# 2. RS485/MODBUS-RTU ver. 2
# for AC converters ACM

Contents

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## 1. Introduction

Communication with the converter goes on the principle of MASTER – SLAVE by protocol MODBUS RTU. The command is represented by n 8-bit data. Protocol MODBUS RTU defines the end of the command after a time delay longer than the time for sending a 3.5 bits. For baud rate higher than 19200 Bd the delay is constant about 1.8ms. After this time, the command is considered the completed and will be decoded. The first check performed is the calculation and control CRC (checksum). If the converter receives incompatible data or does not agree with the CRC, the converter does not respond. If the converter receives the data with the correct address, but during decode it encounters a syntax error, it corresponds by error messages according (see error messages table 9).

## 2. Transmission parameters

The device is connected to the RS485 serial line. Transmission parameters (address, parity, baud rate) can be set in the registry *Communication* with address 714d. The description is in the part ***Word communication***. The default setting is address 01h, even parity transmission (8E1) and baud rate 19200Bd.

### MODBUS RTU protocol structure

| address (8 bits) | function (8 bits) | data | CRC16 (16 bits) |
|---|---|---|---|

- address — Address number for communication with the relevant converter. Address may be from the range 1..247.
- function — a number of the relevant function, which is defined by the MODBUS protocol. A description of supported functions is given in chapter no.5
- data — a length and meaning of the data varies according to the function used. Description in the table for the relevant function.
- CRC — The CRC code is used to detect transmission errors. When a message is received, it is calculated and checked with the transmitted code. If both codes are not identical, a transmission error has occurred, the converter is not responding and is waiting for the next command.

## 3. Data structure

The MODBUS protocol uses 16b registers to store data. Our converters use separate 16b registers for 16b data and two consecutive 16b registers for 32b data. The description of the used data types, the way of storing the hexadecimal value and the sorting of bytes during communication is given in the following tables.

**Tab.1 Description of data type**

| Data type | Description of data type |
|---|---|
| Word | unsigned 16b value |
| Short | signed 16b value |
| DWord | unsigned 32b value |
| Long | signed 32b value |
| Float | 32b float value by IEE754 |

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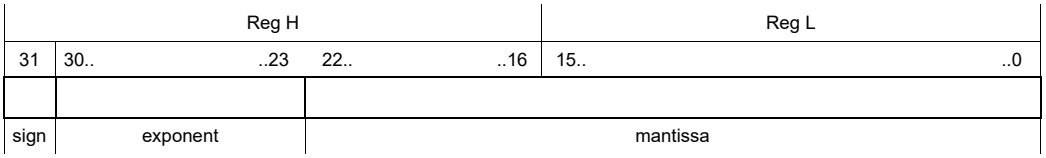
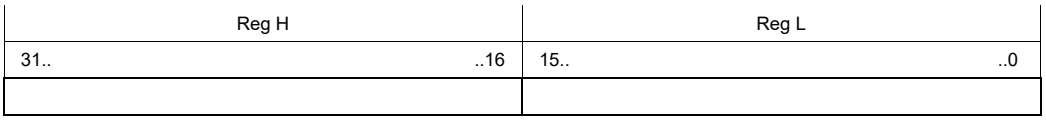
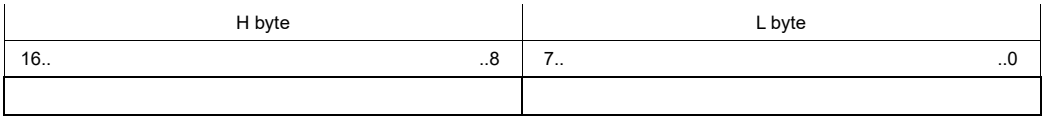
**Tab.2 How numbers are stored in hex format**

| Type | Format |
|---|---|
| 32b float |  |
| 32b dword, long |  |
| 16b word, short |  |

Real number calculation 32b float from hexadecimal value:

$$Value = (-1)^{sign} * 2^{(exponent-127)} * \frac{mantissa + 2^{23}}{2^{23}}$$

Sorting mode 32b value during data transfer determines bit Swp register 704d. If Swp = 0, then the sorting method is the same as they are used PLC Modicon, WAGO etc., (see tab 3).

