)

Address	Format	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	(1)
0x1016	**UD_WORD**	3-phase : reactive power	(1)
0x1018	**UD_WORD**	3-phase : apparent power	(1)
0x101a	**U_WORD**	3-phase : sign of active power	(4)
0x101b	**U_WORD**	3-phase : sign of reactive power	(4)
0x101c	**UD_WORD**	3-phase : Tariff 1 "SUN indicator" positive active energy	(2)
0x101e	**UD_WORD**	3-phase : Tariff 1 "SUN indicator" positive reactive energy	(2)
0x1020	**UD_WORD**	Future developments	---
0x1022	**UD_WORD**	0	
0x1024	**S_WORD**	3-phase : power factor	1/100 signed
0x1025	**U_WORD**	3-phase : sector of power factor (cap or ind)	0 : PF = 1 1 : ind (a) 2 : cap (r)
0x1026	**U_WORD**	Frequency	Hz/10
0x1027	**UD_WORD**	3-phase : average power	(1)
0x1029	**UD_WORD**	3-phase : Tariff 1 "SUN indicator" peak maximum demand	(1)
0x102b	**U_WORD**	Time counter for average power	minutes
0x102c	**UD_WORD**	Phase 1 : active power	(1)
0x102e	**UD_WORD**	Phase 2 : active power	(1)
0x1030	**UD_WORD**	Phase 3 : active power	(1)
0x1032	**U_WORD**	Phase 1 : sign of active power	(4)
0x1033	**U_WORD**	Phase 2 : sign of active power	(4)
0x1034	**U_WORD**	Phase 3 : sign of active power	(4)
0x1035	**UD_WORD**	Phase 1 : reactive power	(1)

0x1037	UD_WORD	Phase 2 : reactive power	(1)
0x1039	UD_WORD	Phase 3 : reactive power	(1)
0x103b	U_WORD	Phase 1 : sign of reactive power	(4)
0x103c	U_WORD	Phase 2 : sign of reactive power	(4)
0x103d	U_WORD	Phase 3 : sign of reactive power	(4)
0x103e	UD_WORD	3-phase : Tariff 2 "MOON indicator" positive active energy	(2)
0x1040	UD_WORD	3-phase : Tariff 2 "MOON indicator" positive reactive energy	(2)
0x1042	UD_WORD	3-phase : Tariff 2 "MOON indicator" peak maximum demand	(1)
0x1044	S_WORD	Phase 1 : power factor	1/100 signed
0x1045	S_WORD	Phase 2 : power factor	1/100 signed
0x1046	S_WORD	Phase 3 : power factor	1/100 signed
0x1047	U_WORD	Phase 1 : power factor sector	0 : PF = 1 1 : ind (a) 2 : cap (r)
0x1048	U_WORD	Phase 2 : power factor sector	0 : PF = 1 1 : ind (a) 2 : cap (r)
0x1049	U_WORD	Phase 3 : power factor sector	0 : PF = 1 1 : ind (a) 2 : cap (r)
0x104a	U_WORD	0	
0x104b	U_WORD	0	
0x104c	U_WORD	0	
0x104d	U_WORD	0	
0x104e	U_WORD	0	
0x104f	U_WORD	0	
0x1050	UD_WORD	0	
0x1052	UD_WORD	0	
0x1054	UD_WORD	0	
0x1056	UD_WORD	0	
0x1058	UD_WORD	0	
0x105a	UD_WORD	0	
0x105c	UD_WORD	0	
0x105e	UD_WORD	0	
0x1060	UD_WORD	0	
0x1062	UD_WORD	0	
0x1064	UD_WORD	0	
0x1066	UD_WORD	0	
0x1068	UD_WORD	0	
0x106a	UD_WORD	0	
0x106c	UD_WORD	0	
0x106e	U_WORD	Run hour meter	Hour
0x106f	U_WORD	0	
0x1070	UD_WORD	0	
0x1072	UD_WORD	0	
0x1074	UD_WORD	0	
0x1076	UD_WORD	0	
0x1078	UD_WORD	0	
0x107a	UD_WORD	0	
0x107c	UD_WORD	Run hour meter	minutes
0x107e	UD_WORD	0	
0x1080	UD_WORD	3-phase : Total positive active energy	(3)

0x1082	**UD_WORD**	3-phase : Total positive reactive energy	(3)
0x1084	**UD_WORD**	3-phase : Tariff 1 "SUN indicator" positive active energy	(2)
0x1086	**UD_WORD**	3-phase : Tariff 1 "SUN indicator" positive reactive energy	(2)
0x1088	**UD_WORD**	3-phase : Tariff 2 "MOON indicator" positive active energy	(2)
0x108a	**UD_WORD**	3-phase : Tariff 2 "MOON indicator" positive reactive energy	(2)
0x108c	**UD_WORD**	3-phase : Tariff 1 "SUN indicator" peak maximum demand	(1)
0x108e	**UD_WORD**	3-phase : Tariff 2 "MOON indicator" peak maximum demand	(1)
0x1090	**UD_WORD**	3-phase : Partial positive active energy	(2)
0x1092	**UD_WORD**	3-phase : Partial positive reactive energy	(2)
0x1200	**U_WORD**	Current transformer ratio (KTA)	No unit
0x1201	**U_WORD**	Voltage transformer ratio (KTV)	1/100 (hundredths)
0x1202	**UD_WORD**	Future developments	---
0x1204	**U_WORD**	Device identifier	0x72
0x1205	**U_WORD**	Future developments	---
0x1206	**U_WORD**	0	
0x1540	**U_WORD**	Tariff 1 positive active energy wrap round	(5)
0x1541	**U_WORD**	Tariff 2 positive active energy wrap round	(5)
0x1542	**U_WORD**	Tariff 1 positive reactive energy wrap around	(5)
0x1543	**U_WORD**	Tariff 2 positive reactive energy wrap around	(5)
0x1628	**U_WORD**	Input state: 0 = NULL 1 = Tariff 1 "SUN indicator" 2 = Tariff 2 "MOON indicator"	0 : NULL 1 : Tariff 1 2 : Tariff 2

