Technical Information

Connecting Batteries with external Battery Management System to SUNNY ISLAND 6.0H-11

Legal Provisions

Trademarks

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1 Informations on this Document

1.1 Additional Informations

This documentation describes how to use the Sunny Island 6.0H-11from software version 2.1 and higher with batteries having an external Battery Management System (hereafter referred as BMS) This supplement complements the technical description of the Sunny Island 6.0H-11.

Together with this documentation, the following documents shall be observed:

[1]	Off-grid Inverter – Sunny Island 8.0H / 6.0H, Sunny Remote Control • Operating Manual (ENGLISH) • Betriebsanleitung (GERMAN)
[2]	Off-grid Inverter – Sunny Island 8.0H / 6.0H • Technical Description (ENGLISH) • Technische Beschreibung (GERMAN)
[3]	Off-grid Inverter – Sunny Island 8.0H / 6.0H • Installation Manual (ENGLISH) • Installationsanleitung (GERMAN)
[4]	Independence with SUNNY ISLAND – Grid-connected storage systems for increased self-consumption • Brochure (ENGLISH) • Broschüre (GERMAN): „Mehr Unabhängigkeit mit Sunny Island – Netzgekoppelte Speicher zur Eigenverbrauchsoptimierung“
[5]	SMA Flexible Storage System – Safety concept • Technical Information: only available in GERMAN • Technische Information (GERMAN): „SMA Flexible Storage System –Erläuterung zum Sicherheitskonzept“
[6]	SMA Smart Home – The System for more Independence • Planning Guidelines (ENGLISH) • Planungsleitfaden (DEUTSCH)
[7]	Sunny Island 6.0H – Self-consumption only • Operating Manual: only available in GERMAN • Betriebsanleitung (GERMAN)
[8]	Sunny Island 6.0H – Self-consumption only • Technical Description: only available in GERMAN • Technische Beschreibung (GERMAN)
[9]	Sunny Island 6.0H – Self-consumption only • Installation Manual: only available in GERMAN • Installationsanleitung (GERMAN)

All the documents can be found on www.SMA-Solar.com.

1.2 Glossary and definitions

Following table gives an overview of the terms and definitions used in this document and which are relevant for the operation of Sunny Island with Battery System with an external BMS. Further description can be found in above stated documents.

Operating states:

Operating state	Description
Off	Not operating, no display message
Init	Initialization of the inverter. During this operating state no messages on CAN-Bus are sent or received
Startup	Sunny Island is started (DC-Voltage from the battery system is sensed) and during start-up the defined configuration of the inverter is used. The inverter uses during the startup the predefined – default values of the battery. The communication via CAN-Bus is enabled after Inverter expects that the BMS sends all relevant messages as described later.
Standby	Inverter is connected to the battery which is providing a DC-Voltage. In Standby Mode of Inverter battery system provides energy which is needed for the inverter. Inverter expects that the BMS sends all relevant messages as described later in this document.
Run	Inverter is connected to the grid/loads and provides AC-Power. Inverter charge or discharge battery depending on actual needs in the specified application. The running mode is not dictated by the battery but solely depends on the application and follows the needs of this application. Battery limits in terms of SOC limits, voltage limits and current limits are observed. Please note that discharging current limit is not valid in 2 cases: 1. Inverter runs in Off-Grid Mode: In this case the loads have a priority and are supplied until a specified SOC Limit is reached (see Battery Protection Modes) 2. In case that the sent charging voltage limit is below the actual measured voltage SI discharges the battery and ignores the dis-charge current limit as the charging voltage has higher priority.
Error condition	Sunny Island reacts on every error condition (e.g. alarms sent by external BMS) by going into standby. If the cause is removed (automatically or manually) the Sunny Island will start automatically or must be started manually (For the reaction of Sunny Island to other error conditions than above described please refer to [1]). During the booting procedure, all pending failures are generally confirmed without an entry being made in the history. This way, after the booting procedure failure that is still pending will be re-entered, or if the system detects that this failure has gone, it is entered as no longer being present.
Shutdown	Sunny Island is switched off.

Protection of the battery system in Sunny Island

The operation of the overall system and the protection of the battery system in Sunny Island are based on the SOC of the battery. The battery preservation mode prevents the battery from being deeply discharged as far as possible when the energy supply is low, thus, preventing a total system failure as well as damage to the battery.

Battery protection modes:

Battery protection modes	Description
Level 1	The first level is used to switch the Sunny Island into standby mode at times when the energy is not necessarily required. For the self-consumption increase application this limit has been set to SOC=0% so it is lower than level 3 and therefore skipped. For the off-grid application please refer to [2].
Level 2	The second level of the battery preservation mode ensures that the Sunny Island is started regularly every two hours only in the time period during which energy supply is expected, and that it attempts to charge the battery from the AC side. For the self-consumption increase application this limit has been set to SOC=0% so it is lower than level 3 and therefore skipped. For the off-grid application please refer to [2].
Level 3	The third level ensures that the battery is protected from deep discharge and thus against damage. In this case, the Sunny Island is switched off completely. To start it, please refer to [1]. At all three levels, the Sunny Island is stopped only if no battery charging current flows within 5 minutes (limit is at least 3A charging current) – these values are configurable in expert mode for off-grid application only – please refer to [1], [2]. Please note that a re-start/recharging of the system is only possible if the charging current is available (grid) and the voltage is higher than a lower voltage limit.

Required for the optimal operation of the product

The firmware of the Sunny Island can be updated using the SD card. When the Sunny Island starts up or when the SD card is inserted, the Sunny Island searches for special update files on the SD card. If it finds files containing new firmware versions, it performs an update.

Updates:

Update	Description
Update FW of Sunny Island	During the update procedure no information is available on the CAN-Bus and no information can be received from the external BMS. Please make sure that the battery system provides DC-Voltage for the complete duration of the update procedure. In case of the singles-phase system the updating takes approximately 5.5minutes. In case of the 3~ System both Master and Slaves has to be updated. In this case the updating takes approximately 16 minutes.
Update external BMS	Update of the external BMS cannot be performed by Sunny Island. Battery system provider must ensure that his system can be updated on the battery system and provide the documentation when delivering the system. Update of the external BMS must be performed when Sunny Island is switched off.

2 Use of batteries with an external Battery Management System

This chapter describes the possibilities and restrictions when connecting Sunny Island6.0H and Sunny Island 8.0H (referred as Sunny Island in this document) to a battery with an external Battery-Management-System. Sunny Island is equipped with an internal battery management which has been especially developed for the use of the lead acid batteries. This document describes only the technical requirements for the use of Sunny Island **with external BMS** irrespective of the battery technology used.

Use of the internal battery management for Lead Acid batteries

For the use of the internal battery management for Lead Acid batteries, please refer to the Sunny Island technical manual [2].

Essential for a trouble-free and safe operation:

- The use of all other battery technologies than Lead Acid Battery is only permitted when an external BMS is used.
- The use of all battery technologies is only permitted when the battery system fulfils all relevant safety standards.
- The battery system (cells, modules, BMS and safety relevant elements) must be designed in a way that the system itself is inherent/intrinsic safe. The system must be able to protect itself from all unaccepted/unintended conditions for the battery. Moreover the system must be designed in a way that incorrect assembly is impossible.
- The use of all battery technologies is only permitted when the battery is compatible with the Sunny Island safety concept – see [5].

