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MODBUS

RS485 SERIAL PROTOCOL

ED39DIN
DMM3
VIP39DIN (discontinued)
VIP396
SIRIO
STAR3
STAR3din

VERSION
24 FEBRUARY 2006

The STAR3, STAR3 din , VIP396, VIP39din, DMM3, SIRIO and ED39din instruments have three different MODBUS protocol formats which can be selected with the set-up menu of the instruments.

This manual describes the RTU and IEEE formats in detail.
We are not providing full details of the ASCIII format, as we advise against using this format.
The main reason why it was implemented is to make the new instruments compatible with previously developed, existing software, using the format of VIP ENERGY and of many other previous instruments.

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“MODBUS RTU” PROTOCOL

CHARACTERISTICS OF THE “MODBUS RTU” PROTOCOL.

- Selected transmission mode: RTU
- Coding system : 8-bit binary
- Error detection method: CRC
- Serial protocol characteristics:

Baud-rate: 19200 / 9600 / 4800 / 2400
Data bits: 8
Parity bit:: None / Odd / Even
Stop bits: 1

FORMAT OF THE STRUCTURE OF THE “MODBUS RTU” PROTOCOL MESSAGE.

In the RTU transmission mode, the data structure (Frame) can only by synchronised by simulating a synchronised message.

The receiver controls reception time between characters.

If a time equivalent to 3 characters and a half elapses without a new character being received or the structure (Frame) being completed, the receiver rejects the frame and considers the next byte as an address.

CHECK ERROR (CRC) CALCULATION PROCEDURE.

1) Load a 16-bit register with ones only (FFFFH).
2) Execute an exclusive OR between the register and the transmission buffer byte.
3) Shift the register thus obtained by one bit to the right.
4) If the excluded bit on the right is 1, execute an exclusive OR between the register and the 16-bit “A001H” polynomial.
5) Repeat steps 3 and 4 eight times.
6) Repeat steps 2,3,4 and 5 for all the message bytes.
7) The final contents of the 16-bit register is the CRC (error check) and is transmitted at the end of the message, beginning with the least significant byte.

The following C language routine is used for calculating the CRC.

```
/******************************************************************************/
/* Function : CalcCRC                    */
/* purpose  : CRC calculation of a string          */
/* Param INP : string of characters          */
/*     : Number of characters          */
/*   OUT : WORD with the calculated checksum          */
/* Return  :                    */
/******************************************************************************/
unsigned int CalcCRC(char * lpCMD ,unsigned char num_char,unsigned int checksum)
{
 #define POLINOMIO 0xA001
 #define NUM_SHIFT 8

 unsigned char cnt;
 unsigned char shift;
 unsigned char carat;

 for (cnt = 0;cnt < num_char ; cnt++)
 {
  carat  = *lpCMD;
```

```
  checksum ^= (WORD)carat;
  lpCMD++;
  for(shift = 1; shift < NUM_SHIFT + 1 ; shift++)
  {
    if((checksum & 0x0001) == 0)
     checksum = checksum >> 1;
    else
     checksum = ((checksum >> 1) ^ POLINOMIO);
  }
 }
 return(checksum);
}
```

AVAILABLE FUNCTIONS OF “MODBUS RTU”.

- READ OUTPUT STATUS (01H)
- READ INPUT STATUS (02H)
- READ HOLDING REGISTER (03H)
- READ INPUT REGISTER (04H)
- FORCE SINGLE COIL * (05H)
- PRESET SINGLE REGISTER * (06H)
- READ EXCEPTION STATUS (07H)
- FORCE MULTIPLE COILS * (0FH)
- REPORT SLAVE ID (11H)
- WRITE AN EEPROM (16-BIT) REGISTER (43H)
- READ AN EEPROM (16-BIT) REGISTER (44H)

* messages addressable to all slaves (slave address = 0).

LIST OF IMPLEMENTED “MODBUS RTU” PROTOCOL COMMANDS AND THEIR LIMITATIONS.

READ OUTPUT STATUS (01H).

A function for reading status of digital output coils.

P.C.		INSTRUMENT
AA,01H,SSSS,WWWW,CRC	⟶	
	⟵	AA,01H,BB,D1,CRC

where:
- AA = Address of selected Instrument (1 binary byte)
- 01H = Read command code of read output status (1 binary byte)
- SSSS = Address of the output status from which reading begins (2 binary bytes)
- WWWW = Number of output status to read (2 binary bytes)
- CRC = Cyclical Redundancy Check (2 binary bytes)
- BB = Number of bytes read (1 binary byte)
- D1 = Bytes that were read.

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N.B.
The address of the output status is obtained by subtracting 1 from the output status address
E.g..: To read output status 2 (in decimals) $\Rightarrow$ (2 – 1) = 1 (in decimals) this is the value for SSSS
D1…Dn: The answer must be interpreted looking at the single bits
the LSB (less significant bit) correspond to the status of the SSSS input
the next bit is the status of the next input , in case WWWW>1 (more than one input has been requested)

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OUTPUT STATUS ADDRESS LIST

Same as list of “Force single coils” command 05H (listed below)

READ INPUT STATUS (02H). (only for OEM models)

A function for reading status of digital input.

P.C.		INSTRUMENT
AA,02H,SSSS,WWWW,CRC	⟶	
	⟵	AA,02H,BB,D1,CRC

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where:
- AA = Address of selected Instrument (1 binary byte)
- 02H = Read command code of read input status (1 binary byte)
- SSSS = Address of the input status from which reading begins (2 binary bytes)
- WWWW = Number of input status to read (2 binary bytes)
- CRC = Cyclical Redundancy Check (2 binary bytes)
- BB = Number of bytes read (1 binary byte)
- D1 = Bytes that were read.