**Tab.3 Sorting 32b during data transfer (Swp = 0)**

| Reg L | | Reg H | |
|---|---|---|---|
| H byte | L byte | H byte | L byte |

E.g.:
16b word 4660d - 1234h — it is sent first byte 12h, then 34h
32b long32 305419896d - 12345678h — it is sent first byte 56h, then 78h, then 12h and finally 34h
32b real 0.15d - 3E19999Ah — it is sent first byte 99h, then 9Ah, then 3Eh and finally 19h

If Swp = 1, sorting 32b during data transfer it is as Big Endian, (see tab 3). Bit Swp=1 have affects only during data transfer 32b value by function 04.

**Tab.4 Sorting 32b during data transfer (Swp = 1)**

| Reg H | | Reg L | |
|---|---|---|---|
| H byte | L byte | H byte | L byte |

E.g.:
16b word 4660d - 1234h — it is sent first byte 12h, then 34h
32b long32 305419896d - 12345678h — it is sent first byte 12h, then 34h, then 56h and finally 78h
32b real 0.15d - 3E19999Ah — it is sent first byte 3Eh, then 19h, then 99h and finally 9Ah

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## 4. Supported features and error messages

The converter supports some standard MODBUS RTU protocol functions. Their list and description are given below.

### 4 .1. Function 03h

Function 03h used to read the specified 16-bit or 32-bit converter registers.

Command structure:
<converter address> <03h> <register address> <number of registers read> <CRC>

**Tab.5 Function 03h**

| Meaning of command parameters | |
|---|---|
| converter address | 8bit value of address from the range 1..247 |
| register address | 16b the address of the first read memory location |
| number of registers read | 16b the value of the number of consecutive memory locations, allowable values are 0x0001, 0x0002, 0x0003, 0x0004. |
| CRC | checksum |

Right answer:
<converter address> <03h> <2*N> <N*16b consecutive read registers> <CRC>

In the event of an error in the command, the converter does not respond at all or responds with an error message, the meaning of which is in part 5***. Error messages***.

### 4 .2. Function 04h

Function 04h used to read the specified 16-bit or 32-bit converter registers. Bit Swp register 704d affects the shift 16b value to 32b word. (see ***4 Data structure*** tab. 3 and 3)

Command structure:
<converter address> <04h> <register address> <number of registers read> <CRC>

**Tab.6 Function 04h**

| Meaning of command parameters | |
|---|---|
| converter address | 8bit value of address from the range 1..247 |
| register address | 16b the address of the first read memory location |
| number of registers read | 16b the value of the number of consecutive memory locations, allowable values are 0x0001, 0x0002, 0x0003, 0x0004. |
| CRC | checksum |

Right answer:
<converter address> <03h> <2*N> <N*16b consecutive read registers, whose order is determined by the Swp bit > <CRC>

In the event of an error in the command, the converter does not respond at all or responds with an error message, the meaning of which is in part 5***. Error messages***.

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## 4 .3. Function 06h

Function 03h used to write the specified 16-bit value on specified converter register.

Command structure:
<converter address> <06h> <register address> <written value> <CRC>

**Tab.7 Function 06h**

| Meaning of command parameters | |
|---|---|
| converter address | 8bit value of address from the range 1..247 |
| register address | 16b the address of memory location |
| written value | 16b the written value |
| CRC | checksum |

Right answer:
<converter address> <06h> <register address> <written value> <CRC>

In the event of an error in the command, the converter does not respond at all or responds with an error message, the meaning of which is in part 5***. Error messages***.
The values written to the registers affecting the converter settings do not take effect until the device is reset (function 08h).

## 4 .4. Function 08h

Function 08h invokes software reset of addressed converter.

Command structure:
<converter address> <08h> <0001FF00h> <CRC>

**Tab.8 Function 08h**

| Meaning of command parameters | |
|---|---|
| converter address | 8bit value of address from the range 1..247 |
| 0001FF00h | Fixed value |
| CRC | checksum |

Right answer:
<converter address> <08h> <0001FF00h> <CRC>

In the event of an error in the command, the converter does not respond at all or responds with an error message, the meaning of which is in part 5***. Error messages***.

## 4 .5. Function 11h

Function 11h is used for identification of converter and number of used firmware.

Command structure:
<converter address> <11h> <CRC>

**Tab.9 Function 11h**

| Meaning of command parameters | |
|---|---|
| converter address | 8bit value of address from the range 1..247 |
| CRC | checksum |

Right answer:
<converter address> <11h> <04h> <type> <ver. of MB protocol> <ver. of Firmware> <FFh> <CRC>

In the event of an error in the command, the converter does not respond at all or responds with an error message,

the meaning of which is in part 5***. Error messages***.

