KACO new energy

# MODBUS Protocol

## Application Note

Tx1 and Tx3 Series

# Contents



# 1 Introduction

This document describes the general aspects of the MODBUS protocol of the KACO string inverter series. The inverters support a subset of data models according to the SunSpec specification. For a detailed description of particular models refer to [8]. In this document the supported subset is highlighted.

Besides that KACO supports some vendor specific models which will be described in [9].

**Supported MODBUS protocols (legacy devices with local GUI)**

- Modbus TCP/UDP

**Supported MODBUS protocols (new devices with dedicated web interface)**

- Modbus TCP/UDP
- Modbus RTU

**Supported Inverter Model**

- blueplanet TL1/TL3 series
- Powador TL3 series

**Supported SW Version**

| Inverter Family | SW Version | Supported Models Device ID) | Supported Registers | Activation in HMI / WEBGUI | Comment |
|---|---|---|---|---|---|
| blueplanet TL3 | V2.02 or higher | Read only inverter models 001, 102, 103 | - | Switch on/off all inverter models | First basic implementation |
| Powador TL3 | V2.10 or higher | | | | |
| blueplanet TL1 | V3.00 or higher | | | | |
| blueplanet TL3 | V3,22 or higher | 001, 102, 103, **122, 123** | **122** (TmSrc) Device; **123** (WMax LimPct) | Switch on/off all inverter models | |
| Powador TL3 | - | | | | |
| blueplanet TL1 | V3.26 or higher | | | | |
| blueplanet TL3 | V4.00 or higher | 001, 102, 103, 122, 123, **112, 113, 129, 130, 135, 136, 160** | | - Switch on/off only read only registers<br>- Switch on/off read and write registers | Support some inverter control models |
| Powador TL3 | V4.00 or higher | | | | |
| blueplanet TL1 | V4.00 or higher | | | | |

To see all supported models and registers of this software version, see the attached excel charts:

SunSpec-Information-Model-Reference.xlsx

SunSpec-Information-Model-Reference-Kaco.xlsx (not for TL1)

# 2 Configuration

## 2.1 Physical Connection

In order to use the MODBUS features the device must be connected to Ethernet, or to a RS485 bus respectively. For more detailed information, please refer to the inverter´s Operating instruction in chapter “Connecting the interfaces”.

## 2.2 GUI Setting

It is necessary to activate the MODBUS/SunSpec protocol via the corresponding menus in local GUI or WEBGUI. For US series inverters the MODBUS/SunSpec protocol is activated by default.
The MODBUS/TCP Port is set to 502 by default.

The write access to the MODBUS registers has to be activated separately in the inverter MODBUS/SunSpec protocol menu. If not, only read access is permitted for security reasons.

For more detailed information, please refer to the inverter´s Operating instruction in chapter “Menu structure”.

## 2.3 Restricted write access

Some SunSpec settings have to be stored permanently on the inverters internal FLASH memory, so they will be persistent over a power cycle.

**NOTE**

These values must NOT be written periodically, because this would destroy the inverters internal FLASH memory. Values which are NOT to be written periodically are marked by a red RW field in the SunSpec model tables below.

| **Example** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 0 | 1 | RW | ActCrv | Unit16 | - | - | Index of active curve. 0=no active curve. | 1-4 |

# 3 Modbus Register Reading & Writing

## 3.1 Function Code

You can use two following MODBUS function codes.

- 03 (0x03) Read holding registers
- 06 (0x06) Write single holding register
- 16 (0x10) Write multiple holding registers

## 3.2 An Example of Request and Response

This is an example of request and response for reading 8 registers starting from address 40001.

| **Request** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **MBAP** | | | | **PDU** | | |
| Data (Hex) | **00 00** | **00 00** | **00 06** | **01** | **03** | **9C 40** | **00 08** |
| Field Name | Trans-action ID | Protocol ID | Length | Unit Identifier | Function Code | *Starting Address | # of Registers |

* The address of response is always 1 less than the address of register map in accordance with the MODBUS specification.

| **Response** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **MBAP** | | | | **PDU** | | |
| Data (Hex) | **00 00** | **00 00** | **00 13** | **01** | **03** | **10** | **53 75 6e 53 00 01 00 42 4b 41 43 4f 20 4e 65 77** |
| Field Name | Trans-action ID | Protocol ID | Length | Unit Identifier | Function Code | Byte Count | Register Values |

The field “Unit Identifier (UID)” in the request is only supported for the new device generation, where it will be used to address one or more auxiliary devices (e.g. String combiner), connected to the device via an RS485 bus.

For legacy devices it will simply be ignored in the context of the TCP protocol.

When using the UDP option, the Unit Identifier has to be set to zero. In the corresponding response, the UID from request will returned.

## 3.3 Data Types

This MODBUS Protocol Data Type follows the one of SunSpec Specifications [8], [9].

- uint32, uint16, int16
- string, bitfield32, enum16

For more detailed information, please refer to SunSpec Specifications [8] in Chapter “Standard Data Formats”.

