Sensor-Technik Wiedemann GmbH
Mobile Controllers and Measurement Technologies

mBMS Software Guide

Table of content

Document History:

Version	Date	Name	Change
1.5	06.12.2016	W.Ekrot	Changed Icons in chapter 6 Adapt description of figure 42 Adapt naming of chapter 5.8.1
	02.12.2016	W. Ekrot	Adapt Figure 42
	22.11.2016	W. Ekrot	Integrate new chapter - 5 mBMS Functionality - 6 mBMS Functional Safety New title page
1.4	05.10.2016	S. Singer	FAQ / Troubleshooting: Huge SOC value change after recalibration issue added
1.3	28.01.2016 25.04.2016 15.06.2016 13.07.2016	S. Singer	- PMB main switch aging counter reset description added - New chapter added: Another example of cell configuration - FAQ / Troubleshooting chapter split into system and toolchain relevant issues - DIN KL15 Wake-up option description added - New current sensor hardware variants (PMB1000 and PMB2000) description added
1.2	13.01.2016	S. Singer	- New chapter added: Network Management - Interlock / Isolation error reaction description fixed - Amount of CSC Ropes removed in description
1.1	15.12.2015	S. Singer	- CAN 3 naming changed: Old: Battery CAN; New: Sensor CAN - CSC Auto ID Conflict chapter removed. - Troubleshooting: “System reports 0% SOC” added - New chapter added: “How to upgrade to newer mBMS software release” - safety_ds_conf__600A_optional.bsc description added - Response on Error Message description added
1.0	15.04.2015	S. Singer	First Release

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

1 Copyright Notice

They are subject to change without prior notice.

In spite of careful development and extensive reviews it is not possible to guarantee perfect correctness and completeness of our User Manuals. Therefore, liability for any damage resulting from incompleteness or incorrectness cannot be accepted.

2 Introduction

This document gives a compact overview how to configure the mBMS[1] software for your Battery-Setup systematically. It contains also a detail description of the mBMS functions and the important control command of the communication interface

This document describes the standard variant of the mBMS. Customer specific variant may differ.

Before begin reading this document, be sure you have installed the Battery Management Components corresponding to the “mBMS Hardware Guide” document.

2.1 Documents

You can find the latest release of this document and related documents online:

- STW Cloud: https://cloud.sensor-technik.de/
- Download area on www.sensor-technik.de

Related documents include:
- mBMS Hardware Guide

[1] *This document describes the 2nd generation of STW’s mBMS*

2.2 Software Release Content

Check online the latest software releases:

- STW Cloud: https://cloud.sensor-technik.de/

Directory	File(s)	Description
1__mBMS_Toolchain	mBMS_Toolchain_Setup.exe	Setup file for Toolchain installation.
2__SW_Update_Package	y_bmc_update_package__[version].pack	Demo Software Update Package file
2__SW_Update_Package \ Subpackages	y_bmc_firmware__[version].subpack	Firmware update sub-package. Contains only firmware data.
	y_bmc_dataset__[version].subpack	Demo dataset update sub-package. Contains only demo dataset data.
3__Development_Kit \ Dataset_Configuration	appl_ds_conf.bcc	Demo dataset application configuration file
	safety_ds_conf.bsc	Demo dataset safety configuration file
	safety_ds_conf__2000A_optional.bsc	Demo dataset safety configuration file. Special for optional PMB2000 usage.
3__Development_Kit \ Interface_Description	mBMS_ESS_CAN.dbc mBMS_Interpack_CAN.dbc Sensor_CAN.dbc SC_DIAG_IF.dbc	CAN interface description files
4__Release_Notes	Generator_Log.txt	Release Generator log file.

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

3 System Scope

3.1 Responsibility of system components

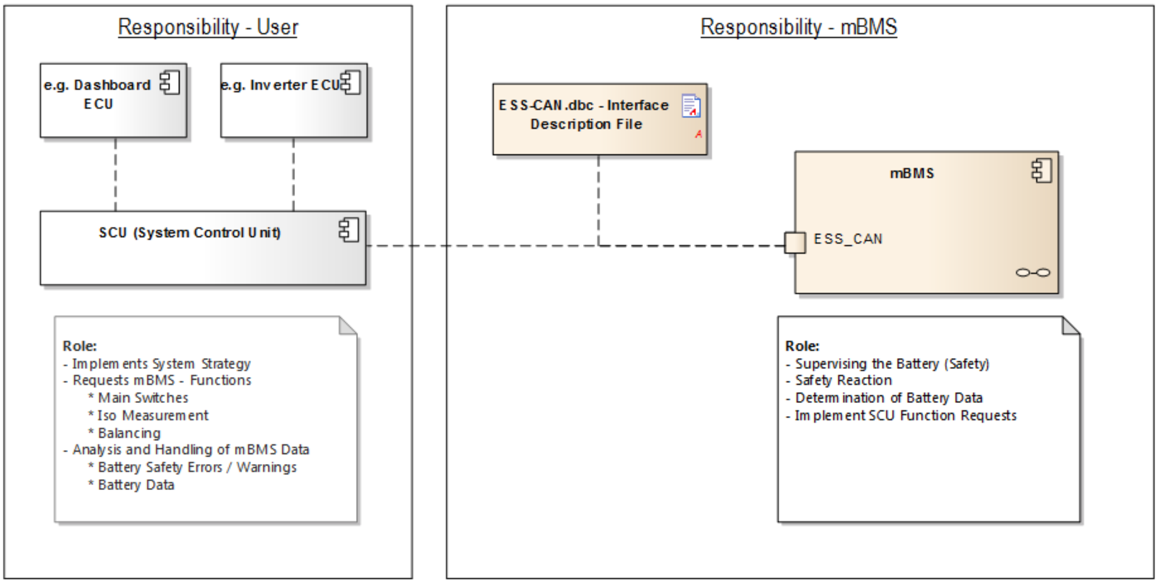


Figure 1 – System Responsibility

The mBMS has the responsibility to supervise the battery and react on safety issues. Measured Battery Data like Cell Voltage, Cell Temperature, Battery Voltage, etc. and determined Application-Data like State of Charge, Power Prediction, etc. will be sent via the ESS-CAN to the SCU.

The SCU implements the system strategy and controls the mBMS. It also has to evaluate the received battery data and meet system decisions (e.g. display warning on the vehicle's dashboard when the SOC-Value is lower than 10%).

3.2 Software Components Overview

3.2.1 mBMS

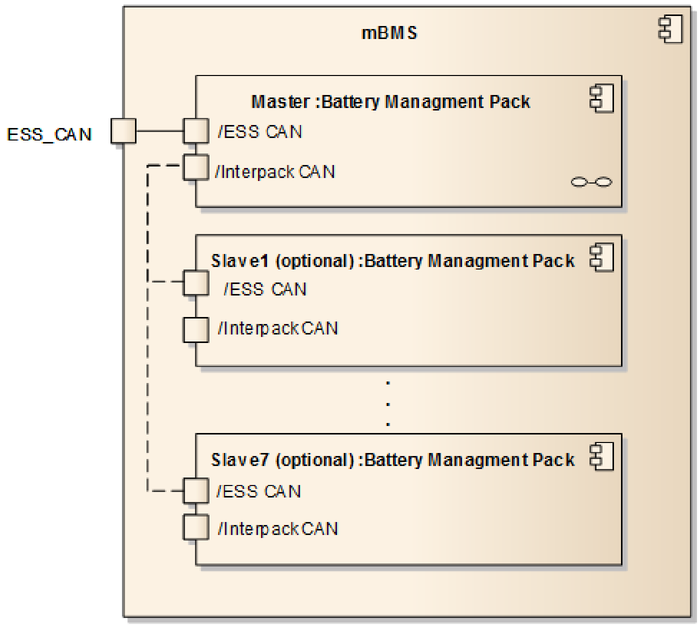


Figure 2 – mBMS Components

mBMS contains of

- at least one Master-Pack (= Standalone)
- and up to 7 Slaves (=Multipack, optional)

3.2.2 Battery Management Pack

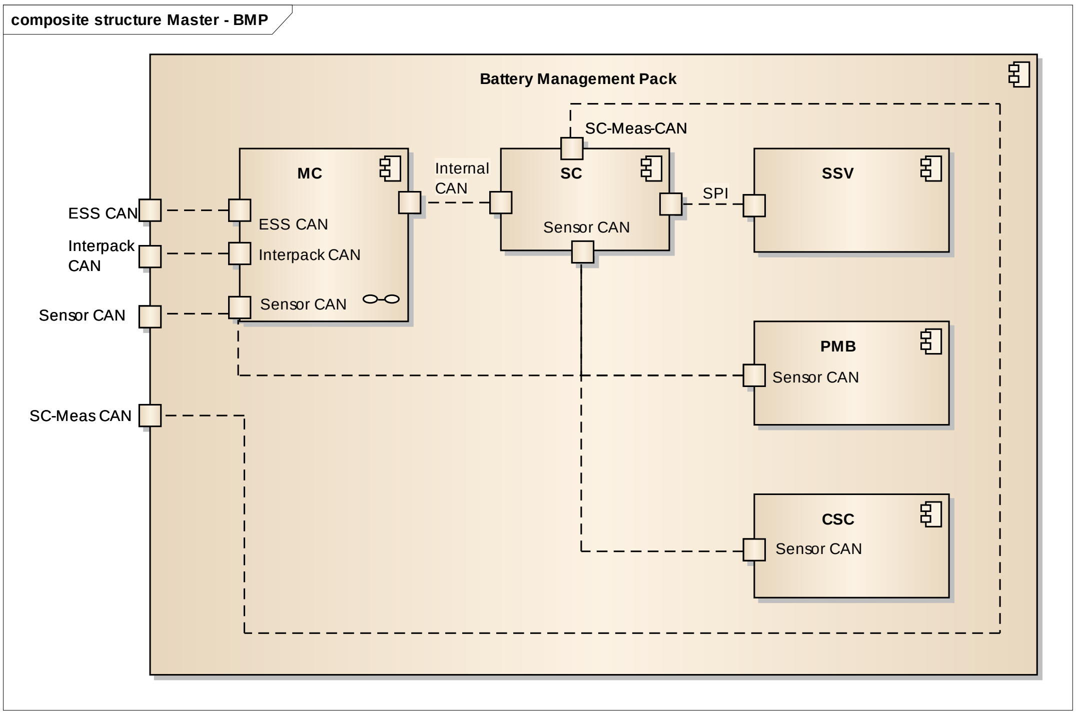


Figure 3 – Battery Management Pack Components

Component	Meaning	Description
MC	Main Controller	Battery Application is running on MC
SC	Safety Controller	Safety Application is running on SC
SSV	System Supervisor	Redundant System Supervisor
PMB	Power Measurement Board	Measuring of HV
CSC	Cell Sensor Circuit	Measuring of Cell Data

3.3 CAN-Interface

CAN-Interface	Channel	DBC-File	Description
ESS-CAN	CAN 1	`mBMS_ESS_CAN.dbc`	Interface to external systems (e.g. SCU, BMS Update Tool, BMS Diagnostic Tool)
Interpack CAN	CAN 2	`mBMS_Interpack_CAN.dbc`	Interface between the battery packs (Master/Slaves)
Sensor CAN	CAN 3	`Sensor_CAN.dbc`	Internal CAN between battery sub-components (PMB, CSCs) This interface is useful for deeper battery data (Further Cell-Information)
SC-Meas CAN	CAN 4	`SC_DIAG_IF.dbc`	Safety Controller diagnostic interface. This interface is useful for detailed safety error diagnostic (complete description system safety errors and states)

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

4 mBMS Toolchain

The mBMS Toolchain allows the user to configure, to update and to diagnose the mBMS.

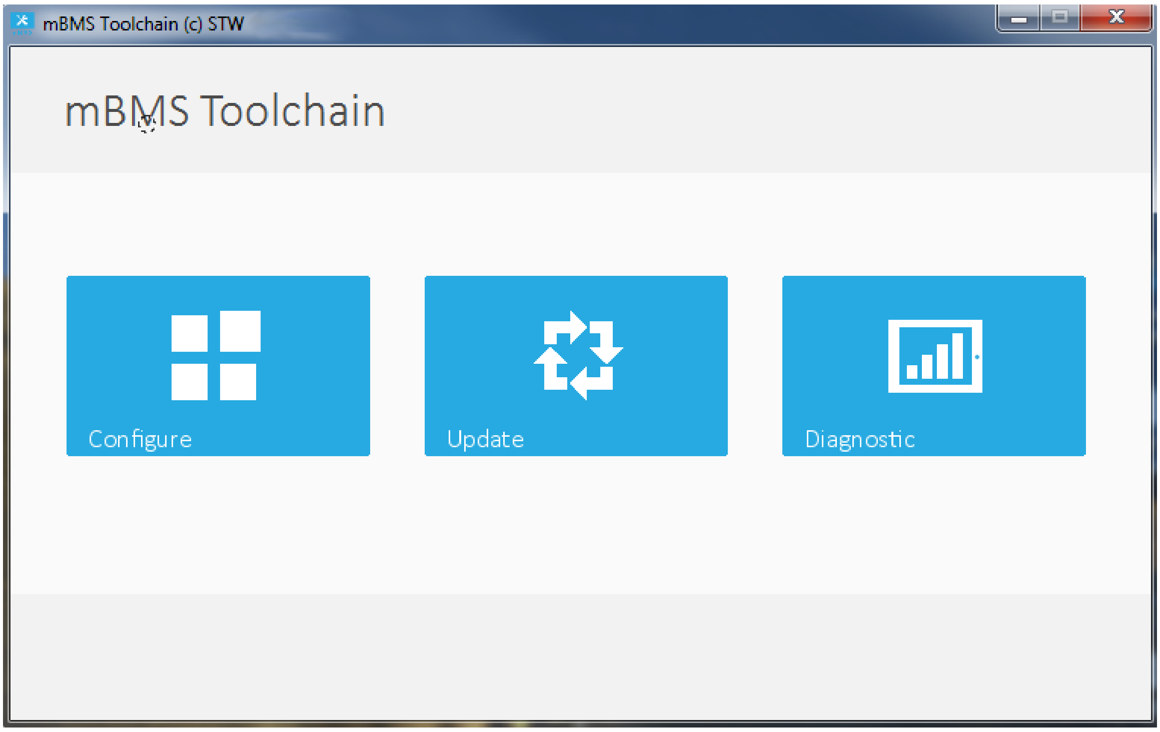


Figure 4 – mBMS Toolchain Wizard

To get a better understanding for mBMS Toolchain handling, all steps will be described by example based on a demo battery system.

