SOLAR ELECTRIC

KOSTAL

PIKO IQ/PLENTICORE



KOSTAL Interface description MODBUS (TCP) & SunSpec

with control information

Version

Release date: 17.07.2026

Revision Version: 2.9

Valid from firmware version:

PIKO/PLENTICORE G1:	UI	01.30.12092
PLENTICORE G2:	SW	02.15.xxxxx
PLENTICORE G3:	SW	3.07.00.xxxxx
PLENTICORE MP G3:	SW	3.07.00.xxxxx

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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.
- Remote charge and discharge control of hybrid and battery inverters

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 prohibited. 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.

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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.

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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
S16	A signed integer 16-bit-value, 1 register
S32	A signed integer 32-bit-value, 2 registers
MBD	Multiple bytes data.

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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.

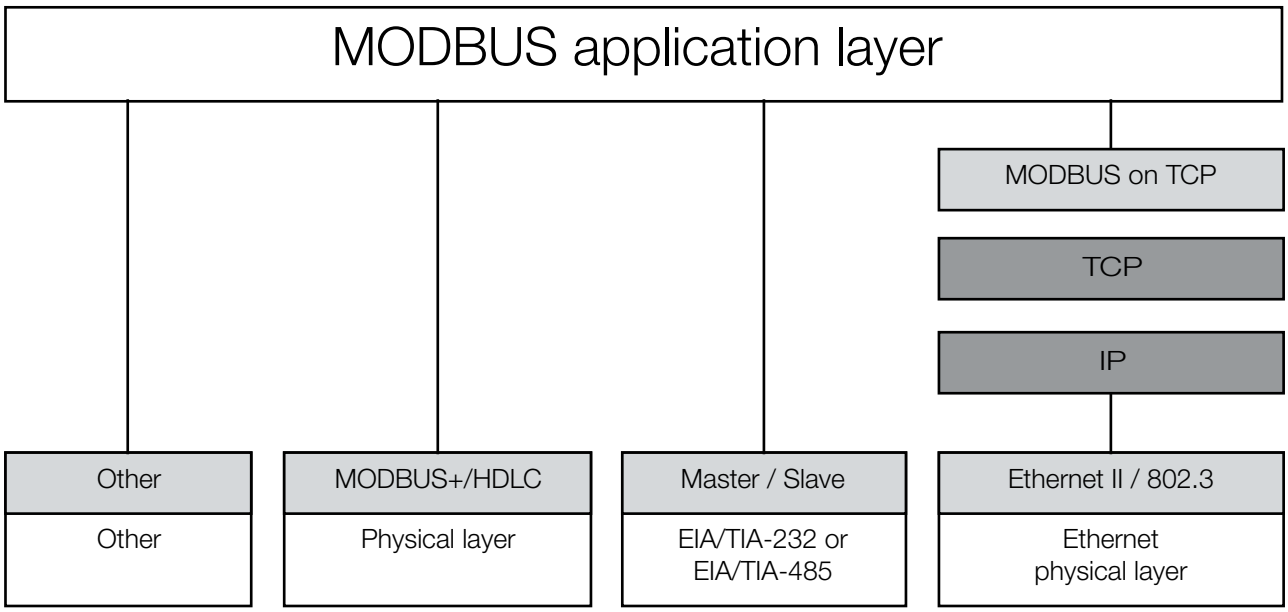


Abb. 1: MODBUS communication stack

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. See MODBUS Messaging Implementation Guide V1.0a.

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2.1.1 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).

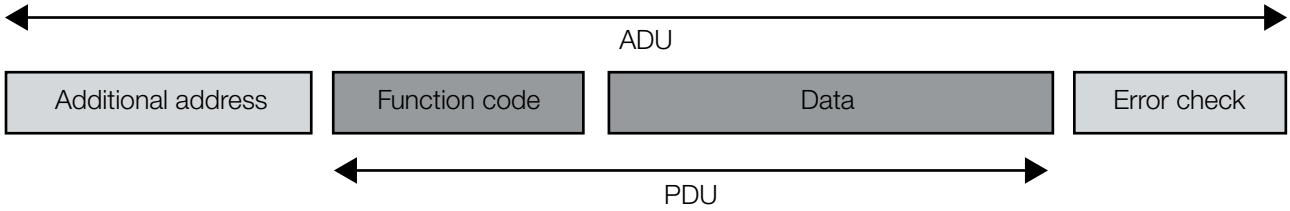


Abb. 2: General MODBUS frame

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.