  Sunny Island allows for connecting Batteries having an operational DC voltage range between 41V and 63V. The battery system consisting of battery cells/modules, external BMS, safety relevant elements and if applicable controller (hereafter referred as battery system) must fulfil all power/DC-current requirements (see Section 10 "Technical data SI6.0H-11", page 35).
- Only Battery systems with an operational DC Voltage range between 41V and 63V can be used with Sunny Island.
- Only battery systems fulfilling power/DC-currents requirements can be used without any restrictions regarding Sunny Island performance (see Section 10 "Technical data SI6.0H-11", page 35). Otherwise, battery system supplier must clearly state these restrictions.
- In order to use battery system as defined above, battery system must communicate with Sunny Island via CAN-Bus according to this document.

Figure 1 shows the system configuration of Sunny Island connected to the battery with external Battery-Management-System (BMS). Battery systems consists of mandatory elements (indicated in black) and optional elements (indicated in blue). The necessity of optional elements is defined by battery system supplier according to the requirements of the safety concept described in [5].

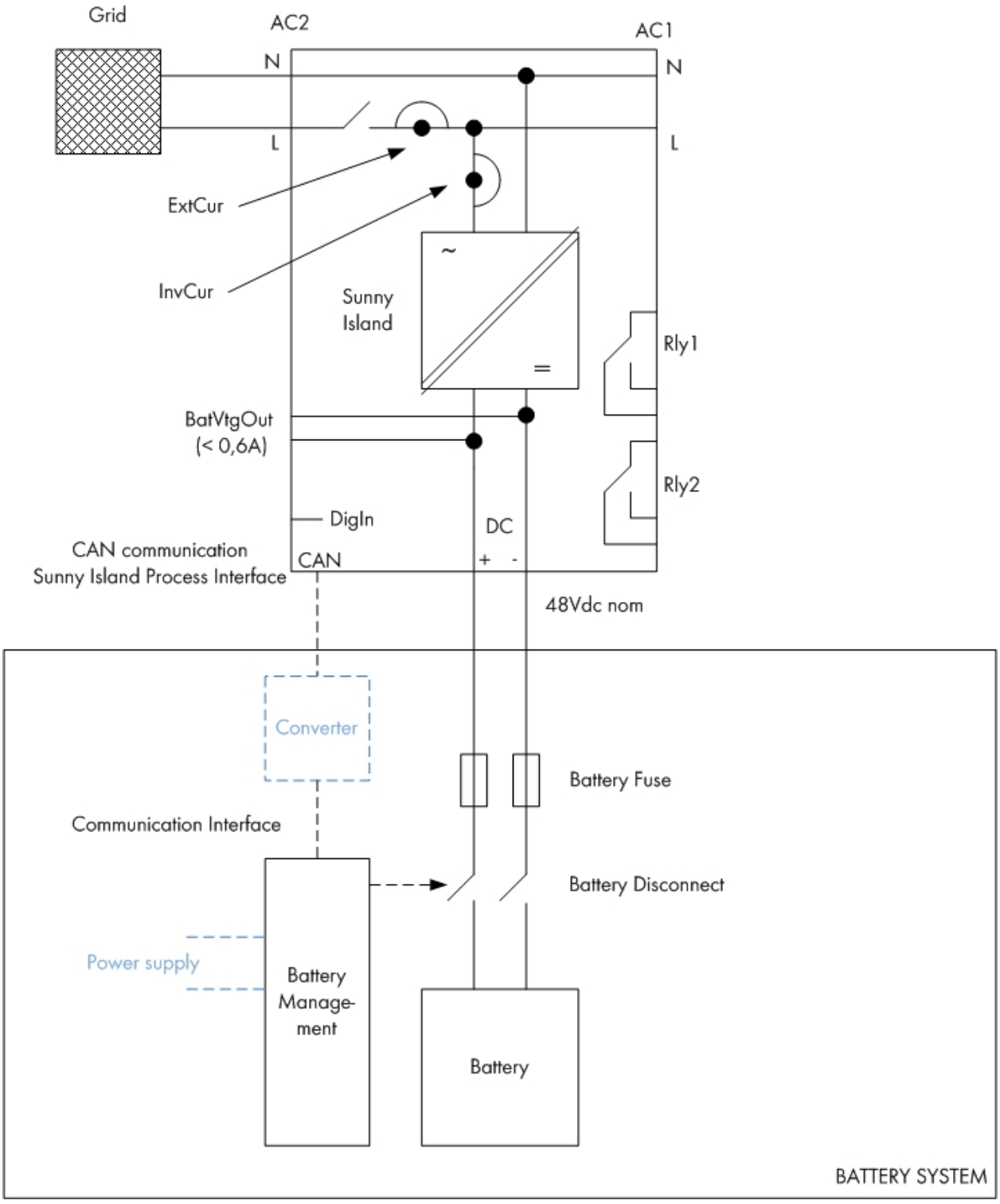

Figure 1: System overview of Sunny Island connected to the battery system with an external Battery-Management-System (BMS)

Power Supply of the Battery System (e.g. external BMS)

It is generally necessary, that the external battery management is supplied with energy when the system starts. It is mandatory that the battery system provides DC-voltage in the specified voltage range in order to start Sunny Island.

Start from DC-side only

Sunny Island can start from DC-side only.

Essential for a trouble-free and safe operation:

- Power Supply of the Battery System (e.g. external BMS) must be provided by the battery system itself.

  Sunny Island cannot provide power supply to the battery system (e.g. external BMS).

3 Installation

3.1 Sunny Island system

All details on mechanical and electrical installation and configuration regarding Sunny Island can be found in [3].

Essential for a trouble-free and safe operation:

- All details on mechanical and electrical installation and configuration of the battery system must be provided by the battery system manufacturer.
- The connection of the battery system to the Sunny Island and especially the connection of the eventually needed additional safety related elements must be provided by the battery system provider.

3.2 DC-Battery connection

Essential for a trouble-free and safe operation:

- Battery must be connected observing all valid regulations (e.g. DIN EN 50272-2, Safety requirements for secondary batteries und battery installations).

  There is a "DC –" and a "DC +" connection available for each ring cable lug for the battery feed cables in the Sunny Island. All information on DC-Cable cross sections, terminal etc. of Sunny Island is given in [3]. Battery system provider must make sure that the terminal lugs of the battery system are compatible with the DC-Cable cross sections required by Sunny Island.
- For the safety issues battery fuse must be used. Battery fuse can be integrated in the battery system or can be installed externally. If battery fuse is already integrated in the battery system, battery system provider must indicate this in his system description and make sure that the size of the fuse fulfils the requirements. If the battery fuse is installed externally, battery system provider must give information regarding design of the battery fuse.
- In case of reverse polarity it is expected that the battery fuse trips. If no battery fuse is installed or wrong declared in can cause severe damage, in worst case it will result in a total damage of the inverter.
- Battery system provider must prevent the possibility of miswiring of the battery and implement all safety measures in case of.

3.3 CAN-Communication connection

The process interface allows direct communication using standard communication infrastructure to read battery process data from and also to control remotely Sunny Island. The external battery management **must be connected** to Sunny Island. Sunny Islands provides only a proprietary CAN bus interface.
The electrical connection is described below. Direct connection to the CAN-BUS must fulfill the requirements described in figure 1. Alternatively adapted converter (e.g. CAN to Modbus TCP, **indicated as converter** in Figure 1) with adequate configuration can be used.