**Tab.10 Type of converter in answer of function 11h**

| Type of converter | |
|---|---|
| $80_H$ | ACM-U/M |
| $81_H$ | ACM-I/M |
| $82_H$ | ACM-1P/M or ACM-1P4/M |
| $83_H$ | ACM-1P3/M |
| $84_H$ | ACM-2P/M |
| $85_H$ | ACM-3P/M |

In the event of an error in the command, the converter does not respond at all or responds with an error message, the meaning of which is in part 5***. Error messages***.

# 5. Error messages

If an error is triggered during the execution of the command, the converter responds with an error message containing the function number increased by 80h and also containing the error number (see tab 10).

Error answer:
<converter address> <number of function + 80h> < error number> <CRC>

**Tab.11 Meaning of numbers in error message**

| error number | meaning of error |
|---|---|
| 01h | unknown function |
| 02h | wrong number of registers |
| 03h | command error (wrong data) |
| 04h | measured value out of range (see part 17) |

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## 6. Measuring

The ACM converter can measure a variety of quantities. The possibility of measuring these quantities is given and depends on the type of transducer and its connection for measurement. The converter type must be specified in the order and cannot be changed in the device configuration. Exceptions are type 1P/M and 1P4/M (see meaning of the register 704d.

If the set nominal value of the input current and voltage is exceeded by more than 120% and the register value is read, error message 04h will be provided.

If the set input current and voltage rating is exceeded by more than 120% and the relevant or total active or reactive power, frequency, phase shift or power factor register is read, error message 04h will be provided.

When the voltage drops below 10% of the set nominal value and the frequency register is read, error message 04h will be provided.

If the voltage or current drops below 10% of the set nominal value and the phase shift register or power factor is read, error message 04h will be provided.

With error message 04h, the corresponding error register bit 720d or 721d will be set. (see part 15)

**Tab.12 Type of converter**

| type | measured quantity |
|---|---|
| **ACM-U/M** | AC voltage and frequency converter |
| **ACM-I/M** | AC current converter |
| **ACM-1P/M** | converter for a single-phase network |
| **ACM-1P3/M** | converter for a three-wire balanced symmetrical network |
| **ACM-1P4/M** | converter for a four-wire balanced network |
| **ACM-2P/M** | converter for a three-wire network (Aron connection) |
| **ACM-3P/M** | converter for a four-wire network |

**Tab.13 Definition of measured quantities in register $Def_1$ 712d**

| **Reg. $712_d$ $Def_1$, nr. bit** | **value** | **Type of converter** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **U/M** | **I/M** | **1P/M** | **1P4/M** | **1P3/M** | **2P/M** | **3P/M** |
| 0 | U | **x** | | **x** | **x** | **x** | | |
| 1 | U1N | | | | | | | **x** |
| 2 | U2N | | | | | | | **x** |
| 3 | U3N | | | | | | | **x** |
| 4 | U12 | | | | | | **x** | |
| 5 | U23 | | | | | | **x** | |
| 6 | I | | **x** | **x** | **x** | **x** | | |
| 7 | I1 | | | | | | **x** | **x** |
| 8 | I2 | | | | | | | **x** |
| 9 | I3 | | | | | | **x** | **x** |
| 10 | P | | | **x** | **x** | **x** | **x** | **x** |
| 11 | P1 | | | | | | | **x** |
| 12 | P2 | | | | | | | **x** |
| 13 | P3 | | | | | | | **x** |
| 14 | Q | | | **x** | **x** | **x** | **x** | **x** |
| 15 | Q1 | | | | | | | **x** |

**Tab.14 Definition of measured quantities in register Def2 713d**

| Reg. $713_d$ $Def_2$, nr. bit | value | Type of converter | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | U/M | I/M | 1P/M | 1P4/M | 1P3/M | 2P/M | 3P/M |
| 0 | Q2 | | | | | | | x |
| 1 | Q3 | | | | | | | x |
| 2 | PH | | | x | x | x | | |
| 3 | PH1 | | | | | | | x |
| 4 | PH2 | | | | | | | x |
| 5 | PH3 | | | | | | | x |
| 6 | PF | | | x | x | x | | |
| 7 | PF1 | | | | | | | x |
| 8 | PF2 | | | | | | | x |
| 9 | PF3 | | | | | | | x |
| 10 | F | x | | x | x | x | x | x |

The converter type is listed in the register at address 600d.