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

4.1 Demo Battery System

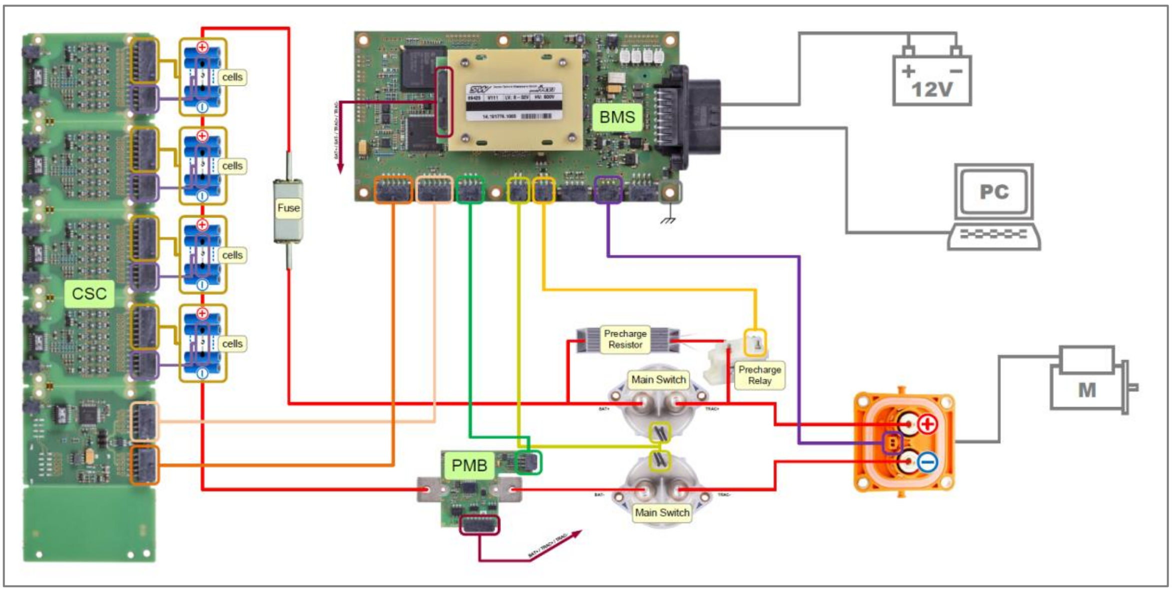


Figure 5 – Demo System

Key components:

- 1 x BMS
- 1 x CSC
- 1 x PMB

Additional components:

- 2 x Main Switch: TE connectivity, EV200
- 1 x Precharge Resistor: KRAH-RWI VHPR100-33R
- 1 x Precharge Relay
- 1 x Fuse
- 12 x Cells (see specification below)
- 4 x Cell temperature sensors (NTC 10k 8016)

Cell-Specification:

- Manufacturer: Sony
- Name: US18650FT
- Model Number: US18650FTC1
- Key-Facts:
  - Max. Charge-Up Voltage: 3.6 V
  - Min. Discharge Voltage (Vcut): 2.0 V
  - Nominal Voltage: 3.2 V
  - Max. Temperature: 60 °C

4.2 How to connect the PC with the mBMS

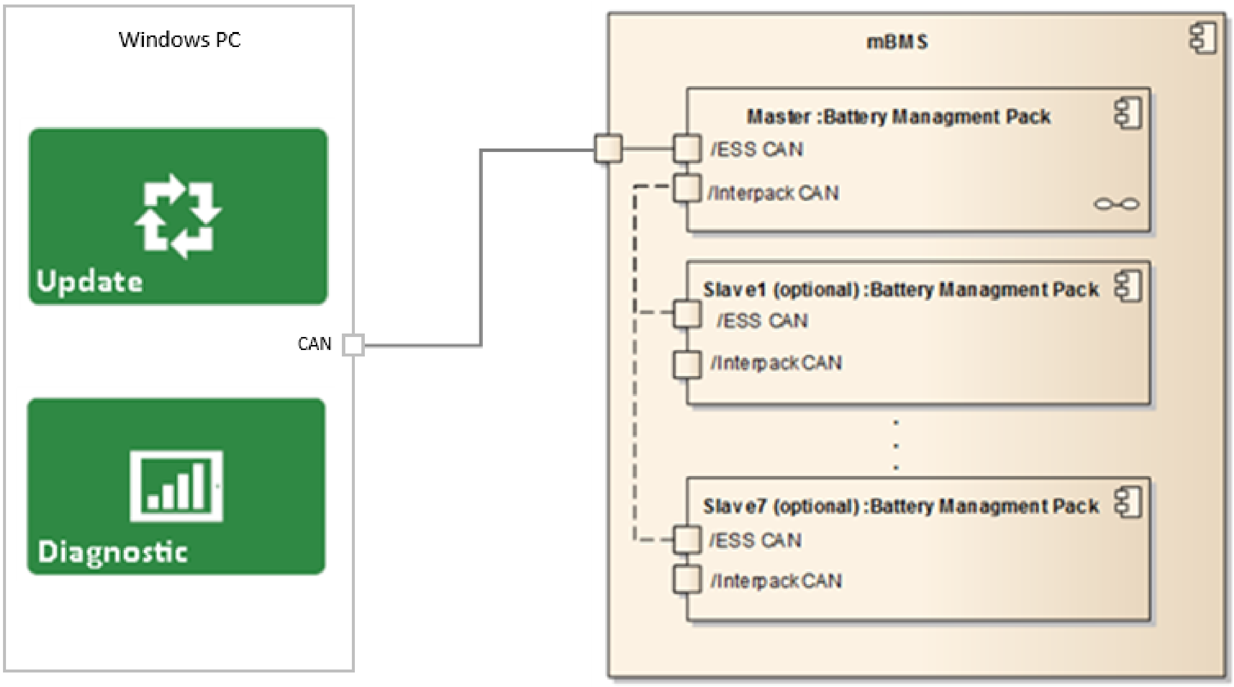


Figure 6 - Connect PC with mBMS

Connect your PC to mBMS ESS-CAN via a CAN-Interface-Device.
These devices are supported and recommended:

- Peak CAN Interface
- Vector CAN Interface

High level communication DLLs are installed with the toolchain in the folder `{Installation_Directory}…\STW\mBMS\Tools\CANDLLS`.

Interface	Communication DLL
Peak CAN	`stwpeak2.dll`
Vector CAN	`stwvec32.dll`

The communication DLL has to be selected according to CAN-Interface-Device in use.

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

4.3 Configure

The mBMS can be configured according to your battery setup using the BMC-Dataset-Configurator Tool.

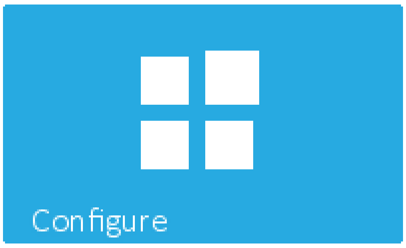


Figure 7 – Configure-Button

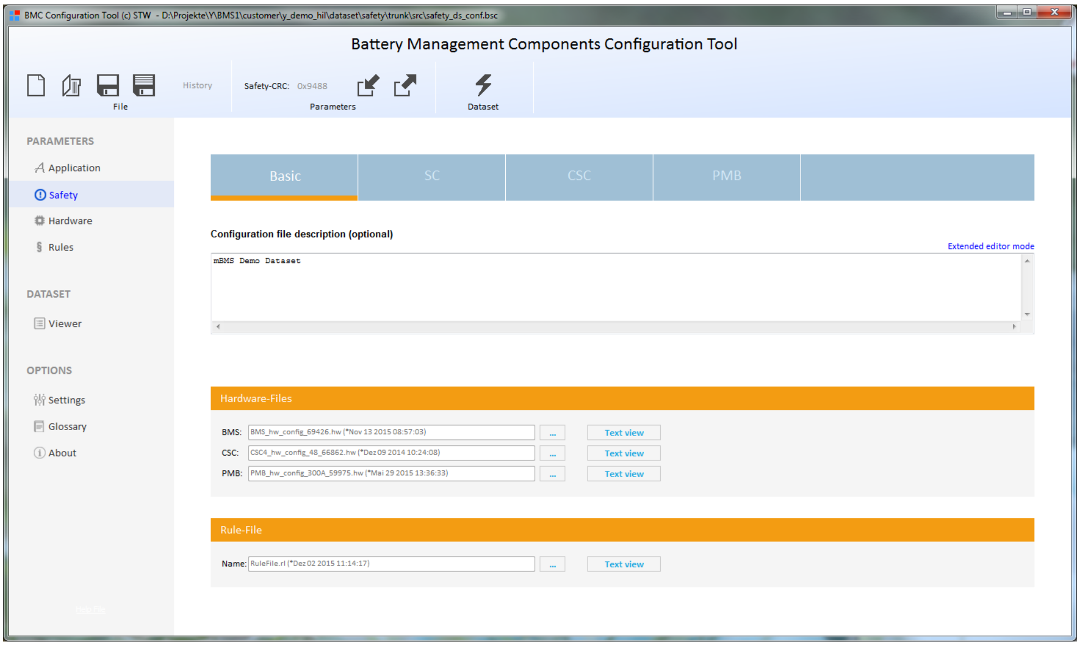


Figure 8 – Screenshot of the Configuration Tool

4.3.1 Parameter Structure

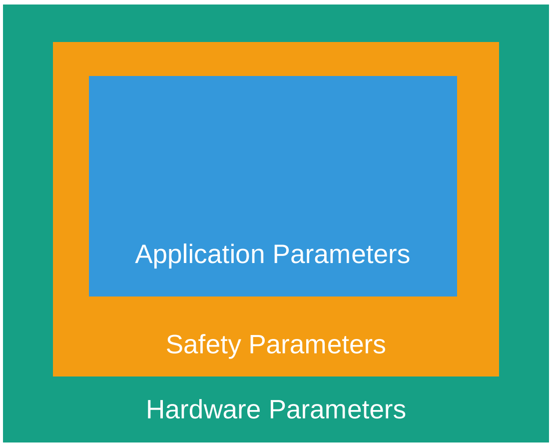


Figure 9 – Parameter Structure

There are three groups of parameters:

Parameter-Group	Description
Hardware Parameters	Used for protection of the key Battery Management Components (defined by STW)
Safety Parameters	Are based on HW-Parameters. Used for configuration of the safety components application running on Safety Controller, SSV, PMB, CSCs.
Application Parameters	Are based on safety parameters. Used for configuration (Cell Specification) of the battery application running on the Main Controller.

4.3.2 Example Configuration Step by Step

Let's have a look how to configure the software parameters for the demo system.

4.3.2.1 Safety Parameters

Safety parameters will be described in a `*.bsc` file. There is a demo configuration file "`safety_ds_conf.bsc`" included in the software release. Load this file into the BMC Dataset Configuration Tool.

Tipp: Register the file type `*.bsc` on your PC to associate it with the BMC Configurator.

BSC-File includes:

- Hardware Parameters (BMS, CSC, PMB), defined by STW
- Rule File (Describes the limits-algorithm of the Safety-Parameters (based on Hardware-Parameters), defined by STW
- Safety Parameters (Parameters for safety relevant components SC and SSV, CSC, PMB

Please take the time to define the safety limits carefully to prevent the setup from malfunction and the environment and user from harmful injuries or death.

Let's change the parameters component by component to our demo system setup.

4.3.2.1.1 SC

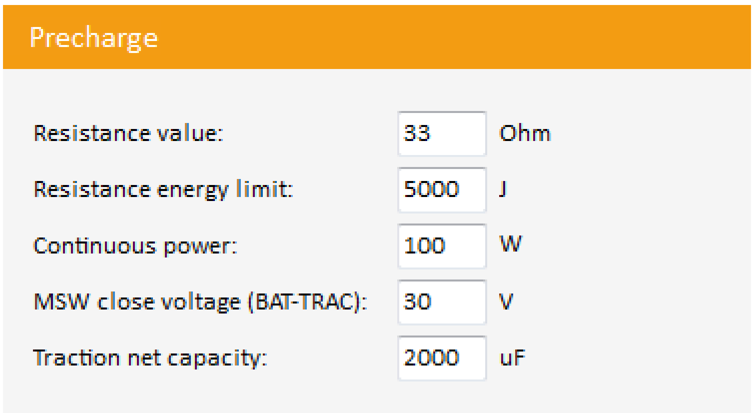


Figure 10 – Precharge parameters

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

Parameter	Value for demo system	Comment
Resistance value	33 Ohm	Resistance value of precharge resistor used
Resistance energy limit	5000 J	Energy limit of precharge resistor used
Continuous power	100 W	Continuous power value of precharge resistor used
MSW close voltage (BAT-TRAC)	30 V	Required voltage difference between (BAT-TRAC) to finish the precharge (Default 30V) and close the second MSW
Traction net capacity	2000 uF	Capacity on the traction net side (e.g. Inverter Capacity) Min. permitted value permitted is 1000uF. If your real capacity is lower, the minimum value (1000uF) should be used. Background: Low capacities are pre-charged very fast and the process may outperform the sensor.