N.B.
The address of the input status is obtained by subtracting 1 from the input status address
E.g..: To read input status 2 (in decimals) $\Rightarrow$ (2 – 1) = 1 (in decimals) this is the value for SSSS
D1: The answer must be interpreted looking at the single bits
the LSB (less significant bit) correspond to the status of the SSSS input
the next bit is the status of the next input , in case WWWW>1 (more than one input has been requested)

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INPUT STATUS ADDRESS LIST

1 **Status of the digital input .**
Valid values: 0 or 1 in binary
N.B.
- 0 means that the external contact is closed
- 1 means that the external contact is open

READ HOLDING REGISTER (03H).

A function for reading registers used for programming operation of the instrument.
The registers are programmed with the “PRESET SINGLE REGISTER (06H)” function.

P.C. INSTRUMENT

AA,03H,SSSS,WWWW,CRC ⟶

⟵ AA,03H,BB,D1,..,Dn,CRC

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where:
- AA = Address of selected VIP (1 binary byte)
- 03H = Read command code of N Holding registers (1 binary byte)
- SSSS = Address of the holding register from which reading begins (2 binary bytes)
- WWWW = Number of registers to read (2 binary bytes): max 40 words
- CRC = Cyclical Redundancy Check (2 binary bytes)
- BB = Number of bytes read (1 binary byte)
- D1,..,Dn = Bytes that were read.

N.B.
The address of the holding register is obtained by removing the code (e.g. “3”) and subtracting 1 from the register number itself.
E.g..: Reg. 30003 (in decimals) ⇒ ~~3~~0003 (in decimals) ⇒ (0003 – 1) = 0002 (in decimals).

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HOLDING REGISTERS LIST

30001 **KA: amperometric transformation ratio.**
Valid values: 0000 - 9999 (in BCD).
N.B.
- If the set KA has a decimal part, it is rounded to the integer value.
- If KA is greater than 9999 (in BCD), it is saturated at 9999 (in BCD).

30002 **KV: voltmetric transformation ratio.**
Valid values: 0000 - 9999 (in BCD).
N.B.
- If the set KV has a decimal part, it is rounded to the integer value.
- If KV is greater than 9999 (in BCD), it is saturated at 9999 (in BCD).

30003 Integration time for Demand values **(from 1 to 99 min. (in BCD).**

READ INPUT REGISTER (04H).

This function is used to read the registers in which the measures are stored.
With this instrument, up to 12 registers can be obtained per request.

P.C.		INSTRUMENT
AA,04H,SSSS,WWWW,CRC	⟶	
	⟵	AA,04H,BB,D1,..,Dn,CRC

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where:

- AA = Address of selected VIP (1 binary byte)
- 04H = Read command code of N input registers (1 binary byte)
- SSSS = Address of the input register from which reading begins (2 binary bytes)
- WWWW = Number of registers to read (2 binary bytes): max 12 words
- CRC = Cyclical Redundancy Check (2 binary bytes)
- BB = Number of bytes read (1 binary byte)
- D1,..,Dn = Bytes that were read.

N.B.
The address of the input register, to be used to request the data, is obtained by removing the function code (e.g. "4") and subtracting 1 from the register number itself.
E.g..: Reg. 40003 (in decimals) ⇒ 0003 (in decimals) ⇒ (0003 – 1) = 0002 (in decimals).

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INPUT REGISTERS LIST
VALID ONLY FOR STAR3, STAR3din , DMM3, SIRIO, ED39din rel 2.00 on; VIP396 rel. 5.01 on, VIP39din rel. 5.0 on

In case of instruments having a firmware release lower than the one mentioned, refer to the list of addresses available at page 9.

The measure in BCD are available in floating point format with two registers : the first is the mantissa the second is the exponent
The mantissa is expressed with 3 BCD numbers on 12 bits . The msb is the sign
The exponent is in binary format . The complement 2 is used for negative exponent.
The counters are expressed with 8 BCD numbers for the integer part and 4 BCD numbers for decimal part .
The counters is available on 3 registers. The first two are the integer part . The last is the decimal part. The magnitude of the counters is always the kilo (kWh, kVArh kVAh)

0001	**V (3ph)**	**Three phase Voltage** (mantissa in BCD**)**
0002	**V (3 ph□)**	**Three phase Voltage** (exponent in binary format**)**
0003	**A (3 ph□)**	**total Current**
0004	**A (3 ph□)**	**total Current**
0005	**kW (3 ph□)**	**total active Power**
0006	**kW (3 ph□)**	**total active Power**