## 3.4 Modbus UDP support

Modbus UDP is supported by the inverters as of packet version 4.0 and higher. The Modbus UDP port is the same as the Modbus TCP port (defaults to port 502).

The support for Modbus UDP is restricted to write only Modbus commands. Therefore it has to be assured that Modbus write access is enabled in the inverter menu. The commands are being processed, but no answer is send to the Modbus client. Read requests have to be transferred via Modbus TCP.

In Modbus UDP unicast and broadcast write requests are supported by the inverters.

# 4 Register Map

## 4.1 Scaling factors

SF in below table is an abbreviation of "Scale Factor". You can calculate a real value of specific address using SF value, received value via MODBUS and following equation.

**{Real Value} = {Received value via MODBUS} * $10^{\{SF\}}$**

Example:
Address offset 29 and 30 mean DC voltage and the DCV-SF value is -1. If a received value via MODBUS is 5042, DC voltage is as follow.

**{DC Voltage} = (5042) * $10^{(-1)}$ = 504.2 Volt**

The way to use Scale factor is the same of SunSpec specification.

## 4.2 SunSpec register map

The register map must start with the SunSpec ID, indicating that the following registers are Modbus/SunSpec registers. The base register address is 40001, and has the following representation:

| Address Start | Address End | Size | R/W | Name | Type | Units | SF | Description | Value Range |
|---|---|---|---|---|---|---|---|---|---|
| 40001 | 40002 | 2 | R | SunSpec ID | uint32 | - | - | Uniquely identifies this as a SunSpec Modbus Map | 0x53756e53 |

**NOTE**
To read the base register 40001, use the address 0x9C40 (=40000) on the wire. [10]

After this SunSpecID the supported SunSpec models follow one by one. To retrieve the offsets for the supported SunSpec models in the register map, the headers for each model have to be parsed until a specific "END_OF_MAP" model is found. This model has the following content:

| Addr. Offset | Block Offset | Size | R/W | Name | Type | Units | SF | Description | Value Range |
|---|---|---|---|---|---|---|---|---|---|
| 0 | - | 1 | R | SunSpec DID | Uint16 | - | - | End of Register map | 0xFFFF |
| 1 | - | 1 | R | SunSpec Length | Unit16 | - | - | Model length | 0 |

**Example:**

The SunSpec ID (0x53756e53 ="SunS") starts at register 40001.

Therefore the first SunSpec model starts at register 40003.

Assuming the first model is SunSpec Common Model (DID 1 and Length 66) the address of the next model can be calculated as follows::

**40003 (Model offset) + 66 (Model length) = 40069** (Next model register)

The next model starts then at register 40069, and the header may be retrieved from there.

This method to enumerate all supported models can be repeated, until the "END_OF_MAP" model with DID 0xFFFF is found.

To retrieve an explicit value from a certain model, the offset of that value has to be added to the models offset retrieved in the manner above.

> **NOTE**
> Again - keep in mind, that when you refer to a specific address in a model you´ve to use the <register_address -1> on the wire!

# 5 Register description

For a detailed description of particular models / registers refer to [8] and [9]

## 5.1 Common Block (Device ID001)

The register description for "Common Block (DID 001) is only an example may not reflect the current implementation.

| Addr. Offset | Block Offset | Size | R/W | Name | Type | Units | SF | Description | Value Range |
|---|---|---|---|---|---|---|---|---|---|
| 0 | - | 1 | R | SunSpec DID | unit16 | - | - | SunSpec Common Model | 001 (dec) |
| 1 | - | 1 | R | SunSpec Length | uint16 | - | - | Model Length | 66 (dec) |
| 2 | 0 | 16 | R | Manufacturer | string | - | - | | „KACO new energy“ |
| 18 | 16 | 16 | R | Model | string | - | - | KACO inverter name | e.g. "Powador 39.0 TL3" |
| 34 | 32 | 8 | R | Options | string | - | - | Data logger ID-String | e.g. "390TL“ |
| 42 | 40 | 8 | R | Version | string | - | - | The packet version of the currently installed software | e.g. "V2.10" |
| 50 | 48 | 16 | R | Serial Number | string | - | - | Serial number set during production process | e.g. "39.0TL011 23456" |
| 66 | 64 | 1 | - | Device Address | uint16 | - | - | Not implemented | - |
| 67 | 65 | 1 | R | - | pad | - | - | Force even alignment | 0 |

# 6 References

**Modbus Organization**

[1] http://www.modbus.org

[2] Modbus_Application_Protocol_V1_1b3.pdf

[3] Modbus_Messaging_Implementation_Guide_V1_0b.pdf

**SunSpec Specification**

[4] http://www.sunspec.org

[5] SunSpec-Alliance-Specification-Common-Models-v1.5.pdf

[6] SunSpec Alliance Specification - Inverter Models v1.1.pdf

[7] SunSpec Information Models – 12041.pdf (SunSpec Information Model Specification – SunSpec Alliance Interoperability Specification V1.8)

**SunSpec Models**

[8] SunSpec-Information-Model-Reference.xlsx

[9] SunSpec-Information-Model-Reference-Kaco.xlsx

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