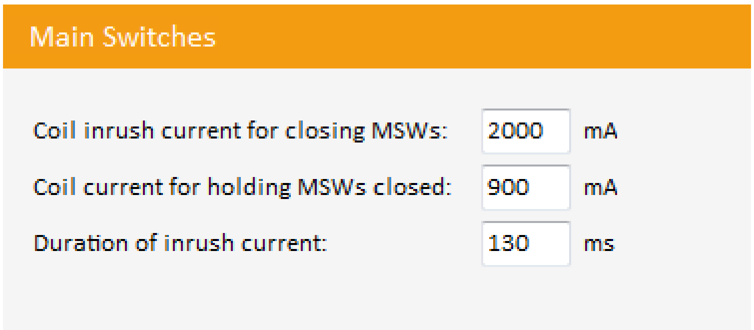


Figure 11 – Main Switches parameters

Parameter	Value for demo system	Comment
Coil inrush current for closing MSWs (=I_PICKUP)	2000 mA	Datasheet values of main switches used. When using main switches with economizer (internal current control) the I_PICKUP and I_HOLD should be set to maximum.
Coil current for holding MSWs closed (=I_HOLD)	900 mA	
Duration of inrush current (=T_PICKUP)	130 ms	Datasheet value of main switches used. Required time, I_PICKUP needs to be present for closing the main switches. Default: 150 ms

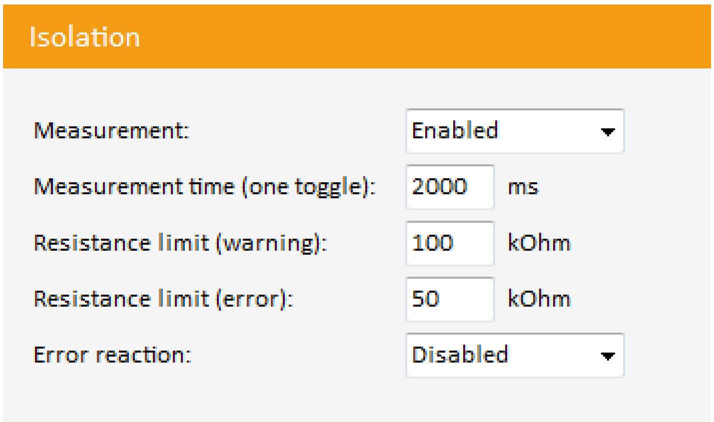


Figure 12 – Isolation measurement parameters

Parameter	Value for demo system	Comment
Measurement	Enabled	System/User defined decision. Enable or Disable Isolation Measurement
Measurement time (one toggle)	2000 ms	Isolation measurement time depends on Y-Capacity of the system. Measurement Time [ms] >= 2 * Y-Capacity [nF]
Resistance limit (warning)	100 kOhm	System/User defined value. Common warning limit definition: 150 Ohm/V
Resistance limit (error)	50 kOhm	System/User defined value. Common error limit definition: 100 Ohm/V
Error reaction	Disabled	System/User defined decision. If Enabled, system safety error will be set on isolation issue

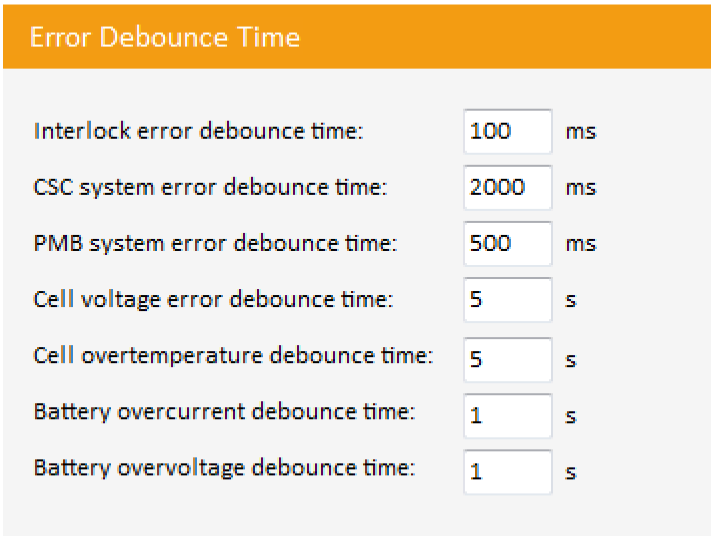


Figure 13 – Error debounce time parameters

Parameter	Value for demo system	Comment
Interlock error debounce[2] time	100 ms	System/User defined value.
CSC system error debounce time	2000 ms	System/User defined value.
PMB system error debounce time	500 ms	System/User defined value.
Cell voltage error debounce time	5 s	System/User defined value.
Cell overtemperature debounce time	5 s	System/User defined value.
Battery overcurrent debounce time	1 s	System/User defined value.
Battery overvoltage debounce time	1 s	System/User defined value.

[2] *To avoid setting errors when they are not really present (by noise on the lines, or peaks in the measurements) a debouncing mechanism assures the error conditions are present for a while before setting the error.*

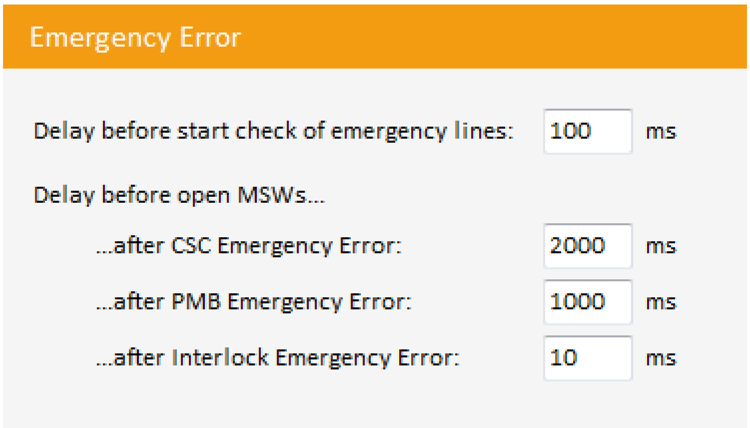


Figure 14 – Emergency delay parameters

Parameter	Value for demo system	Comment
Delay[3] before start check of emergency lines	100 ms	Delay before start check of hardware emergency lines after start-up. (Default 100 ms)
Delay before open MSWs		
...after CSC Emergency Error	2000 ms	System/User defined value.
...after PMB Emergency Error	1000 ms	System/User defined value.
...after IL Emergency Error	10 ms	System/User defined value.

[3] *Delay time starts after error debouncing process*

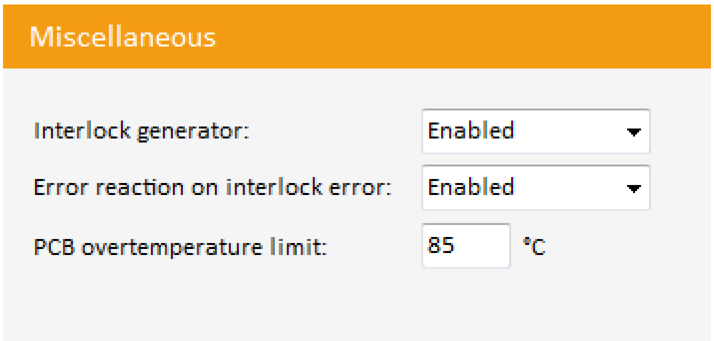


Figure 15 – Miscellaneous parameters

Parameter	Value for demo system	Comment
Interlock generator	Enabled	Enable / Disable interlock signal generator.
Error reaction on interlock error	Enabled	System/User defined decision. If Enabled, system safety error will be set on interlock signal issue
PCB overtemperature limit	85 °C	System/User defined value.

4.3.2.1.2 CSC

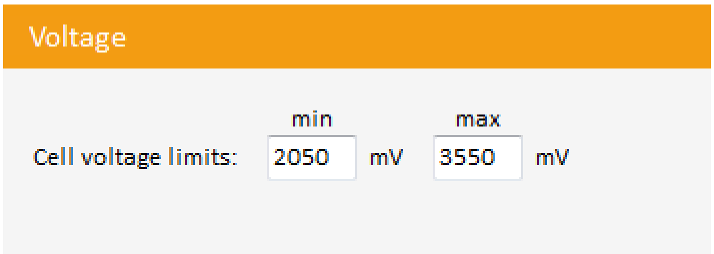


Figure 16 – Cell voltage parameters

Parameter	Value for demo system	Comment
Cell voltage limits	Min: 2050 mV Max: 3550 mV	According to cell specification.

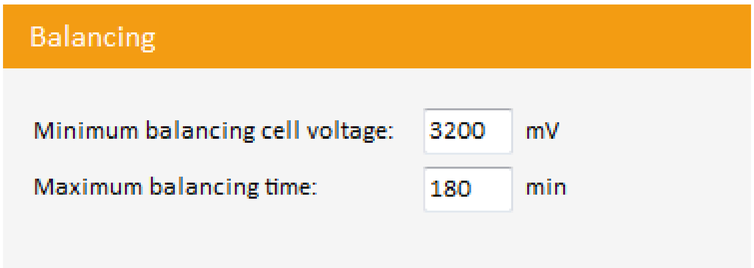


Figure 17 – Balancing parameters

Parameter	Value for demo system	Comment
Minimum balancing cell voltage	3200 mV	System/User defined value. According to cell specification. Usually nominal voltage will be used.
Maximum balancing time	180 min	System/User defined value. Balancing will be stopped after reaching this time.

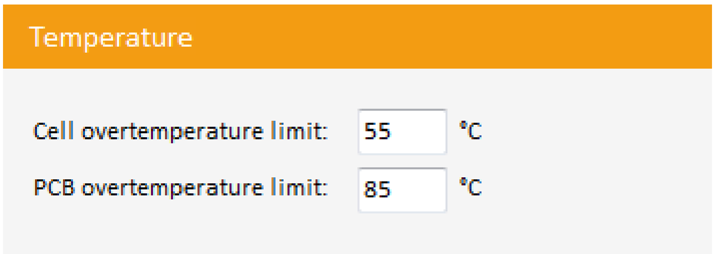


Figure 18 – Temperature parameters

Parameter	Value for demo system	Comment
Cell overtemperature limit	55 °C	According to cell specification.
PCB overtemperature limit	85 °C	System/User defined value.

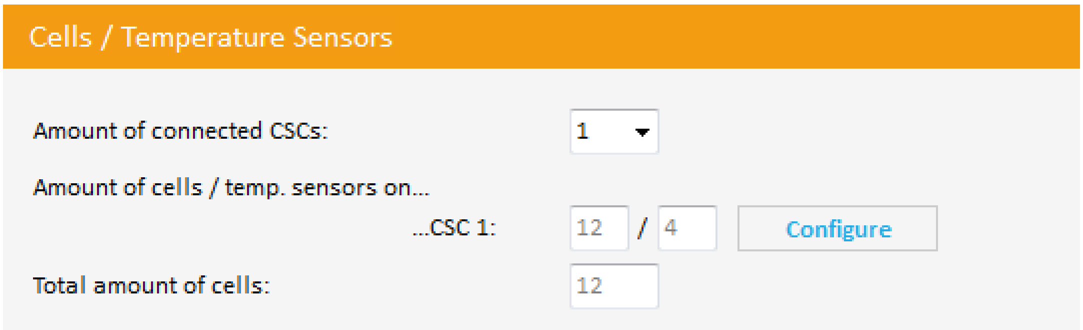


Figure 19 – Cells / Temperature parameters

Parameter	Value for demo system	Comment
Amount of connected CSCs	1	Amount of connected CSCs in a Battery Management Pack

The CSC has to be configured according to the cell wiring which is described in the chapter “CSC configurations” in the document “mBMS2 Hardware Guide”.
In the demo system only one measurement module is used, it handles 12xCells and 4xTemperature Sensors.

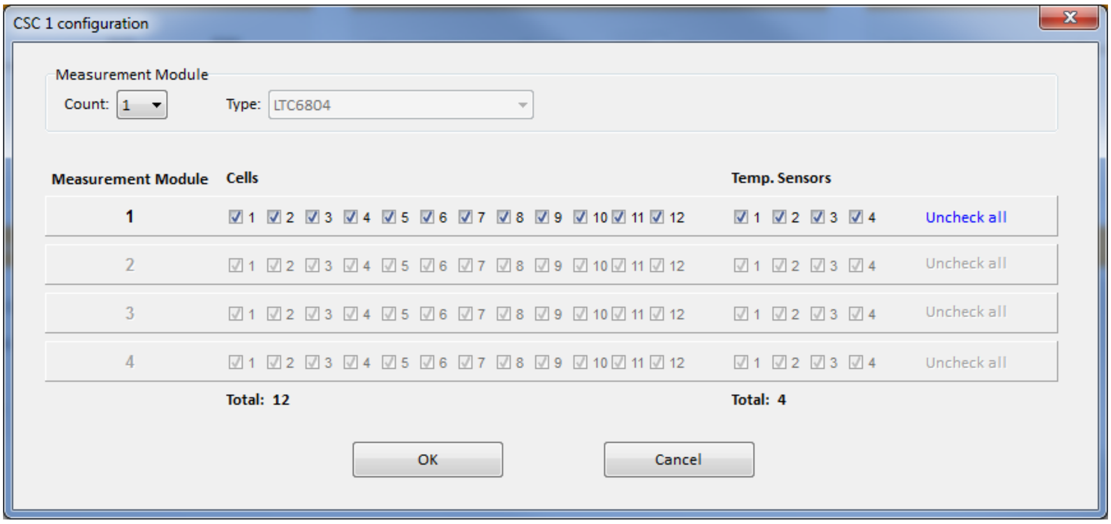


Figure 20 – CSC configuration (12 cells / 4 temp. sensors)

4.3.2.1.3 PMB

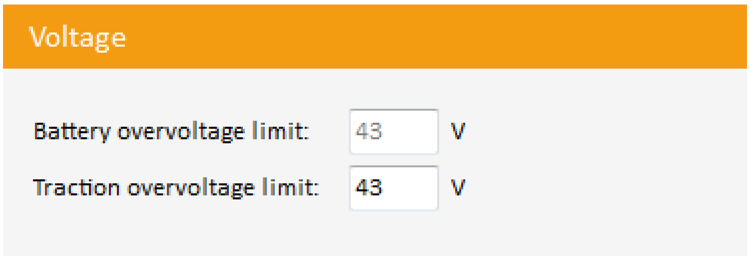


Figure 21 – High Voltage configuration parameters

Parameter	Value for demo system	Comment
Battery overvoltage limit	43 V	Read-only information. Value will be determined according to amount of cells and the maximum voltage. 12 cells * 3550 mV = 42,6 V (≈ 43 V)
Traction overvoltage limit	43 V	System/User defined value. Default = Battery overvoltage limit.