Pin configuration RJ-45 plug "ComSyncIn" of Sunny Island:

Pin	Signal
1	Sync1 – reserved
2	CAN_GND
3	SYNC_H
4	CAN_H
5	CAN_L
6	SYNC_L
7	Sync7 – reserved
8	Sync8 – reserved

CAN and SYNC needed to be terminated

The Sunny Island CAN communication interface includes a second communication line – SYNC Bus. Both lines (CAN and SYNC) needed to be terminated at each end of the communication bus.

Termination using 120 Ohm resister according to CAN specification is also possible for both busses.

Essential for a trouble-free and safe operation:

- For the CAN-Sync-Bus (named ComSyncIn/ComSyncOut) at Sunny Island a termination is required at both ends of the cable for each communication Bus: CAN and SYNC.
- The termination at Sunny Island side is typically the RJ45 termination plug (ISDN terminator), plugged into one of the sockets, while the other socket connects to next Sunny Island.
- The termination uses a 100 Ohm resistor between CAN_H and CAN_L and another 100 Ohm resistor between SYNC_H and SYNC_L.

4 Commissioning

4.1 Important Informations

Essential for a trouble-free and safe operation:

- The battery must provide DC-Voltage for the startup of Sunny Island!

  Sunny Island cannot be started from the AC side.
- It is mandatory that the battery system is inherent safe and when the DC-Voltage is available for the Sunny Island, all protective/safety measures of the battery system are active.
- Due to the input capacity of the Sunny Island, high inrush current from the battery to Sunny Island might occur when the battery is connected to the input terminals of Sunny Island:
  - SI8.0H: approximately. 48000µF
  - SI6.0H: approximately. 48000µF

Required for the optimal operation of the product

If there is a pre-charge resistor required by the battery system, in order to prevent high inrush current, the value of this resistor shall be less than 50 Ohms because of required voltage rise of the internal power supply when powering up Sunny Island. Otherwise the inverter may not start (enters Low Battery Mode (LBM) – please refer to [1]).

- The general description of the Start-up procedure is indicated in figure 2:
  - Sunny Island has been installed and connected according to [3].
  - Sunny Island is **OFF**.
  - Battery voltage is available and Sunny Island can be turned on directly on Sunny Island by pushing the start-stop button (please refer to [1])
  - After initial Start-Up with first commissioning (QCG – Quick Configuration Guide) according to [1] and on all subsequent Start-Ups Sunny Island goes into „STANDBY" and wait for a Start command Press the start-stop button on Sunny Island or the button on the Sunny Remote Control and hold it until you hear a signal.
  - After receiving Start command (refer to [1]) Sunny Island checks if the grid is available, voltage in appropriate range, synchronizes and connects to this grid and generates/provides an AC voltage (see figure 2).
  - Please note that after receiving start signal the connecting to the grid takes some time for grid supervision according to the country standards (please refer to [2] Parameter **GdVldTm**). In Germany time elapsed after start command is at least 60 seconds.

4.2 Parameters for Li-Ion Batteries in QCG

During the initial start-up of the Sunny Island the Quick Configuration Guide (QCG) starts automatically. On the display (Sunny Remote Control – SRC-20) the user is guided through a menu structure which allows quick and easy commissioning of the system. Please note that in QCG not all parameters are shown, but only the mandatory values for the start of the system.

Battery parameters which are shown in QCG after delivery and during first commissioning of the system and when "New Battery" is selected are:

Parameter number	Parametername	Description	Default Value	Explanation
003.06	BatTyp	Battery type	LiIon_Ext-BMS	For the use of all batteries with external BMS please select the Default value LiIon_Ext-BMS.

After selecting the battery type please define the nominal capacity of the battery:

Parameter number	Parametername	Description	Default Value	Explanation
003.09	BatCpyNom	Nominal Battery Capacity	120Ah	The battery capacity cannot be set lower than 100Ah. Although the battery used can have capacity lower than this, the smallest displayed value currently is 100Ah.

Please note that in case that no further parameters (which are not included in QCG) has been changed, following default values for the battery with external BMS are used. In order to change this value an installer must use an expert level. Please note that as long no communication via CAN-Bus has been established the default values are valid.

Default values for the LiIon-external BMS battery type:

Parameter number	Parametername	Description	Default Value	Explanation
222.13	BatChrgVtg	Battery charging voltage set-point	54V	Please note that in case that the actual battery voltage is higher than this set-point and no update is received via CAN-Bus, inverter will discharge to this voltage without any restriction regarding discharging current.
222.01	BatChrgCurMax	DC charge current limitation	0A	Please note that during charging when the voltage set-point is reached Sunny Island will reduce (according to the battery charging voltage set-point - BatChrgVtg) the charging current. In case the battery reduces this set-point, Sunny Island cannot immediately adapt to the new value but needs approximately 10sec – depends on the current step. Please consider this restriction when defining warn-ing/alarm conditions.
271.01	BatDiChgCurMax	DC discharge cur-rent limitation	0A	Please note that this value is only observed when operating in grid-tide mode. During emer-gency mode (back-up) the value is ignored.
–	–	SOC value	0%	Cannot be set via SRC
226.02	BatDiChgVtg	Battery discharge voltage limit	42V	Please note that this limit also applies when starting Sunny Island. Therefore, when starting the battery it should be set to the value which allows charging of the battery (if not forbidden).
–	–	SOH value	100%	Cannot be set via SRC

Following figure describes the start-up procedure of the Sunny Island with battery system using external BMS under the assumption that the installation of the Sunny Island and the battery system has been performed correctly.