0007	**kVAr (3 ph□)**	**total reactive Power**
0008	**kVAr (3 ph□)**	**total reactive Power**
0009	**kVA (3 ph□)**	**total apparent Power**
0010	**kVA (3 ph□)**	**total apparent Power**
0011	**PF (3 ph□)**	**total power factor**
0012	**PF (3 ph□)**	**total power factor**
0013	**kW avg (3 ph□)**	**Demand active power**
0014	**kW avg (3 ph□)**	**Demand active power**
0015	**kVA avg (3 ph□)**	**Demand apparent power**
0016	**kVA avg (3 ph□)**	**Demand apparent power**
0017	**kW max (3 ph□)**	**Maximum demand active power**
0018	**kW max (3 ph□)**	**Maximum demand active power**
0019	**kVA max (3 ph□)**	**Maximum demand apparent power**
0020	**kVA max (3 ph□)**	**Maximum demand apparent power**
0021	**kWh (3 ph□)**	**Total active energy counter (integer part in BCD)**
0022	**kWh (3 ph□)**	**Total active energy counter (integer part in BCD)**
0023	**kWh (3 ph□)**	**Total active energy counter (decimal part in BCD)**
0024	**kVArh (3 ph□)**	**Total reactive energy counter**
0025	**kVArh (3 ph□)**	**Total reactive energy counter**
0026	**kVArh (3 ph□)**	**Total reactive energy counter**
0027	**S/N**	**serial number**
0028	**S/N**	**serial number**
0029	**V (L1)**	**Voltage L1**
0030	**V (L1)**	**Voltage L1**
0031	**V (L2)**	**Voltage L2**
0032	**V (L2)**	**Voltage L2**
0033	**V (L3)**	**Voltage L3**
0034	**V (L3)**	**Voltage L3**
0035	**A (L1)**	**Current L1**
0036	**A (L1)**	**Current L1**
0037	**A (L2)**	**Current L2**
0038	**A (L2)**	**Current L2**
0039	**A (L3)**	**Current L3**
0040	**A (L3)**	**Current L3**
0041	**kW (L1)**	**Active power L1**
0042	**kW (L1)**	**Active power L1**
0043	**kW (L2)**	**Active power L2**
0044	**kW (L2)**	**Active power L2**
0045	**kW (L3)**	**Active power L3**
0046	**kW (L3)**	**Active power L3**
0047	**Frequency**	**Hz**
0048	**Frequency**	**Hz**
0049	**kVAr (L1)**	**reactive power L1 measured (includes the power of the distortion, if any . Is the real RMS reactive power))**
0050	**kVAr (L1)**	**reactive power L1 measured**
0051	**kVAr (L2)**	**reactive power L2 measured**
0052	**kVAr (L2)**	**reactive power L2 measured**
0053	**kVAr (L3)**	**reactive power L3 measured**
0054	**kVAr (L3)**	**reactive power L3 measured**
0055	**kVA (L1)**	**apparent power L1**
0056	**kVA (L1)**	**apparent power L1**
0057	**kVA (L2)**	**apparent power L2**
0058	**kVA (L2)**	**apparent power L2**

0059	kVA (L3)	apparent power L3
0060	kVA (L3)	apparent power L3
0061	kVAr (L1)	reactive power fnd L1 (not including distortion, only fundamental order)
0062	kVAr (L1)	reactive power fnd L1
0063	kVAr (L2)	reactive power fnd L2
0064	kVAr (L2)	reactive power fnd L2
0065	kVAr (L3)	reactive power fnd L3
0066	kVAr (L3)	reactive power fnd L3
0067	pf (L1)	power factor L1
0068	pf (L1)	power factor L1
0069	pf (L2)	power factor L2
0070	pf (L2)	power factor L2
0071	pf (L3)	power factor L3
0072	pf (L3)	power factor L3
0073	A n	Neutral current (***)
0074	A n	Neutral current (***)
0075	A avg (L1)	Demand Current L1
0076	A avg (L1)	Demand Current L1
0077	A avg (L2)	Demand Current L2
0078	A avg (L2)	Demand Current L2
0079	A avg (L3)	Demand Current L3
0080	A avg (L3)	Demand Current L3
0081	Amax (L1)	Maximum demand current A L1
0082	Amax (L1)	Maximum demand current A L1
0083	Amax (L2)	Maximum demand current A L2
0084	Amax (L2)	Maximum demand current A L2
0085	Amax (L3)	Maximum demand current A L3
0086	Amax (L3)	Maximum demand current A L3
0087	kVAr avg	Demand reactive power (***)
0088	kVAr avg	Demand reactive power (***)
0089	kVAr max	Maximum demand reactive power(***)
0090	kVAr max	Maximum demand reactive power(***)
0091	kWh cog	Exported active energy counter (cogeneration) (*)
0092	kWh cog	Exported active energy counter (*)
0093	kWh cog	Exported active energy counter (*)
0094	kVArh cog	lagging reactive energy counter (cogeneration) (*)
0095	kVArh cog	lagging reactive energy counter (*)
0096	kVArh cog	lagging reactive energy counter (*)
0097	kVAh	Apparent energy counter (***)
0098	kVAh	Apparent energy counter (***)
0099	kVAh	Apparent energy counter (***)
0100	kWh T1	Active energy counter tariff T1 (**)
0101	kWh T1	Active energy counter tariff T1 (**)
0102	kWh T1	Active energy counter tariff T1 (**)
0103	kWh T2	Active energy counter tariff T2 (**)
0104	kWh T2	Active energy counter tariff T2 (**)
0105	kWh T2	Active energy counter tariff T2 (**)
0106	kWh T3	Active energy counter tariff T3 (**)
0107	kWh T3	Active energy counter tariff T3 (**)
0108	kWh T3	Active energy counter tariff T3 (**)
0109	kWh T4	Active energy counter tariff T4 (**)

0110	**kWh T4**	**Active energy counter tariff T4 (**)**
0111	**kWh T4**	**Active energy counter tariff T4 (**)**
0112	**Inp1**	**Digital input counter 1 (**)**
0113	**Inp1**	**Digital input counter 1 (**)**
0114	**Inp1**	**Digital input counter 1 (**)**
0115	**Inp2**	**Digital input counter 2 (**)**
0116	**Inp2**	**Digital input counter 2 (**)**
0117	**Inp2**	**Digital input counter 2 (**)**
0195	**D/I Status**	**Digital Input Status (*****)**
0196	**D/I Status**	**Digital Input Status (*****)**
0197	**THD Vtot%**	**Total harmonic distortion Vtot (****)**
0198	**THD Vtot %**	**Total harmonic distortion Vtot (****)**
0199	**THD Itot%**	**Total harmonic distortion Itot (****)**
0200	**THD Itot%**	**Total harmonic distortion Itot (****)**
0201	**THD V1%**	**Total harmonic distortion V1 (*)**
0202	**THD V1%**	**Total harmonic distortion V1 (*)**
0203	**THD V2%**	**Total harmonic distortion V2 (*)**
0204	**THD V2%**	**Total harmonic distortion V2 (*)**
0205	**THD V3%**	**Total harmonic distortion V3 (*)**
0206	**THD V3%**	**Total harmonic distortion V3 (*)**
0207	**THD A1%**	**Total harmonic distortion A1 (*)**
0208	**THD A1%**	**Total harmonic distortion A1 (*)**
0209	**THD A2%**	**Total harmonic distortion A2 (*)**
0210	**THD A2%**	**Total harmonic distortion A2 (*)**
0211	**THD A3%**	**Total harmonic distortion A3 (*)**
0212	**THD A3%**	**Total harmonic distortion A3 (*)**

