SOLAR ELECTRIC

KOSTAL

PIKO CI

KOSTAL MODBUS (TCP) with control information

Interface description

Version

Release date: 11.07.2024

Revision version: 1.4

Valid from version:
PIKO CI 30 / PIKO CI50/60
Firmware (FW): V3.17
Internal code (Control board CB): PIKO CI 30 - 012601 / PIKO CI 50/60 - 012401
Communication board version (CSB): 012403

PIKO CI 100
Firmware (FW): V02
Internal code (Control board CB): 020202
Communication board version (CSB): 020206
Arc Fault Circuit Interrupter (AFCI): 010002

Inhalt

1. Introduction

1.1 Disclaimer of liability

The activities described in this document may only be carried out by specialists who have the following qualifications:

- Knowledge of IP-based network protocols
- Training in the installation and configuration of IT systems
- Knowledge of the functionality and operation of inverters
- Training in dealing with dangers and risks associated with the operation of electrical devices and systems
- Knowledge of and observance of this document

Any instance of misuse will result in the termination of the warranty, guarantee and general liability to the fullest extent permitted by law of the manufacturer.

Nothing in this conditions limits or excludes the liability of KOSTAL for:
Death or personal injury resulting from its negligence; or fraud or fraudulent misrepresentation. KOSTAL shall not under any circumstances whatever be liable for loss of profits; or any special, indirect or consequential loss, costs, damages, charges or expenses.

1.2 Intended Use

The Modbus interface is designed for industrial use and has the following tasks:

- Remote control of the grid management services of a PV system.
- Remote-controlled query of measured values from a PV system.
- Remote-controlled change of parameters of a PV system.

The Modbus interface can be used via the Modbus TCP protocol.

All components have to stay within their permitted operating and installation requirements. The products should only be used in line with their documentation and the local applicable standards and directives.

Alterations to the product, e.g. changes or modifications, are perhibitted. Any use of the product other than that described in the Intended Use section does not qualify as the intended use. Tobserve all instructions contained therein.

1.3 Target group

These instructions are aimed at the aforementioned qualified specialist who needs information on the Modbus interface in order to use it for industrial use and to create their own products.

1.4 Safety Information

This section contains safety information that must be observed at all times. Opening the Modbus interface from extern can be results in the manipulation of the PV system data in the Ethernet network.

If KOSTAL solar inverters are connected to the Internet, there is a risk that unauthorized users can access and manipulate the data of your PV system.

- Set up a firewall.
- Close unnecessary network ports in your router.
- Remote access should only be done through a virtual private network (VPN).
- Do not set up port forwarding for the Modbus ports used.

KOSTAL under no circumstances shall have any liability for any loss or damage invcurres by the use of the Modbus interface. The use of the interface and reliance on the information is solely at the users risk.

1.5 MODBUS Protocol

MODBUS is an application layer messaging protocol, positioned at level 7 of the OSI model, which provides client/server communication between devices connected on different types of buses or networks.

The industry's serial de facto standard since 1979, MODBUS continues to enable millions of automation devices to communicate. Today, support for the simple and elegant structure of MODBUS continues to grow. The Internet community can access MODBUS at a reserved system port 502 on the TCP/IP stack.

MODBUS is a request/reply protocol and offers services specified by function codes. MODBUS function codes are elements of MODBUS request/reply PDUs. The objective of this document is to describe the function codes used within the framework of MODBUS transactions.

The MODBUS Application Protocol is currently used in the solar sector mainly for system communication in PV power plants. The MODBUS protocol has been developed for reading data from- or writing data to clearly defined data areas.

1.6 Data Formats

The following data formats describe how data is to be interpreted. The data formats are important, for example, for the display of data or for its further processing. The data formats are listed in the Format column of the assignment tables.

U16	An unsigned integer 16-bit-value, 1 register
U32	An unsigned integer 32-bit-value, 2 registers
R32	A real (float) 32-bit-value, 2 registers
S16	A signed integer 16-bit-value, 1 register
S32	A signed integer 32-bit-value, 2 registers
CRC	16 bit CRC check, low byte in front
RO	Read only, only support 0x03 command
RW	Read and write, support 0x03, 0x6, 0x10 command

2. MODBUS protocol description

2.1 Application Layer

MODBUS is an application layer messaging protocol, positioned at level 7 of the OSI model, which provides client/server communication between devices connected on different types of buses or networks.

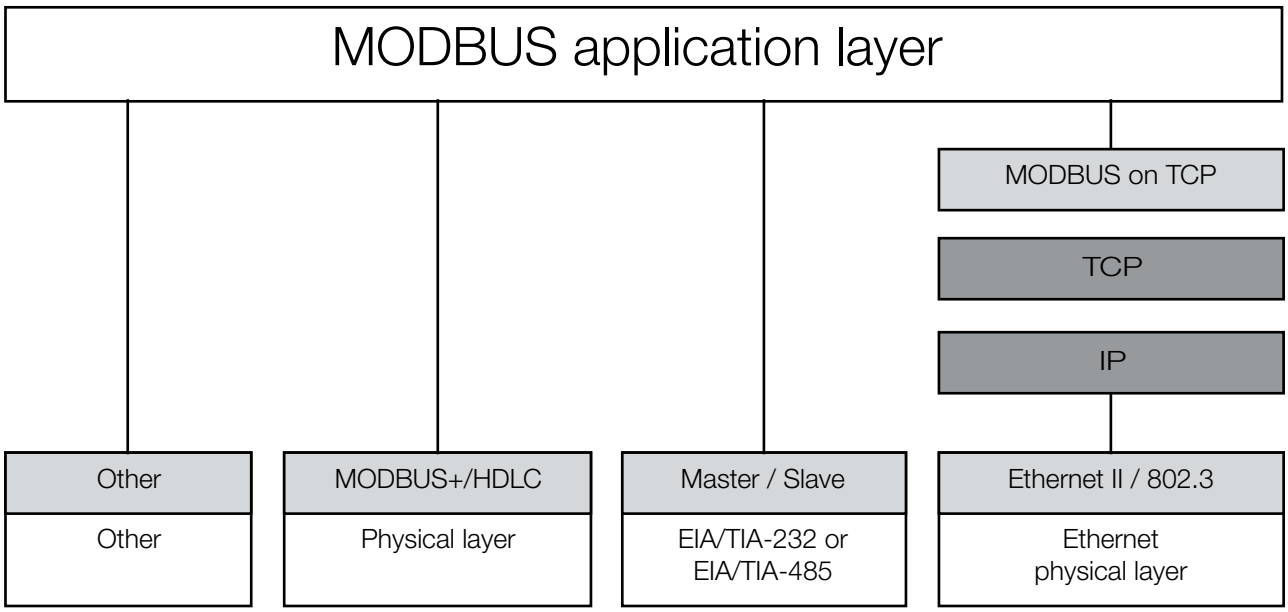


Abb. 1: MODBUS communication stack

MODBUS is an application layer messaging protocol for client/server communication between devices connected on different types of buses or networks.

Scope of this document is the implementation TCP/IP over Ethernet and serial ocer RS485. See MODBUS Messaging Implementation Guide V1.0a.

3. MODBUS on TCP/IP

3.1 Application Layer

The MODBUS TCP protocol is used in this interface.

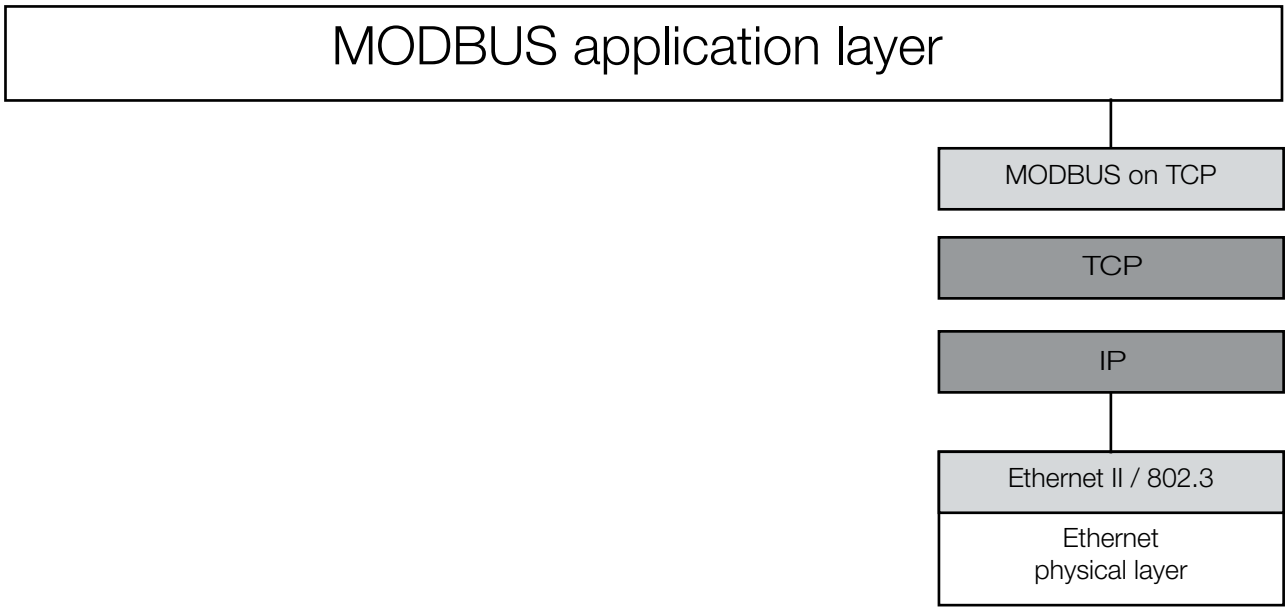


Abb. 2: MODBUS Protocols and ISO/OSI Model

Layer	ISO/OSI Layer	
7	Application	MODBUS / TCP
6	Presentation	MODBUS / TCP
5	Session	MODBUS / TCP
4	Transport	TCP
3	Network	IP
2	Data Link	IEEE 802.3 (Ethernet)
1	Physical	IEEE 802.3 (Ethernet)

3.2 Modbus Frame

The MODBUS protocol defines a simple protocol data unit (PDU) independent of the underlying communication layers. The mapping of MODBUS protocol on specific buses or network can introduce some additional fields on the application data unit (ADU).