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

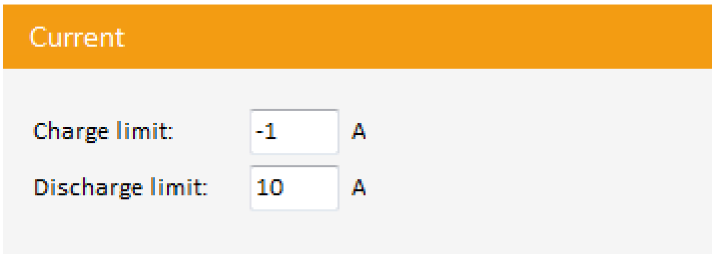


Figure 22 – Current parameters

Parameter	Value for demo system	Comment
Charge limit	-1 A [4]	Safety Limit, According to cell specification.
Discharge limit	10 A	Safety Limit, According to cell specification.

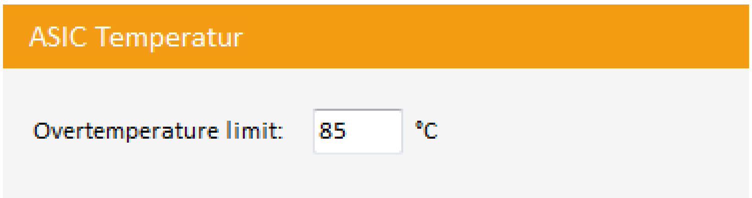


Figure 23 – ASIC temperature parameter

Parameter	Value for demo system	Comment
Overtemperature limit	85 °C	System/User defined value.

[4] *Definition: Charge current will be described as a negative value, Discharge current as a positive.*

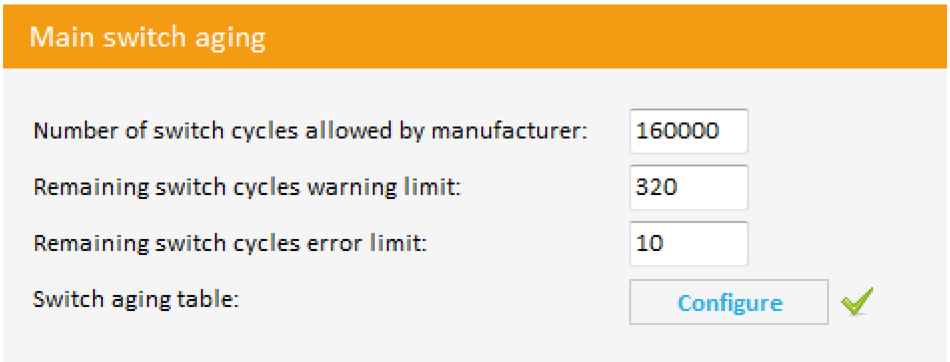


Figure 24 – Main switch aging parameters

Parameter	Value for demo system	Comment
Number of switch cycles allowed by manufacturer	160 000	Datasheet value of main switches used. **The value from the dataset, that will be first flashed on the ECU's will be used for the switch cycle counter. The saved value can only be changed by reset the switch cycle counter.**
Remaining switch cycles warning limit	320	System/User defined value.
Remaining switch cycles error limit	10	System/User defined value.
Switch aging table	View example table in `safety_ds_conf.bsc`	Datasheet value of main switches used. Switch cycles according to power class.

Shortly before reaching the number of allowed switch cycles the system reports a warning, and when the value is reached a safety error is set.
On replacing the main switches, the switch cycles counter in PMB needs to be reset. The reset can be done with a command on the sensor CAN (see also Reset the main switch counter on Sensor-CAN).

4.3.2.2 Application Parameters

Application parameters will be described in a `*.bcc` file. There is a demo configuration file "`appl_ds_conf.bcc`" including in the software release. Load this file into the BMC Dataset Configuration Tool.

Tipp: Register the file type `*.bcc` on your PC to associate it with the BMC Configurator.

BCC-File includes:

- BSC-File (Safety-Parameters).
  Attention: On updating safety parameters, the bsc file should be updated inside the bcc file.
- Application Parameters (Cell specific parameters, based on safety parameters)

Let's see how to setup the application parameters according to cells, which are used in the demo system.

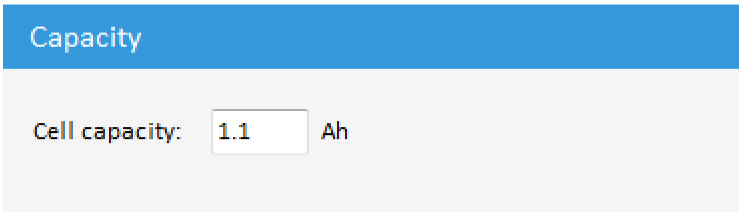


Figure 25 – Cell capacity parameter

Parameter	Value for demo system	Comment
Cell capacity	1.1 Ah	According to cell specification.

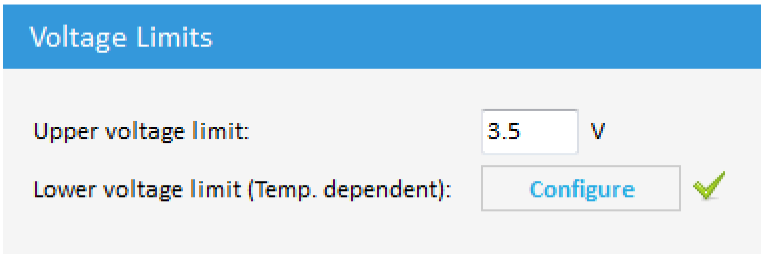


Figure 26 – Voltage limits parameters

Parameter	Value for demo system	Comment
Upper voltage limit	3.5 V	According to cell specification. Application limit = Safety upper voltage limit - System/User defined tolerance.
Lower voltage limit (Temperature dependent)	2.4 V	According to cell specification. Application limit = Safety lower voltage limit + System/User defined tolerance. Note:Temperature value is not relevant if chart size = 1

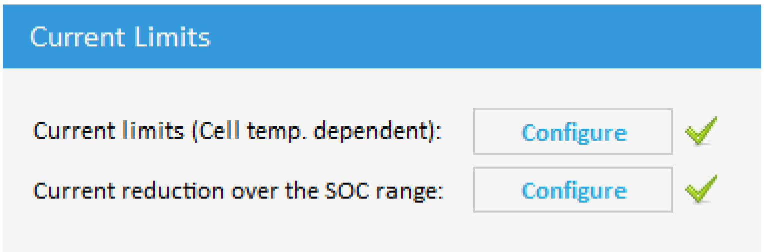


Figure 27 – Current limits parameters

Parameter	Value for demo system	Comment
Current limits (Cell Temperature dependent)	Charge: -0.9 A Discharge: 5 A	According to cell specification. Application limit = Safety current limit +/- System/User defined tolerance.
Current reduction over the SOC range	Charge: 0-80 % SOC ➝ 100 % 81-95 % SOC ➝ 50 % 96-100 % SOC ➝ 0 % Discharge: 0-9 % SOC ➝ 0 %	System/User defined values.

	10-39 % SOC → 50 % 40-100 % SOC → 100 %	

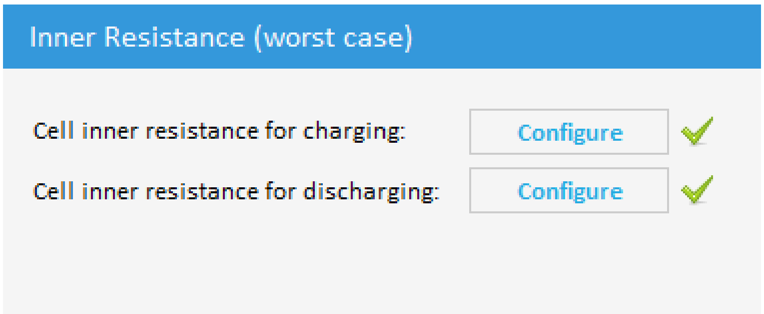


Figure 28 – Cell inner resistance parameters

<table>
<tr><th>Parameter</th><th>Value for demo system</th><th>Comment</th></tr>
<tr><td>Cell inner resistance for charging (worst case)</td><td rowspan="2">view example matrix in <code>appl_ds_conf.bcc</code></td><td rowspan="2">According to cell specification.
Default: Worst case value = Nominal * 1,5

Worst case values will be used, if the application cannot determinate the cell resistance while operation (because of a small load current e.g.).

If there is no information from the manufacturer, you can apply to the determined values by the application on the ESS-CAN and define the worst case values. (e.g.: ESS-CAN value = 100 mOhm; Defined dataset worst case value = 150 mOhm).</td></tr>
<tr><td>Cell inner resistance for discharging (worst case)</td></tr>
</table>

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

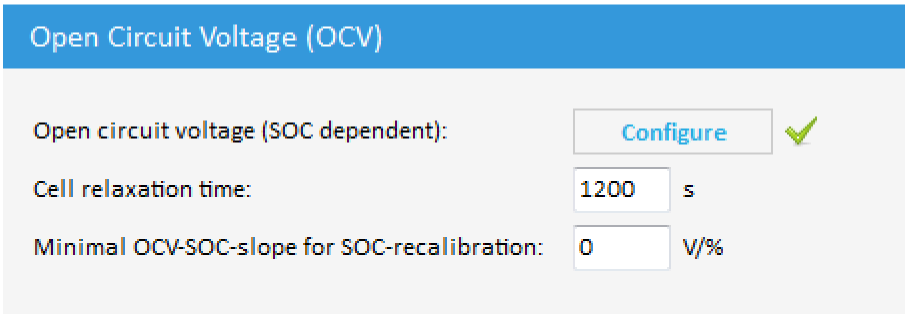


Figure 29 – Open Circuit Voltage parameters

Parameter	Value for demo system	Comment
Open circuit voltage (SOC dependent)	0 % SOC → 3.121 V 10 % SOC → 3.213 V 30 % SOC → 3.273 V 60 % SOC → 3.292 V 80 % SOC → 3.328 V 95 % SOC → 3.331 V 97 % SOC → 3.337 V 99 % SOC → 3.351 V 100 % SOC → 3.373 V	System/User defined operating area (SOC range) according to cell specification.
Cell relaxation time	1200 s	System/User defined value according to cell specification. Relaxation time starts when there is no load current present. After the relaxation time, the application performs a SOC recalibration, where the SOC value will be determined according to the OCV.
Minimal OCV-SOC-slope for SOC-recalibration	0 V/%	System/User defined value according to cell specification. Default=0 (Recalibration can be done within complete SOC range) This limit can be used to prevent the SOC recalibration in some flat SOC areas, to avoid incorrect determined values.

4.3.3 Generating Datasets

After the configuration of the safety and application parameters, safety dataset and application dataset hexfiles can be generated.

Configuration File	Dataset Result
`safety_ds_conf.bsc`	Safety Dataset - `safety_ds.hex` [5]
`appl_ds_conf.bcc`	Application Dataset - `appl_ds.hex` Due to the bsc file content is a part of a bcc file, the safety dataset can also be created.

Let's see how to bring the generated datasets to the mBMS.

[5] *There is no relevance in file naming. You are free to use your own naming convention.*

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

4.4 Update

The Update-Tool allows the user to update the complete mBMS-Network.
The tool must have the exclusive control over the mBMS operating state (Shut-Down, Wake-Up…). While updating the tool will Reset / Wake-Up / Shut-Down the mBMS automatically.

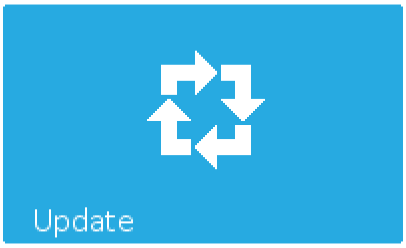


Figure 30 – Update-Button

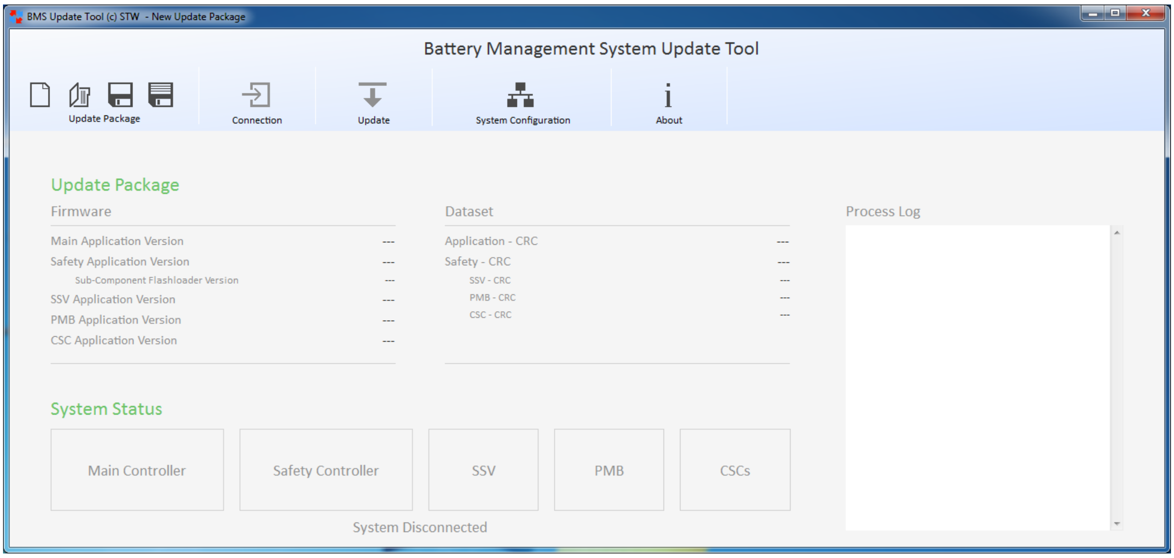


Figure 31 – Screenshot of the Update Tool

4.4.1 Software Update Packages (`*.pack`)

The mBMS Software Update Packages provide the user an easy and simple way of software version management.
A Software Update Package (`*.pack` file) includes all necessary hex-files, which are necessary for mBMS update.

