BMW Storage Protocol Proposal

##### Control information

|  |  |  |  |
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# Introduction

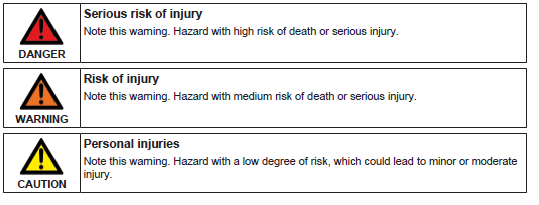
This document describes the Modbus Register Mapping for stationary battery storage systems manufactured by SMA.

# Explanation of Symbols

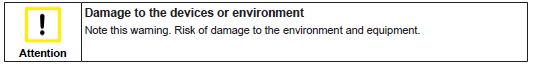
The following symbols with corresponding warnings or explanatory text are used in this documentation. Read and follow the warnings.

## Symbols that warn of personal injury

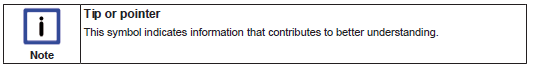
The following set of warning signs are common for all documents.



**Symbols that warn of damage to property or equipment:**



**Symbols indicating further information or tips:**



# Safety

The Modbus interface of the supported Battery Control System is designed for industrial use and is used for monitoring and control tasks.

## Intended use

The Battery Storage System and the BCS are designed for a working environment that meets the requirements of protection class IP20. This involves finger protection and protection against solid foreign objects up to 12.5 mm, but not protection against water. Operation of the devices in wet and dusty environments is not permitted, unless specified otherwise. The specified limits for electrical and technical data must be adhered to.

## Improper use

The Battery Storage System and the BCS are not suitable for operation in the following areas:

• Area with potentially explosive atmospheres

• Areas with a hazardous environment, e.g. corrosive gases or chemicals.

• Living areas. In living areas, the relevant standards and guidelines for interference emissions must be adhered to, and the devices must be installed in housings or control boxes with suitable attenuation of shielding.

**Staff qualification**

The tasks described in this document must be performed by qualified persons only. Qualified persons must have the following skills:

• Knowledge of IP-based network protocols

• Training in the installation and configuration of IT systems

• Knowledge of the Modbus specification

• Knowledge of the SMA specification

• Knowledge of and compliance with this document and all safety precautions

All operations involving software and hardware may only be carried out by qualified personnel with knowledge of the battery storage equipment as well as control and automation engineering.

All interventions must be carried out with knowledge of control programming, and the qualified personnel must be familiar with the current standards and guidelines for the automation environment.



The parameters of the Battery Control System can be changed with writable Modbus registers

(RW/WO) are intended for long-term storage of device settings. Cyclical changing of these parameters leads to destruction of the flash memory in the devices.

Device parameters must not be changed cyclically. Parameters for the control and limitation of the nominal Battery System, as described in this document, can be changed by experts if needed.

## Information on Data Security



You can connect the supported BCS devices to the Internet. When connecting to the Internet, there is a risk that unauthorized users can access and manipulate the data of your system. Take appropriate protective measures:

• Set up a firewall.

• Close unnecessary network ports.

• Only enable remote access via VPN tunnel.

• Do not set up port forwarding at the Modbus port in use.

# Product Description

## Modbus Protocol

The Modbus Application Protocol is a communication protocol that is commonly used in the PV solar sector for system communication, but is also applicable to other systems like Battery Storage Systems. The Modbus protocol has been developed for reading data from or writing data to clearly defined data areas. The Modbus specification does not prescribe what data is within which data area. The data areas must be defined device-specifically in Modbus profiles.

The Modbus profile specially developed by SMA is the SMA Modbus profile. Modbus is capable of transmitting 1-bit and 16-bit values. However, the SMA specification makes only use of the register values (16-bit). Depending on the value a register contains it is either signed or unsigned. By setting two adjacent registers together, 32-bit values are represented. In the SMA specification the low word is then written first.