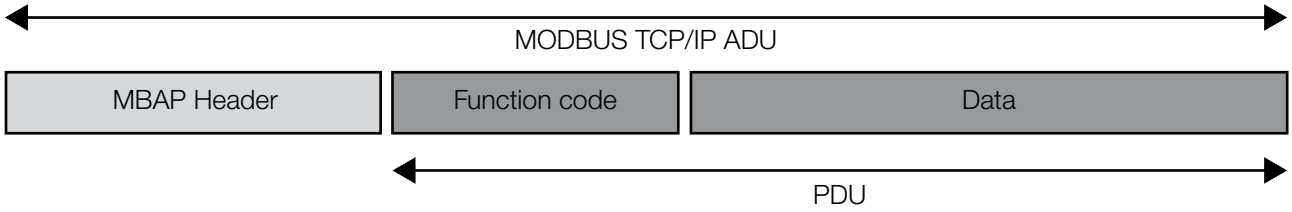


Abb. 3: MODBUS frame TCP/IP

Abbreviations:

ADU	Application Data Unit
HDLC	High Level Data Link Control
HMI	Human Machine Interface
IETF	Internet Engineering Task Force
I/O	input/Output
IP	Internet Protokoll
MAC	Media Access Control
MB	MODBUS Protokol
MBAP	MODBUS Apllication Protokol
PDU	Protocol Data Unit
PLC	Programmable Logic Control
TCP	Transmission Control Protocol

The MODBUS application data unit is built by the client that initiates a MODBUS transaction. The function indicates to the server what kind of action to perform.

The function code field of a MODBUS data unit is coded in one byte. Valid codes are in the range of 1 ... 255 decimal (the range 128 – 255 is reserved and used for exception responses). When a message is sent from a Client to a Server device the function code field tells the server what kind of action to perform. Function code “0” is not valid.

3.2.1 Data Encoding

MODBUS uses a ‘big-Endian’ representation for addresses and data items. This means that when a numerical quantity larger than a single byte is transmitted, the most significant byte is sent first. So for example

Register size	value	
16 - bits	0x1234	the first byte sent is 0x12, then 0x34

3.2.2 Function code list

The following MODBUS commands are supported by the implemented MODBUS interface:

MODBUS command	Function code	Quantity of Registers[1]
Read Holding Registers	0x03	1 to 125
Write Single Register	0x06	1

[1] Register content is 16-bits width.

3.2.3 MBAP header

The Modbus Application Header is added to the start of the message. The MBAP header contains the following fields:

Fields	Length	Description
Transaction Identifier	2 Bytes	Identification of a MODBUS Request/ Response transaction.
Protocoll Identifier	2 Bytes	The MODBUS protocol is identified by the value 0.
Length	2 Bytes	The length field is a byte count of the following fields, including the Unit Identifier and data fields.
Unit Identifier	1 Byte	Identification of a remote slave that is connected via a serial line or other buses.

3.2.4 Read Holding Registers (0x03)

This function code is used to read the contents of a contiguous block of holding registers in the inverter. The Request PDU specifies the starting register address and the number of registers. In the PDU Registers are addressed starting at zero. Therefore registers numbered1-16 are addressed as 0-15.

The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

Request

Function code	1 Byte	0x03
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Registers	2 Bytes	1 to 125 (0x7D)

Response

Function code	1 Byte	0x03
Byte count	1 Bytes	0x0000 to 0xFFFF
Register value	N[1] x 2 Bytes	1 to 125 (0x7D)

[1]N = Quantity of Registers

Error

Error code	1 Byte	0x83
Exception code	1 Bytes	01 or 02 or 03 or 04

Here is an example of a request to read registers 108 – 110:

Request		Response	
Field Name	(hex)	Field Name	(hex)
Function	03	Function	03
Starting Address Hi	00	Byte Count	06
Starting Address Low	6B	Register value Hi (108)	02
No. of Registers Hi	00	Register value Low (108)	2B
No. of Registers Low	03	Register value Hi (109)	00
		Register value Low (109)	00
		Register value Hi (110)	00
		Register value Low (110)	64

The contents of register 108 are shown as the two byte values of 0x022B. The contents of registers 109 –110 are 0x0000 and 0x0064.

3.2.5 Write Single Register (0x06)

This function code is used to write a single holding register in the inverter.

The Request PDU specifies the address of the register to be written.

The normal response is an echo of the request, returned after the register contents have been written.

Request

Function code	1 Byte	0x06
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Registers	2 Bytes	0x0000 to 0xFFFF

Response

Function code	1 Byte	0x06
Byte count	1 Bytes	0x0000 to 0xFFFF
Register value	2 Bytes	0x0000 to 0xFFFF

Error

Error code	1 Byte	0x86
Exception code	1 Bytes	01 or 02 or 03 or 04

Here is an example of a request to write register 2 to 0x0003:

Request		Response	
Field Name	(hex)	Field Name	(hex)
Function	06	Function	06
Register Address Hi	00	Register Address Hi	00
Register Address Low	01	Register Address Low	01
Register Value Hi	00	Register Value Hi	00
Register Value Low	03	Register Value Low	03

3.3 Physical Layer - LAN (TCP)

3.3.1 Ethernet port

A electrical interface in accordance with IEEE 802.3 standard is used for the interface. A RJ45 connector is used for connection.

3.3.2 Electrical interface

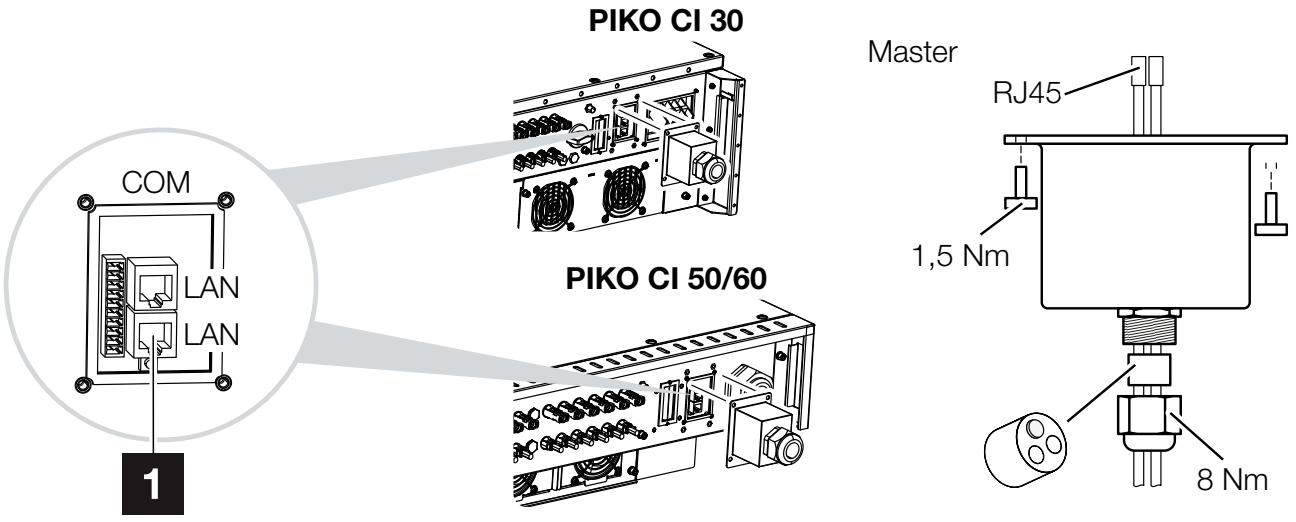


Abb. 4: LAN - Interface PIKO CI 30-60

Item	Designation	Explanation
1	Ethernet connection (RJ45)	RJ45 max. 100 Mbit (LAN connection for linking to a router, for example)

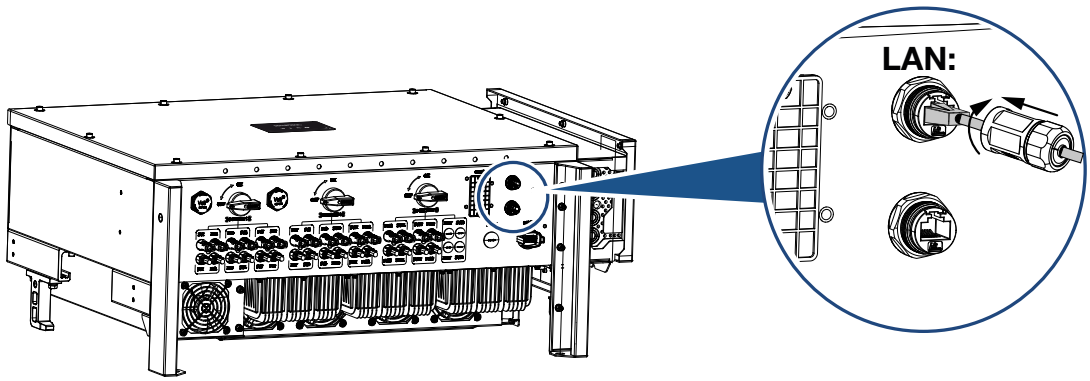


Abb. 5: LAN - Interface PIKO CI 100

3.4 TCP-Port, UDP-Port and Unit-ID

To access the inverter via MODBUS / TCP, the following TCP-Port and MODBUS-Unit-ID are used as default values:

TCP-Port	1502 (dec)
UDP-Port	53321 (dec) (CSB version >= 011007) 1502 (dec) (CSB version < 011007) CSB version is read from address 0x1A60
Unit-ID[1]	71 (dec)

[1] The Unit-ID is modifiable.