Tipp: Register the file type (`*.pack`) on your PC to associate it with the BMS Update Tool.

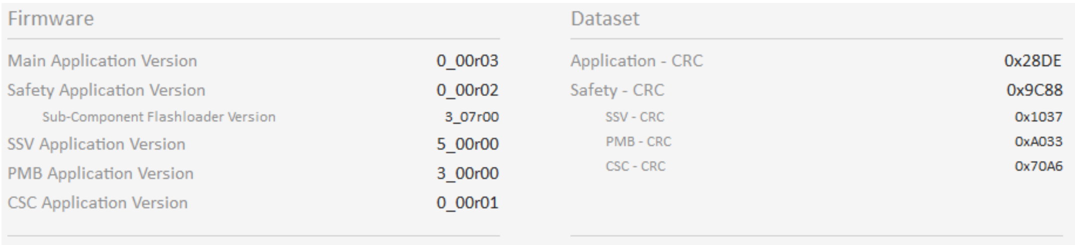


Figure 32 – Software Update Package content

A Software Update Package includes following two parts:

Content	Description
Firmware	Firmware for the Battery Management Components. Created by STW
Dataset	Safety and battery application configuration datasets. Created by user according to his battery system.

4.4.2 Example Update Step by Step

4.4.2.1 Setup Update Tool

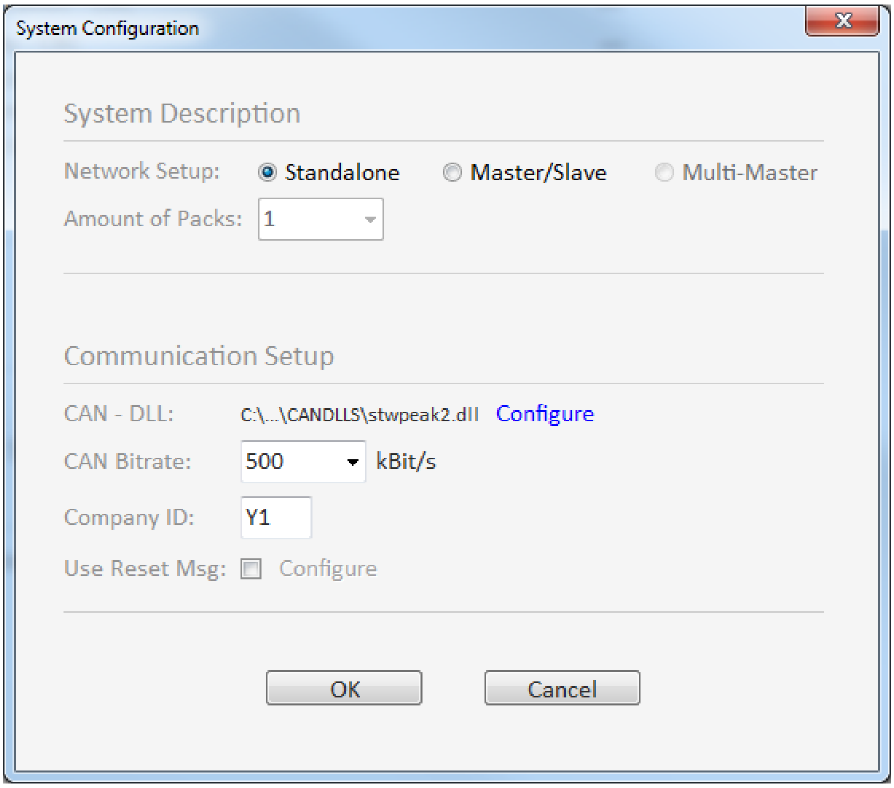
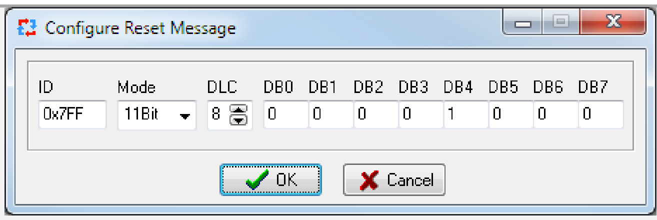


Figure 33 – System Configuration Dialog

Configuration parameter	Value for demo system	Comment
Network Setup	Standalone	mBMS network setup (Standalone / Master-Slave / Multi-Master)
Amount of Packs	1	Members in the mBMS network.
CAN-DLL	stwpeak2.dll	CAN-Interface high level communication DLL. See chapter **4.2 How to connect the PC with the mBMS** for more information.
CAN Bitrate	500 kBit/s	CAN Bitrate Default: 500 kBit/s
Company ID	Y1	Customer Company ID, defined by STW See `company_id.txt` on the STW Cloud
Use Reset Msg	Disabled	Default: disabled. **Important:** When using BMS with KL15 Wake-up option, the reset message should be configured like:

		 (Message: EXT_FuncRequest (0x7FF), Signal: Func_reset)

4.4.2.2 Modify Software Update Package

There is a demo Software Update Package file “`y_bmc_update_package__[version].pack`” including in the software release. After loading this file, generated demo system datasets `safety_ds.hex` and `appl_ds.hex` (created in chapter **4.3.3 Generating Datasets**) can be imported via drag&drop.

Finally the Software Update Package can be saved as a customer modified package (e.g. `my_mBMS_demo_sw_package.pack`).

4.4.2.3 Connect & Update

When a valid and complete software update package is loaded, the Icon “Connection” will be activated.

Before connecting to system, check if the supply voltage is present. The mBMS should go to sleep mode automatically when there is no communication on the ESS-CAN.
The mBMS sleep mode is required for successful connect/update procedure.

On system-connect the tool will address all mBMS-Packs in the network and get their current target versions.

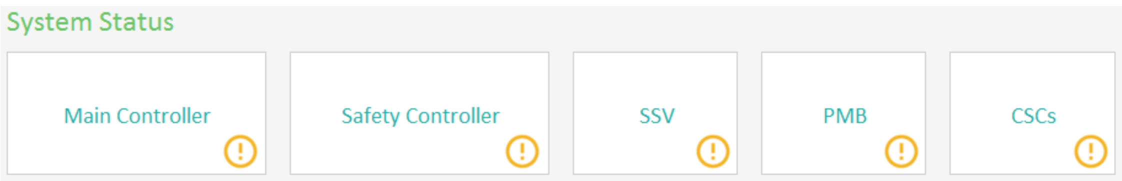


Figure 34 – System Status, connected view

System Status displays which components have to be updated. On mouse move affected BMS-Packs can be seen.

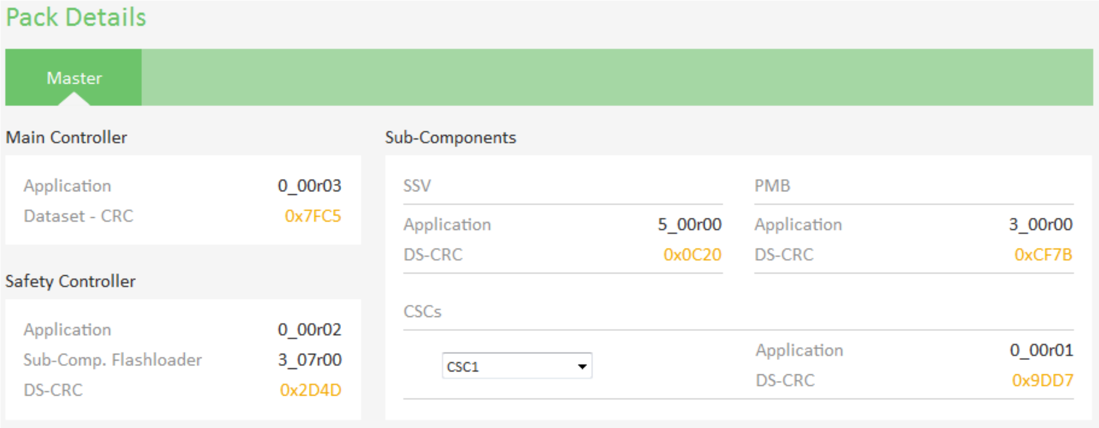


Figure 35 – BMS Pack details

Pack details visualize which versions are running on the target. Version deviations (Target vs. Update Package) are colored (orange).

After a successful connection to the system, the Icon “Update” will be activated.
During the update procedure the tool will update all affected components in the network automatically. This process might take few minutes.

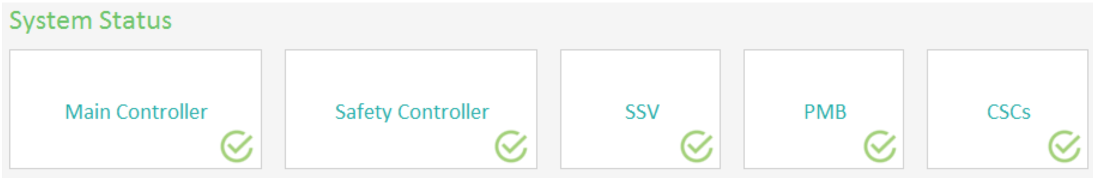


Figure 36 – System Status after successful update

4.4.3 Use Case – Initial update

After production the Battery Management Components might have no software running (Factory settings). Hence the System Status will report some missing software versions. A System Update will fix this issue.

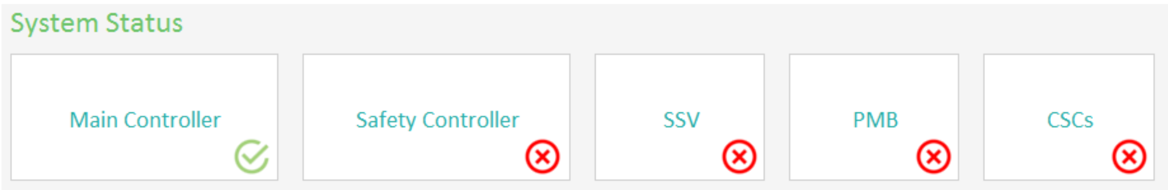


Figure 37 – Factory settings System Status

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

4.5 Diagnostic

The Diagnostic Tool can be used during initial diagnostics of the mBMS.
The tool will be connected via ESS-CAN and is able to access a subset of System Control Unit features (see also **3.1 Responsibility**). Only common ESS-CAN Interface (described in `ESS_CAN.dbc`) will be supported.
Don't forget to setup the CAN interface correctly.

Figure 38 – Diagnostic-Button

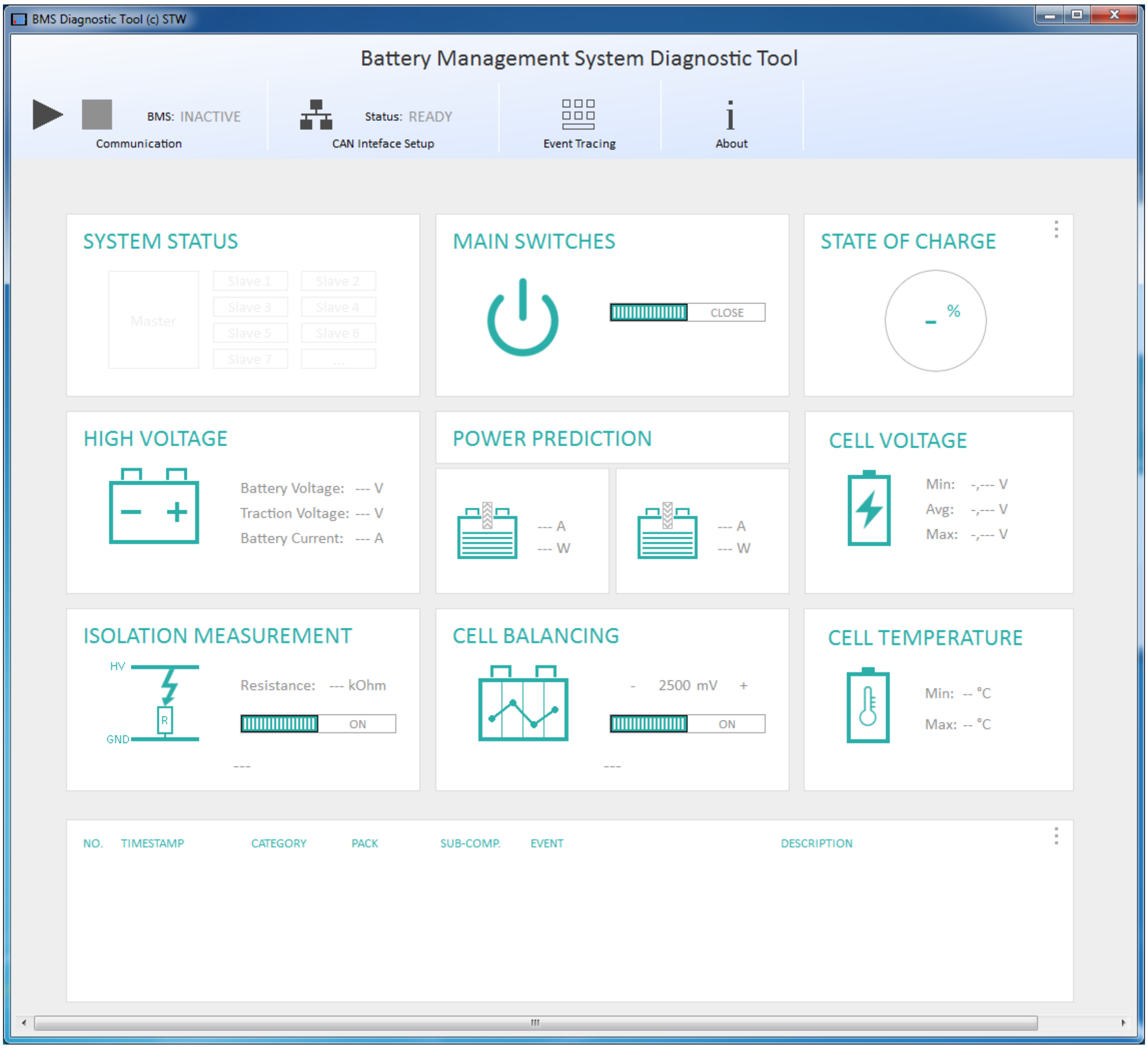


Figure 39 – Screenshot of the Diagnostic Tool

With the Diagnostic Tool, the user is able to request main mBMS functions and display main battery data.