## Addressing and Data Transmission in the Modbus Protocol

### Data transmission

In accordance with the Modbus specification, only a specific volume of data can be transmitted in a single data transmission as a simple protocol data unit (PDU). The data also contains function-dependent parameters such as the function code, start address or number of Modbus registers to be transmitted. The amount of data depends on the Modbus command used and has to be taken into account during data transmission.

### Reading and Writing of Data

The Modbus interface can be used via the Modbus TCP protocol. Using Modbus TCP enables read and write access (RO/RW).

Following commands are supported:

|  |  |  |
| --- | --- | --- |
| **Modbus command** | **Hexadecimal value** | **Data volume (number of registers)** |
| Read Holding Registers | 0x03 | 1 to 125 |
| Read Input Registers | 0x04 | 1 to 125 |
| Write Single Register | 0x06 | 1 |
| Write Multiple Registers | 0x10 | 1 to 123 |

Table 2: Modbus Commands

### Write Register

The write register can be written using function codes 0x06 and 0x10 and read using function code 0x03. Not all registers are yet available because they are optional or reserved for future use.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Name** | **Register** | **Bit** | **Bit Name** | **Bit Description** | **Data Type** | **Units** |
| HeartBeat | 1399 |  |  |  | uint16 |  |
| BmsSttCmd | 1400 | 15 | Reset BMS | trigger reset of BMS manually (e.g. during service etc. using inverter control) | uint16 |  |
| 14 | Clear BMS Error | clear error during operation, without disconnecting battery (no reboot) to be set before "close connector" - BMS to decide handling |
| 13 | Reserved BMS-Sleep |  |
| 12 | RESERVED |  |
| 11 | RESERVED |  |
| 10 | RESERVED |  |
| 9 | RESERVED |  |
| 8 | RESERVED |  |
| 7 | RESERVED |  |
| 6 | RESERVED |  |
| 5 | RESERVED |  |
| 4 | RESERVED |  |
| 3 | Close Pre-Charge | Battery should close it's precharge unit --  Signal NOT NECESSARY, NOT USED |
| 2 | Close Contactor | High: Battery should close contactors Low: Battery should open contactors Pre-Charge is activated automatically if applicable Battery changes its state to operation, when pre-charge completed and contactor closed Signal Close Contactor is removed, if inverter is in alarm state (due to internal alarm or alarm received from BMS) |
| 1 | Reserved Operation | Battery should wake up from Stop |
| 0 | Reserved Enable Battery | enable aux. power supply |
| OpStt | 1401 |  |  |  | uint16 |  |
|
|
|
| DcLinkVtg | 1402 |  |  |  | uint16 | 0,1V |
| DcLinkCur | 1403 |  |  |  | int16 |  |
| OpMod\_ReqOk | 1404 |  |  |  | uint16 |  |
|
|
|
|
|
|
| OpMod\_ReqCanc | 1405 |  |  |  | uint16 |  |
|
|
|
|
|
|
| ConnStrategy | 1406 | 15 | RESERVED |  | uint16 |  |
| 14 | RESERVED |  |
| 13 | RESERVED |  |
| 12 | RESERVED |  |
| 11 | RESERVED |  |
| 10 | RESERVED |  |
| 9 | RESERVED |  |
| 8 | RESERVED |  |
| 7 | RESERVED |  |
| 6 | RESERVED |  |
| 5 | RESERVED |  |
| 4 | RESERVED |  |
| 3 | RESERVED |  |
| 2 | RESERVED |  |
| 1 | High SOC first (discharging) | Catch up procedure  inverter will provide this information if applicable. Ony one of X SOC first is set. If data is not available, none of X SOC fist is set |
| 0 | Low SOC first (charging) | Catch up procedure  inverter will provide this information if applicable. Ony one of X SOC first is set. If data is not available, none of X SOC fist is set |
| SystemTime | 1407 1408 |  |  |  | uint32 |  |