4. MODBUS on Serial

4.1 Apllication Layer

The MODBUS Serial Line protocol is used in this interface.

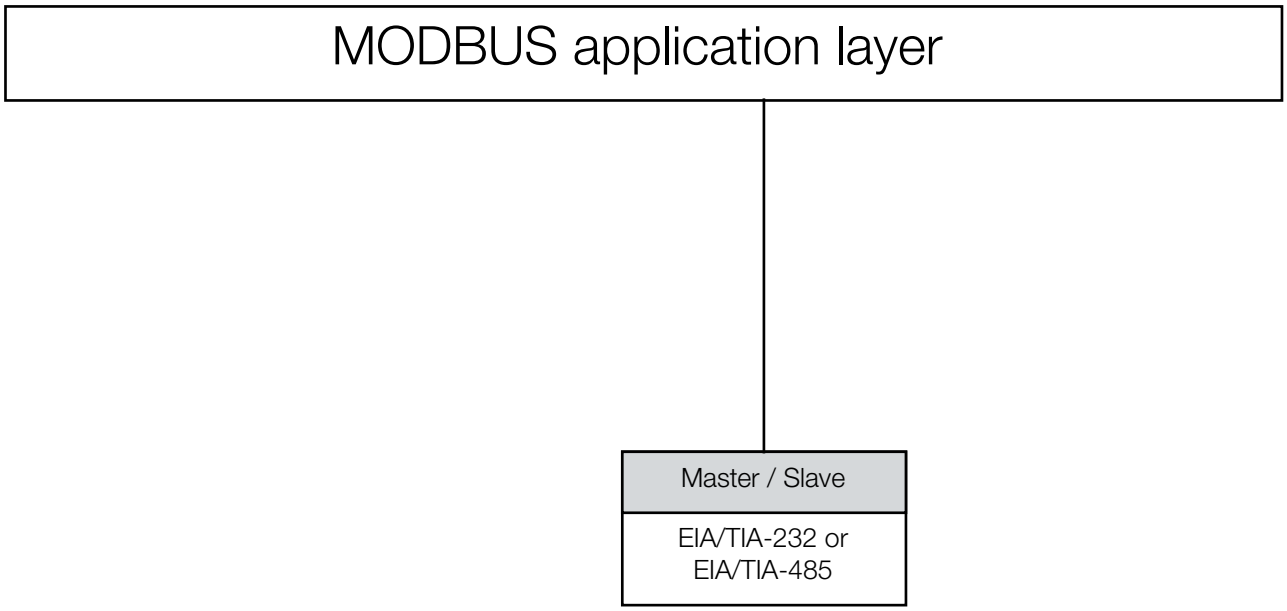


Abb. 6: MODBUS Protocols and ISO/OSI Model

Layer	ISO/OSI Layer	
7	Application	MODBUS Application Protocoll
6	Presentation	Empty
5	Session	Empty
4	Transport	Empty
3	Network	Empty
2	Data Link	MODBUS Serial line Protocoll
1	Physical	EIA/TIA-485 (or EIA/TIA-232)

4.2 MODBUS frame

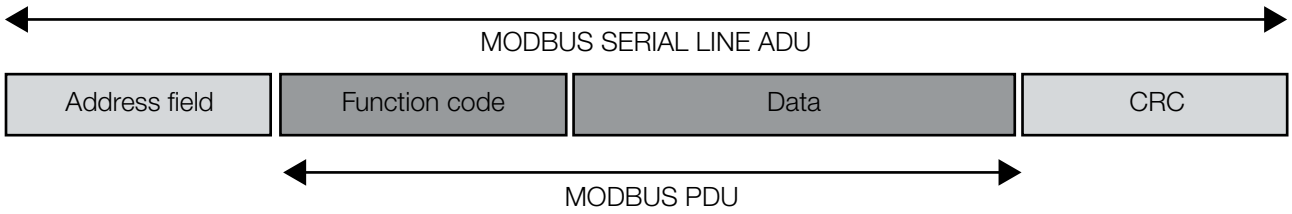


Abb. 7: MODBUS frame Serial Line

Abbreviations:

ADU	Application Data Unit
Host	The one that initiates communication is called the host
Slave	The one that passive responses command called the slave
IETF	Internet Engineering Task Force
I/O	input/Output
MB	MODBUS Protokol
MBAP	MODBUS Apllication Protokol
PDU	Protocol Data Unit

4.3 Master / Slaves protocol principle

The MODBUS Serial Line protocol is a Master-Slaves protocol. Only one master (at the same time) is connected to the bus, and one or several (247 maximum number) slaves nodes are also connected to the same serial bus.

A MODBUS communication is always initiated by the master. The slave nodes will never transmit data without receiving a request from the master node. The slave nodes will never communicate with each other. The master node initiates only one MODBUS transaction at the same time.

The master node issues a MODBUS request to the slave nodes in two modes:

1. In **unicast mode**, the master addresses an individual slave. After receiving and processing t he request, the slave returns a message (a ‚reply') to the master. In that mode, a MODBUS transaction consists of 2 messages: a request from the master, and a reply from the slave. Each slave must have an unique address (from 1 to 247) so that it can be addressed independently from other nodes.
2. In **broadcast mode**, the master can send a request to all slaves. No response is returned to broadcast requests sent by the master. The broadcast requests are necessarily writing commands. The address 0 is reserved to identify a broadcast exchange.

A request telegram can be sent as soon as no communication has taken place on the RS485 bus for at least 100 ms.

4.3.1 Addressing rules

The MODBUS addressing space comprises 256 different addresses.

0	From 1 to 247	From 248 to 255
Broadcast address	Slave individual addresses	Reserved

4.3.2 RTU Transmission Mode

The RTU mode is used in this protocol interface.

RTU (Remote Terminal Unit) mode, each 8–bit byte in a message contains two 4–bit hexadecimal characters.

The format (11 bits) for each byte in RTU mode is:

Coding System: 8–bit binary

Bits per Byte: 1 start bit
8 data bits, least significant bit sent first
1 bit for parity completion, here even parity is used.
1 stop bit

RTU frame description:

Slave Address	Function Code	Data	CRC
1 byte	1 byte	0 up to 252 byte(s)	2 bytes CRC Low | CRC Hi

4.3.3 CRC generation

An example of a C language function performing CRC generation is shown on the following pages. All of the possible CRC values are preloaded into two arrays, which are simply indexed as the function increments through the message buffer.

One array contains all of the 256 possible CRC values for the high byte of the 16-bit CRC field, and the other array contains all of the values for the low byte.

Indexing the CRC in this way provides faster execution than would be achieved by calculating a new CRC value with each new character from the message buffer.

Note : This function performs the swapping of the high/low CRC bytes internally. The bytes are already swapped in the CRC value that is returned from the function. Therefore the CRC value returned from the function can be directly placed into the message for transmission.

The function takes two arguments:

- const unsigned char *pbMsg; A pointer to the message buffer containing binary data to be used for generating the CRC
- unsigned short wLength ; The quantity of bytes in the message buffer.

The function returns the CRC as a type unsigned short.

CRC Generation Function

```
unsigned short swCRC16 (const unsigned char *pbMsg,unsigned short wLength)
{
   unsigned char bCRCHi = 0xFF;
   unsigned char bCRCLo = 0xFF;
   unsigned short wIndex;
   while(wLength--)
   {
      wIndex = bCRCHi ^ *pbMsg++;
      bCRCHi = bCRCLo ^ CRC_HIGH[wIndex];
      bCRCLo = CRC_LOW[wIndex];
   }
   return(bCRCHi << 8 | bCRCLo);
}
```

High-Order Byte Table

```
/* Table of CRC values for high–order byte */
static unsigned char auchCRCHi[] =
{
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
    0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
    0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01,
    0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81,
    0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
    0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01,
    0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
    0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
    0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01,
    0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
    0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
    0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01,
    0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
    0x40
} ;
```