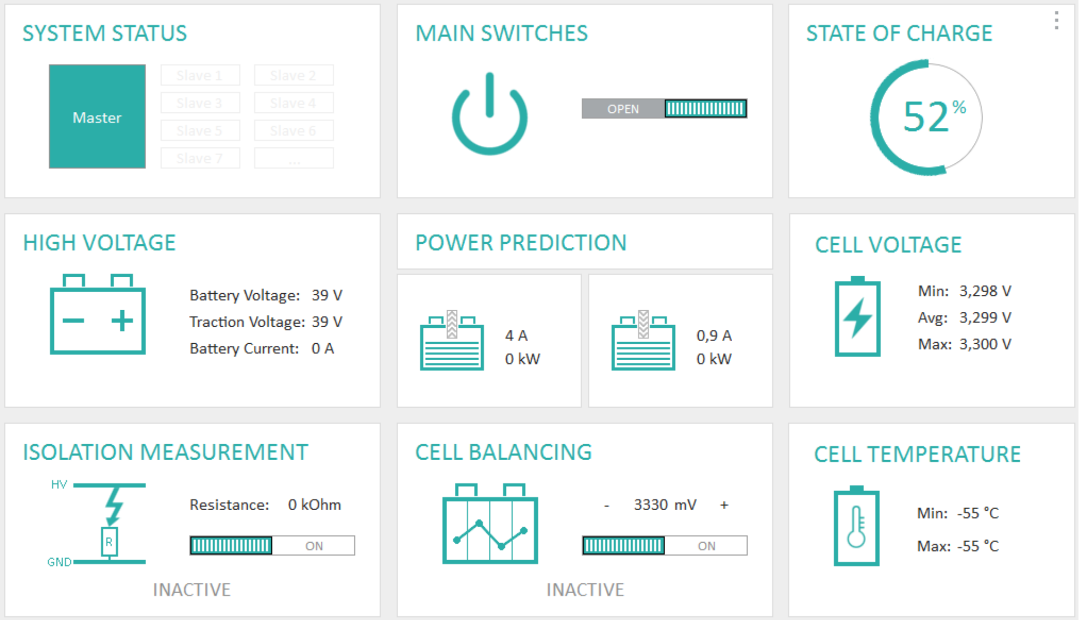


Figure 40 – Diagnostic of Demo System

4.6 How to upgrade to newer mBMS software release

STW is working continuously on the mBMS software to provide more features and improve the quality of the mBMS product.

If you want to upgrade your mBMS to a newer software release, please follow the following instructions.

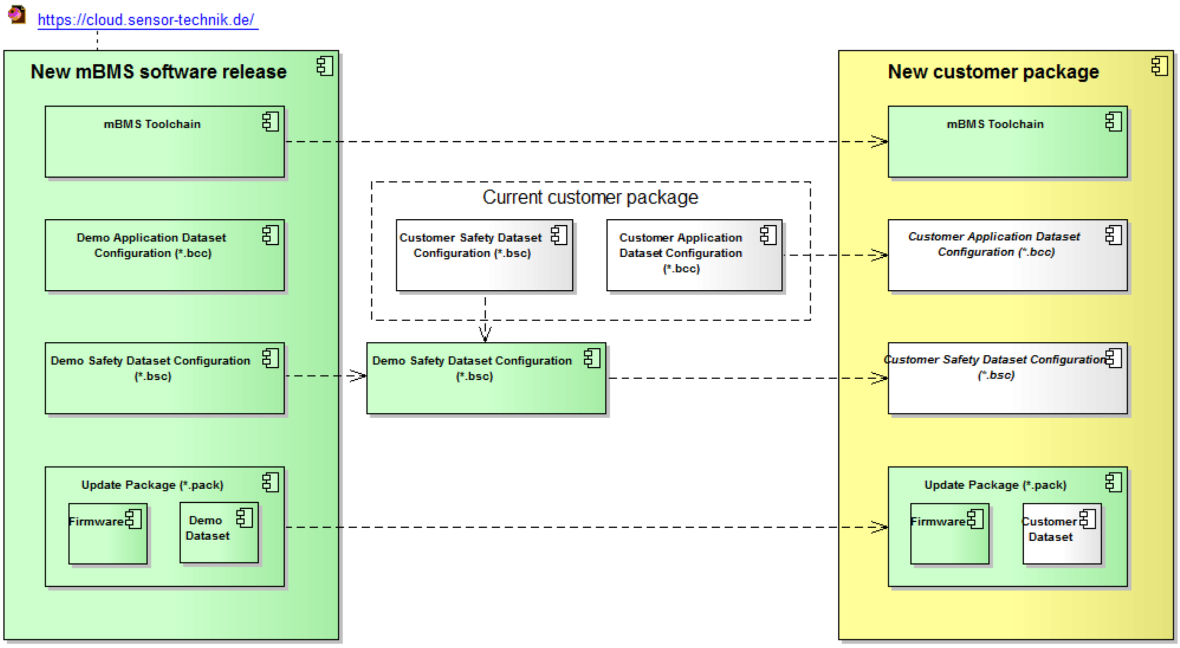


Figure 41 – How to upgrade to newer mBMS software release

Step	Description	Tool to use
1	Download new mBMS software release (https://cloud.sensor-technik.de/).	STW Cloud
2	Install new mBMS Toolchain on your PC.	mBMS Toolchain Installer
3	Demo Safety Dataset Configuration file (*.bsc) from the new software release has to be used! It includes the hardware and rule files which are compatible with the newest BMC Dataset Configurator version. Open `safety_ds_conf.bsc` file.	BMC Dataset Configurator
4	Import your customized safety parameters. **Double check the imported safety parameters!**	
5	Save your new safety parameters configuration file (e. g. `my_customized_safety_ds_conf.bsc`).	
6	Application Dataset Configuration (*.bcc) can be used from previous release. Open this file.	

7	Import the new safety dataset configuration.	
8	Save your application parameters configuration file (e. g. `my_customized_appl_ds_conf.bcc`).	
9	Create dataset hex files.	
10	Open the software update package (`y_bmc_update_package__[version].pack`) from new release. It includes the newest firmware.	BMS Update Tool
11	Import your dataset hex files.	
12	Save the new update package file (e. g. `my_custom_update_package__[version].pack`).	
13	Update your mBMS with the new update package.	

5 mBMS Controlling

After a successful commissioning of the battery system with the mBMS Toolchain, follow the integration into real application and the controlling of the mBMS by the SCU.
This chapter describes all important mBMS control functions, which are necessary for the SCU.

5.1 Operation State Management

There are two hardware variants of the BMS:

- CAN Wakeup
- KL15 Wakeup

For more information, see mBMS-Hardware-Guide.

CAN Wakeup variant
The System Control Unit is responsible for Network-Management. It has to manage the Wake-up / Shut-Down synchronization of all ESS-CAN bus participants.

Following requirements have to be fulfilled to perform a regular mBMS Wake-Up / Shut-Down via ESS-CAN:

Message	Signal	Description
EXT_FuncRequest *(mBMS Rx-MSg)*	`Func_sys_state_req`	Wakeup/ON Start ESS-CAN communication with stay alive sys-state signal (Func_sys_state_req = 1) Stay alive signal has to be present while communicating with the mBMS. Shutdown/OFF: The sys-state signal has to be switched to shut-down (Func_sys_state_req = 0) and the ESS-Communication has to be stopped.
mBMS_FuncSTAT *(mBMS Tx-MSg)*	`BMS_stay_alive`	Wakeup/ON BMS_stay_alive = 1 Shutdown/OFF BMS_stay_alive = 0

KL15 signal should not be set when using CAN Wakeup hardware variant.

KL15 Wakeup variant:
The Wake-Up / Shut-Down handling is handled with the digital input signal "KL15". Due to there is no logic needed from the SCU side, this handling is much easier to implement in a system.

Following requirements have to be fulfilled to perform a regular mBMS Wake-Up / Shut-Down via KL15:

KL15 Signal State	BMS Operation State	Comment
1	Wake-up / ON	The CAN-Message mBMS_FuncSTAT will transmit the Signal BMS_KL15_state = 1
0	Shutdown / OFF	The CAN-Message mBMS_FuncSTAT will transmit the Signal BMS_KL15_state = 0

Func_sys_state_req CAN signal should not be set when using KL15 Wakeup hardware variant.

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

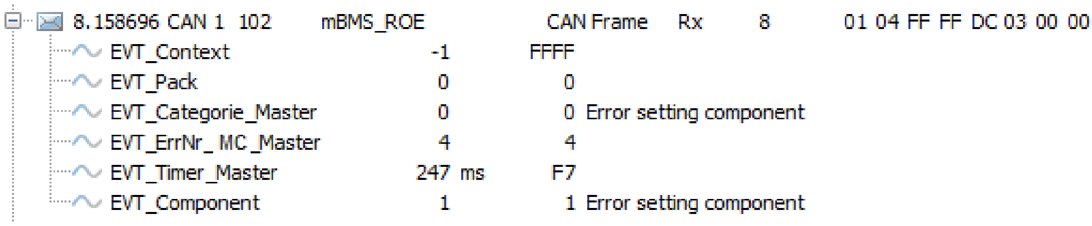
5.2 Response on Error Message

System events (errors, warnings) will be sent in the mBMS_ROE message on the ESS-CAN. For more information, please refer to the interface description file "`mBMS_ESS_CAN.dbc`". A error description can be found under appendix CAN-Error-Description.pdf

Evaluation using example of Pin-Configuration Warning:

- Screenshot Diagnostic Tool:

- CAN-Trace:



User / SCU should focus on events coming from components Main Controller and Safety Controller (EVT_Component: 1 = MC; 2 = SC).

Sub-Component events (PMB and CSCs) can be used for detailed system diagnostic purpose. E. g. in case there is no access to the Sensor-CAN.

5.3 Close main switches

To get the battery voltage on the traction net side, the high voltage main switches of the mBMS must be closed. The main switches will be controlled by defined CAN signals.

ESS-CAN-Interface

Message	Signal	Description
EXT_FuncRequest *(mBMS Rx-MSg)*	Func_MSW_Request_…	**Main Switch close request** of battery pack X
mBMS_FuncSTAT *(mBMS Tx-MSg)*	BMS_Master_MSW_Closed … BMS_Slave7_MSW_Closed	**Main switch close response** of battery pack X

Conditions to close the main switches

- No Errors active
- CAN message EXT_FuncRequest must be send in the defined cycle time and the Signal Func_MSW_Request_… must be set to 1(for Close) (0 for Open).

In a multipack system the BMS can handle the main switch close order automatically.
For this the CAN signals Func_MSW_Request_… must be set to 1.
The BMS will close the main switches with lower battery voltage first.

It is also possible that the SCU decide the close order of the pack main switches. For this the CAN signals Func_MSW_Request_… must be set in the wished order. It is recommended, to send the close request for the next pack after the response was received.

Issues why main switches will not be closed

- Safety errors are active or the application errors master/slave-, dataset- configuration or ESS-CAN request message timeout.

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

5.4 ISO Measurement

Isolation monitoring supervises the isolation resistance of the high voltage circuit of the vehicle. The resistance value is measured between HV+ and GND of the vehicle battery and HV- and GND of the vehicle battery.

The mBMS measures the resistance value of the complete system (including the internal measurement resistors) in kOhm. The measured value will be compared with the configured limits. mBMS transmits states of the measured value as well as the value itself via CAN.

In a multipack system, the isolation measurement will be handled by the BMS automatically. One of the packs which has closed the main switches, will activate the isolation measurement, if an activate-request is available.

ESS-CAN-Interface

Message	Signal	Description
EXT_FuncRequest *(mBMS Rx-MSg)*	Func_iso_measurement	Isolation measurement controlling (only possible if enabled in safety dataset) 0: disable 1: enable
mBMS_FuncSTAT *(mBMS Tx-MSg)*	BMS_iso_meas_act	ISO measurement state. 0: inactive 1: active
	BMS_iso_value_valid	ISO value valid state. 0: value invalid 1: value valid
mBMS_Trac_Info *(mBMS Tx-MSg)*	BMS_Iso_Resist	Isolation resistance value

Conditions for Isolationmeasurement

- Only one ISO measurement must be active in a system. (ISO measurement ECU's from other supplier must be switched off.)
- To be able to control the Isolationmeasurement over the CAN, the ISO measurement must be enabled in the safety dataset configuration.
- The ISO measurement can be activated/deactivated over the CAN signal Func_iso_measurement.
- If the BMS activate the ISO measurement, it sends as response the CAN signal BMS_iso_eas_act = 1
- The ISO resistance value will be transmitted in the in the CAN signal BMS_Iso_Resist. The ISO measurement needs time to measure the resistance value.
  Over the CAN signal BMS_iso_value_valid, the BMS inform the system if the resistance value is valid or not.

Issues why ISO measurement will not be started

- Conditions are not fulfilled
- Failure in the CAN communication.
- Failure in the hardware connection / hardware defect

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

5.5 Balancing

The reason for balancing is the compensation of varying self-discharge rates that the cells may develop during their operational life. The development of varying capacity loss is not an issue that should be attacked by the balancing mechanism. When cells are relatively new, there should be no need for balancing at all.
When a battery is constructed, all cells should have identical SOC (and also voltage) in order to prevent the need for a lasting initial balancing procedure.

The need for balancing shall be determined and the balancing procedure shall be started only, when
- the battery system is in a quiescent state with no significant current flowing,
- when all cell voltages are on a stabilized level and
- the SOC has reached a narrow pre-determined band

With the mBMS balancing functionality, the cell voltage of each single cell can be aligned to the minimal cell voltage value.