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2.1.2 Data Encoding

The MODBUS communication can be set to '***little-endian (CDAB) Standard Modbus***' (default) or '***big-endian (ABCD) Sunspec***' under **Settings > Modbus/Sunspec (TCP)**.

Example for '***big-endian (ABCD) Sunspec***':
This means that when a numerical quantity larger than a single byte is transmitted, the most significant byte is sent first. So for

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

2.1.3 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
Write Multiple Registers	0x10	1 to 2

[1] Register content is 16-bits width.

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2.1.4 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.

Cycle Time

KOSTAL recommends a polling/cycle time of more than 1 s for MODBUS access.
Depending on the specific system and environmental conditions, shorter cycle times may be possible; in other cases, however, longer cycle times may be required to ensure stable operation.

In the target system, the user must validate the selected cycle time and ensure that it is suitable in terms of system stability, communication reliability and the requirements of the application.

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

[1]N = Quantity of Registers

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Error Response

Function 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 Code	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.

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2.1.5 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
Register address	2 Bytes	0x0000 to 0xFFFF
Register value	2 Bytes	0x0000 to 0xFFFF

Response

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

Error Response

Function 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 Code	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

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2.1.6 Write Multiple Registers (0x10)

This function code is used to write multiple contiguous registers in a remote device.
For KOSTAL inverters, up to two contiguous registers can be written with a single request.

The values to be written are specified in the request data field. Data is packed as two bytes per register.
The normal response returns the function code, starting address, and quantity of registers written.

Request

Function code	1 Byte	0x10
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Registers	2 Bytes	0x0001 to 0x0002
Byte Count	1 Byte	4
Register Value	4 Bytes	Value

Response

Function code	1 Byte	0x10
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Registers	2 Bytes	0x0001 to 0x0002

Error Response

Function code	1 Byte	0x90
Exception code	1 Bytes	01 or 02 or 03 or 04

Here is an example of a request to write two registers starting at 2 to 00 08 and 00 09 hex:

Request		Response	
Field Name	(hex)	Field Name	(hex)
Function Code	10	Function Code	10
Starting Address Hi	00	Starting Address Hi	00
Starting Address Low	08	Starting Address Low	08
Quantity of Registers Hi	00	Quantity of Registers Hi	00
Quantity of Registers Lo	02	Quantity of Registers Lo	02
Byte Count	04		
Register 1 Value Hi	00		
Register 1 Value Low	0A		
Register 2 Value Hi	0B		
Register 2 Value Low	BC		

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2.1.7 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.

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MODBUS Exception Codes		
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.
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.

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2.2 Data Link Layer

2.2.1 Overview

The MODBUS TCP protocol is used in this interface.