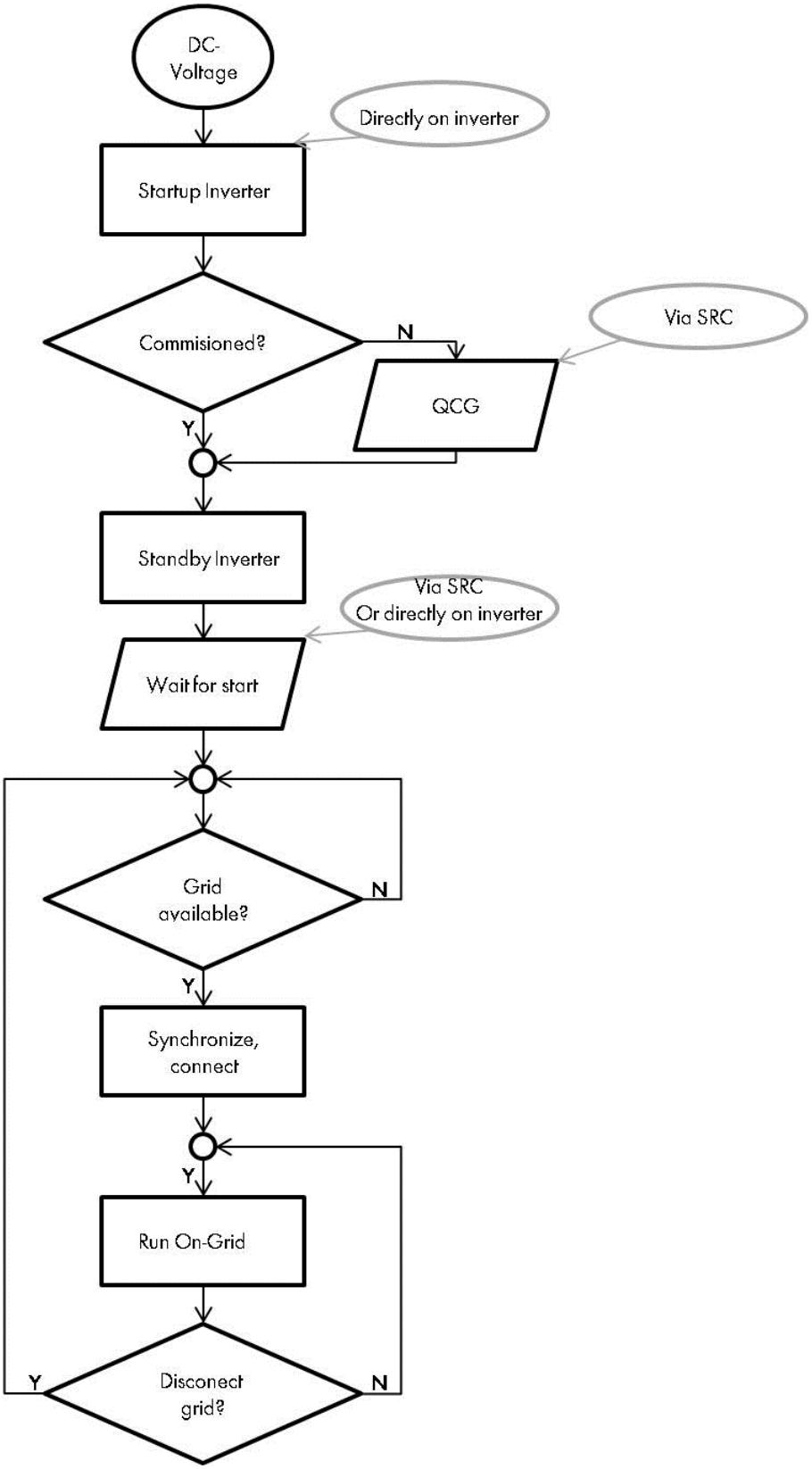

Figure 2: Start-up procedure

All other settings (optimization etc.) can be done later on – please refer to [1], [2]).

5 Battery Management Connection

5.1 General information

Required for the optimal operation of the product

Sunny Island sends out all process values (mentioned in this document) via the internal CAN bus every second. Due to internal restrictions it can sometimes occur that some data will be left out for one cycle.

All settings to Sunny Island using this communication interface cannot be read back from Sunny Island - They are write only"

Values to Sunny Island must not be sent out faster than every 200msec (inhibit time).

CAN data is transmitted with encoding in little endian - low byte first – unless stated otherwise.

Each defined process value has an internal default. Please refer to (see Section 4.2 "Parameters for Li-Ion Batteries in QCG", page 13).

Sunny Island accepts new settings sent from the external BMS after a comparison to internal limits. Values beyond the limits (out of the range) are rejected without notice. The last sent acceptable value is kept as the valid value, as long as no timeout detected (see below).

Values marked invalid return to internal default

- invalid signed, 0x8000: reset to default
- invalid unsigned, 0xFFFF: reset to default

Unused fields of used frames must set to „invalid"

Essential for a trouble-free and safe operation:

- Sunny Island supervises CAN-Bus IDs 0x355, In case that after 60 seconds no messages from the external BMS has been received Sunny Island goes into standby with following error:

  F952 ExtBMSTimeout

  In case that after 60 seconds no messages from the external BMS of CAN-ID 0x351 has been received Sunny Island presents the following warning:

  W952 WrnExtBMSTmOut

  Please note that the error handling causes that the default values (see Section 4 "Commissioning", page 13), and SOC Values is set to 0% which results in complete shutdown of Sunny Island due to battery protection mode (see Section 1.2 "Glossary and definitions", page 6).

- Sunny Island loses every setting that came via the described communication interfaces (process interface) when switched off! After restart, default values of Sunny Island are valid until overwritten by external BMS (see Section 4 "Commissioning", page 13).

  As the default value for SOC is 0%, this will result in completely switching off Sunny Island due to battery protection (see Section 1.2 "Glossary and definitions", page 6).

5.2 Sunny Island CAN Communication parameters

The CAN-Bus interface is primarily designed for the communication between Sunny Island-Devices (if more than one installed) during normal operation. Please note that the identifiers described here represent only a subset of the identifiers which are actually implemented and used.

CAN 2.0A
500kBit/sec
11-Bit Identifiers
Galvanic isolated

- **SMA does not permit the usage of the Sunny Island CAN bus other than described here!**
- **No further CAN-IDs are allowed to be used than defined in this document!**

5.3 Process values that are to be sent via the CAN bus to the SI6.0H

The following table shows the parameters which can be sent by an external BMS to the Sunny Island. Please note that there are different types of parameters defined as well as the reaction of Sunny Island to these parameters. Please note that the Sunny Island uses default parameters which are described in Chapter (see Section 4 "Commissioning", page 13). These values are to be overwritten by external BMS:

All described parameters are mandatory values.

Mandatory values are crucial for the safety of the battery system and overall performance of the whole system and are expected to be sent by the external BMS. Sunny Island incorporates a control algorithm which checks the mandatory parameters and in case of not well implemented communication (by the external BMS or wrong installation of the system) it does not allow the system to operate. The quality of the values and the impact on system behavior are solely responsibility of the battery provider.

Battery charging voltage: This is a set point and limit for the battery charging voltage sent to Sunny Island. This value is the allowed, typically temperature compensated, charging voltage for the whole battery system pack. If the battery is charged from the grid (on-grid mode) than this limit is accurately hold by Sunny Island. If the battery is charged from other energy sources, the actual voltage value might swing around the set-point due to permanent variations on both load side and source (for example PV, Wind etc.) side. Please note that the battery system should fit the technical requirements of Sunny Island (see Section 10 "Technical data SI6.0H-11", page 35).

Battery charging current limitation: This is solely the limit for the charging current sent to Sunny Island. It is not to be understood as a set-point as the available charging current is calculated by other algorithm and not to be set by the battery. Please note that the actual charging current is not constant but changes according to the algorithm. This value is the allowed, typical or rated charging current value for the whole battery pack. It is just the limit which must not be exceeded during charging. Please note that the battery system should fit the technical requirements of Sunny Island (see Section 10 "Technical data SI6.0H-11", page 35).

Battery discharging current limitation: This is the limit for the discharging current sent to Sunny Island. This value is the allowed, typical or rated discharging current value for the whole battery system. Please note that this value is not the set-point value and the discharging current varies according to the system needs. If the system is operated in off-grid mode than also overload situations are possible. It is important that the battery system continues operating even during overload situation and cover the demand of the system. Please note that discharging current limitation is not valid in 2 cases:

- Inverter runs in Off-Grid Mode: In this case the loads have a priority and are supplied until a specified SOC Limit is reached (see Battery Protection Modes)
- In case that the sent charging voltage limit is below the actual measured voltage SI discharges the battery and ignores the discharge current limit as the charging voltage has higher priority

Please note that the battery system should fit the technical requirements of Sunny Island (see Section 10 "Technical data SI6.0H-11", page 35).