ESS-CAN-Interface

Message	Signal	Description
EXT_BalancingRequest *(mBMS Rx-MSg)*	Func_balancing	Balancing activation request. 0: inactive 1: active
	Threshold_voltage	Balancing voltage
mBMS_FuncSTAT *(mBMS Tx-MSg)*	BMS_balancing_act	Balancing activation response. 0: inactive 1: active

Conditions for starting balancing

- mBMS must be always in operational mode
- CSC should not have any errors
- The minimal cell voltage must be higher than the configured value “Minimum balancing cell voltage” (see configuration CSC)
- The threshold voltage of the CAN message EXT_BalancingRequest must be higher than the configured value “Minimum balancing cell voltage” and equal or lower than the minimal cell voltage.
- To start the balancing, the CAN signal Func_balancing must be set to 1: active.
- If balancing will be started successfully, the mBMS will send the response message mBMS_FuncSTAT::BMS_balancing_act = 1

Issues why balancing stops or will not be started

- Balancing will stop if all cell voltages are equal
- Balancing will stop after the configured time value “Maximum balancing time” will arrive.
- Conditions not fulfilled.
- CSC-Errors

5.6 Output control

mBMS contains two outputs for customer specific use. The outputs can be controlled by the defined CAN signals.

ESS-CAN-Interface

Message	Signal	Description
EXT_FuncRequest *(mBMS Rx-MSg)*	Func_Output_Pack_No	BMS Pack number of the controlled output
	Func_Output_No	BMS output number
	Func_Output_PWM_value	BMS output PWM value. PWM-Value from 0% - 100%
mBMS_FuncSTAT *(mBMS Tx-MSg)*	FuncSTAT_Output_Pack_No	BMS Pack number of the controlled output, response signal
	FuncSTAT_Output_No	BMS output number, response signal
	FuncSTAT_Output_U_Feedback	BMS output voltage feedback, response signal.

Issues why Output control not work

- Failure in the CAN communication.
- Failure in the hardware connection / hardware defect.

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

5.7 Reset

The CAN reset request can be used to reset the errors and also for the update process on BMS with KL15-wakeup.

ESS-CAN-Interface

Message	Signal	Description
EXT_FuncRequest *(mBMS Rx-MSg)*	Func_reset	0: disable 1: enable
mBMS_FuncSTAT *(mBMS Tx-MSg)*	BMS_reset_denied	Response to the reset request 0: reset accepted 1: reset denied

Conditions

- Reset will be done, if the main switches are opened. If the main switches are closed, a reset request will be denied.

Issues why Reset not work

- Conditions not fulfilled.
- Failure in the CAN communication.
- Failure in the hardware connection / hardware defect.

5.8 Main switch aging

The "Main switch aging" functionality controls the switch cycle counter of the high voltage main switches. The switch cycle counter is dependent from the power under the main switches will be opened. Open the main switches under high power will cause a high counter value as opening the main switches under current 0A.

The configured number of switch cycles, allowed by the manufacture, will be saved in the PMB, to count down the switch cycle counter. The first configuration read by the PMB will be saved and can't be changed by adapting of the dataset configuration.
The switch cycle counter can only be changed by resetting the switch cycle counter (see Reset the main switch counter on Sensor-CAN).
If the switch cycle counter will arrive the warning limit, a MSW-Warning will be set and transmitted on the ESS-CAN. In this case it is recommended to change the main switches soon.
If the switch cycle counter will arrive the error limit, a MSW-Error will be set and transmitted on the ESS-CAN. In this case the BMS will be go into the safe state and the main switches can't be closed more.

5.8.1 Reset the main switch counter on Sensor-CAN

After replacing the main switches by new one, the main switch cycle counter must be reset to the configured value. For the reset process it is necessary to get a connection with the Sensor-CAN.

Sensor-CAN-Interface

Message	Signal	Description
SC_DATA_REQUEST *(PMB Rx-MSg)*	SC_MSW_Age_Req	3: Reset main switch aging
PMB_MSW_OPEN *(PMB Tx-MSg)*	PMB_MSW_AGE	Main switch cycle counter value. (Response message to SC_DATA_REQUEST)

After a successful reset, the PMB_MSW_AGE-Signal will transmit the configured value "Number of switch cycles allowed by manufacture".

If the maximal switch cycle counter is used up, the main switches must be replaced by new one and then reset the switch cycle counter. Otherwise there is no guarantee that the main switches can be opened in the next operation cycle.

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

6 mBMS battery states

In this chapter the battery states and their dependencies are described.

The figure below shows an abstract view of the battery application and its information flow. Detail information's can be found in the chapter below.

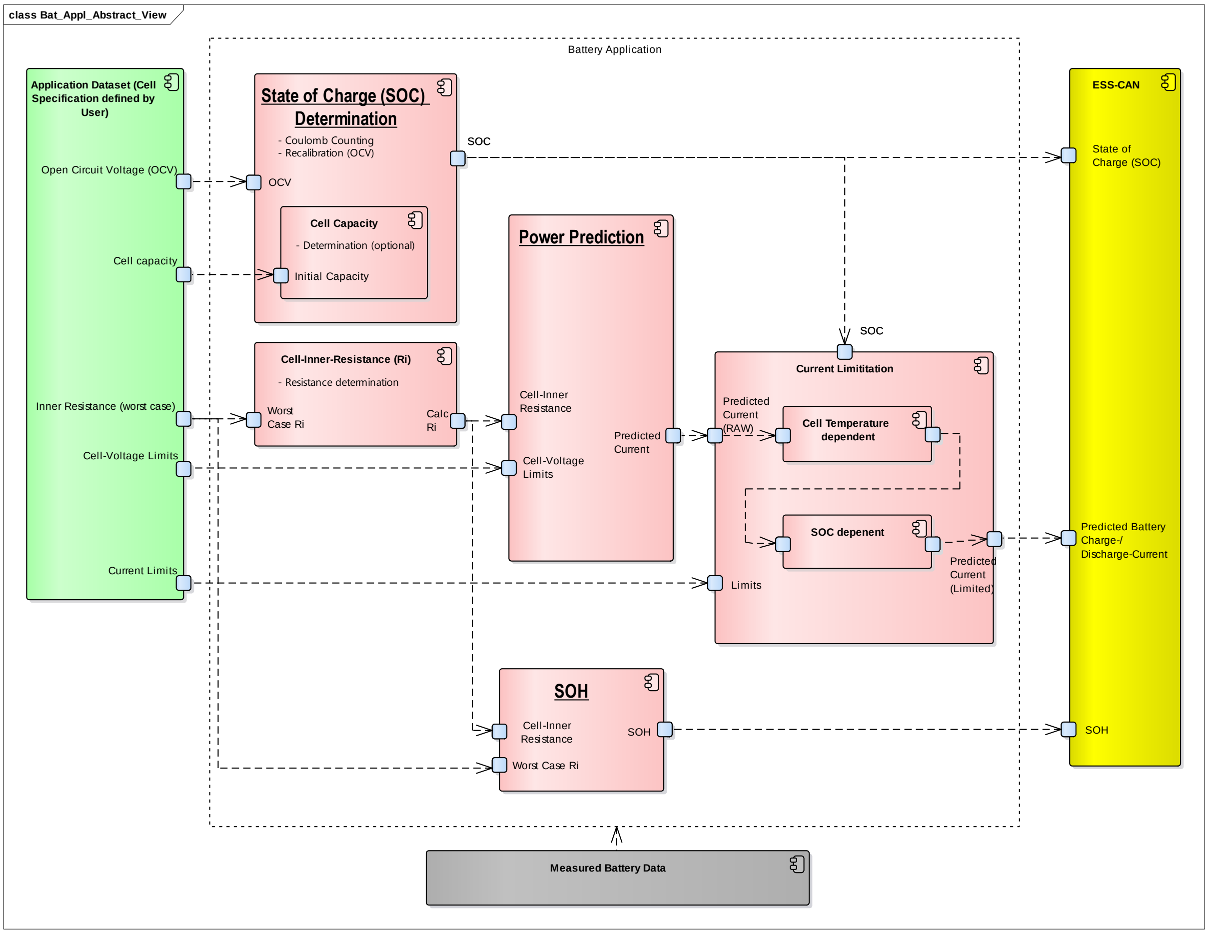


Figure 42 – Battery Application overview

6.1 State of charge (SOC)

The SOC will be calculated via the current integration method.
This requires the configuration parameters open circuit voltage (OCV), cell capacity and the sensor data cell voltage and current. The SOC value on the ESS-CAN is dependent from the minimal cell voltage.

For further details see Application Parameters and Battery application information flow

ESS-CAN-Interface

Message	Signal	Description
mBMS_Bat_Info *(mBMS Tx-MSg)*	BMS_SOC	Actual battery state of charge.

6.1.1 SOC recalibration

It is recommended to enable a SOC recalibration of the battery system.
Normally the SOC recalibration will be done automatically, as configured in the dataset (see Application Parameters).
The SOC recalibration can be started also manually over the ESS-CAN.

ESS-CAN-Interface

Message	Signal	Description
EXT_FuncRequest *(mBMS Rx-MSg)*	Func_SOC_recalib	SOC recalibration request. 0: inactive 1: active
mBMS_FuncSTAT *(mBMS Tx-MSg)*	BMS_SOC_RecalibState_Master … BMS_SOC_RecalibState_Slave7	SOC recalibration response of manual and automatic recalibration. 0: inactive 1: active

Conditions for starting SOC recalibration automatically

- mBMS KL30 must be always on
- Cell voltages must be inside the OCV-curve
- After “Cell relaxation time” is up. (the counter will be started when the measured battery current is lower than 200mA)
- The conditions for “Minimal OCV-Slope for SOC-recalibration” must be fulfilled (see Application Parameters).

After the first successful recalibration, the mBMS will do cyclic (cycle time = 3 x “Cell relaxation time”) SOC recalibration if all conditions are fulfilled.

Conditions for Starting SOC recalibration manually

- Cell voltages must be inside the OCV-curve
- The conditions for "Minimal OCV-Slope for SOC-recalibration" (see Application Parameters) must be fulfilled.
- Transmit the CAN message EXT_FuncRequest::Func_SOC_recalib = 1.

SOC recalibration state

The CAN signal BMS_SOC_RecalibState_... is on startup always 0.
After the first recalibration, the state will be change to 1.
The recalibration state will be reset at a battery current > 200mA for discharge and battery current < -200mA for charge.

Issues why SOC recalibration will not be started

- Conditions not fulfilled.
- Failure in the CAN communication.

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

6.2 Cell inner resistance

The cell resistance will be calculated using the OCV method.
For calculation of the resistance, a cell voltage jump is necessary, which is dependent among others from the current. The experience show, that the current limit is dependent from the battery size and so it was decided that:

Current limit for cell resistance calculation = maximal battery voltage limit / 100

Example:
maximal battery voltage limit = 800V
⇨ Current limit for cell resistance calculation = 800/100 = 8A

In this example the cell resistance will be calculated, when the battery current is higher than 8A.

If the resistance value can't be calculated, the worst case values form the dataset (Application Parameters) will be used.

ESS-CAN-Interface

Message	Signal	Description
mBMS_RI_OCV_Approx *(mBMS Tx-MSg)*	Cell_Ri_Ch_OCV	Cell resistance charge determined by OCV method
	Cell_Ri_DCh_OCV	Cell resistance discharge determined by OCV method
	Cell_Ri_Ch_Approx	Approximate cell resistance charge. The value change between the worst case value of the dataset and the calculated OCV-method value.
	Cell_Ri_DCh_Approx	Approximate cell resistance charge. The value change between the worst case value of the dataset and the calculated OCV-method value.

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

6.3 Power prediction

With the cell inner resistance values and the configured voltage limit values (see Application Parameters), the application calculates the power prediction (see Battery application information flow).

Optionally the calculated power prediction can be reduced dependent by the temperature and the SOC. For this it is necessary to configure the current limits in der application dataset (see Application Parameters).

The power prediction values are always 0, when the main switches are opened.

ESS-CAN-Interface

Message	Signal	Description
mBMS_PP *(mBMS Tx-MSg)*	PP_I_chg	Actual possible charge current.
	PP_Pwr_chg	Actual possible charge power.
	PP_I_dchg	Actual possible discharge current.
	PP_Pwr_dchg	Actual possible discharge power.

6.4 State of health (SOH)

The SOH describes the aging state of the battery. The SOH is a relative information and will be calculated depending from the cell inner resistance.

With the first calculated SOH (and the measured cell resistance), the assumption will be made, that the battery has a SOH of 100%. The configured cell inner resistance in the dataset will be used as information for the end of life.

ESS-CAN-Interface

Message	Signal	Description
mBMS_Bat_Info *(mBMS Tx-MSg)*	BMS_SOH	Actual battery state of health. The value on CAN will be shown in 5% Steps

Conditions
The SOH calculation should normally be done under the same conditions.
The cell inner resistance is dependent from different parameters and they have influence to the SOH value. Accordingly, there were made some limitations to the SOH calculation.
The SOH calculation will be done

- Only at the charge process
- at SOC from 20% to 80%
- at a cell temperature from 20°C to 30°C
- if a cell inner resistance calculation is possible (see Cell inner resistance)

If the SOH calculation was successfully done, the new SOH-value will be shown after a restart of the system. The SOH value will be saved into the EEPROM during the shutdown process. For the SOH value and other EEPROM data it is necessary that the shutdown process will be done correctly. Otherwise the data will be lost. (see also Operation State Management)

General: SOH = 100% means NEW
SOH = 0% means end of life reached

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

7 mBMS Functional Safety

> This chapter is not a safety manual but a general description of the mBMS safety functionality.

The system has been developed with a strong focus on functional safety. Many typical hazards relevant for lithium-ion batteries and their application in vehicles have been taken into account for the design of the mBMS system. The mBMS system is therefore suitable to create a functionally safe battery system that is able to protect from possible hazards. Certain potential hazards may not be detected or prevented by means of the mBMS or other electronics. For such hazards other measures have to be taken by the battery designer and manufacturer.

7.1 mBMS Safe State

The mBMS defines the safe state as OFF with the battery system exposing no high voltage to its environment. Two main switch relays are used to operate on each pole of the system for that purpose. The relays are operated by the mBMS. The mBMS is in the safe state by default.