The selection of quantities for measurement is performed by writing individual bits to two 16b registers Def1, Def2 with address 712d and 713d. See tab 12 and 13 for how to store 16b words.

The meaning of the marks describing the measured quantity is in table 14.

**Tab.15 Designation of the measured quantity**

| | |
|---|---|
| U | Input voltage |
| U1N, U2N, U3N | Voltage between the respective phase and middle conductor |
| U12, U23 | Voltage between the two respective phase conductors |
| I | Input current |
| I1, I2, I3 | Current in the relevant phase conductor |
| P | Total active network power |
| P1, P2, P3 | Active power measured by relevant systems |
| Q | Total reactive network power |
| Q1, Q2, Q3 | Reactive power measured by individual systems |
| PH | Phase shift between input current and voltage |
| PH1, PH2, PH3 | Phase shift angle between input current and input voltage of relevant measuring systems |
| PF | Power factor |
| PF1, PF2, PF3 | Power factor of relevant systems |
| F | Frequency |

The frequency measurement is derived from the voltage profile. In the case of a multi-system instrument, the frequency is measured on the first system.

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## 7. Registers of converter

The converter uses registers 16b and 32b to store data, while the MODBUS RTU uses a word to communicate 16b. In the case of 32b registers, the storage method is 16b

**Tab.16 Store 32b words**

| Address register | bit 0-15 |
|---|---|
| Address register + 1 | bit 16-31 |

### 7 .1. Registers for measurement (read only)

The measured values can be obtained from the registers with the address 100d – 126d and registers with address 300d – 352d. In the registers 100d...there are 16b values in RAW format. They are number of type word and short (integers). In the registers 300d...there are 32b values in SCAL format. By multiplying the Raw and Scal numbers, we get the actual measured value in engineering quantities Description of registers is in tab 16 and 17. When using measuring transformers, the Scal values are affected by entering the parameters of these transformers. The measured value registers are read-only.

**Tab.17 Raw values**

| Address dec | Address hex | Measured quantity | Type | Address dec | Address hex | Measured quantity | Type |
|---|---|---|---|---|---|---|---|
| 100 | 0064 | U | word | 114 | 0072 | Q | short |
| 101 | 0065 | U1N | word | 115 | 0073 | Q1 | short |
| 102 | 0066 | U2N | word | 116 | 0074 | Q2 | short |
| 103 | 0067 | U3N | word | 117 | 0075 | Q3 | short |
| 104 | 0068 | U12 | word | 118 | 0076 | PH | short |
| 105 | 0069 | U23 | word | 119 | 0077 | PH1 | short |
| 106 | 006A | I | word | 120 | 0078 | PH2 | short |
| 107 | 006B | I1 | word | 121 | 0079 | PH3 | short |
| 108 | 006C | I2 | word | 122 | 007A | PF | short |
| 109 | 006D | I3 | word | 123 | 007B | PF1 | short |
| 110 | 006E | P | short | 124 | 007C | PF2 | short |
| 111 | 006F | P1 | short | 125 | 007D | PF3 | short |
| 112 | 0070 | P2 | short | 126 | 007E | F | word |
| 113 | 0071 | P3 | short | | | | |

Measured value Raw = 10000d corresponds 100% nominal values, measured value Raw = -10000d corresponds - 100% nominal values.

The exception is the Raw value of frequency, phase shift and power factor, where Raw value corresponds to the actual measured quantity. The frequency is in [mHz], phase shift in [0,01°], power factor v [0,0001].