Battery discharge voltage limit: This is the limit for stopping operation of Sunny Island and change into Standby-Mode. Please note that this value is also a limit for restarting Sunny Island. If the actual battery voltage is below this limit no re-start of the system is possible. Basically this limit should address two issues: In case of very high loads in backup or off-grid mode the voltage might suddenly drop and this limit prevents the damaging of the battery. After the disconnection of the load, it is expected that the voltage will recover and the restart will be possible. On the other hand if the system has been switched off for a longer period this limit should signalize if the recharge of the battery is still allowed or not.

State of Charge – SOC: Sunny Island does not calculate the SOC of the battery system but relies on the SOC-Value sent by the external BMS. This value should be accurately calculated by the external BMS as a lot of system functions are triggered by the SOC-Value. For example the battery protection mode (see [1], [2]) is triggered by SOC or algorithm for self consumption increase uses SOC value for the control purposes. Please note that charging of the battery will not stop according to SOC value (for example at 100%). Only discharging of the battery is stopped by defined SOC-values. It is expected that the battery provider detailed describes in his manual the definition of the SOC and the accuracy of the value.

State of Charge (Higher Resolution) – HiResSOC: Same as SOC, but with higher resolution, for better management. If this value is available (Telegram), Sunny Island uses this value instead of SOC.

Alarm messages: In order to protect the battery system from damages which may occur on cell, module or system level, alarm messages are sent to Sunny Island. In case of any alarm, Sunny Island will raise an alarm message (and log), immediately stop inverting and change to error condition (standby) until alarm is cleared. Sunny Island waits until alarm has gone (alarm clearing by the external BMS) and restarts. Different alarm messages are predefined. It is strongly recommended to diversify alarm messages from the BMS and link them to proposed alarm messages. It facilitates the trouble shooting both for customer and for the battery provider.

Please note that alarm handling is defined as followed:

There are 2 bits defined for handling the alarm messages of the battery: a bit indicating that alarm is raised by the external BMS (in the table below indicated as External Alarm arrive) and a bit indicating that alarm issue has been resolved, in the table below indicated as External Alarm leave (see Section 7 "Messages", page 31).

Required for the optimal operation of the product

Besides the above mentioned parameters the external BMS should sent also parameters relevant for display and diagnostic purposes:

- Please observe that Sunny Island does not react on any of these values.

State of Health – SOH: Sunny Island does not calculate the SOH of the battery system but displays and logs the SOH-Value sent by the external BMS. Battery provider should detailed describe in his manual the definition of this value as well as at which value some restrictions are expected and at which value the replacement of the battery system is required.

Battery Voltage: This is the actual battery system voltage measured by the external BMS. This value is logged by Sunny Island and it can differ due to cabling from the displayed value for the DC-Voltage of the Sunny Island. If the difference is exceeding some volts, the system cabling should be checked.

Battery Current: This is the actual battery system current measured by the external BMS. This value is logged by Sunny Island and it can differ from the displayed value for the DC-Current of the Sunny Island.

Battery Temperature: This is the actual measured battery system temperature measured by the external BMS. This value is logged by Sunny Island.

Warnings: The warnings are sent to Sunny Island from the external BMS. These values are only logged and displayed. Sunny Island does not react on these warnings.

Battery system data: In order to allow easy trouble shooting for the battery system provider it is possible to identify the battery installed. Following information can be sent via CAN-Bus: Manufacturer name, Battery type, Version of the Battery management system, Battery capacity as well as Manufacturer ID.

Emergency stop (optional): It is possible to send a message to command to Sunny Island to go into stand-by. It is an additional option and Sunny Island can be restarted immediately. This message does not replace Alarm-Messages and should not be used to signalize battery problems.

Data from external BMS (Orange mandatory values):

Byte	0	1	2	3	4	5	6	7
CAN-ID	0		1		2		3	
0x351	Battery charge voltage		DC charge current limitation		DC discharge current limitation		discharge voltage	
0x355	SOC value		SOH value		HiResSOC			
0x356	Battery Voltage		Battery Current		Battery Temperature			
0x35A	Alarms				Warnings			
0x35B	Events							
0x35E	Manufacturer-Name-ASCII							
0x35F	Bat-Type		BMS Version		Bat-Capacity		reserved Manufacturer ID	

Remote Quick Stopp (optional):

Byte	0	1	2	3	4	5	6	7
CAN-ID	0		1		2		3	
0x00F	No data							

Required for the optimal operation of the product

After receiving this message, Sunny Island will immediately go into standby. Please send start command, to start again. Manual start is also possible.

For eventual monitoring purposes Sunny Island sends out every second following process values (read only). Please note that battery voltage and battery current are Sunny Island measured values.

Byte	0	1	2	3	4	5	6	7
CAN-ID	0		1		2		3	
0x305	Battery voltage		Battery current		Battery temperature		SOC battery	
0x306	SOH battery		Charging procedure	Operating state	active Error Message		Battery Charge Voltage Set-point	

Name	Data type	Scal-ing	Unit	Min*	Max*	Default*	Description	CAN ID	CAN-Byte	CAN-Byte-Bit
Battery charge voltage	U16	0.1	V	41	63	54	Set point for battery charge voltage	0x0351	0	
DC charge current limitation	S16	0.1	A	0	1200	0	DC charge current limitation	0x0351	2	
DC discharge current limita-tion	S16	0.1	A	0	1200	0	DC discharge current limitation	0x0351	4	
Battery discharge voltage	U16	0.1	V	41	48	41	Voltage discharge limit	0x0351	6	
SOC value	U16	1	%	0	100	0	State of Charge (SOC) value from an external BMS	0x0355	0	
SOH value	U16	1	%	0	100	100	State of Health (SOH) value from external Battery Man-agement	0x0355	2	
HiResSOC	U16	0.01	%	0	100	0	High resolution SOC value: It allows more sophisticated protection of the battery	0x355	4	
Battery Voltage	S16	0.01	V			0.0	Measured actual Battery Voltage value from external BMS	0x0356	0	
Battery Current	S16	0.1	A			0.0	Measured actual Battery Current value from external BMS	0x0356	2	
Battery Temperature	S16	0.1	degC			25.0	Measured actual Battery Temperature value from external BMS	0x0356	4	

Name	Data type	Scal-ing	Unit	Min*	Max*	Default*	Description	CAN ID	CAN-Byte	CAN-Byte-Bit
External Alarm 1 General arrive	Bit			0	1	0	External Alarm indicating general battery system prob-lems which are not explicitly described below Byte 0, Bit 0: General Alarm arrives	**0x35A**	0	0
External Alarm 1 General leave	Bit			0	1	0	External Alarm External Alarm indicating general battery system problems which are not explicitly described below have been resolved Byte 0, Bit 1: General Alarm leaves	**0x35A**	0	1
External Alarm 2 Battery High Voltage arrive	Bit			0	1	0	External Alarm indicating voltage being higher than the Battery accepts Byte 0, Bit 2: Battery High Voltage arrives	**0x35A**	0	2
External Alarm 2 Battery High Voltage leave	Bit			0	1	0	Byte 0, Bit 3: Battery High Voltage leaves	**0x35A**	0	3
External Alarm 3 Battery Low Voltage arrive	Bit			0	1	0	External Alarm indicating voltage being lower than the Battery accepts Byte 0, Bit 4: Battery Low Voltage arrives	**0x35A**	0	4
External Alarm 3 Battery Low Voltage leave	Bit			0	1	0	External Alarm indicating voltage that under voltage on the battery has been resolved Byte 0, Bit 5: Battery Low Voltage leaves	**0x35A**	0	5
External Alarm 4 Battery High Temp arrive	Bit			0	1	0	External Alarm indicating that the battery temperature is higher than the battery accepts Byte 0, Bit 6: Battery High Temp arrives	**0x35A**	0	6
External Alarm 4 Battery High Temp leave	Bit			0	1	0	External Alarm indicating that the battery over tempera-ture has been resolved Byte 0, Bit 7: Battery High Temp leaves	**0x35A**	0	7