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

7.2 mBMS Conditions for entering or not leaving the Safe State

The mBMS enters the **Safe State** upon occurrence of at least one of the following events:

- Over-voltage of battery cells
- Under-voltage of battery cells
- Over-temperature of battery cells
- Battery over-current
- Loss of Interlock signal
- Crash Signal activated (KL30c)
- Voltage Supply
- Routine diagnostic fail
    - Sensor communication control and internal BMS communication control
    - Supply voltage control
    - CSC- and PMB- Emergency
    - Interlock
    - Coil current control
- Startup diagnostic fail
    - CSC- and PMB- Emergency test
    - Interlock test
    - MSW-Control-Test
    - MSW-Age test
    - MSW-Supply-Test
    - Stuck test
    - Watchdog tests
    - PMB-, CSC-, SSV- communication
    - Dataset configuration

The Safe State is not left as long one or more of above status are active.

A short on the battery's poles is not considered as a hazard being handled by the mBMS primarily. A proper fuse should be selected by the battery manufacturer braking current in the event of a short. The mBMS will boost the main switch relays for a predefined time interval, being reserved for the fuse's reaction. The relays will then be deactivated.

Sensor-Technik Wiedemann GmbH, Am Bärenwald 6, 87600 Kaufbeuren, Tel.: 08341/95050, Fax: 08341/950555, www.sensor-technik.de

7.3 mBMS Safety Architecture Overview

Internal Communication

The Sensors (CSC, PMB) and the Battery Main Supervisor communicate via a dedicated internal Sensor-CAN bus backed up with an additional emergency signal providing redundancy. That is triggered upon the occurrence of a condition forcing the safe state. A proprietary interface based on Linear-Technology's “isoSPI” is utilized for communication with cell voltage and temperature sensors.

The integrity of internal communication is ensured by STW.

Cell Sensor Circuit (CSC)

CSC is called the device which measures the cell voltages cell temperatures. The CSC supervise the measured values to the configured limits. In case of a limit violation the CSC will inform the Battery Main Supervisor over the CAN and in case of an emergency additionally over a hardware line.

Power Measurement Board (PMB)

The PMB measure and monitor the battery –current, -voltage and the traction net voltage. Additionally, the PMB monitors the CSC via flow control algorithm and supervise the number of switch cycles of the main switches.
The PMB is equipped with a unique redundant safety circuit which enables the PMB to directly interrupt the emergency line if a too high charging or discharging current is detected. The emergency line will be also set, when the configured maximal number of switch cycles will be arrived or the flow control goes fail.

In case of a fail, the PMB inform the Battery Main Supervisor over the CAN-Interface.

Battery Main Supervisor

A diverse triple controller subsystem in the Battery Main Supervisor shares tasks and ensures absence of interference among software components.

- The Main Controller (MC - TC1796) takes care of functions being not related with functional safety, like battery state determination (SOC, PP, SOH)
- The Safety Controller (SC - XC2287) takes care of all safety related tasks and
- The System Super Visor (SSV - ATmega168) supervise the SC working correctly

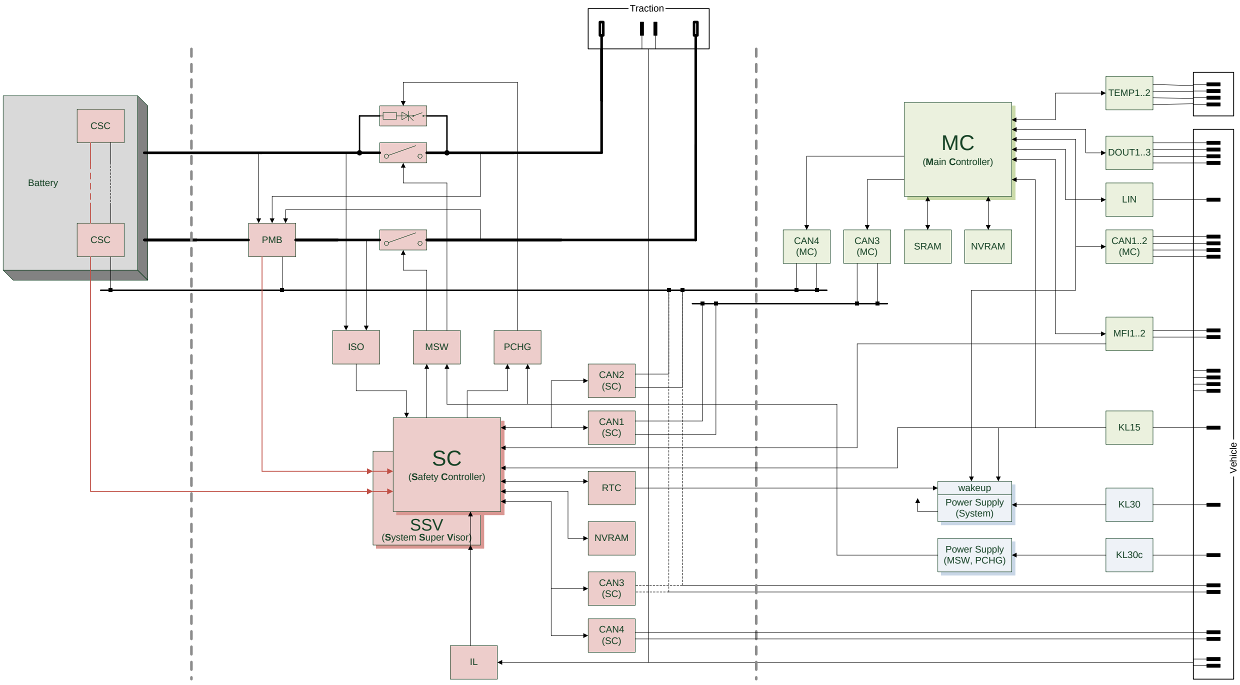


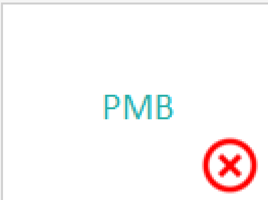
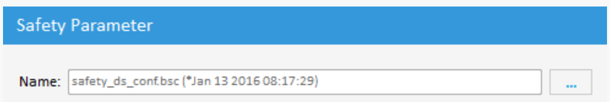
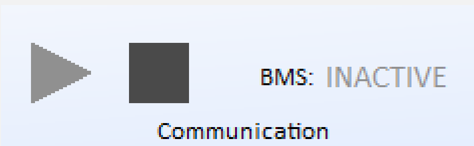
Figure 43 – mBMS overview

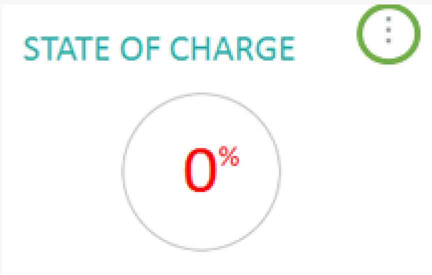
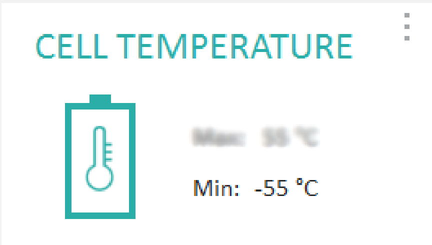
Most components undergo diagnostic procedures permanently, thus ensuring the integrity of the system. Some components are checked at least once at startup.

Component	Check
PMB (Power Measurement Board)	Startup + Cyclic
CSC (Cell Sensor Circuit)	Startup + Cyclic
IL (Interlock)	Configuration dependent. e.g. Generation and Reaction enabled => Startup + Cyclic
MC (Main Controller)	Cyclic
MSW (Main switches)	Startup + State-change
PCHG (Precharge)	On process
ISO (Isolation measurement)	Cyclic
Power supply	Startup + Cyclic

8 FAQ / Troubleshooting

8.1 Toolchain

Issue	Reason/Solution
Error while high level DLL configuration	Low level drivers are usually installed with the CAN-Interface software. If not, they can also be installed while mBMS-Toolchain-Setup. Just click “YES” if the dialog will ask you if you want to start the CAN communication setup and follow the setup instructions.
BMS Update Tool - System Status - Missing Version Information 	If the BMS Update Tool cannot find components, please check component wiring (power supply, communication) like described in the mBMS Hardware Guide.
BMS Update Tool - Update Package – Application- / Safety-Dataset interoperability warning 	Safety CRCs inside the application and safety datasets are not equal. On updating safety parameters, the bsc file should be updated inside the bcc file. Update the .bsc file inside the .bcc file and regenerate the application dataset. 
BMS Diagnostic Tool - Communication - BMS INACTIVE 	Check the connection to the BMS Master Pack via ESS-CAN. Check your CAN Interface Setup.
BMS Diagnostic Tool	The SOC value was not determined yet. Please trigger the SOC recalibration manually.

- State of Charge - System reports 0% SOC  	Afterwards the system should be shut-down to store the SOC value in the non-volatilely memory for further usage when wake up next time. (see also SOC recalibraiton)
BMS Diagnostic Tool - Cell Temperature – Min value = -55°C (SNA)  	Some of declared sensors are not detected by the CSC. Check: - CSC Temperature sensor configuration in safety dataset. - Check the connection of the temperature sensors.

8.2 System

Issue	Reason/Solution
CSC shows no voltages but a maximum temperature of 125°C is shown.	The isoSPI-bus is interrupted. Check: - all connectors are fitted correctly - no wire is broken - the polarity of the wires - Input and Output of the CSC boards are not swapped (right direction) - the correct amount of CSC cards are configured
CSC-LED's	On Error the effected CSC can be located via LED information. LED-Color description: - Red: Emergency Error - Red (flashing): Configuration Error - Green (flashing): OK
The insulation value (ISO value) floats or value is lower than measured with external devices.	If there is an external insulation monitor, the BMS internal insulation monitor has to be disabled. Only one active insulation monitor is allowed within a system.
SOC Recalibration will not be performed	SOC recalibration will be performed when following requirements are fulfilled: - OCV-SOC slope is above the configured value (Application dataset) - Cell voltage is within the configured OCV range (Application dataset)
There is a huge SOC value change after SOC recalibration (periodically)	The cell configuration is incorrect (application dataset). Check: - Cell capacity - Open circuit voltage (OCV) table Tip: Test your configuration with several charging/discharging cycles. Pay attention on the SOC value change after recalibration. See also example configuration in chapter 9.1.
Main switches can't be closed	Safety errors are active or the application errors master/slave-, dataset- configuration or ESS-CAN request message timeout.

A error description can be found under appendix CAN-Error-Description.pdf

9 Appendix

9.1 Another example of cell configuration

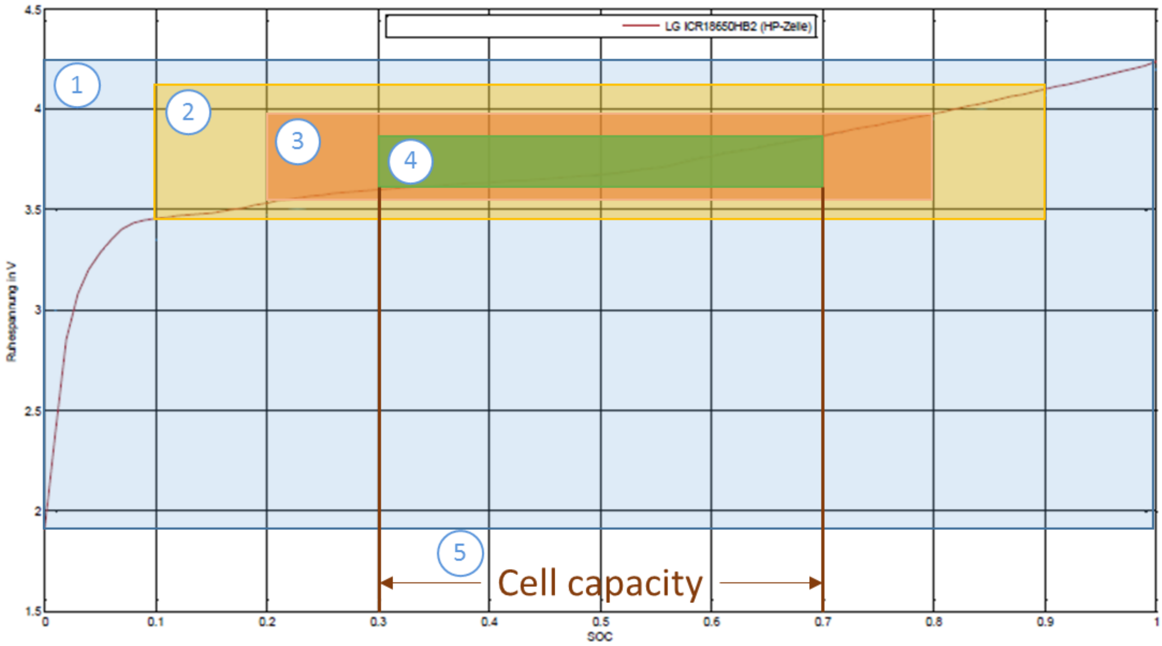


Figure 42 – LG ICR1865OHB2 cell configuration

Marker	Description	Comment
1	Physical cell limits	Cell voltage should never exceed the range of 2V – 4.2V
2	Safety limits	Safety parameters are set to 3.45V – 4.10V
3	Application range	Application parameters are set to 3.52V – 3.95V **Note:** Battery application use these limits for power prediction calculation.
4	SOC range	SOC range definition SOC 0% 3.6V – SOC 100% 3.75V **Note:** Define enough buffer to the application parameters to reach the SOC borders as fast as possible.
5	Cell capacity range	Cell capacity is set to 0.56 Ah (ca. 40% of complete range capacity 1.4 Ah)

10 Terms and abbreviations

B

BCC Battery Configuraton Components
BMC Battery Management Components
BMS Battery Main Supervisor
BSC Battery Safety Components

C

CSC Cell Sensor Circuit

D

DBC Vector CAN Database Description File

E

ESS Energy Storage System

I

isoSPI isolated SPI bus - interconnection bus of the CSC modules
ISO Isolation Measurement

M

mBMS STW's modular Battery Management System
MC Main Controller
MSW Main Switch

O

OCV Open Circuit Voltage

P

PMB Power Measurement Board

S

SC Safety Controller
SCU System Control Unit
SOC State Of Charge
SOH State Of Health
SSV System Supervisor