(*) Available only on STAR 3
(**) Available only on ED39DIN
(***) Available only on STAR 3, DMM3, SIRIO, VIP396 rel. 5.01 on; VIP39DIN rel. 5.00 on, ED39din rel. 2.00 on.
(****) Available only on STAR3 rel 6.03 on
(*****) Available only on OEM models

INPUT REGISTERS HARMONICS DATA
VALID ONLY FOR STAR3 HARMO rel 3.00 on, STAR3din HARMO rel 1.00 on

The harmo version of the instruments STAR3 and STAR3din transmits all the data describing the harmonic spectrum i.e . modules of the voltage vectors, modules of the current vectors and cosinus of the angles between voltage and current vectors of the same harmonics.
The data are available per each phase.

Harmonic Voltage data

H01 (fundamental)
0213 V1 h01 phase voltage L1 harmonic 1
0214 V1 h01 phase voltage L1 harmonic 1
0215 V2 h01 phase voltage L2 harmonic 1
0216 V2 h01 phase voltage L2 harmonic 1
0217 V3 h01 phase voltage L3 harmonic 1

0218 V3 h01 phase voltage L3 harmonic 1

H02 harmonic 2
0219 V1 h02 phase voltage L1 harmonic 2
0220 V1 h02 phase voltage L1 harmonic 2
0221 V2 h02 phase voltage L2 harmonic 2
0222 V2 h02 phase voltage L2 harmonic 2
0223 V3 h02 phase voltage L3 harmonic 2
0224 V3 h02 phase voltage L3 harmonic 2
…….
…….
consecutive addresses for all the harmonics data from 3 until the last :

H25 harmonic 25
0357 V1 h25 phase voltage L1 harmonic 25
0358 V1 h25 phase voltage L1 harmonic 25
0359 V2 h25 phase voltage L2 harmonic 25
0360 V2 h25 phase voltage L2 harmonic 25
0361 V3 h25 phase voltage L3 harmonic 25
0362 V3 h25 phase voltage L3 harmonic 25

Harmonic Current data

H01 (fundamental)
0375 A1 h01 phase current L1 harmonic 1
0376 A1 h01 phase current L1 harmonic 1
0377 A2 h01 phase current L2 harmonic 1
0378 A2 h01 phase current L2 harmonic 1
0379 A3 h01 phase current L3 harmonic 1
0380 A3 h01 phase current L3 harmonic 1

H02 harmonic 2
0381 A1 h02 phase current L1 harmonic 2
0382 A1 h02 phase current L1 harmonic 2
0383 A2 h02 phase current L2 harmonic 2
0384 A2 h02 phase current L2 harmonic 2
0385 A3 h02 phase current L3 harmonic 2
0386 A3 h02 phase current L3 harmonic 2
…….
…….
consecutive addresses for all the harmonics data from 3 until the last :

H25 harmonic 25
0519 A1 h025 phase current L1 harmonic 25
0520 A1 h025 phase current L1 harmonic 25
0521 A2 h025 phase current L2 harmonic 25
0522 A2 h025 phase current L2 harmonic 25
0523 A3 h025 phase current L3 harmonic 25
0524 A3 h025 phase current L3 harmonic 25

Phase angle Harmonic Current data

the instruments transmits the cos ϕ_i , where ϕ_i is the angle between the vectors voltage – current of the harmonic order i-th

H01 (fundamental)
0537 Pf1 h01 phase power factor L1 harmonic 1
0538 Pf1 h01 phase power factor L1 harmonic 1
0539 Pf2 h01 phase power factor L2 harmonic 1
0540 Pf2 h01 phase power factor L2 harmonic 1
0541 Pf3 h01 phase power factor L3 harmonic 1
0542 Pf3 h01 phase power factor L3 harmonic 1

H02 harmonic 2
0543 Pf1 h02 phase power factor L1 harmonic 2
0544 Pf1 h02 phase power factor L1 harmonic 2
0545 Pf2 h02 phase power factor L2 harmonic 2
0546 Pf2 h02 phase power factor L2 harmonic 2
0547 Pf3 h02 phase power factor L3 harmonic 2
0548 Pf3 h02 phase power factor L3 harmonic 2
…….
…….
consecutive addresses for all the harmonics data from 3 until the last :

H25 harmonic 25
0681 Pf1 h25 phase power factor L1 harmonic 25
0682 Pf1 h25 phase power factor L1 harmonic 25
0683 Pf2 h25 phase power factor L2 harmonic 25
0684 Pf2 h25 phase power factor L2 harmonic 25
0685 Pf3 h25 phase power factor L3 harmonic 25
0686 Pf3 h25 phase power factor L3 harmonic 25

INPUT REGISTERS LIST OF FORMER VERSIONS OF THE FIRMWARE.
The following list must be used for instrumenst having a firmware release lower than ED39din rel 2.00 ; VIP36 rel. 5.01, VIP39din rel. 5.0

0001 3-phase voltage (mantissa in BCD).
0002 3-phase voltage (binary exponent as complement of 2)
0003 3-phase current (mantissa in BCD).
0004 3-phase current (binary exponent as complement of 2)
0005 3-phase active power (mantissa in BCD).
0006 3-phase active power (binary exponent as complement of 2)
0007 3-phase reactive power (mantissa in BCD).
0008 3-phase reactive power (binary exponent as complement of 2)
0009 3-phase apparent power (mantissa in BCD).
0010 3-phase apparent power (binary exponent as complement of 2)
0011 3-phase Cosphi (mantissa in BCD).
0012 3-phase Cosphi (binary exponent as complement of 2).
0013 Demand 3-phase active power (mantissa in BCD).
0014 Demand 3-phase active power (binary exponent as complement of 2)
0015 Demand 3-phase apparent power (mantissa in BCD).
0016 Demand 3-phase apparent power (binary exponent as complement of 2)