Low-Order Byte Table

```
/* Table of CRC values for low–order byte */
static char auchCRCLo[] =
{
    0x00, 0xC0, 0xC1, 0x01, 0xC3, 0x03, 0x02, 0xC2, 0xC6, 0x06, 0x07, 0xC7, 0x05, 0xC5, 0xC4,
    0x04, 0xCC, 0x0C, 0x0D, 0xCD, 0x0F, 0xCF, 0xCE, 0x0E, 0x0A, 0xCA, 0xCB, 0x0B, 0xC9, 0x09,
    0x08, 0xC8, 0xD8, 0x18, 0x19, 0xD9, 0x1B, 0xDB, 0xDA, 0x1A, 0x1E, 0xDE, 0xDF, 0x1F, 0xDD,
    0x1D, 0x1C, 0xDC, 0x14, 0xD4, 0xD5, 0x15, 0xD7, 0x17, 0x16, 0xD6, 0xD2, 0x12, 0x13, 0xD3,
    0x11, 0xD1, 0xD0, 0x10, 0xF0, 0x30, 0x31, 0xF1, 0x33, 0xF3, 0xF2, 0x32, 0x36, 0xF6, 0xF7,
    0x37, 0xF5, 0x35, 0x34, 0xF4, 0x3C, 0xFC, 0xFD, 0x3D, 0xFF, 0x3F, 0x3E, 0xFE, 0xFA, 0x3A,
    0x3B, 0xFB, 0x39, 0xF9, 0xF8, 0x38, 0x28, 0xE8, 0xE9, 0x29, 0xEB, 0x2B, 0x2A, 0xEA, 0xEE,
    0x2E, 0x2F, 0xEF, 0x2D, 0xED, 0xEC, 0x2C, 0xE4, 0x24, 0x25, 0xE5, 0x27, 0xE7, 0xE6, 0x26,
    0x22, 0xE2, 0xE3, 0x23, 0xE1, 0x21, 0x20, 0xE0, 0xA0, 0x60, 0x61, 0xA1, 0x63, 0xA3, 0xA2,
    0x62, 0x66, 0xA6, 0xA7, 0x67, 0xA5, 0x65, 0x64, 0xA4, 0x6C, 0xAC, 0xAD, 0x6D, 0xAF, 0x6F,
    0x6E, 0xAE, 0xAA, 0x6A, 0x6B, 0xAB, 0x69, 0xA9, 0xA8, 0x68, 0x78, 0xB8, 0xB9, 0x79, 0xBB,
    0x7B, 0x7A, 0xBA, 0xBE, 0x7E, 0x7F, 0xBF, 0x7D, 0xBD, 0xBC, 0x7C, 0xB4, 0x74, 0x75, 0xB5,
    0x77, 0xB7, 0xB6, 0x76, 0x72, 0xB2, 0xB3, 0x73, 0xB1, 0x71, 0x70, 0xB0, 0x50, 0x90, 0x91,
    0x51, 0x93, 0x53, 0x52, 0x92, 0x96, 0x56, 0x57, 0x97, 0x55, 0x95, 0x94, 0x54, 0x9C, 0x5C,
    0x5D, 0x9D, 0x5F, 0x9F, 0x9E, 0x5E, 0x5A, 0x9A, 0x9B, 0x5B, 0x99, 0x59, 0x58, 0x98, 0x88,
    0x48, 0x49, 0x89, 0x4B, 0x8B, 0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D, 0x4D, 0x4C, 0x8C,
    0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42, 0x43, 0x83, 0x41, 0x81, 0x80,
    0x40
```

4.3.4 Function code list

The following MODBUS commands are supported by the implemented MODBUS interface:

Index	Function code	Description
1	0x03	Read Register
2	0x06	Write a single Register
3	0x10	Write multiple Registers

4.3.5 Read Register (0x03)

1. Host query command format:

Parameter	Lenght	Description
Slave address	1 byte	1~247
Function code	1 byte	0x03
Register Start address	2 byte	0x0000~0xFFFF
Register number	2 byte	1~124
CRC code	2 byte	

2. Slave normal respond format:

Parameter	Lenght	Description
Slave address	1 byte	1~247
Function code	1 byte	0x03
Byte number	2 byte	Register Number*2
Register value	2 ~248 byte	
CRC code	2 byte	

3. Slave abnormal respond format:

Parameter	Lenght	Description
Slave address	1 byte	1~247
Function code	1 byte	0x83
Abnormal code	1 byte	refer “AbnormalCodeTable”
CRC code	2 byte	

Example:

Host query command : 01 03 10 01 00 01 D1 0A
Slave normal respond : 01 03 02 08 FC BF C5
Slave abnormal respond: 01 83 02 C0 F1

4.3.6 Write a single Register (0x06)

1. Host query command format:

Parameter	Lenght	Description
Slave address	1 byte	1~247
Function code	1 byte	0x06
Address	2 byte	0x0000~0xFFFF
Register value	2 byte	0x0000~0xFFFF
CRC code	2 byte	

2. Slave normal respond format:

Parameter	Lenght	Description
Slave address	1 byte	1~247
Function code	1 byte	0x06
Address	2 byte	0x0000~0xFFFF
Register value	2 byte	0x0000~0xFFFF
CRC code	2 byte	

3. Slave abnormal respond format:

Parameter	Lenght	Description
Slave address	1 byte	1~247
Function code	1 byte	0x86
Abnormal code	1 byte	refer“AbnormalCodeTable”
CRC code	2 byte	

Example:

Host query command : 01 06 51 01 00 01 09 36
Slave normal respond : 01 06 51 01 00 01 09 36
Slave abnormal respond: 01 86 04 43 A3

4.3.7 Write multiple Register (0x10)

1. Host query command format:

Parameter	Lenght	Description
Slave address	1 byte	1~247
Function code	1 byte	0x10
Register Start address	2 byte	0x0000~0xFFFF
Register Number	2 byte	1~122
Byte number	1 byte	Register Number * 2
Register value	2 ~244 byte	
CRC code	2 byte	

2. Slave normal respond format:

Parameter	Lenght	Description
Slave address	1 byte	1~247
Function code	1 byte	0x10
Register Start address	2 byte	0x0000~0xFFFF
Register Number	2 byte	1~122
CRC code	2 byte	

3. Slave abnormal respond format:

Parameter	Lenght	Description
Slave address	1 byte	1~247
Function code	1 byte	0x90
Abnormal code	1 byte	refer “AbnormalCodeTable”
CRC code	2 byte	

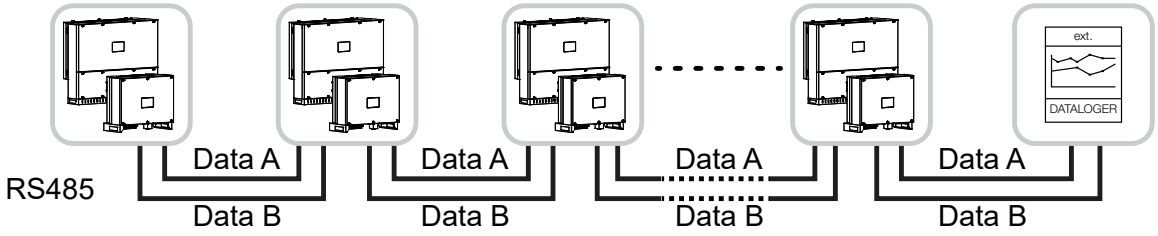
Example:

Host query command : 01 10 30 00 00 04 08 07 E1 01 01 00 00 00 00 7B 73
Slave normal respond : 01 10 30 00 00 04 CE CA
Slave abnormal respond: 01 90 02 CD C1

4.4 Physical Layer - RS485 (Serial)

4.4.1 RS485 port

The Modbus communication adopts 2-line RS-485 interface, RTU mode. And a single host can connect up to 247 inverters.



Parameter	Description
Transfer mode	RTU mode
Communication mode	Half duplex
Baud rate	19200
Start bit	1
Data bit	8
Check bit	None
Stop bit	2

4.4.2 Electrical interface

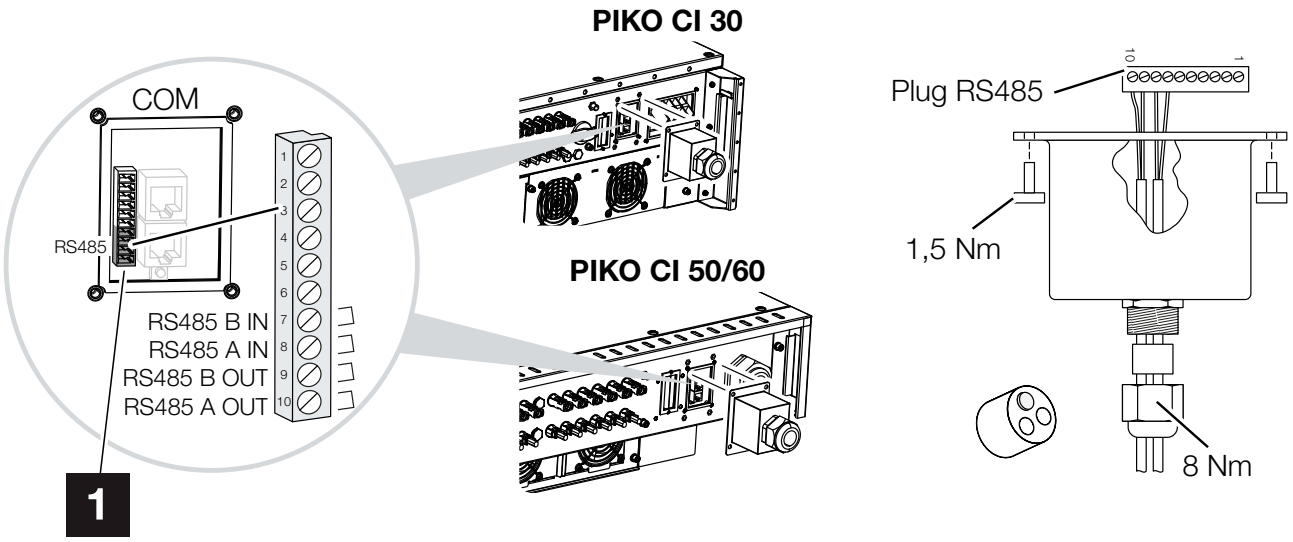
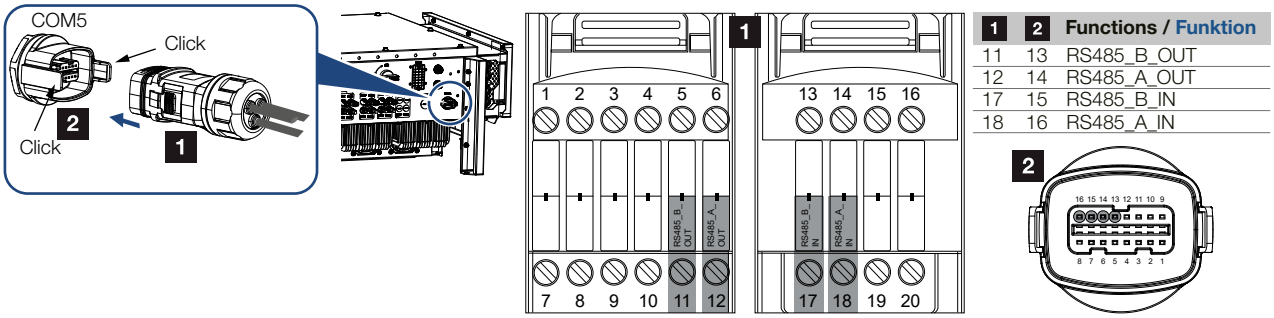