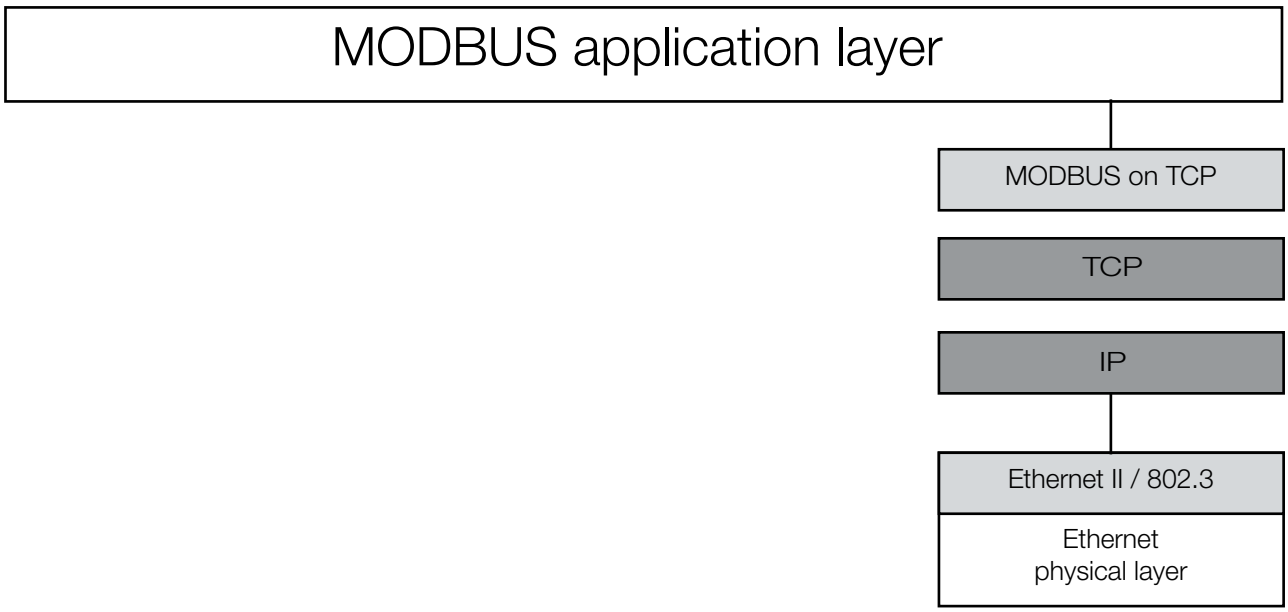


Abb. 3: MODBUS Protocols and ISO/OSI Model

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)

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2.3 Physical Layer

2.3.1 Ethernet port

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

2.3.2 Electrical interface

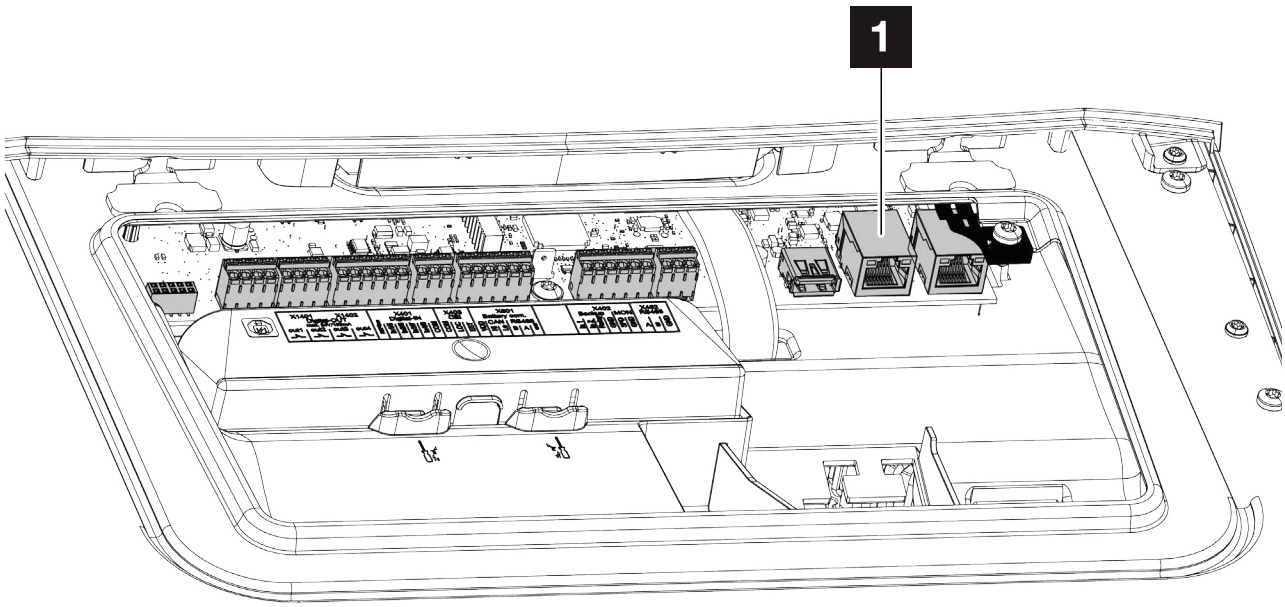


Abb. 4: As example here the PLENTICORE G3 Smart Communication Board - Interface

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

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3. MODBUS Register table

3.1 TCP-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)
Unit-ID[1]	71 (dec)

[1] The Unit-ID is modifiable.