0017	*3-phase active power Maximum demand (mantissa in BCD).*
0018	*3-phase active power Maximum demand (binary exponent as complement of 2)*
0019	*3-phase apparent power Maximum demand (mantissa in BCD).*
0020	*3-phase apparent power Maximum demand (binary exponent as complement of 2)*
0021	*Counter of 3-phase positive active energy (whole part (MSW) in BCD).*
0022	*Counter of 3-phase positive active energy (whole part (LSW) in BCD).*
0023	*Counter of 3-phase positive active energy (decimal part).*
0024	*Counter of 3-phase positive reactive energy (whole part (MSW) in BCD).*
0025	*Counter of 3-phase positive reactive energy (whole part (LSW) in BCD).*
0026	*Counter of 3-phase positive reactive energy (decimal part).*
0027-0028	*Available (not used).* *Fixed on 0.*
0029	*L1 phase voltage (mantissa in BCD).*
0030	*L1 phase voltage (binary exponent as complement of 2)*
0031	*L2 phase voltage (mantissa in BCD).*
0032	*L2 phase voltage (binary exponent as complement of 2)*
0033	*L3 phase voltage (mantissa in BCD).*
0034	*L3 phase voltage (binary exponent as complement of 2)*
0035	*L1 phase current (mantissa in BCD).*
0036	*L1 phase current (binary exponent as complement of 2)*
0037	*L2 phase current (mantissa in BCD).*
0038	*L2 phase current (binary exponent as complement of 2)*
0039	*L3 phase current (mantissa in BCD).*
0040	*L3 phase current (binary exponent as complement of 2)*
0041	*L1 phase active power (mantissa in BCD).*
0042	*L1 phase active power (binary exponent as complement of 2)*
0043	*L2 phase active power (mantissa in BCD).*
0044	*L2 phase active power (binary exponent as complement of 2)*
0045	*L3 phase active power (mantissa in BCD).*
0046	*L3 phase active power (binary exponent as complement of 2)*
0047	*Frequency (mantissa in BCD).*
0048	*Frequency (binary exponent as complement of 2)*
0049	*True active power L1 phase (mantissa in BCD).*
0050	*True active power L1 phase (binary exponent as complement of 2)*
0051	*True active power L2 phase (mantissa in BCD).*
0052	*True active power L2 phase (binary exponent as complement of 2)*
0053	*True active power L3 phase (mantissa in BCD).*
0054	*True active power L3 phase (binary exponent as complement of 2)*
0055	*L1 phase apparent power (mantissa in BCD).*
0056	*L1 phase apparent power (binary exponent as complement of 2)*
0057	*L2 phase apparent power (mantissa in BCD).*
0058	*L2 phase apparent power (binary exponent as complement of 2)*
0059	*L3 phase apparent power (mantissa in BCD).*
0060	*L3 phase apparent power (binary exponent as complement of 2)*
0061	*L1 phase total reactive power (mantissa in BCD).*
0062	*L1 phase reactive power (binary exponent as complement of 2)*
0063	*L2 phase total reactive power (mantissa in BCD).*
0064	*L2 phase reactive power (binary exponent as complement of 2)*
0065	*L3 phase total reactive power (mantissa in BCD).*
0066	*L3 phase reactive power (binary exponent as complement of 2)*
0067	*L1 Cosphi phase (mantissa in BCD).*
0068	*L1 Cosphi phase (binary exponent as complement of 2)*
0069	*L2 Cosphi phase (mantissa in BCD).*
0070	*L2 Cosphi phase (binary exponent as complement of 2)*
0071	*L3 Cosphi phase (mantissa in BCD).*
0072	*L3 Cosphi phase (binary exponent as complement of 2)*

REGISTERS AVAILABLE FOR ED39Din only:

0100 energy_tariff T1 .integers
0101 energy_ tariff T1.integers
0102 energy_ tariff T1.decimals
0103 energy_ tariff T2.integers
0104 energy_ tariff T2.integers
0105 energy_ tariff T2.decimals
0106 energy_ tariff T3.integers
0107 energy_ tariff T3.integers
0108 energy_ tariff T3.decimals
0109 energy_ tariff T4.integers
0110 energy_ tariff T4.integers
0111 energy_ tariff T4.decimals

0112 digital input counter 1 .integers
0113 digital input counter 1.integers
0114 digital input counter 1.decimals
0115 digital input counter 2.integers
0116 digital input counter 2.integers
0117 digital input counter 2.decimals

N.B.

- All register measurements, with the exception of energy counters and some specific registers, are in floating point format with mantissa + exponent.
  The mantissa (consisting of 3 BCD digits on 12 bits plus the sign on the register's most significant bit) is the quantity in its fundamental unit of measure.
  The exponent is expressed in binary form (as a complement of 2) and determines the position of the dot in the measurement (FFFFH = 10^{-1}; 0000H = 10º; 0001H = 10^{1}; etc.).

  Examples:
  1) Representation of 221 V 3-phase:
     Register 0001 = 0221H (mantissa)
     Register 0002 = 0000H (exponent).
  2) Representation of 70.8 A 3-phase:
     Register 0003 = 0708H (mantissa)
     Register 0004 = FFFFH (exponent).
  3) Representation of–0.82 of 3-phase P.F:
     Register 0011 = 8082H (mantissa)
     Register 0012 = FFFEH (exponent).

- The counters consist of 9 BCD digits which determine the whole value in kWh (always positive only) and 4 BCD digits for the decimal part.

  Example:
  Representation of 1748206.1500 kWh 3-phase:
  Register 0021 = 0174H (whole part (MSW))
  Register 0022 = 8206H (whole part (LSW))
  Register 0023 = 1500H (decimal part).