Abb. 8: RS485 - Interface PIKO CI 30-60



1	2	Functions / Funktion
11	13	RS485_B_OUT
12	14	RS485_A_OUT
17	15	RS485_B_IN
18	16	RS485_A_IN

Abb. 9: RS485 - Interface PIKO CI 100

5. Exception Responses

When a client device sends a request to a server device it expects a normal response. One of four possible events can occur from the client's query:

- If the server device receives the request without a communication error, and can handle the query normally, it returns a normal response.
- If the server does not receive the request due to a communication error, no response is returned. The client program will eventually process a timeout condition for the request.
- If the server receives the request, but detects a communication error (parity, CRC...), no response is returned. The client program will eventually process a timeout condition for the request.
- If the server receives the request without a communication error, but cannot handle it (for example, if the request is to read a non-existent output or register), the server will return an exception response informing the client of the nature of the error.

The exception response message has two fields that differentiate it from a normal response:

Function Code Field: In a normal response, the server echoes the function code of the original request in the function code field of the response. All function codes have a most – significant bit (MSB) of 0 (their values are all below 80 hex). In an exception response, the server sets the MSB of the function code to 1. This makes the function code value in an exception response exactly 80 hex higher than the value would be for a normal response.

With the function code's MSB set, the client's application program can recognize the exception response and can examine the data field for the exception code.

Data Field: In a normal response, the server may return data or statistics in the data field (any information that was requested in the request). In an exception response, the server returns an exception code in the data field. This defines the server condition that caused the exception.

The exception codes are listed:

MODBUS Exception Codes		
Code	**Name**	**Meaning**
01	ILLEGAL FUNCTION	The function code received in the query is not an allowable action for the server. This may be because the function code is only applicable to newer devices, and was not implemented in the unit selected. It could also indicate that the server is in the wrong state to process a request of this type, for example because it is un-configured and is being asked to return register values.
02	ILLEGAL DATA ADDRESS	The data address received in the query is not an allowable address for the server. More specifically, the combination of reference number and transfer length is invalid. For a controller with 100 registers, the PDU addresses the first register as 0, and the last one as 99. If a request is submitted with a starting register address of 96 and a quantity of registers of 4, then this request will successfully operate (address -wise at least) on registers 96, 97, 98, 99. If a request is submitted with a starting register address of 96 and a quantity of registers of 5, then this request will fail with Exception Code 0x02 “Illegal Data Address” since it attempts to operate on registers 96, 97, 98, 99 and 100, and there is no register with address 100.
03	ILLEGAL DATA VALUE	A value contained in the query data field is not an allowable value for server. This indicates a fault in the structure of the remainder of a complex request, such as that the implied length is incorrect. It specifically does NOT mean that a data item submitted for storage in a register has a value outside the expectation of the application program, since the MODBUS protocol is unaware of the significance of any particular value of any particular register.
04	SERVER DEVICE FAILURE	An unrecoverable error occurred while the server was attempting to perform the requested action.
05	ACKNOW LEDGE	Specialized use in conjunction with programming commands.
06	SERVER DEVICE BUSY	Specialized use in conjunction with programming commands. The server is engaged in processing a long – duration program command. The client should retransmit the message later when the server is free.
08	MEMORY PARITY ERROR	Specialized use in conjunction with function codes 20 and 21 and reference type 6, to indicate that the extended file area failed to pass a consistency check. The server attempted to read record file, but detected a parity error in the memory. The client can retry the request, but service may be required on the server device.

MODBUS Exception Codes		
0A	GATEWAY PATH UNAVAILABLE	Specialized use in conjunction with gateways, indicates that the gateway was unable to allocate an internal communication path from the input port to the output port for processing the request. Usually means that the gateway is misconfigured or overloaded.
0B	GATEWAY PATH UNAVAILABLE	Specialized use in conjunction with gateways, indicates that no response was obtained from the target device. Usually means that the device is not present on the network.

6. MODBUS Register table

6.1 Query the operating data

Addr (hex)	Addr (dec)	Description	Unit	Format	N[1)]	Access	Function Code
0x02	2	MODBUS Enable	-	Bool	1	R/W	0x03/0x06
0x04	4	MODBUS Unit-ID	-	U16	1	R/W	0x03/0x06
0x06	6	Inverter article number	-	String	8	RO	0x03
0x0E	14	Inverter serial number	-	String	8	RO	0x03
0x1E	30	Number of bidirectional converter	-	U16	1	RO	0x03
0x20	32	Number of AC phases	-	U16	1	RO	0x03
0x22	34	Number of PV strings	-	U16	1	RO	0x03
0x24	36	Hardware-Version	-	U16	2	RO	0x03
0x26	38	Software-Version Maincontroller (MC)	-	String	8	RO	0x03
0x2E	46	Software-Version IO-Controller (IOC)	-	String	8	RO	0x03
0x36	54	Power-ID	-	U16	2	RO	0x03
0x38	56	Inverter state[2]	-	U16	2	RO	0x03
0x64	100	Total DC power	W	Float	2	RO	0x03
0x6C	108	Home own consumption from grid	W	Float	2	RO	0x03
0x70	112	Total home consumption Grid	Wh	Float	2	RO	0x03
0x72	114	Total home consumption PV	Wh	Float	2	RO	0x03
0x74	116	Home own consumption from PV	W	Float	2	RO	0x03
0x76	118	Total home consumption	Wh	Float	2	RO	0x03
0x7A	122	Power limit from EVU	%	Float	2	RO	0x03
0x7C	124	Total home consumption rate	%	Float	2	RO	0x03
0x90	144	Worktime	s	Float	2	RO	0x03
0x96	150	Actual cos ϕ	-	Float	2	RO	0x03
0x98	152	Grid frequency	Hz	Float	2	RO	0x03
0x9A	154	Current Phase 1	A	Float	2	RO	0x03
0x9C	156	Active power Phase 1	W	Float	2	RO	0x03
0x9E	158	Voltage Phase 1	V	Float	2	RO	0x03
0xA0	160	Current Phase 2	A	Float	2	RO	0x03
0xA2	162	Active power Phase 2	W	Float	2	RO	0x03
0xA4	164	Voltage Phase 2	V	Float	2	RO	0x03
0xA6	166	Current Phase 3	A	Float	2	RO	0x03
0xA8	168	Active power Phase 3	W	Float	2	RO	0x03
0xAA	170	Voltage Phase 3	V	Float	2	RO	0x03
0xAC	172	Total AC active power	W	Float	2	RO	0x03
0xAE	174	Total AC reactive power	Var	Float	2	RO	0x03
0xB2	178	Total AC apparent power	VA	Float	2	RO	0x03
0xDA	218	Cos ϕ (powermeter)	-	Float	2	RO	0x03