3.2 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
0x05	5	MODBUS Byte Order Note[7]	-	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	-	U32	2	RO	0x03
0x38	56	Inverter state[2]	-	U32	2	RO	0x03
0x3A	58	Overall software version (UI / SW)[11]	-	String	13	RO	0x03
0x62	98	Temperature of controller PCB	°C	Float	2	RO	0x03
0x64	100	Total DC power	W	Float	2	RO	0x03
0x68	104	State of energy manager[3]	-	U32	2	RO	0x03
0x6A	106	Home own consumption from battery[8]	W	Float	2	RO	0x03
0x6C	108	Home own consumption from grid[8]	W	Float	2	RO	0x03
0x6E	110	Total home consumption Battery[8]	Wh	Float	2	RO	0x03
0x70	112	Total home consumption Grid[8]	Wh	Float	2	RO	0x03
0x72	114	Total home consumption PV[8]	Wh	Float	2	RO	0x03
0x74	116	Home own consumption from PV[8]	W	Float	2	RO	0x03
0x76	118	Total home consumption[8]	Wh	Float	2	RO	0x03
0x78	120	Isolation resistance	Ohm	Float	2	RO	0x03
0x7A	122	Power limit from EVU	%	Float	2	RO	0x03
0x7C	124	Total home consumption rate	%	Float	2	RO	0x03

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Addr (hex)	Addr (dec)	Description	Unit	Format	N[1)]	Access	Function Code
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
0xBE	190	Battery charge current	A	Float	2	RO	0x03
0xC2	194	Number of battery cycles	-	Float	2	RO	0x03
0xC8	200	Actual battery charge (-) / discharge (+) current	A	Float	2	RO	0x03
0xCA	202	PSSB fuse state[5]	-	Float	2	RO	0x03
0xD0	208	Battery ready flag	-	Float	2	RO	0x03
0xD2	210	Act. state of Charge SoC	%	Float	2	RO	0x03
0x9DEC	40428	Act. state of Health SoH[10]	%	U16	1	RO	0x03
0xD6	214	Battery temperature	°C	Float	2	RO	0x03
0xD8	216	Battery voltage	V	Float	2	RO	0x03
0xDA	218	Cos ϕ (powermeter)	-	Float	2	RO	0x03
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

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Addr (hex)	Addr (dec)	Description	Unit	Format	N[1)]	Access	Function Code
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
0xFE	254	Total reactive power (powermeter) Sensor position 2 (grid connection): (+) Power supply, (-) feed-in Sensor position 1 (home consumption): (+) House consumption, (-) generation	Var	Float	2	RO	0x03
0x100	256	Total apparent power (powermeter) Sensor position 2 (grid connection): (+) Power supply, (-) feed-in Sensor position 1 (home consumption): (+) House consumption, (-) generation	VA	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
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
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
0x200	512	Battery gross capacity	Ah	U32	2	RO	0x03
0x202	514	Battery actual SOC	%	U16	1	RO	0x03
0x203	515	Firmware Maincontroller (MC)	-	U32	2	RO	0x03