- If a “Single-phase” instrument is used, all 3-phase measurements equal the measurements of the L1 phase, while the measurements of the L2 and L3 phases have no significance.

FORCE SINGLE COIL (05H).

Function for executing commands on the instrument.
The commands are shown as output coils. The status of the coils can be checked by means of the command Read Output Status 01H

P.C. VIP

AA,05H,NNNN,bbbb,CRC ⟶

⟵ AA,05H,NNNN,bbbb,CRC

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OR THE FOLLOWING "RADIO BROADCASTING" MESSAGE CAN BE USED. IT SENDS A COMMAND SIMULTANEOUSLY TO ALL THE INSTRUMENTS WITHOUT OBTAINING ANY ANSWER:

P.C. VIP

00H,05H,NNNN,bbbb,CRC ⟶

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where:
- AA = Address of selected VIP (1 binary byte)
- 05H = Code of the1 bit (coil) (1 binary byte) writing command.
- NNNN = Number of the bit (coil) to be written (2 binary bytes):
  0000H $\leq$ Number of bit $\leq$ 000FH
- bbbb = FF00H: bit = 1 (On); 0000H: bit = 0 (Off) (2 binary bytes)
- CRC = Cyclical Redundancy Check (2 binary bytes).

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N.B.
The number of the bit (coil) to be written is obtained by subtracting 1 from the number of the coil itself.
E.g.: Coil 0003 (in decimals) $\Rightarrow$ (0003 – 1) = 0002 (in decimals).

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LIST OF COILS:

0001	*	**Reset of mean active power.**
0002	*	**Reset of mean apparent power.**
0003	*	**Reset of active power Maximum demand.**
0004	*	**Reset of apparent power Maximum demand.**
0005	*	**Reset of energy counters.**
0006	*	**General reset of the instrument (broadcast only command)**
0007	*	**Reset of active power Maximum demand and demand values.**
0008	*	**Reset of apparent power Maximum demand and demand values.**
0009	*	**NOT USED**
0010	*	**Relay N°1 (if available)**
0011	*	**Relay N°2 (if available)**

PRESET SINGLE REGISTER (06H).

This function is used for programming a holding type register with the instrument's operating parameters.

P.C. VIP

AA,06H,NNNN,D1,D2,CRC ⟶

⟵ AA,06H,NNNN,D1,D2,CRC

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where:

- AA = Address of selected VIP (1 binary byte)
- 06H = Code of the1 holding register (1 binary byte) writing command.
- NNNN = Number of the holding register (coil) to be written (2 binary bytes):
- D1 = 1st datum to be written (MSB) (1 binary byte)
- D2 = 2nd datum to be written (LSB) (1 binary byte)
- CRC = Cyclical Redundancy Check (2 binary bytes).

N.B.

The address of the holding register is obtained by removing the code (e.g. "4") and subtracting 1 from the register number itself.

E.g.: Reg. 40003 (in decimals) ⇒ 40003 (in decimals) ⇒ (0003 – 1) = 0002 (in decimals).

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READ EXCEPTION STATUS (07H).

This function makes it possible to check the instrument's operating status.

P.C. VIP

AA,07H,CRC ⟶

⟵ AA,07H,SF,CRC

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where:

- AA = Address of selected VIP (1 binary byte)
- 07H = Code of the operating status reading commanding (1 binary byte)
- SF = Byte of the operating status of the read instrument (1 binary byte)
  - bits 7 – 2 = 0 (Available (not handled))
  - bit 1 = 1: Operation OK
  - bit 0 = 0 (Available (not handled))
- CRC = Cyclical Redundancy Check (2 binary bytes).

REPORT SLAVE ID (11H).

This function is used to identify the type of instrument and some information associated with it (options, etc.).

P.C.		VIP
AA,11H,CRC	⟶	
	⟵	AA,11H,BB,TT,SS,O1,O2,CRC

where:

- AA = Address of selected VIP (1 binary byte)
- 11H = Code of the "Report slave ID" (1 binary byte) command.
- CRC = Cyclical Redundancy Check (2 binary bytes)
- BB = Number of bytes received for reading = 04H (fixed) (1 binary byte)
- TT = Type of instrument = 0DH (Vip Energy) (fixed) (1 binary byte)
- SS = Slave status (run indicator) = FFH (ON) (fixed) (1 binary byte)
- O1 = 1st option byte of the instrument (1 binary byte)

- Internal TA option:

bit	7	6	5	4	3	2	1	0	
	0	-	-	-	-	-	-	-	⇒ TA = 5 A
	1	-	-	-	-	-	-	-	⇒ TA = 30 A

- RPQS option:

bit	7	6	5	4	3	2	1	0	
	-	-	-	-	-	-	0	-	⇒ Option not present
	-	-	-	-	-	-	1	-	⇒ Option present

- Serial line option:

bit	7	6	5	4	3	2	1	0	
	-	-	-	-	-	-	-	0	⇒ Option not present
	-	-	-	-	-	-	-	1	⇒ Option present

- O2 = 2nd option byte of the instrument (1 binary byte)
  - bit 7 = 1 (fixed) (RTU Option active)
  - bit 6-4 = Available
  - bit 3-0 = Software version (0-15).

LIST OF IMPLEMENTED ERROR STRINGS AND INTERPRETATION

ILLEGAL FUNCTION.

Errors caused by reception of an unrecognised function code.

P.C. VIP

← AA,FF,01H,CRC

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where:
- AA = Address of selected VIP (1 binary byte)
- FF = Code of command received with bit 7 forced to 1 (1 binary byte); e.g. 81H: command code for reading 1 bit (unrecognised)
- CRC = Cyclical Redundancy Check (2 binary bytes)

ILLEGAL DATA ADDRESS.

Error caused by reception of an address referring to data which is off the valid range set for that type of command.

E.g.:

If "SSSS = 0FF0H" in an N holding register reading command, this type of error is generated.