Addr (hex)	Addr (dec)	Description	Unit	Format	N[1)]	Access	Function Code
0xDC	220	Frequency (powermeter)	Hz	Float	2	RO	0x03
0xDE	222	Current phase 1 (powermeter)	A	Float	2	RO	0x03
0xE0	224	Active power phase 1 (powermeter)	W	Float	2	RO	0x03
0xE2	226	Reactive power phase 1 (powermeter)	Var	Float	2	RO	0x03
0xE4	228	Apparent power phase 1 (powermeter)	VA	Float	2	RO	0x03
0xE6	230	Voltage phase 1 (powermeter)	V	Float	2	RO	0x03
0xE8	232	Current phase 2 (powermeter)	A	Float	2	RO	0x03
0xEA	234	Active power phase 2 (powermeter)	W	Float	2	RO	0x03
0xEC	236	Reactive power phase 2 (powermeter)	Var	Float	2	RO	0x03
0xEE	238	Apparent power phase 2 (powermeter)	VA	Float	2	RO	0x03
0xF0	240	Voltage phase 2 (powermeter)	V	Float	2	RO	0x03
0xF2	242	Current phase 3 (powermeter)	A	Float	2	RO	0x03
0xF4	244	Active power phase 3 (powermeter)	W	Float	2	RO	0x03
0xF6	246	Reactive power phase 3 (powermeter)	Var	Float	2	RO	0x03
0xF8	248	Apparent power phase 3 (powermeter)	VA	Float	2	RO	0x03
0xFA	250	Voltage phase 3 (powermeter)	V	Float	2	RO	0x03
0xFC	252	Total active power (powermeter) Sensor position 1 (home consumption): (+) House consumption, (-) generation Sensor position 2 (grid connection): (+) Power supply, (-) feed-in	W	Float	2	RO	0x03
0x102	258	Current DC1	A	Float	2	RO	0x03
0x104	260	Power DC1	W	Float	2	RO	0x03
0x10A	266	Voltage DC1	V	Float	2	RO	0x03
0x10C	268	Current DC2	A	Float	2	RO	0x03
0x10E	270	Power DC2	W	Float	2	RO	0x03
0x114	276	Voltage DC2	V	Float	2	RO	0x03
0x116	278	Current DC3	A	Float	2	RO	0x03
0x118	280	Power DC3	W	Float	2	RO	0x03
0x11E	286	Voltage DC3	V	Float	2	RO	0x03
0x12C	300	Current DC4	A	Float	2	RO	0x03
0x12E	302	Power DC4	W	Float	2	RO	0x03
0x134	308	Voltage DC4	V	Float	2	RO	0x03
0x140	320	Total yield	Wh	Float	2	RO	0x03
0x142	322	Daily yield	Wh	Float	2	RO	0x03
0x144	324	Yearly yield	Wh	Float	2	RO	0x03
0x146	326	Monthly yield	Wh	Float	2	RO	0x03
0x180	384	Inverter network name	-	String	32	RO	0x03

Addr (hex)	Addr (dec)	Description	Unit	Format	N[1)]	Access	Function Code
0x1A0	416	IP enable	-	U16	1	RO	0x03
0x1A2	418	Manual IP / Auto-IP	-	U16	1	RO	0x03
0x1A4	420	IP-address	-	String	8	RO	0x03
0x1AC	428	IP-subnetmask	-	String	8	RO	0x03
0x1B4	436	IP-gateway	-	String	8	RO	0x03
0x1BC	444	IP-auto-DNS	-	U16	1	RO	0x03
0x1BE	446	IP-DNS1	-	String	8	RO	0x03
0x1C6	454	IP-DNS2	-	String	8	RO	0x03
0x203	515	Firmware Maincontroller (MC)	-	U32	2	RO	0x03
0x213	531	Inverter Max Power	W	U16	1	RO	0x03
0x214	532	Inverter Peak Generation Power Scale Factor[3]	-	-	1	RO	0x03
0x217	535	Inverter Manufacturer	-	String	16	RO	0x03
0x227	551	Inverter Model ID	-	String	8	RO	0x03
0x22F	559	Inverter Serial Number	-	String	16	RO	0x03
0x23F	575	Inverter Generation Power (actual)	W	S16	1	RO	0x03
0x240	576	Power Scale Factor[3]	-	-	1	RO	0x03
0x241	577	Generation Energy	Wh	U32	2	RO	0x03
0x243	579	Energy Scale Factor[3]	-	-	1	RO	0x03
0x260	608	Modbus Address For Digital Meter	-	U16	1	R/W	0x03/0x06
0x261	609	Digital Meter Power Direction (from grid to load is positive) 0x0000 : Positive 0x0001 : Negative	-	U16	1	R/W	0x03/0x06
0x262	610	Zero Feed-in Mode 0x0000 : Disable 0x0001 : Power limit by external command 0x0002 : Power limit by PVI external CT sensor 0x0003 : Power limit by digital meter device	-	U16	1	R/W	0x03/0x06
0x263	611	Power Limit Meter Position 0x0000 : CT or Meter on Grid 0x0001 : CT or Meter on Load	-	U16	1	R/W	0x03/0x06
0x264	612	Max feed-in power	W	U32	2	R/W	0x03/0x06
0x300	768	Productname (e.g. PIKO CI)	-	String	32	RO	0x03
0x320	800	Power class (e.g. 30)	-	String	32	RO	0x03

Addr (hex)	Addr (dec)	Description	Unit	Format	N[1)]	Access	Function Code
0x101E	4126	Error message 1[5)]	-	U16	1	RO	0x03
0x101F	4127	Error message 2[5)]	-	U16	1	RO	0x03
0x1020	4128	Error message 3[5)]	-	U16	1	RO	0x03
0x1A1C	6684	Control board firmware version	-	String	3	RO	0x03
0x1A60	6752	Communication service board firmware version	-	String	3	RO	0x03
0x3005	12293	Output power de-rating percent	%	u16	1	R/W	0x03/0x06
0x300B	12299	"Ripple control receiver enable flag 0x0000 : Disable 0x0001 : Enable"	-	u16	1	R/W	0x03/0x06
0x300C	12300	RCR0 Active Power(%)	%	u16	1	R/W	0x03/0x06
0x300D	12301	RCR1 Active Power(%)	%	u16	1	R/W	0x03/0x06
0x300E	12302	RCR2 Active Power(%)	%	u16	1	R/W	0x03/0x06
0x300F	12303	RCR3 Active Power(%)	%	u16	1	R/W	0x03/0x06
0x3010	12304	RCR4 Active Power(%)	%	u16	1	R/W	0x03/0x06
0x3011	12305	RCR5 Active Power(%)	%	u16	1	R/W	0x03/0x06
0x3012	12306	RCR6 Active Power(%)	%	u16	1	R/W	0x03/0x06
0x3013	12307	RCR7 Active Power(%)	%	u16	1	R/W	0x03/0x06
0x3014	12308	RCR8 Active Power(%)	%	u16	1	R/W	0x03/0x06
0x3015	12309	RCR9 Active Power(%)	%	u16	1	R/W	0x03/0x06
0x3016	12310	RCR10 Active Power(%)	%	u16	1	R/W	0x03/0x06
0x3017	12311	RCR11 Active Power(%)	%	u16	1	R/W	0x03/0x06
0x3018	12312	RCR12 Active Power(%)	%	u16	1	R/W	0x03/0x06
0x3019	12313	RCR13 Active Power(%)	%	u16	1	R/W	0x03/0x06
0x301A	12314	RCR14 Active Power(%)	%	u16	1	R/W	0x03/0x06
0x301B	12315	RCR15 Active Power(%)	%	u16	1	R/W	0x03/0x06
0x3085	12421	Output power de-rating by Modbus command	W	u32	2	R/W	0x03/0x06
0x30B3	12467	"Power limit function 0x0000 : Disable 0x0001 : External device 0x0002 : CT sensor 0x0003 : Digital Power Meter"	-	u16	1	R/W	0x03/0x06
0x30B4	12468	"Power limit CT Ratio 0x0001 : 1000 : 1 0x0002 : 2000 : 1 0x0003 : 2500 : 1 0x0004 : 3000 : 1 0x0005 : 4000 : 1 0x0006 : 5000 : 1 0x0007 : 6000 : 1 0x0008 : 10000 : 1"	-	u16	1	R/W	0x03/0x06

Addr (hex)	Addr (dec)	Description	Unit	Format	N[1)]	Access	Function Code
0x30B5	12469	"Device location 0x0000 : CT On Grid 0x0001 : CT On Load"	-	u16	1	R/W	0x03/0x06
0x30B9	12473	Maximum feed in grid power	W	u32	2	R/W	0x03/0x06
0x317F	12671	"RCR current input status(16bits) Example: 0x0001(input signal 1 active) 0x8000(input signal 16 active)"	-	u16	1	RO	0x03
0x3180	12672	RCR0 Reactive Power(%)	%	s16	1	R/W	0x03/0x06
0x3181	12673	RCR1 Reactive Power(%)	%	s16	1	R/W	0x03/0x06
0x3182	12674	RCR2 Reactive Power(%)	%	s16	1	R/W	0x03/0x06
0x3183	12675	RCR3 Reactive Power(%)	%	s16	1	R/W	0x03/0x06
0x3184	12676	RCR4 Reactive Power(%)	%	s16	1	R/W	0x03/0x06
0x3185	12677	RCR5 Reactive Power(%)	%	s16	1	R/W	0x03/0x06
0x3186	12678	RCR6 Reactive Power(%)	%	s16	1	R/W	0x03/0x06
0x3187	12679	RCR7 Reactive Power(%)	%	s16	1	R/W	0x03/0x06
0x3188	12680	RCR8 Reactive Power(%)	%	s16	1	R/W	0x03/0x06
0x3189	12681	RCR9 Reactive Power(%)	%	s16	1	R/W	0x03/0x06
0x318A	12682	RCR10 Reactive Power(%)	%	s16	1	R/W	0x03/0x06
0x318B	12683	RCR11 Reactive Power(%)	%	s16	1	R/W	0x03/0x06
0x318C	12684	RCR12 Reactive Power(%)	%	s16	1	R/W	0x03/0x06
0x318D	12685	RCR13 Reactive Power(%)	%	s16	1	R/W	0x03/0x06
0x318E	12686	RCR14 Reactive Power(%)	%	s16	1	R/W	0x03/0x06
0x318F	12687	RCR15 Reactive Power(%)	%	s16	1	R/W	0x03/0x06
0x3190	12688	RCR0 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x3191	12689	RCR1 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x3192	12690	RCR2 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x3193	12691	RCR3 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x3194	12692	RCR4 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x3195	12693	RCR5 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x3196	12694	RCR6 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x3197	12695	RCR7 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x3198	12696	RCR8 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x3199	12697	RCR9 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x319A	12698	RCR10 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x319B	12699	RCR11 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x319C	12700	RCR12 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x319D	12701	RCR13 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x319E	12702	RCR14 Power Factor	0,001	s16	1	R/W	0x03/0x06