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Addr (hex)	Addr (dec)	Description	Unit	Format	N[1)]	Access	Function Code
0x205	517	Battery Manufacturer	-	String	8	RO	0x03
0x20F	527	Battery Serial Number	-	U32	2	RO	0x03
0x211	529	Work Capacity	Wh	U32	2	RO	0x03
0x213	531	Inverter Max Power	W	U16	1	RO	0x03
0x214	532	Inverter Max Power Scale Factor[4]	-	-	1	RO	0x03
0x215	533	Active Power Setpoint	%	U16	1	RW	0x03/0x06
0x217	535	Inverter Manufacturer	-	String	16	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[4]	-	-	1	RO	0x03
0x241	577	Generation Energy	Wh	U32	2	RO	0x03
0x243	579	Energy Scale Factor[4]	-	-	1	RO	0x03
0x246	582	Actual battery charge/discharge power	W	S16	1	RO	0x03
0x247	583	Reactive Power Setpoint	%	S16	1	RW	0x03/0x06
0x249	585	Delta-cos ϕ Setpoint	-	S16	1	RW	0x03/0x06
0x24A	586	Battery Firmware	-	U32	2	RO	0x03
0x24C	588	Battery Type[6]	-	U16	1	RO	0x03
0x260	608	I/O-Board, Switched Output 1	-	U16	1	RW	0x03/0x06
0x261	609	I/O-Board, Switched Output 2	-	U16	1	RW	0x03/0x06
0x262	610	I/O-Board, Switched Output 3	-	U16	1	RW	0x03/0x06
0x263	611	I/O-Board, Switched Output 4	-	U16	1	RW	0x03/0x06
0x300	768	Productname (e.g. PLENTICORE plus)	-	String	32	RO	0x03
0x320	800	Power class (e.g. 10)	-	String	32	RO	0x03
0x416	1046	Total DC charge energy (DC-side to battery)	Wh	Float	2	RO	0x03
0x418	1048	Total DC discharge energy (DC-side from battery)	Wh	Float	2	RO	0x03
0x41A	1050	Total AC charge energy (AC-side to battery)	Wh	Float	2	RO	0x03
0x41C	1052	Total AC discharge energy (battery to grid)	Wh	Float	2	RO	0x03
0x41E	1054	Total AC charge energy (grid to battery)	Wh	Float	2	RO	0x03
0x420	1056	Total DC PV energy (sum of all PV inputs)	Wh	Float	2	RO	0x03
0x422	1058	Total DC energy from PV1	Wh	Float	2	RO	0x03
0x424	1060	Total DC energy from PV2	Wh	Float	2	RO	0x03
0x426	1062	Total DC energy from PV3	Wh	Float	2	RO	0x03
0x428	1064	Total energy AC-side to grid	Wh	Float	2	RO	0x03
0x42A	1066	Total DC power (sum of all PV inputs)	W	Float	2	RO	0x03
0x9D9A	40346	Total Real Energy Exported[9]	Wh	U32	2	RO	0x03
0x9DA2	40354	Total Real Energy Imported[9]	Wh	U32	2	RO	0x03

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Notes:

[1] N = Quantity of Registers

[2] Inverter States

0	Off
1	Init
2	IsoMeas
3	GridCheck
4	StartUp
5	-
6	FeedIn
7	Throttled
8	ExtSwitchOff
9	Update
10	Standby
11	GridSync
12	GridPreCheck
13	GridSwitchOff
14	Overheating
15	Shutdown
16	ImproperDcVoltage
17	ESB
18	Unknown

[3] States of energy manager (internal energy flow)

0x00	Idle
0x01	n/a
0x02	Emergency Battery Charge
0x04	n/a
0x08	Winter Mode Step 1
0x10	Winter Mode Step 2

[4] 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 complement integer, the signed range is -10 … 10.

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[5] PSSB-fuse-state

0x00	Fuse fail
0x01	Fuse ok
0xFF	Unchecked

[6] Battery type

0x0000	No battery (PV-Functionality)
0x0002	PIKO Battery Li
0x0004	BYD
0x0008	BMZ
0x0010	AXIstorage Li SH
0x0040	LG
0x0200	Pylontech
0x0400	AXIstorage Li SV
0x1000	Dyness
0x2000	VARTA
0x4000	ZYC
0x8000	HELIVOR
0x10000	M-TEC (only PLENTICORE G3)

[7] MODBUS Byte Order, important for read or write accesses to float-formatted registers

0x00	Little-endian (CDAB)
0x01	Big-endian (ABCD)

[8] Explanations of the energy flow

Home own consumption from battery/grid/PV: The actual power in Watt consumed by home and provided from battery, grid, or PV.

Total home consumption battery/grid/PV: The total amount of energy in Watthours consumed by home and provided from battery, grid, or PV.

Total home consumption: Sum of all energy consumed by home and provided from battery, grid and PV.

[9] Valid from version

PLENTICORE G2:	SW 02.12.xxxxx
PLENTICORE G3:	SW 3.04.01.xxxxx
PLENTICORE MP G3:	SW 3.05.00.xxxxx

[10] Only available if the connected battery system is providing this value.

[11] Only PLENTICORE plus G2 and PLENTICORE (MP, BI) G3

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3.3 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
0x340	832	Low-Priority Active power setpoint (W), range 0…65535[2]	U16	1	0x06
0x341	833	Low-Priority Active power setpoint scale factor[2, 3]	S8	1	0x03

*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.