P.C. VIP

← AA,FF,02H,CRC

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where:
- AA = Address of selected VIP (1 binary byte)
- FF = Code of command received with bit 7 forced to 1 (1 binary byte); e.g.. 83H: reading command code of N holding registers.
- CRC = Cyclical Redundancy Check 2 (2 binary bytes)

ILLEGAL DATA VALUE.

Error caused by reception of a datum which is off the valid range set for that type of command.

E.g.:

If "WWWW > 0028H (40)" in an N holding register reading command, this type of error is generated.

P.C. VIP

← AA,FF,03H,CRC

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where:
- AA = Address of selected VIP (1 binary byte)
- FF = Code of command received with bit 7 forced to 1 (1 binary byte); e.g.. 83H: reading command code of N holding registers.
- CRC = Cyclical Redundancy Check

NO RESPONSE.

Communication error caused by:
- Overrun or framing error
Address of selected VIP not valid
- Incorrect CRC
- Any type of error detected on a “broadcasting” command (address = 00H)
- Valid but non-enabled command (e.g. writing of activation command for relays 1/2, when “Local” mode is active).

In this case, the Vip does not answer the PC, thus putting it on time-out (which must be at least 3 seconds from the last transmitted byte).

“MODBUS IEEE” PROTOCOL

CHARACTERISTICS “MODBUS IEEE” PROTOCOL.

- Selected transmission mode: IEEE format INTEL LITTLE ENDIAN
- Coding system : 8-bit binary
- Error detection method: CRC
- Serial protocol characteristics:

Baud-rate:	19200 / 9600 / 4800 / 2400
Data bits:	8
Parity bit::	None / Odd / Even
Stop bits:1	

FORMAT OF THE STRUCTURE OF THE “MODBUS IEEE” PROTOCOL MESSAGE.

The IEEE protocol is similar to the RTU version. The functions coincide.

All the measures , including the counters, are expressed using a floating point format and they are saved over 2 registers.
In comparison with the RTU format, the counters are using only two registers instead of three.
Therefore the third register of the counters, used in RTU, has to be ignored.
For instance the active energy counters is available in registers 0021 and 0022.
The register 0023 is not used in IEEE.
Normally is third registers of the counters which has to be ignored except the total reactive energy counter which is the sole exception: in this case is the first register 0024 has to be ignored.

INPUT REGISTERS LIST FOR IEEE FORMAT

0001	**V (3ph)**	**Three phase Voltage**
0002	**V (3 ph□)**	**Three phase Voltage**
0003	**A (3 ph□)**	**total Current**
0004	**A (3 ph□)**	**total Current**
0005	**kW (3 ph□)**	**total active Power**
0006	**kW (3 ph□)**	**total active Power**
0007	**kVAr (3 ph□)**	**total reactive Power**
0008	**kVAr (3 ph□)**	**total reactive Power**
0009	**kVA (3 ph□)**	**total apparent Power**
0010	**kVA (3 ph□)**	**total apparent Power**
0011	**PF (3 ph□)**	**total power factor**
0012	**PF (3 ph□)**	**total power factor**
0013	**kW avg (3 ph□)**	**Demand active power**
0014	**kW avg (3 ph□)**	**Demand active power**
0015	**kVA avg (3 ph□)**	**Demand apparent power**
0016	**kVA avg (3 ph□)**	**Demand apparent power**
0017	**kW max (3 ph□)**	**Maximum Demand active power**
0018	**kW max (3 ph□)**	**Maximum Demand active power**
0019	**kVA max (3 ph□)**	**Maximum Demand apparent power**
0020	**kVA max (3 ph□)**	**Maximum Demand apparent power**
0021	**kWh (3 ph□)**	**Total active energy counter**

0022	**kWh (3 ph□)**	**Total active energy counter**
0023	**N.U**	**Not used**
0024	**N.U**	**Not used** (only for the total reactive energy is the first register the one not used)
0025	**kVArh (3 ph□)**	**Total reactive energy counter**
0026	**kVArh (3 ph□)**	**Total reactive energy counter**
0027	**S/N**	**serial number**
0028	**S/N**	**serial number**
0029	**V (L1)**	**Voltage L1**
0030	**V (L1)**	**Voltage L1**
0031	**V (L2)**	**Voltage L2**
0032	**V (L2)**	**Voltage L2**
0033	**V (L3)**	**Voltage L3**
0034	**V (L3)**	**Voltage L3**
0035	**A (L1)**	**Current L1**
0036	**A (L1)**	**Current L1**
0037	**A (L2)**	**Current L2**
0038	**A (L2)**	**Current L2**
0039	**A (L3)**	**Current L3**
0040	**A (L3)**	**Current L3**
0041	**kW (L1)**	**Active power L1**
0042	**kW (L1)**	**Active power L1**
0043	**kW (L2)**	**Active power L2**
0044	**kW (L2)**	**Active power L2**
0045	**kW (L3)**	**Active power L3**
0046	**kW (L3)**	**Active power L3**
0047	**Frequency**	**Hz**
0048	**Frequency**	**Hz**
0049	**kVAr (L1)**	**reactive power L1 measured** (includes the power of the distortion, if any . Is the real RMS reactive power)
0050	**kVAr (L1)**	**reactive power L1 measured**
0051	**kVAr (L2)**	**reactive power L2 measured**
0052	**kVAr (L2)**	**reactive power L2 measured**
0053	**kVAr (L3)**	**reactive power L3 measured**
0054	**kVAr (L3)**	**reactive power L3 measured**
0055	**kVA (L1)**	**apparent power L1**
0056	**kVA (L1)**	**apparent power L1**
0057	**kVA (L2)**	**apparent power L2**
0058	**kVA (L2)**	**apparent power L2**
0059	**kVA (L3)**	**apparent power L3**
0060	**kVA (L3)**	**apparent power L3**
0061	**kVAr (L1)**	**reactive power fnd L1** (not including distortion, only fundamental order)
0062	**kVAr (L1)**	**reactive power fnd L1**
0063	**kVAr (L2)**	**reactive power fnd L2**
0064	**kVAr (L2)**	**reactive power fnd L2**
0065	**kVAr (L3)**	**reactive power fnd L3**
0066	**kVAr (L3)**	**reactive power fnd L3**
0067	**pf (L1)**	**power factor L1**
0068	**pf (L1)**	**power factor L1**
0069	**pf (L2)**	**power factor L2**
0070	**pf (L2)**	**power factor L2**
0071	**pf (L3)**	**power factor L3**
0072	**pf (L3)**	**power factor L3**
0073	**A n**	**Neutral current (***)**