Name	Data type	Scal-ing	Unit	Min*	Max*	Default*	Description	CAN ID	CAN-Byte	CAN-Byte-Bit
External Alarm 5 Battery Low Temp arrive	Bit			0	1	0	External Alarm indicating that the battery temperature is lower than the battery accepts Byte 1, Bit 0: Battery Low Temp arrives	**0x35A**	1	0
External Alarm 5 Battery Low Temp leave	Bit			0	1	0	External Alarm indicating that the battery under tempera-ture has been resolved Byte 1, Bit 1: Battery Low Temp leaves	**0x35A**	1	1
External Alarm 6 Battery High Temp Charge arrive	Bit			0	1	0	External Alarm indicating that the battery temperature is higher than the battery accepts for charging Byte 1, Bit 2: Battery High Temp Charge arrives	**0x35A**	1	2
External Alarm 6 Battery High Temp Charge leave	Bit			0	1	0	External Alarm indicating that the battery over tempera-ture for charging has been resolved Byte 1, Bit 3: Battery High Temp Charge arrives	**0x35A**	1	3
External Alarm 7 Battery Low Temp Charge arrive	Bit			0	1	0	External Alarm indicating that the battery temperature is lower than the battery accepts for charging Byte 1, Bit 4: Battery Low Temp Charge arrives	**0x35A**	1	4
External Alarm 7 Battery Low Temp Charge leave	Bit			0	1	0	External Alarm indicating that the battery under tempera-ture for charging has been resolved Byte 1, Bit 5: Battery Low Temp Charge leaves	**0x35A**	1	5

Name	Data type	Scal-ing	Unit	Min*	Max*	Default*	Description	CAN ID	CAN-Byte	CAN-Byte-Bit
External Alarm 8 Battery High Current arrive	Bit			0	1	0	External Alarm indicating current is to high Byte 1, Bit 6: Battery High Current arrives	**0x35A**	1	6
External Alarm 8 Battery High Current leave	Bit			0	1	0	External Alarm indicating high current issue has been resolved Byte 1, Bit 7: Battery High Current leaves	**0x35A**	1	7
External Alarm 9 Battery High Current Charge arrive	Bit			0	1	0	External Alarm indicating charging current is to high Byte 2, Bit 0: Battery High Current arrives	**0x35A**	2	0
External Alarm 9 Battery High Current Charge leave							External Alarm indicating high charging current issue has been resolved Byte 2, Bit 1: Battery High Current leaves	**0x35A**	2	1
External Alarm 10 Contactor arrive	Bit			0	1	0	External Alarms indicating technical problems with con-tactor Byte 2, Bit 2: Contactor arrives	**0x35A**	2	2
External Alarm 10 Contactor leave	Bit			0	1	0	External Alarms indicating technical problems with con-tactor has been resolved Byte 2, Bit 3: Contactor leaves	**0x35A**	2	3
External Alarm 11 Short circuit arrive	Bit			0	1	0	External Alarms indicating short circuit within battery system Byte 2, Bit 4: Short circuit arrives	**0x35A**	2	4
External Alarm 11 Short circuit leave	Bit			0	1	0	External Alarms indicating short circuit within battery system has been resolved Byte 2, Bit 5: Short circuit leaves	**0x35A**	2	5

Name	Data type	Scal-ing	Unit	Min*	Max*	Default*	Description	CAN ID	CAN-Byte	CAN-Byte-Bit
External Alarm 12 BMS internal arrive	Bit			0	1	0	External Alarms indicating all the internal faults occurring within BMS if not above or below explicitly specified Byte 2, Bit 6: BMS internal arrives	**0x35A**	2	6
External Alarm 12 BMS internal leave	Bit			0	1	0	External Alarms indicating all the internal faults occurring within BMS (if not above or below explicitly specified) resolved Byte 2, Bit 7: BMS internal arrives	**0x35A**	2	7
External Alarm 13 Cell Imbalance arrive	Bit			0	1	0	External Alarms indicating imbalance between cells (or modules) Byte 3, Bit 0: Cell Imbalance	**0x35A**	3	0
External Alarm 13 Cell Imbalance leave	Bit			0	1	0	External Alarms indicating imbalance between cells (or modules) has been resolved Byte 3, Bit 1: Cell Imbalance	**0x35A**	3	1
External Alarm 14 Arrives Reserved	Bit			0	1	0	External Alarms **(not to be used by the external BMS)** Byte3, Bit 2: reserved	**0x35A**	3	2
External Alarm 14 Leaves Reserved	Bit			0	1	0	External Alarms **(not to be used by the external BMS)** Byte 3, Bit 3: reserved	**0x35A**	3	3
External Alarm 15 Arrives Reserved	Bit			0	1	0	External Alarms **(not to be used by the external BMS)** Byte 3, Bit 4: reserved	**0x35A**	3	4
External Alarm 15 Leaves Reserved							External Alarms **(not to be used by the external BMS)** Byte 3, Bit 5: reserved	**0x35A**	3	5

Name	Data type	Scal-ing	Unit	Min*	Max*	Default*	Description	CAN ID	CAN-Byte	CAN-Byte-Bit
External Alarm 16 Generator arrives	Bit			0	1	0	External Alarms **(not to be used by the external BMS)** Byte 3, Bit 6: reserved	**0x35A**	3	6
External Alarm 16 Generator leaves							External Alarms **(not to be used by the external BMS)** Byte 3, Bit 7: reserved	**0x35A**	3	7
External Warning 1 General arrive	Bit			0	1	0	External Warnings Byte 4, Bit 0: General	**0x35A**	4	0
External Warning 1 General leave	Bit			0	1	0	External Warnings Byte 4, Bit 1: General	**0x35A**	4	1
External Warning 2 Battery High Voltage arrive	Bit			0	1	0	External Warnings Byte 4, Bit 2: Battery High Voltage arrives	**0x35A**	4	2
External Warning 2 Battery High Voltage leave	Bit			0	1	0	External Warnings Byte 4, Bit 3: Battery High Voltage arrives	**0x35A**	4	3
External Warning 3 Battery Low Voltage arrive	Bit			0	1	0	External Warnings Byte 4, Bit 4: Battery Low Voltage arrives	**0x35A**	4	4
External Warning 3 Battery Low Voltage arrive	Bit			0	1	0	External Warnings Byte 4, Bit 5: Battery Low Voltage leaves	**0x35A**	4	5
External Warning 4 Battery High Temp arrive	Bit			0	1	0	Byte 4, Bit 6: Battery High Temp arrives	**0x35A**	4	6
External Warning 4 Battery High Temp leaves	Bit			0	1	0	External Warnings Byte 4, Bit 6: Battery High Temp leaves	**0x35A**	4	73
External Warning 5 Battery Low Temp arrive	Bit			0	1	0	External Warnings Byte 5, Bit 0: Battery Low Temp arrives	**0x35A**	5	0