[2] Supported with SW-Version 1.30 or greater

[3] Scale factor:
As an alternative to floating point format, the low-priority Active Power Setpoint is represented by an integer value 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 8 bit two’s compliment integer, the signed range is -10 … 10.
I.e., a setpoint of 10kW is represented by a value of 10,000 and a scale factor of 0. A setpoint of 200kW is represented by a value of 20000 and a scale factor of +1. The scale factor is read only and has to be read first to get the factor used by the inverter. The desired setpoint has to be scaled with this factor:
Setpoint [W] = Register-Value $_{832}$ * (10 ^ Register-Value $_{833}$)

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3.4 External battery management

Addr (hex)	Addr (dec)	Description	Unit	Format	N[1)]	Access	Function Code
0x400	1024	Battery charge power (AC) setpoint Note[1,6]	W	S16	1	WO	0x06
0x401	1025	Power Scale Factor Note[2, 6]	-	S16	1	RO	0x03
0x402	1026	Battery charge power (AC) setpoint, absolute Note[1,6]	W	Float	2	RW	0x03/0x10
0x404	1028	Battery charge current (DC) setpoint, relative Note [1,3,7]	%	Float	2	RW	0x03/0x10
0x406	1030	Battery charge power (AC) setpoint, relative Note [1,3,6]	%	Float	2	RW	0x03/0x10
0x408	1032	Battery charge current (DC) setpoint, absolute Note [1,7]	A	Float	2	RW	0x03/0x10
0x40A	1034	Battery charge power (DC) setpoint, absolute Note [1,7]	W	Float	2	RW	0x03/0x10
0x40C	1036	Battery charge power (DC) setpoint, relative Note [1,3,7]	%	Float	2	RW	0x03/0x10
0x40E	1038	Battery max. charge power limit, absolute	W	Float	2	RW	0x03/0x10
0x410	1040	Battery max. discharge power limit, absolute	W	Float	2	RW	0x03/0x10
0x412	1042	Minimum SOC	%	Float	2	RW	0x03/0x10
0x414	1044	Maximum SOC	%	Float	2	RW	0x03/0x10
0x42C	1068	Battery work capacity	Wh	Float	2	RO	0x03
0x42E	1070	Battery serial number	-	U32	2	RO	0x03
0x430	1072	Reserved	-	-	2	RO	0x03
0x432	1074	Reserved	-	-	2	RO	0x03
0x434	1076	Maximum charge power limit (read-out from battery)	W	Float	2	RO	0x03
0x436	1078	Maximum discharge power limit (read-out from battery)	W	Float	2	RO	0x03
0x438	1080	Battery management mode Note[4]	-	U8	1	RO	0x03
0x439	1081	reserved	-	-	1	RO	0x03
0x43A	1082	Installed sensor type Note [5]	-	U8	1	RO	0x03

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Notes:

[1] Negative values will charge the battery, positive values will discharge the battery.

[2] Scale factor:
As an alternative to floating point format, the battery charge power setpoint is represented by an integer value 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 8 bit two's compliment integer, the signed range is -10 … 10.

I.e., a setpoint of 10kW is represented by a value of 10,000 and a scale factor of 0. A setpoint of 200kW is represented by a value of 20000 and a scale factor of +1. The scale factor is read only and has to be read first to get the factor used by the inverter. The desired setpoint has to be scaled with this factor:

Setpoint [W] = Register-Value 1024 * (10 ^ Register-Value 1025)

[3] In relation to the corresponding nominal values I_{nom} or P_{nom}

[4] Battery management modes

0x00	No external battery management
0x01	External battery management via digital I/O
0x02	External battery management via MODBUS protocol

[5] Sensor types

0x00	SDM 630 (B+G E-Tech GmbH)
0x01	B-Control EM-300 LR (TQ Systems)
0x02	reserved
0x03	KSEM (KOSTAL Smart Energy Meter
0x04	KEM-C (KOSTAL Energy Meter - Series C)
0x05	KEM-P (KOSTAL Energy Meter - Series P)
0x06	KEM MP-P (KOSTAL Energy Meter MP - Series P)
0xFF	No sensor

[6] PLENTICORE BI and PLENTICORE (MP) G3

[7] Due to normative requirements for gradient limitation, access to this register is not possible permanently in Denmark, nor in Austria for the gradient case (10 minutes).

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3.5 Battery limitation

The battery limitation is available only for PLENTICORE G3 inverters from software version 03.05.xxxxx.