Addr (hex)	Addr (dec)	Description	Unit	Format	N[1)]	Access	Function Code
0x319F	12703	RCR15 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x5000	20480	First Connect Delay Time	s	u16	1	R/W	0x03/0x06
0x5001	20481	Reconnect Delay Time	s	u16	1	R/W	0x03/0x06
0x5002	20482	Grid Frequency High Loss Level_1	0.01Hz	u16	1	R/W	0x03/0x06
0x5003	20483	Grid Frequency Low Loss Level_1	0.01Hz	u16	1	R/W	0x03/0x06
0x5004	20484	Grid Voltage High Loss Level_1	0.1V	u16	1	R/W	0x03/0x06
0x5005	20485	Grid Voltage Low Loss Level_1	0.1V	u16	1	R/W	0x03/0x06
0x5006	20486	Grid Frequency High Loss Time Level_1	ms	u16	1	R/W	0x03/0x06
0x5007	20487	Grid Frequency Low Loss Time Level_1	ms	u16	1	R/W	0x03/0x06
0x5008	20488	Grid Voltage High Loss Time Level_1	ms	u16	1	R/W	0x03/0x06
0x5009	20489	Grid Voltage Low Loss Time Level_1	ms	u16	1	R/W	0x03/0x06
0x500A	20490	Grid Frequency High Loss Level_2	0.01Hz	u16	1	R/W	0x03/0x06
0x500B	20491	Grid Frequency Low Loss Level_2	0.01Hz	u16	1	R/W	0x03/0x06
0x500C	20492	Grid Voltage High Loss Level_2	0.1V	u16	1	R/W	0x03/0x06
0x500D	20493	Grid Voltage Low Loss Level_2	0.1V	u16	1	R/W	0x03/0x06
0x500E	20494	Grid Frequency High Loss Tome Level_2	ms	u16	1	R/W	0x03/0x06
0x500F	20495	Grid Frequency Low Loss Time Level_2	ms	u16	1	R/W	0x03/0x06
0x5010	20496	Grid Voltage High Loss Time Level_2	ms	u16	1	R/W	0x03/0x06
0x5011	20497	Grid Voltage Low Loss Time Level_2	ms	u16	1	R/W	0x03/0x06
0x5012	20498	Grid Frequency High Level 1 back	0.01Hz	u16	1	R/W	0x03/0x06
0x5013	20499	Grid Frequency Low Level 1 back	0.01Hz	u16	1	R/W	0x03/0x06
0x5014	20500	De-rating Grid Frequency High back	0.01Hz	u16	1	R/W	0x03/0x06
0x5015	20501	De-rating Grid Frequency Low back	0.01Hz	u16	1	R/W	0x03/0x06
0x5016	20502	Frequency Protection Level 1 Enable	-	u16	1	R/W	0x03/0x06
0x5017	20503	Frequency De-rating Function	-	u16	1	R/W	0x03/0x06
0x5018	20504	MovingAvgVoltLimit	0.1V	u16	1	R/W	0x03/0x06
0x5019	20505	Reconnect power gradient	%	u16	1	R/W	0x03/0x06
0x501A	20506	P(f) curve power gradient	0,1%	u16	1	R/W	0x03/0x06
0x501B	20507	Insulation Impedance	kΩ	u16	1	R/W	0x03/0x06
0x501F	20511	Grid frequency high Level 1 trip time (High Word)	ms	u16	1	R/W	0x03/0x06
0x5020	20512	Grid frequency low Level 1 trip time (High Word)	ms	u16	1	R/W	0x03/0x06
0x5021	20513	Over Frequency derating start point	0.01Hz	u16	1	R/W	0x03/0x06
0x5022	20514	Over Frequency derating end point	0.01Hz	u16	1	R/W	0x03/0x06
0x5023	20515	Active power change gradient	0.01%/s	u16	1	R/W	0x03/0x06
0x5024	20516	Postive sequence K factor	0,1	u16	1	R/W	0x03/0x06
0x5025	20517	Grid Voltage High Level 1 trip time (High Word)	ms	u16	1	R/W	0x03/0x06
0x5026	20518	Grid Voltage Low Level 1 trip time (High Word)	ms	u16	1	R/W	0x03/0x06
0x5027	20519	Grid Reconnection Voltage High Limit	0.1V	u16	1	R/W	0x03/0x06

Addr (hex)	Addr (dec)	Description	Unit	Format	N[1)]	Access	Function Code
0x5028	20520	Grid Reconnection Voltage Low Limit	0.1V	u16	1	R/W	0x03/0x06
0x5029	20521	Connection soft start output power percent	%	u16	1	R/W	0x03/0x06
0x502A	20522	Negative sequence K factor	0,1	u16	1	R/W	0x03/0x06
0x5030	20528	Reactive Power Control	-	u16	1	R/W	0x03/0x06
0x5031	20529	cosφ	0,001	s16	1	R/W	0x03/0x06
0x5033	20531	Reactive power control settling time (s)	s	u16	1	R/W	0x03/0x06
0x5034	20532	Cosφ(P) curve node 1 Power (%)	%	u16	1	R/W	0x03/0x06
0x5035	20533	Cosφ(P) curve node 2 Power (%)	%	u16	1	R/W	0x03/0x06
0x5036	20534	Cosφ(P) curve node 3 Power (%)	%	u16	1	R/W	0x03/0x06
0x5037	20535	Cosφ(P)) curve node 4 Power (%)	%	u16	1	R/W	0x03/0x06
0x5038	20536	Cosφ(P) curve node 1 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x5039	20537	Cosφ(P) curve node 2 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x503A	20538	Cosφ(P) curve node 3 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x503B	20539	Cosφ(P) curve node 4 Power Factor	0,001	s16	1	R/W	0x03/0x06
0x503C	20540	Q(U) curve node 1 voltage (%)	%	u16	1	R/W	0x03/0x06
0x503D	20541	Q(U) curve node 2 voltage (%)	%	u16	1	R/W	0x03/0x06
0x503E	20542	Q(U) curve node 3 voltage (%)	%	u16	1	R/W	0x03/0x06
0x503F	20543	Q(U) curve node 4 voltage (%)	%	u16	1	R/W	0x03/0x06
0x5040	20544	Q(U) curve node 1 Reactive Power (%)	0,1%	u16	1	R/W	0x03/0x06
0x5041	20545	Q(U) curve node 2 Reactive Power (%)	0,1%	u16	1	R/W	0x03/0x06
0x5042	20546	Q(U) curve node 3 Reactive Power (%)	0,1%	u16	1	R/W	0x03/0x06
0x5043	20547	Q(U) curve node 4 Reactive Power (%)	0,1%	u16	1	R/W	0x03/0x06
0x5049	20553	P(U) Curve node 1 voltage(V)	0.1V	u16	1	R/W	0x03/0x06
0x504A	20554	P(U) Curve node 2 voltage(V)	0.1V	u16	1	R/W	0x03/0x06
0x504B	20555	P(U) Curve node 3 voltage(V)	0.1V	u16	1	R/W	0x03/0x06
0x504C	20556	P(U) Curve node 4 voltage(V)	0.1V	u16	1	R/W	0x03/0x06
0x504D	20557	P(U) Curve node 1 Power (%)	%	u16	1	R/W	0x03/0x06
0x504E	20558	P(U) Curve node 2 Power (%)	%	u16	1	R/W	0x03/0x06
0x504F	20559	P(U) Curve node 3 Power (%)	%	u16	1	R/W	0x03/0x06
0x5050	20560	P(U) Curve node 4 Power (%)	%	u16	1	R/W	0x03/0x06
0x5059	20569	"Cosφ(P) curve type 0x0000: Type1(< 3.68K) 0x0001: Type2(>3.68 and< 13.8K) 0x0002: Type3(> 13.8K) 0x0003: Type4(Customization)"	-	u16	1	R/W	0x03/0x06
0x505A	20570	Q(P) curve node 1 Active Power (%)	%	u16	1	R/W	0x03/0x06
0x505B	20571	Q(P) curve node 2 Active Power (%)	%	u16	1	R/W	0x03/0x06
0x505C	20572	Q(P) curve node 3 Active Power (%)	%	u16	1	R/W	0x03/0x06
0x505D	20573	Q(P) curve node 4 Active Power (%)	%	u16	1	R/W	0x03/0x06