Name	Data type	Scal-ing	Unit	Min*	Max*	Default*	Description	CAN ID	CAN-Byte	CAN-Byte-Bit
External Warning 5 Battery Low Temp leaves	Bit			0	1	0	External Warnings Byte 5, Bit 1: Battery Low Temp leaves	**0x35A**	5	1
External Warning 6 Battery High Temp Charge arrive	Bit			0	1	0	External Warnings Byte 5, Bit 2: Battery High Temp Charge arrives	**0x35A**	5	2
External Warning 6 Battery High Temp Charge leave	Bit			0	1	0	External Warnings Byte 5, Bit 3: Battery High Temp Charge leaves	**0x35A**	5	3
External Warning 7 Battery Low Temp Charge arrive	Bit			0	1	0	External Warnings Byte 5, Bit 4: Battery Low Temp Charge arrives	**0x35A**	5	4
External Warning 7 Battery Low Temp Charge leave	Bit			0	1	0	External Warnings Byte 5, Bit 5: Battery Low Temp Charge leaves	**0x35A**	5	5
External Warning 8 Battery High Current arrive	Bit			0	1	0	External Warnings Byte 5, Bit 6: Battery High Current	**0x35A**	5	6
External Warning 8 Battery High Current leaves	Bit			0	1	0	External Warnings Byte 5, Bit 7: Battery High Current	**0x35A**	5	6
External Warning 9 Battery High Current Charge arrive	Bit			0	1	0	External Warnings Byte 6, Bit 0: Battery High Current Charge arrives	**0x35A**	6	0
External Warning 9 Battery High Current Charge leave	Bit			0	1	0	External Warnings Byte 6, Bit 1: Battery High Current Charge leaves	**0x35A**	6	1
External Warning 10 Contactor arrive	Bit			0	1	0	External Warnings Byte 6, Bit 2: Contactor arrive	**0x35A**	6	2

Name	Data type	Scal-ing	Unit	Min*	Max*	Default*	Description	CAN ID	CAN-Byte	CAN-Byte-Bit
External Warning 10 Contactor leave	Bit			0	1	0	External Warnings Byte 6, Bit 3: Contactor	**0x35A**	6	3
External Warning 11 Short circuit arrive	Bit			0	1	0	External Warnings indicating short circuit within battery system Byte 6, Bit 4: Short circuit arrive	**0x35A**	6	4
External Warning 11 Short circuit leave	Bit			0	1	0	External Warnings Byte 6, Bit 5: Short circuit leave	**0x35A**	6	5
External Warning 12 BMS internal arrive	Bit			0	1	0	External Warnings indicating all the internal warnings occurring within BMS if not above or below explicitly specified Byte 6, Bit 6: BMS internal arrive	**0x35A**	6	6
External Warning 12 BMS internal leave	Bit			0	1	0	External Warnings indicating all the internal warnings occurring within BMS (if not above or below explicitly specified) resolved Byte 6, Bit 6: BMS internal arrive	**0x35A**	6	7
External Warning 13 Cell Imbalance arrive	Bit			0	1	0	External Warnings indicating imbalance between cells (or modules) Byte 7, Bit 0: Cell Imbalance arrives	**0x35A**	7	0
External Warning 13 Cell Imbalance leave	Bit			0	1	0	External Warnings indicating imbalance between cells (or modules) has been resolved Byte 7, Bit 1: Cell Imbalance leaves	**0x35A**	7	1
External Warning 14 Reserved arrive	Bit			0	1	0	External Warnings **(not to be used by the external BMS)** Byte 7, Bit 2: reserved arrives	**0x35A**	7	2

Name	Data type	Scal-ing	Unit	Min*	Max*	Default*	Description	CAN ID	CAN-Byte	CAN-Byte-Bit
External Warning 14 Reserved leave	Bit			0	1	0	External Warnings **(not to be used by the external BMS)** Byte 7, Bit 3: reserved leaves	**0x35A**	7	3
External Warning 15 Reserved arrive	Bit			0	1	0	External Warnings **(not to be used by the external BMS)** Byte 7, Bit 4: reserved arrives	**0x35A**	7	4
External Warning 15 Reserved leave	Bit			0	1	0	External Warnings **(not to be used by the external BMS)** Byte 7, Bit 5: reserved leaves		7	5
External Warning 16 Generator arrive	Bit			0	1	0	External Warnings **(not to be used by the external BMS)** Byte 7, Bit 6: Generator arrives	**0x35A**	7	6
External Warning 16 Generator leave	Bit			0	1	0	External Warnings **(not to be used by the external BMS)** Byte 7, Bit 7: Generator leaves	**0x35A**	7	7

* see Inverter documentation for actual values

The content will be identified via Telegram ID and Byte, or Bit. Therefore the length of the value is to be observed (for this see column “Data type”).
The individual values can be scaled by a factor (for this see column “scaling”). Note: the numbers start at 0.

6 Process values that can be read (only) via the CAN bus from the SI6.0H

Name	Data type	Scaling	Unit	Description	CAN ID	CAN-Byte	CAN-Byte-Bit
Battery voltage	U16	0.1	V	Battery voltage measured by Sunny Island	0x0305	0	
Battery current	S16	0.1	A	Battery current measured by Sunny Island, (negative while charging)	0x0305	2	
Battery temperature	S16	0.1	degC	Battery temperature measured by Battery/ Sunny Island	0x0305	4	
SOC battery	S16	0.1	%	State of charge of the battery received from the external BMS	0x0305	6	
SOH battery	U16	1	%	” State of health of the battery received from the external BMS	0x0306	0	
Charging procedure	U8	None	–,	Charging mode of the SunnyIsland internal Battery Man-agement. If external BMS is selected displayed value is 10	0x306	2	
Operating state	U8	None	–,Operating, Warning,Failure	Operating state of the inverter – (0),Operating (1), Warning (3), Failure (4) Valid only for SI6.0H-11, FW Release 2.1	0x0306	3	
Error Message	U16		Number	Number of the error message	0x0306	4	
Battery charging voltage	U16	0.1	V	Current set point of charging voltage	0x0306	6	
Relay state	U16	Bitcoded		state of the relay bitcoded	0x0307	0	

7 Messages

7.1 General informations

All the messages received from the external BMS are logged in evt-file of Sunny Island.

Warnings are only displayed and logged. No further actions are undertaken by Sunny Island.

Alarm messages are displayed and logged by Sunny Island. Please note that due to communication it approximately takes in worse case **10 second**s to go into fault state - standby. If possible do not open contactors of the battery before Sunny Island had enough time to react on the alarms. In case of safety risk battery can immediately disconnect from the inverter.

Essential for a trouble-free and safe operation:

- Battery management messages are seamlessly integrated in the Sunny Island message System.