Addr (hex)	Addr (dec)	Description	Unit	Format	N[1)]	Access	Function Code
0x500	1280	Max battery charge power	W	Float	2	RW	0x03/0x10
0x502	1282	Max battery discharge power	W	Float	2	RW	0x03/0x10
0x504	1284	Max battery charge power (fallback case)	W	Float	2	RW	0x03/0x10
0x506	1286	Max battery discharge power (fallback case)	W	Float	2	RW	0x03/0x10
0x508	1288	Time until fallback [1	s	U32	2	RW	0x03/0x10

As soon as register 0x500 or 0x502 has been written, they must continue to be written cyclically. If this no longer happens, after a few seconds (time of register 0x508) the limits in register 0x504 and 0x506 become active.

Notes:

[1] Value range: 30 .. 10800 seconds.

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3.6 Plant / Multi Device Control (MDC)

With Multi Device Control (MDC), multiple devices can be combined into a plant consisting of one host and 4 client inverters. Three client inverters can be equipped with a battery system. The following registers provide the MDC capability level and aggregated plant values.

The plant registers are available in **PLENTICORE G3** inverters with a **HOST** role from software version 3.06.10 onwards.

By using registers starting from 0x615 it is possible to control the complete MDC plant. Commands only need to be sent to the MDC HOST inverter. Plant control is possible for software version >= 3.07.00

Addr (hex)	Addr (dec)	Description	Unit	Format	N[1)]	Access	Function Code
0x609	1545	MDC role Note [1	-	S16	1	RO	0x03
0x60B	1547	Plant state of charge (SoC), capacity-weighted	%	Float	2	RO	0x03
0x60D	1549	Plant total battery power (sum) Note [2	W	Float	2	RO	0x03
0x60F	1551	Plant total PV power (sum)	W	Float	2	RO	0x03
0x611	1553	Plant total inverter AC active power (sum)	W	Float	2	RO	0x03
0x613	1555	Plant total external produced power (sum)	Wh	Float	2	RO	0x03
0x615	1557	Min. limit of plant SoC	%	float32	2	RW	0x03/0x10
0x617	1559	Max. limit of plant SoC	%	float32	2	RW	0x03/0x10
0x619	1561	Battery charge-/discharge DC power setpoint	W	float32	2	RW	0x03/0x10
0x61B	1563	Battery work capacity sum of all present batteries	Wh	float32	2	RO	0x03
0x61D	1565	Overall usable battery maximum usable DC-charge power	W	float32	2	RO	0x03
0x61F	1567	Overall usable battery maximum usable DC-discharge power	W	float32	2	RO	0x03
0x621	1569	Maximum battery DC-charge power	W	float32	2	RW	0x03/0x10
0x623	1571	Maximum battery DC-discharge power	W	float32	2	RW	0x03/0x10
0x625	1573	Battery control timeout until fallback (default value is 30s)	s	uint32	2	RW	0x03/0x10

Notes:

[1] Values are: 0 = off, 1 = client, 2 = host, -1 = MDC not available

[2] Negative values indicate battery charging; positive values indicate battery discharging

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4. SunSpec Interface

4.1 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.

4.2 Implemented SunSpec Models

Currently the following SunSpec-Models are implemented:

Model-No	Model-Name
1	Common
103	Three Phase Inverter
113	Three Phase Inverter, float
120	Nameplate
123	Immediate Controls
160	Multiple MPPT
203[1]	Wye-Connect Three Phase (abcn) Meter
802	Battery Base Model
65535	End Model

Notes:

[1] Valid from version

PLENTICORE G2:	SW 02.12.xxxxx
PLENTICORE G3:	SW 3.04.01.xxxxx
PLENTICORE MP G3:	SW 3.05.00.xxxxx

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4.3 Startaddresses

SunSpec device definitions are constructed by concatenating a collection of SunSpec Information Models, starting with the Common Model and ending with the End Model. Each Information Model is uniquely identified and contains a well-known identifier and length. It is therefore recommended that the implemented SunSpec structure is read automatically by browsing the structure until the End-Model is reached.

The following table lists the implemented start addresses for convenience.

Model-No	Startaddress (dec)
1	40003
103	40071
113	40123
120	40185
123	40213
160	40239
203	40309
802	40416
65535	40480

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10/2026 - EN - DOC02308910-0020 - Technische Änderungen und Irrtümer vorbehalten.

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