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**Tab.18 Scal values**

| Address dec | Address hex | Measured quantity | Type | Address dec | Address hex | Measured quantity | Type |
|---|---|---|---|---|---|---|---|
| 300 | 012C | U | float | 328 | 0148 | Q | float |
| 302 | 012E | U1N | float | 330 | 014A | Q1 | float |
| 304 | 0130 | U2N | float | 332 | 014C | Q2 | float |
| 306 | 0132 | U3N | float | 334 | 014E | Q3 | float |
| 308 | 0134 | U12 | float | 336 | 0150 | PH | float |
| 310 | 0136 | U23 | float | 338 | 0152 | PH1 | float |
| 312 | 0138 | I | float | 340 | 0154 | PH2 | float |
| 314 | 013A | I1 | float | 342 | 0156 | PH3 | float |
| 316 | 013C | I2 | float | 344 | 0158 | PF | float |
| 318 | 013E | I3 | float | 346 | 015A | PF1 | float |
| 320 | 0140 | P | float | 348 | 015C | PF2 | float |
| 322 | 0142 | P1 | float | 350 | 015E | PF3 | float |
| 324 | 0144 | P2 | float | 352 | 0160 | F | float |
| 326 | 0146 | P3 | float | | | | |

**Example of calculation of measured quantity:**

Raw registry value at 100d: 5000
Scal registry value at 300d: 0.05

U = 5000 x 0.05 = 250V

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## 7 .2. Information registers (read only)

The register with the address 600d - 603d contains information about the given converter. Values are read-only.

**Tab.19 Registers 600d – 603d**

| Address dec | Address hex | Type | Name | Meaning |
|---|---|---|---|---|
| 600 | 0258 | word | Type | Type and configuration |
| 601 | 0259 | dword | Serial number | Serial number of the converter |
| 603 | 025B | word | Hw version | Version of firmware |

### word *Type 600d*

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 60Hz | 50Hz | | | | | Us | Uf | | 3P | 2P | 1P3 | 1P4 | 1P | I | U |

| | |
|---|---|
| U | AC voltage and frequency converter |
| I | AC current converter |
| 1P | converter has one measuring system and is switched for a single-phase network |
| 1P3 | converter has one measuring system and measured in three-wire balanced symmetrical network |
| 1P4 | converter has one measuring system and measured in four-wire balanced symmetrical network |
| 2P | converter has two measuring systems and measured in three-wire unbalanced network (Aron connection) |
| 3P | converter has three measuring systems and measured in four-wire balanced symmetrical network |
| Uf | input voltage value in the register Un (or Ur) and the measured value is phase voltage |
| Us | input voltage value in the register Un (or Ur) and the measured value is phase-to-phase voltage |
| 50Hz | the converter is switched for measurement in the 50Hz network |
| 60Hz | the converter is switched for measurement in the 60Hz network |

### dword Serial number *601-602d*

Serial number set at the factory.

### word *Hw version 603d*

Number of firmware version contained in the converter

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## 7 .3. Configuration registers (read and write)

Registers with address 700d – 714d contain user settings of converter parameters. rom this registers we can read and also write to them. After changing the data in the registers, it is necessary to RESET the converter (***function 08h***). Only then will the entered changes take effect

**Tab.20 Registr 700d – 714d**

| Address dec | Address hex | Type | Name | Meaning |
|---|---|---|---|---|
| 700 | 02BC | L byte | Text | ASCII character code č.2 |
| | | H byte | | ASCII character code č.1 |
| 701 | 02BD | L byte | | ASCII character code č.4 |
| | | H byte | | ASCII character code č.3 |
| 702 | 02BE | L byte | | ASCII character code č.6 |
| | | H byte | | ASCII character code č.5 |
| 703 | 02BF | word | Date | Date last correct of parameters |
| 704 | 02C0 | word | Configuration | Use of additional transformers, frequency value of the measured network |
| 705 | 02C1 | word | If | Input measured phase current If*10 [mA] |
| 706 | 02C2 | word | In | Rated current of the secondary winding of the additional transformer In*10 [mA] |
| 707 | 02C3 | dword | Ir | Rated current of the primary winding of the additional transformer Ir [A] |
| 709 | 02C5 | word | Un | Rated input voltage Un*100 [V] |
| 710 | 02C6 | dword | Ur | Rated voltage of the primary winding of the additional transformer Ur [V] |
| 712 | 02C8 | word | Def1 | Selection of measured quantities |
| 713 | 02C9 | word | Def2 | Selection of measured quantities |
| 714 | 02CA | L byte | Communication | Converter address |
| | | H byte | Communication | Baud rate, parity, … |

### word *Text 700-702d*

Possibility to save 6 characters of text in the form of ASCII code for possible identification of the converter. "RAWET1" is saved by default.

### word *Datum 703d*

Date of last parameters correct (only for information).