  The general message mechanism relies on a 2-bit representation of each message. Each 2 bits (e.g. 0 and 1) operate together. First Bit (here bit 0) describes the raise of the alarm or warning whereas the other bit (bit 1 in this case) describes the message leaving. Only one of these combined bits should be set to create a message. If both bits are set (or cleared), no change or message is detected.
- General Warning and Alarm handling Sunny Island is described in [1], [2].

Bit 0	Bit 1	Description
0	0	Ignored
1	0	Alarm or warning raised
0	1	Alarm or warning cleared
1	1	ignored

7.2 Warnings

Essential for a trouble-free and safe operation:

- In case of any warning, Sunny Island will raise a warning (log) and clear it when signal disappeared.
- The warning messages that have been sent from the external BMS are shown in the display as warning number and the name and logged in an evt-file. Please refer to the table below:

  Please note that some messages are reserved and not used for displaying messages from an external BMS.

List of warnings from the external BMS their displayed values and names:

Description	Warning	Name
General	W936	XW01General
Battery High Voltage	W937	XW02DcHiVolt
Battery Low Voltage	W938	XW03DcLoVolt
Battery High Temperature	W939	XW04DcHiTmp
Battery Low Temperature	W940	XW05DcLoTmp
Battery High Temperature Charge	W941	XW06DcHiTmpC
Battery Low Temperature Charge	W942	XW07DcLoTmpC
Battery High Current	W943	XW08DcHiCur
Battery High Current Charge	W944	XW09DcHiChgCur
Contactor	W945	XW10Contact

Description	Warning	Name
Short circuit	W946	XW11Short
BMS internal	W947	XW12Bms
Cell imbalance	W948	XW13CellBal
Reserved	W949	XW14
Reserved	W950	XW15
Generator	W951	XW16Generator

7.3 Alarms

Essential for a trouble-free and safe operation:

- In case of any alarm, Sunny Island will raise an alarm message (log) and immediately stop and change to fault state (Fault 2 – see manual [1], [2]) until alarm is cleared.
- Restart depends on "Autostart" setting. See also Sunny Island technical description [1].

Please note that some messages are reserved and not used for displaying messages from an external BMS.

List of alarms from the external BMS and their displayed values and names:

Description	Warning	Name
General	F920	XA01General
Battery High Voltage	F921	XA02DcHiVolt
Battery Low Voltage	F922	XA03DcLoVolt
Battery High Temperature	F923	XA04DcHiTmp
Battery Low Temperature	F924	XA05DcLoTmp
Battery High Temperature Charge	F925	XA06DcHiTmpC
Battery Low Temperature Charge	F926	XA07DcLoTmpC
Battery High Current	F927	XA08DcHiCur
Battery High Current Charge	F928	XA09DcHiChgCur
Contactor	F929	XA10Contact
Short circuit	F930	XA11Short
BMS internal	F931	XA12Bms
Cell imbalance	F932	XA13CellBal
Reserved	F933	XA14
Reserved	F934	XA15
Generator	F935	XA16Generator

8 Parameter setting for different applications

This chapter describes/introduces parameters which must be adapted or are recommended for the correct use of Sunny Island 6.0H and the battery system in a specified application. Other parameters regarding Li-Ion Battery (see Section 4 "Commissioning", page 13).

Self-consumption increase

In this application the battery system is used for the optimization of the use of energy produced by a renewable source. Algorithm for this application is implemented in Sunny Island. Detailed description of this application can be found in [4], [6], [7] or on www.SMA-Solar.com.
In order to define the limits given by the storage technology used it is necessary to define an allowed DOD – Depth of discharge. Please note that this value should be designed in a way that:

- At least one cycle per day is possible – as it is PV self consumption application it depends on the PV production and load profile.
- The system might be left at defined DOD for several days without recharging.
- The risk of deep discharge (voltage curve to be taken into account) must be minimized.

Relevant parameter for self-consumption increase application:

Parameter number	Parametername	Description	Default Value	Explanation
239.01	SlfCsmpIncEna	Self consumption in-crease activated		Default depends on con-figuration
239.02	SlfCsmpSOCMin	Minimum SOC for self-consumption increase application	10%	The battery can be dis-charged always/daily only to this value. If SOC falls below this value (e.g. SOCmin-1%), battery will be re-charged from grid to this value
239.03	SlfCsmpStdbyMod	Inverter goes into standby after reaching minimum SOC while outside PVFeedTm – see [2]	Off	Energy saving possible

If the self consumption increase is enabled Sunny Island will discharge the battery down to the defined minimum SOC (parameter 239.02) and will allow on this point only charging of the battery. In case that the parameter 239.03 is set to disable Sunny Island will in case that actual sent SOC is lower than the defined parameter 239.02 recharge the battery from the grid but only to the defined minimum SOC. It is essential for a good performance of the system, that the SOC of the battery is accurately calculated.

9 Test of the compatibility

In order to check the compatibility of the battery systems with Sunny Island 6.0H at least following tests should be performed:

1. **Confirmation of the compatibility between SI6.0H and Battery system with an external BMS - communication via CAN-Bus**

   The goal of this test is to confirm that all relevant telegrams are sent by the external BMS in a way described in this document, and to check which telegram are time or event based triggered.

2. **Confirmation of safety measures during first commissioning**

   The goal of this tests is to confirm that the battery own safety mechanism would protect the battery system in case of installation failure and use of wrong parameter/battery type. For example the reaction of the battery in case Lead-Acid battery is defined battery type and communication cable has not been connected.

3. **Confirmation of system behaviour**

   The goal of this test is to check the behavior of the battery during the normal operation in self-consumption mode especially if the battery has been discharged to the discharging limit (minimum SOC).

4. **Further tests**

   Additionally DC-Ripple and possible influence on measurement should be analyzed.

10 Technical data SI6.0H-11

The following table shows only some of the relevant technical data for grid-tide operation/self-consumption increase. Please check the complete data sheet available on www.SMA-Solar.com.

Technical data Sunny Island 6.0H-11:

Please note that the following table only shows the parameter for a single-phase system.

Technical data	Sunny Island 6.0H Self-Consumption Only	Sunny Island 6.0H With Back-up functionality
AC-Side Operation on the utility grid		
Rated grid voltage / AC voltage range	230 V/172.5 V ... 264.5 V	
Rated frequency/permissible frequency range	50 Hz/40 Hz ... 70 Hz	
Maximum AC current for in-creased self-consumption	20 A	
Maximum AC power grid-tide charging	4.6 kVA	
Maximum AC power grid-tide discharging	4.6 kVA	
Maximum AC power at 25°C for 30 min/5 min/ 3 sec		
back-up (emergency power mode)	-	6.0 kW/6.8 kW/11.0 kW
DC-Side		
Battery connection		
Rated input voltage/DC voltage range	48 V/41 V ... 63 V	
DC rated charging current /Maximum battery charging current	100 A/110 A	
DC rated discharging current /Maximum battery discharging current		
Battery type	Li-ion (only if all requirements in this document fulfilled),	
Lead Acid – FLA and VRLA		
Battery capacity (range)	100 Ah ... 10,000 Ah	
Efficiency		
Maximum efficiency	95 %	
No-load consumption/standby	< 26 W / < 4 W	
DC-Ripple		
Current	Max. 100% Ripple @100Hz	
Voltage	Depends on battery resistance @100Hz	

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