### Read Register

The read register can be read using function code 0x04. Not all registers are yet available because they are optional or reserved for future use.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Name** | **Register** | **Bit** | **Bit Name** | **Bit Description** | **Data Type** | **Units** |
| LifeSign | 999 |  |  |  | uint16 |  |
| BmsStt | 1000 | 15 | *Stt unknown/undefined* | Reserved | uint16 |  |
| 14 |  | Reserved |
| 13 |  | Reserved |
| 12 |  | Reserved |
| 11 |  | Reserved |
| 10 |  | Reserved |
| 9 | *Pre-charge-completed* | Reserved |
| 8 | Pre-Charge | pre-charge in progress (if applicable) |
| 7 | *Pre-Heat-completed* | Reserved |
| 6 | *Pre-Heat* | Reserved |
| 5 | Error | Error from Battery management Inverter will change to Error State - disconnect AC and stop battery |
| 4 | Operation | in operation, contactors closed and pre-charge completed |
| 3 | Ready | Ready for operation, contactors open pre-condition for command "close contactor" as long as battery does not signal ready, inverter will not trigger "close contactor" signal |
| 2 | *Standby* | Reserved |
| 1 | *Init* | Reserved |
| 0 | *Off* | Reserved |
| ErrBits1 | 1001 | 15 | Communication Error |  | uint16 |  |
| 14 | Imbalance Error |  |
| 13 | Sensor Error |  |
| 12 | Contactor/Fuse Error |  |
| 11 | Insulation Error |  |
| 10 | High Temperature Error |  |
| 9 | Low Temperature Error |  |
| 8 | High SOC Error |  |
| 7 | Low SOC Error |  |
| 6 | Discharge Power Error |  |
| 5 | Charge Power Error |  |
| 4 | Discharge Current Error |  |
| 3 | Charge Current Error |  |
| 2 | High Voltage Error |  |
| 1 | Low Voltage Error |  |
| 0 | Unspecified Error |  |
| ErrBits2 | 1002 | 15 | RESERVED |  | uint16 |  |
| 14 | RESERVED |  |
| 13 | RESERVED |  |
| 12 | RESERVED |  |
| 11 | RESERVED |  |
| 10 | RESERVED |  |
| 9 | RESERVED |  |
| 8 | RESERVED |  |
| 7 | RESERVED |  |
| 6 | RESERVED |  |
| 5 | RESERVED |  |
| 4 | RESERVED |  |
| 3 | RESERVED |  |
| 2 | Rack/String Error |  |
| 1 | SOH Error |  |
| 0 | Container/(Room) Error |  |
| WarnBits1 | 1003 | 15 | Communication Warning |  | uint16 |  |
| 14 | Imbalance Warning |  |
| 13 | Sensor Warning |  |
| 12 | Contactor/Fuse Warning |  |
| 11 | Insulation Warning |  |
| 10 | High Temperature Warning |  |
| 9 | Low Temperature Warning |  |
| 8 | High SOC Warning |  |
| 7 | Low SOC Warning |  |
| 6 | Discharge Power Warning |  |
| 5 | Charge Power Warning |  |
| 4 | Discharge Current Warning |  |
| 3 | Charge Current Warning |  |
| 2 | High Voltage Warning |  |
| 1 | Low Voltage Warning |  |
| 0 | Unspecified Warning |  |
| WarnBits2 | 1004 | 15 | RESERVED |  | uint16 |  |
| 14 | RESERVED |  |
| 13 | RESERVED |  |
| 12 | RESERVED |  |
| 11 | RESERVED |  |
| 10 | RESERVED |  |
| 9 | RESERVED |  |
| 8 | RESERVED |  |
| 7 | RESERVED |  |
| 6 | RESERVED |  |
| 5 | RESERVED |  |
| 4 | RESERVED |  |
| 3 | RESERVED |  |
| 2 | Rack/String Warning |  |
| 1 | SOH Warning |  |
| 0 | Container/(Room) Warning |  |