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| Day (1..31) | | | | | Month(1..12) | | | | Year(0..99) | | | | | | |

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## word Configuration *704d (correspond with register 600d)*

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Swp | | Filter | | | | | | 60Hz | 50Hz | | | | 1P4 | Utr | Itr |

| | |
|---|---|
| Itr | additional current transformer used |
| Utr | additional voltage transformer used |
| 1P4 | switching of the converter for measurement in a four-wire balanced network (computational correction only) |
| 50Hz | switching of the converter for measurement in the network with a frequency of 50Hz |
| 60Hz | switching of the converter for measurement in the network with a frequency of 60Hz |
| Filter | moving average of 4 measured values (0 - filter OFF, 1 - filter ON, default filter ON) |
| Swp | swapping the order of values when reading a 32b word (0 – 16b LSB then 16b MSB, 1 – 16b MSB then 16b LSB, default Swp = 0) |

## word *If 705d*

Input rated phase current. The value is entered in 0,1 mA. The range of values is 4000 x 0,1mA ... 55000 x 0,1mA.

## word *In 706d*

Rated current through the secondary winding of the additional current transformer. The value is entered in 0,1 mA. The range of values is 4000 x 0,1mA ... 55000 x 0,1mA.

## dword *Ir 707-708d*

Rated current through the primary winding of the additional current transformer. The value is entered in A. The maximal value is 200 000A.

## word *Un 709d*

Input rated voltage. The value is entered in 0,01V. The range of values is 4000 x 0,01V ... 55000 x 0,01V.

## dword *Ur 710-711d*

Rated voltage of the primary winding of the additional voltage transformer. The value is entered in V. The maximal value is 2 000 000V.

## word *Def1 712d*

Determination of measured quantities that will be stored for reading in the appropriate registers. If the instrument does not allow their measurement, the setting will be ignored.

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q1 | Q | P3 | P2 | P1 | P | I3 | I2 | I1 | I | U23 | U12 | U3N | U2N | U1N | U |

## word *Def2 713d*

Determination of measured quantities that will be stored for reading in the appropriate registers. If the instrument does not allow their measurement, the setting will be ignored.

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | F | PF3 | PF2 | PF1 | PF | PH3 | PH2 | PH1 | PH | Q3 | Q2 |

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## word Communication *714d*

Communication register in which are stored the converter address, baud rate and method of data transfer settings.

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| | | | Baud rate | | Parity | | | Address | | | | | | | |

Address in range 1 ... 247 (1 default)

Transmission settings

- Even parity 000b (default)
- Odd parity 001b
- Without parity 1 stop bit 1xxb
- Without parity 2 stop bity 01xb

The baud rate can be selected from two sets. It determines the type of set bit 0 registru $1400_H$ ($5120_d$)

| bit 12,11 register $714_d$ | bit 0, register $5120_d$= low | bit 0, register $5120_d$= high |
|---|---|---|
| 00b | 19200 | 19200 |
| 01b | 9600 | 38400 |
| 10b | 4800 | 57600 |
| 11b | 2400 | 115200 |

If a non-standard situation occurs during the writing of values (power failure, communication interruption), the communication register is set to default values, which is the address 01h, even parity, baud rate 19200Bd.

Default communication parameters is 19200 Bd 8E1 with address $01_H$ . It is recommended also 8O1 or 8N2.

# 1. RS485/MODBUS-RTU ver. 2
# for AC converters ACM

## 7 .4. Error registers 720d-721d (read and write)

If the converter responds with an error 04h while reading a register (that is value out of range), we can see in registers with address 720d and 721d information which value caused this error. When reading information on voltage, current, active and reactive power, phase shift, power factor and frequency, it is checked whether the maximum possible size of the set nominal value of the respective voltage and current is not exceeded. When measuring the phase shift, power factor and frequency, it is checked whether the input quantities have not fallen below 10% of the set nominal value.

| Address dec | Address hex | Type | Name | Meaning |
|---|---|---|---|---|
| 720 | 0258 | word | Over | Overrange the set range |
| 721 | 0259 | word | Under | Below 10% the set range |

### word *over* 720d

The bits indicate the value, which is overrange.

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | I3 | | I2 | I1 | I | U23 | U12 | U3N | U2N | U1N | U |

### word *under* 721d

The bits indicate the value, which is 10% below range

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | I3 | I2 | I1 | I | U23 | U12 | U3N | U2N | U1N | U |

The bits indicate the value that has error 04h. The registry must be deleted by the user, it is not deleted automatically.