Addr (hex)	Addr (dec)	Description	Unit	Format	N[1)]	Access	Function Code
0x505E	20574	Q (P) curve node 1 Reactive Power (%)	0,1%	u16	1	R/W	0x03/0x06
0x505F	20575	Q (P) curve node 2 Reactive Power (%)	0,1%	u16	1	R/W	0x03/0x06
0x5060	20576	Q (P) curve node 3 Reactive Power (%)	0,1%	u16	1	R/W	0x03/0x06
0x5061	20577	Q (P) curve node 4 Reactive Power (%)	0,1%	u16	1	R/W	0x03/0x06
0x5062	20578	"Grid voltage Protection 0x0000: Disable 0x0001: Enable"	-	u16	1	R/W	0x03/0x06
0x5063	20579	LVRT triggering threshold	0.1V	u16	1	R/W	0x03/0x06
0x5064	20580	HVRT triggering threshold	0.1V	u16	1	R/W	0x03/0x06
0x5065	20581	Fault Ride Through Mode	-	u16	1	R/W	0x03/0x06
0x5066	20582	Zero current mode triggering threshold	%	u16	1	R/W	0x03/0x06
0x5067	20583	Grid voltage jump triggering threshold	%	u16	1	R/W	0x03/0x06
0x5101	20737	Regulation Code	-	u16	1	R/W	0x03/0x06
0x5104	20740	De-rating Watt Percent	%	u16	1	R/W	0x03/0x06
0x5106	20742	"MPPT Shadow Management 0x0000: Disable 0x0001: shadow manage 0x0002: I-V curve detect"	-	u16	1	R/W	0x03/0x06
0x5107	20743	Mppt Shadow Management Interval Time	s	u16	1	R/W	0x03/0x06
0x510E	20750	"Island Detection 0x0000: Disable 0x0001: Enable"	-	u16	1	R/W	0x03/0x06
0x510F	20751	Grid Voltage Unblanced limit	%	u16	1	R/W	0x03/0x06
0x5110	20752	Leakage Current Limit (mA)	mA	u16	1	R/W	0x03/0x06
0x5111	20753	String Abnormal Detection	-	u16	1	R/W	0x03/0x06
0x5114	20756	Reactive Power	%	s16	1	R/W	0x03/0x06
0x5117	20759	"Insulation Resistor Detect Function 0x0000: Disable 0x0001: Enable"	-	u16	1	R/W	0x03/0x06
0x5118	20760	"Leakage current Detect Function 0x0000: Disable 0x0001: Enable"	-	u16	1	R/W	0x03/0x06
0x511D	20765	"Grid high voltage load de-rating function 0x0000: Disable 0x0001: Enable"	-	u16	1	R/W	0x03/0x06
0x5121	20769	Reactive Power	0,01%	s16	1	R/W	0x03/0x06
0x5219	21017	"Remote off singal status 0x0000 : Non-active 0x0001 : Active"	-	u16	1	RO	0x03

Addr (hex)	Addr (dec)	Description	Unit	Format	N[1)]	Access	Function Code
0x521A	21018	"Remote off function 0x0000 : Disable 0x0001 : Enable"	-	u16	1	R/W	0x03/0x06
0x600F	24591	"Setting Output power factor (+) Positive : over-excited (lag, inductive) (-) Negative : under-excited (lead, capacitive)"	0,001	s16	1	R/W	0x03/0x06
0x6010	24592	"Setting Reactive Power Percent (+) Positive : over-excited (lag, inductive) (-) Negative : under-excited (lead, capacitive)"	0,01%	s16	1	R/W	0x03/0x06
0x7000	28672	Current DC1	A	Float	2	RO	0x03
0x7002	28674	Power DC1	W	Float	2	RO	0x03
0x7004	28676	Voltage DC1	V	Float	2	RO	0x03
0x7006	28678	Current DC2	A	Float	2	RO	0x03
0x7008	28680	Power DC2	W	Float	2	RO	0x03
0x700A	28682	Voltage DC2	V	Float	2	RO	0x03
0x700C	28684	Current DC3	A	Float	2	RO	0x03
0x700E	28686	Power DC3	W	Float	2	RO	0x03
0x7010	28688	Voltage DC3	V	Float	2	RO	0x03
0x7012	28690	Current DC4	A	Float	2	RO	0x03
0x7014	28692	Power DC4	W	Float	2	RO	0x03
0x7016	28694	Voltage DC4	V	Float	2	RO	0x03
0x7018	28696	Current DC5[4]	A	Float	2	RO	0x03
0x701A	28698	Power DC5[4]	W	Float	2	RO	0x03
0x701C	28700	Voltage DC5[4]	V	Float	2	RO	0x03
0x701E	28702	Current DC6[4]	A	Float	2	RO	0x03
0x7020	28704	Power DC6[4]	W	Float	2	RO	0x03
0x7022	28706	Voltage DC6[4]	V	Float	2	RO	0x03
0x7024	28708	Current DC7[4]	A	Float	2	RO	0x03
0x7026	28710	Power DC7[4]	W	Float	2	RO	0x03
0x7028	28712	Voltage DC7[4]	V	Float	2	RO	0x03
0x702A	28714	Current DC8[4]	A	Float	2	RO	0x03
0x702C	28716	Power DC8[4]	W	Float	2	RO	0x03
0x702E	28718	Voltage DC8[4]	V	Float	2	RO	0x03

Notes:

[1] N = Quantity of Registers

[2] Inverter States

1	Init
6	FeedIn
10	Standby
15	Shutdown

[3] Scale factors: As an alternative to floating point format, values are represented by integer values with a signed scale factor applied. The scale factor explicitly shifts the decimal point to the left (negative value) or the right (positive value). Scale factors are 16 bit two's compliment integer, the signed range is -10 … 10.

[4] Depending on the actual number of MPPTs on the device

[5] Error messages - 4126, 4127, 4128

Addr (Hex)	Addr(DEC)	Bit	Description error messages	PIKO CI 30/50/60	PIKO CI 100
0x101E	4126	0	High DC component of output current	x	x
		1	Inverter relay abnormal	x	x
		2	Remote off	-	x
		3	Inverter over temperature	x	x
		4	Leakage current abnormal	x	x
		5	PV string reverse	x	x
		6	Model type error	x	x
		7	Fan abnormal	x	x
		8	DC Link voltage unbalanced	x	x
		9	DC Link over voltage	x	x
		10	Internal communication error	x	x
		11	Software incompatibility	x	x
		12	Inverter EEPROM error	x	x
		13	Consistent warning	x	x
		14	Inverter abnormal	x	x
		15	BOOST abnormal	x	x

Addr (Hex)	Addr(DEC)	Bit	Description error messages	PIKO CI 30/50/60	PIKO CI 100
0x101F	4127	0	Grid over voltage	x	x
		1	Grid under voltage	x	x
		2	Grid absent	x	x
		3	Grid over frequency	x	x
		4	Grid under frequency	x	x
		5	PV over voltage	x	x
		6	PV insulation abnormal	x	x
		7	Leakage current abnormal	x	x
		8	Reserved	-	-
		9	Control power abnormal	x	x
		10	PV string abnormal	x	x
		11	PV under voltage	x	x
		12	Overvoltage protection module defective	x	x
		13	Grid abnormal	x	x
		14	Arc fault	-	x
		15	Grid high average voltage	-	x
0x1020	4128	0	Reserved	-	-
		1	Reserved	-	-
		2	Reserved	-	-
		3	Reserved	-	-
		4	AFCI module lost	-	x
		5	Master lost	x	x
		6	Meter lost	x	x
		7	Reserved	-	-
		8	Grid N abnormal	-	x
		9	Reserved	-	-
		10	Reserved	-	-
		11	Reserved	-	-
		12	PID device abnormal	-	x
		13	Reserved	-	-
		14	Reserved	-	-
		15	Reserved	-	-

6.2 Active power and reactive power control

These registers are only writeable and their parameters are not stored in the long-term storage memory of the inverter. That means the inverter will discard these settings when it powers on or resets.

Addr(Hex)	Addr(DEC)	Description	Format	*N	Function
0x215	533	Active power setpoint (%), range:1..100	U16	1	0x06
0x247	583	Reactive power setpoint (%), range: -100…0…100	S16	1	0x06
0x249	585	Delta cos ϕ setpoint[1] range: -32768…0…32767	S16	1	0x06

*N = Quantity of Registers

Note:

[1] The inverters can contribute to grid management by feeding in with a fixed cos ϕ. The displacement factor cos ϕ is an unsigned factor that is nonetheless characterized by the suffix „underexcited“ or „overexcited“. However, a „delta cos ϕ“ is transmitted here to the inverter, whereby a negative value corresponds to underexcited operation and a positive value corresponds to overexcited operation.

The value range -1.0…+1.0 is shown for the transmission of the desired value to the value range -32768…+32767 of a 16 bit whole number (signed short) with a suffix.

Example:

Setting	Delta cos ϕ	Reactive power
0	0	cos ϕ = 1.00
-1638	-0.05	cos ϕ = 0.95 underexcited
+3276	+0.10	cos ϕ = 0.90 overexcited

The maximum setting range is -26214…26214 (corresponds to a max. cos ϕ of 0.80). The setting range actually realizable by the inverter is found in the data sheet of the inverter.

7. SunSpec Interface

7.1 Overview

Information in SunSpec is defined through a set of 'Information Models' representing functionality implemented by devices or plants. SunSpec Alliance Interoperability Specifications describe these information models, data exchange formats and communication protocols used in distributed energy resource systems.

SunSpec information Models are defined using the SunSpec Model Definition XML (SMDX) encoding. Please reference the SMDX file for the definitive version of any SunSpec Information Model, at http://sunspec.org/download.

SunSpec information Models are communication protocol agnostic, but MODBUS is currently the most popular transport protocol in use.

For further information refer to www.sunspec.org.

7.2 Implemented SunSpec Models

Currently the following SunSpec-Models are implemented:

Model-No	Start Address (dec)	Model-Name
1	40003	Common
103	40071	Three Phase Inverter
113	40123	Three Phase Inverter, float
120	40185	Nameplate
123	40213	Immediate Controls
160	40239	Multiple MPPT
65535	40329	End Model

02/2024 - EN - DOC02576215-0005 - Technische Änderungen und Irrtümer vorbehalten.

Aktuelle Informationen finden Sie unter www.kostal-solar-electric.com.