| InfBits | 1005 | 15 | RESERVED |  | uint16 |  |
| 14 | RESERVED |  |
| 13 | RESERVED |  |
| 12 | RESERVED |  |
| 11 | RESERVED |  |
| 10 | RESERVED |  |
| 9 | RESERVED |  |
| 8 | RESERVED |  |
| 7 | RESERVED |  |
| 6 | RESERVED |  |
| 5 | RESERVED |  |
| 4 | RESERVED |  |
| 3 | RESERVED |  |
| 2 | RESERVED |  |
| 1 | RESERVED |  |
| 0 | RESERVED |  |
| DcAmpOpMax | 1006 |  |  |  | int16 | 1A |
| DcAmpOpMin | 1007 |  |  |  | int16 | 1A |
| DcVolOpMax | 1008 |  |  |  | uint16 | 0,1V |
| DcVolOpMin | 1009 |  |  |  | uint16 | 0,1V |
| DcAmpDynMax | 1010 |  |  |  | int16 | 1A |
| DcAmpDynMin | 1011 |  |  |  | int16 | 1A |
| DcVolDynMax | 1012 |  |  |  | uint16 | 0,1V |
| DcVolDynMin | 1013 |  |  |  | uint16 | 0,1V |
| NoStrgConn | 1014 |  |  |  | uint16 |  |
| NoStrgTot | 1015 |  |  |  | uint16 |  |
| SOCTot | 1016 |  |  |  | int16 | 0,01% |
| SOCConn | 1017 |  |  |  | int16 | 0,01% |
| RemChrgAh | 1018 |  |  |  | uint16 | Ah |
| RemDischrgAh | 1019 |  |  |  | uint16 | Ah |
| RemChrgkWh | 1020 |  |  |  | uint16 | 1kWh |
| RemDischrgkWh | 1021 |  |  |  | uint16 | 1kWh |
| NomEngyConn | 1022 |  |  |  | uint16 | 1kWh |
| NomEngyTot | 1023 |  |  |  | uint16 | 1kWh |
| NomCapConn | 1024 |  |  |  | uint16 | Ah |
| NomCapTot | 1025 |  |  |  | uint16 | Ah |
| SOH | 1026 |  |  |  | uint16 | 0,01% |
| DcVolConn | 1027 |  |  |  | uint16 | 0,1V |
| DcVolTot | 1028 |  | If applicable |  | uint16 | 0,1V |
| DcAmp | 1029 |  |  |  | int16 | 0,1A |
| TmpAvg | 1030 |  |  |  | int16 | 0,1°C |
| TmpMin | 1031 |  |  |  | int16 | 0,1°C |
| TmpMax | 1032 |  |  |  | int16 | 0,1°C |
| CellVolMin | 1033 |  |  |  | uint16 | mV |
| CellVolMax | 1034 |  |  |  | uint16 | mV |
| CellVolAvg | 1035 |  |  |  | uint16 | mV |
| RisIn | 1036 |  |  |  | uint16 | mOhm |
| RisIso | 1037 |  | If applicable |  | uint16 | 0,1kOhm |
| TmpCont | 1038 |  | If applicable |  | int16 | 0,1°C |
| TmpAmb | 1039 |  | If applicable |  | int16 | 0,1°C |
| HmdtCont | 1040 |  | If applicable |  | uint16 | 0.1% |
| DcAmpDynMaxHiRes | 1041 |  |  |  | int16 | 0.1A |
| DcAmpDynMinHiRes | 1042 |  |  |  | int16 | 0.1A |
| Cnt.FullCycleCnt | 1043 |  |  |  | uint16 |  |
| Cnt.TotOpTm | 1044 1045 |  |  |  | uint32 | h |
| BmsComProVer | 1046 1047 |  |  |  | uint32 |  |
| SerNo | 1048 1049 |  |  |  | uint32 |  |
| SwVer | 1050 1051 |  |  |  | uint32 |  |
| OpMod.Req | 1052 |  | RESERVED |  | uint16 |  |
|
| OpMod.Run | 1053 |  | RESERVED |  | uint16 |  |
|
| OpMod.Canc | 1054 |  | RESERVED |  | uint16 |  |
|
|
| OpMod.Compl | 1055 |  | RESERVED |  | uint16 |  |
|
|
| OpMod.TmToEndOfOp | 1056 |  | RESERVED |  | uint16 |  |
| OpMod.TmToFull | 1057 |  | RESERVED |  | int16 |  |
| OpMod.TmToEqual | 1058 |  | RESERVED |  | int16 |  |
| OpMod.TmToBal | 1059 |  | RESERVED |  | int16 |  |
| OpMod.TmToCal | 1060 |  | RESERVED |  | int16 |  |
| OpMod.TmToSlfTst | 1061 |  | RESERVED |  | int16 |  |
| DcAmpSpt / Reserve1 | 1062 |  | RESERVED |  | int16 | 0,1A |
| DcVolSpt / Reserve2 | 1063 |  | RESERVED |  | uint16 | 0,1V |