(1) ----------

W, var, VA / 100

(2) ----------

	Measurement unit	**Display Format**	**Protocol Format**
Direct Connection	Wh(varh) * 10	xxxxxx.yy k	Xxxxxxyy

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

	Measurement unit	**Display Format**	**Protocol Format**
Direct Connection	kWh(varh) * 1	xxxxxxxx k	Xxxxxxxx

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

0 : positive
1 : negative

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

wrap around means : when the main register of the energy value increases over 100 000 000 , the register is then reset to 0 and the wrap around value is incremented by 1

5.0 SETUP PARAMETERS

D6CExxx parameters may be red and written accordingly to the procedure described in the following.
The variable table to read and write the parameters are located at the same address.
It is allowed to write the setup parameters addressed at 0x2000 only by a single telegram for each group.

Standard Setup parameters read

Length : 20 BYTES

0x2000	**U_WORD**	Energy mode accumulation	0 : not used 1 : not used 2 : not used
0x2001	**U_WORD**	Power Averaging time	0:5min 1:8min 2:10min 3:15min 4:20min 5:30min 6:60min
0x2002	**U_WORD**	Pulse on	0:Act Energy 1:Rea Energy
0x2003	**U_WORD**	Pulse weight	(kWh/kvarh) 0: 0.001 1: 0.010 2: 0.100 3: 1.000 4: 10.00 5: 100.0
0x2004	**U_WORD**	Pulse duration	0: 50msec 1: 100msec 2: 200msec 3: 300msec 4: 400msec 5: 500msec
0x2005	**U_WORD**	Percentage of rated 3phase active power run hour meter	40..5000 means (0.4%..50.00%)
0x2006	**U_WORD**	Device address	1..255
0x2007	**U_WORD**	Baud rate	0:4800 1:9600 2:19200
0x2008	**U_WORD**	Parity	0:none 1:odd 2:even
0x2009	**U_WORD**	Time between characters	3..99mS

Procedure to write

Every write operation must be preceded by a “Master Unlock Key” command.

Address 0x2700 : write word with value = 0x5AA5 (Master Unlock Key)

Reset of NEMO parameters

Any writing operation of any parameter will have effect **only** in the volatile memory (RAM).
After any writing operation of parameters described in the following of the document, if necessary to go back to the default
it is mandatory to send the following commands :

Address 0x2700 : write WORD with value = 0x 5AA5 (Master Unlock Key)
Address 0x2800 : write WORD with value = 0x YYYY (any value)

This command will reset the NEMO and in this way all changes will be lost so returning to the previous conditions.

EEPROM savings

If it is necessary to save the new parameters in EEPROM it is mandatory to send these following messages :

Address 0x2700 : write WORD with value = 0x 5AA5 (Master Unlock Key)
Address 0x2600 : write WORD with value = 0x YYYY (any value)

Write address table

Address	Format	Description	Value
0xC8	**U_WORD**	Reset partial positive active energy Reset partial positive reactive energy Reset Hour Meter Reset Peak Maximum Demand Tariff 1 "SUN indicator" Reset Peak Maximum Demand Tariff 2 "MOON indicator"	(10)
0x2000	**6 U_WORD**	Standard setup parameters	(14)
0x2600	**U_WORD**	Saving in EEPROM parameters changed by Remote commands	(11)
0x2700	**U_WORD**	Enable Remote Writing Operation	(12)
0x2800	**U_WORD**	Load previous setup parameters stored in EEPROM	(13)

(10) To reset desired measurements write the following word (in binary) :

0|0|0|0|0|0|0|0|0|0|b5|b4|b3|b2|b1|b0

b0 = 1 => reset partial positive active energy

b1 = 1 => reset partial positive reactive energy

b2 = 1 => not used

b3 = 1 => Reset Hour Meter

b4 = 1 => Reset Peak Maximum Demand Tariff 1 "SUN indicator"

b5 = 1 => Reset Peak Maximum Demand Tariff 2 "MOON indicator"

b6 .. b15 = not used

(11) Write any value to save the new parameters changed by Remote commands

(12) To do any remote programming write operation, it's mandatory to write a safety key = 0x5AA5.

(13) Write any value to abort any remote programming write operation and reload the previous values.

(14) **Standard Setup parameters write**

0x2000	**U_WORD**	Energy mode accumulation	0 : not used 1 : not used 2 : not used
0x2001	**U_WORD**	Power Averaging time	0:5min 1:8min 2:10min 3:15min 4:20min 5:30min 6:60min
0x2002	**U_WORD**	Pulse on	0:Act Energy 1:Rea Energy
0x2003	**U_WORD**	Pulse weight	(kWh/kvarh) 0: 0.001 1: 0.010 2: 0.100 3: 1.000 4: 10.00 5: 100.0
0x2004	**U_WORD**	Pulse duration	0: 50msec 1: 100msec 2: 200msec 3: 300msec 4: 400msec 5: 500msec
0x2005	**U_WORD**	Percentage of rated 3phase active power run hour meter	40..5000 means (0.4%..50.00%)