0074	A n	Neutral current (***)
0075	A avg (L1)	Demand Current L1
0076	A avg (L1)	Demand Current L1
0077	A avg (L2)	Demand Current L2
0078	A avg (L2)	Demand Current L2
0079	A avg (L3)	Demand Current L3
0080	A avg (L3)	Demand Current L3
0081	Amax (L1)	Maximum Demand current A L1
0082	Amax (L1)	Maximum Demand current A L1
0083	Amax (L2)	Maximum Demand current A L2
0084	Amax (L2)	Maximum Demand current A L2
0085	Amax (L3)	Maximum Demand current A L3
0086	Amax (L3)	Maximum Demand current A L3
0087	kVAr avg	Demand reactive power (***)
0088	kVAr avg	Demand reactive power (***)
0089	kVAr max	Maximum Demand reactive power(***)
0090	kVAr max	Maximum Demand reactive power(***)
0091	kWh cog	Exported active energy counter (cogeneration) (*)
0092	kWh cog	Exported active energy counter (*)
0093	N.U	Not used
0094	kVArh cog	lagging reactive energy counter (cogeneration) (*)
0095	kVArh cog	lagging reactive energy counter (*)
0096	N.U	Not used
0097	kVAh	Apparent energy counter (***)
0098	kVAh	Apparent energy counter (***)
0099	N.U	Not used
0100	kWh T1	Active energy counter tariff T1 (**)
0101	kWh T1	Active energy counter tariff T1 (**)
0102	N.U	Not used
0103	kWh T2	Active energy counter tariff T2 (**)
0104	kWh T2	Active energy counter tariff T2 (**)
0105	N.U	Not used
0106	kWh T3	Active energy counter tariff T3 (**)
0107	kWh T3	Active energy counter tariff T3 (**)
0108	N.U	Not used
0109	kWh T4	Active energy counter tariff T4 (**)
0110	kWh T4	Active energy counter tariff T4 (**)
0111	N.U	Not used
0112	Inp1	Digital input counter 1 (**)
0113	Inp1	Digital input counter 1 (**)
0114	N.U	Not used
0115	Inp2	Digital input counter 2 (**)
0116	Inp2	Digital input counter 2 (**)
0117	N.U	Not used
0195	D/I Status	Digital Input Status (*****)
0196	D/I Status	Digital Input Status (*****)
0201	THD V1%	Total harmonic distortion V1 (*)
0202	THD V1%	Total harmonic distortion V1 (*)
0203	THD V2%	Total harmonic distortion V2 (*)
0204	THD V2%	Total harmonic distortion V2 (*)

0205	**THD V3%**	**Total harmonic distortion V3 (*)**
0206	**THD V3%**	**Total harmonic distortion V3 (*)**
0207	**THD A1%**	**Total harmonic distortion A1 (*)**
0208	**THD A1%**	**Total harmonic distortion A1 (*)**
0209	**THD A2%**	**Total harmonic distortion A2 (*)**
0210	**THD A2%**	**Total harmonic distortion A2 (*)**
0211	**THD A3%**	**Total harmonic distortion A3 (*)**
0212	**THD A3%**	**Total harmonic distortion A3 (*)**

(*) Available only on STAR 3
(**) Available only on ED39DIN
(***) Available only on STAR 3, DMM3, SIRIO, VIP396 rel. 5.01 on; VIP39DIN rel. 5.00 on, ED39din rel. 2.00 on.
(*****) Available only on OEM models

INPUT REGISTERS HARMONICS DATA

VALID ONLY FOR STAR3 HARMO rel 3.00 on, STAR3din HARMO rel 1.00 on
In IEEE mode the registers are the same of the RTU mode. See addresses in the RTU section.

"MODBUS ASCII" PROTOCOL.

The Modbus ASCII protocol was included in the new instruments to maintains the compatibility with the existing softwares and applications developed for the VIP ENERGY, VIP ONE, VIP96 PLUS family.

This compatibility ensures the advantage of replacing old instrument on the serial line, e.g. VIP ENERGY, with a STAR3din without having to modify the software.
It also creates a common language for all instruments.

We advise you not to develop new software to interact with the STAR3, DMM3, SIRIO, Vip396, VIP39din and ED39din instruments, using the ASCII protocol.
The RTU format offer the complete control of the instruments and allows also to read single measures..
The ASCII format is a limited simulation of the VIP ENERGY protocol.
It does not allow to write information into the instrument such as CT and PT ratio.
It does not allow to read directly single measures !!

The only one command recognized is the reading of the string that contains the entire set of measures.
The answer will be a data frame identical to the one transmitted by the Vip Energy.

The measures available only in the new instruments, not available in the Vip Energy
data frame, will not be transmitted e.g.: the neutral current
The measures not available in the new instruments, such as single line counters, will be replaced with zeroes

The reference manual to be used for this protocol is the one of the VIP Energy.
The format of the data frame is blocked as 7 data bits and 2 stop bits.
The parity can be adjusted from the instrument's keyboard

The annex Acrobat PDF document contains some pages of this manual that explain how to read the entire string of measures.

Documento Acrobat

Contact Elcontrol Energy to receive the complete version

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