# Technical Data

## Modbus Communication Ports

The next table shows the default setting of the supported network protocols

|  |  |
| --- | --- |
| **Network protocol** | **Communication port, default setting** |
| TCP | 502 |

Table 9: Modbus Communication Ports



You should only use free communication ports. The following range is generally available:

49152 to 65535.

If you change one of the communication ports, you must also change the corresponding

communication port of a connected Modbus client system.

## Data Processing and Time Behavior

This chapter will define the data processing and reaction times of the Modbus interface.

### Data Transfer Interval via the Modbus Protocol

The time period between data transfers via the Modbus protocol is limited.

### Reaction Time of the Modbus Interface

The reaction time of the Modbus interface is bounded by the network utilization and the number of connected inverters. The reaction time of the Modbus Interface between the arrival of the parameter specifications until the corresponding measured values can vary on utilization of the BCS.

# Descriptions

|  |  |
| --- | --- |
| **Abbreviation** | **Name** |
| BMS | Battery management system |
| BmsComProVer | Version of used communication protocol |
| BmsStt | BMS state |
| BmsSttCmd | BMS state command |
| CellVolAvg | Average cell voltage |
| CellVolMax | Maximum cell voltage |
| CellVolMin | Minimum cell voltage |
| Cnt.FullCylceCnt | Battery full cycles count |
| Cnt.TotOpTm | Battery operating time counter |
| ConnStrategy | Battery connection strategy |
| DcAmp | DC current measured by the battery |
| DcAmpDynMax | Battery maximum limit dynamic current |
| DcAmpDynMaxHiRes | Battery maximum limit dynamic current (higher resolution) |
| DcAmpDynMin | Battery minimum limit dynamic current |
| DcAmpDynMinHiRes | Battery minimum limit dynamic current (higher resolution) |
| DcAmpOpMax | Absolute maximum operating current of battery |
| DcAmpOpMin | Absolute minimum operating current of battery |
| DcLinkCur | Inverter measured current on DC-Bus |
| DcLinkVtg | Inverter measured voltage on DC-Bus |
| DcVolConn | DC voltage of the connected racks measured by the battery |
| DcVolTot | Average DC voltage measured by the battery |
| DcVolDynMax | Battery maximum limit dynamic voltage |
| DcVolDynMin | Battery minimum limit dynamic voltage |
| DcVolOpMax | Absolute maximum operating voltage of battery |
| DcVolOpMin | Aboslute minimum operating voltage of battery |
| ErrBits | Battery alarm message |
| HmdtCont | Humidity container |
| InfBits | Battery information message |
| NomCapConn | Battery nominal capacity (connected racks) |
| NomCapTot | Battery nominal capacity (all racks) |
| NomEngyConn | Battery nominal energy (connected racks) |
| NomEngyTot | Battery nominal energy (all racks) |
| NoStrgConn | Number of connected strings |
| NoStrgTot | Number of strings installed |
| OpMod\_ReqCanc | Operation mode request canceled |
| OpMod\_ReqOk | Operation mode request granted |
| OpStt | Operating state inverter |
| RemChrgAh | Remaining charge capacity |
| RemChrgkWh | Remaining energy to charge |
| RemDischrgAh | Remaining discharge capacity |
| RemDischrgkWh | Remaining energy to discharge |
| RisIn | Battery internal resistance |
| RisIso | Insulation resistance |
| SerNo | Battery serial number |
| SOCConn | Battery state of charge (connected strings) |
| SOH | Battery state of health |
| SOCTot | Battery state of charge (all strings) |
| SwVer | Battery software version |
| TmpAmb | Ambient temperature |
| TmpAvg | Average battery temperature |
| TmpCont | Battery container or room temperature |
| TmpMax | Maximum battery temperature |
| TmpMin | Minimum battery temperature |
| WarnBits | Battery warning message |
|  |  |
|  |  |