

PC Configuration toolbox

LIBAL S-BMS PRO

LiBAL s-BMS PRO™ content



- Connection
- System architecture
- Basic functions in **LiBAL s-BMS PRO™** (Functions only available in read mode in **LiBAL s-BMS SERVICE™**)
 - Cell management
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 - Charger control
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 - SOH estimation
 - Battery model
 - I/O ports
 - CAN bus
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 - Errors and warnings
 - AUTO-off Function
 - Product Support
- Basic functions in **LiBAL s-BMS PRO™** and **LiBAL s-BMS SERVICE™**
 - Diagnostics
 - Configuration management
 - Bootload
 - Battery Lifetime diagnostics
 - Service entry
 - Logging

PC Connection

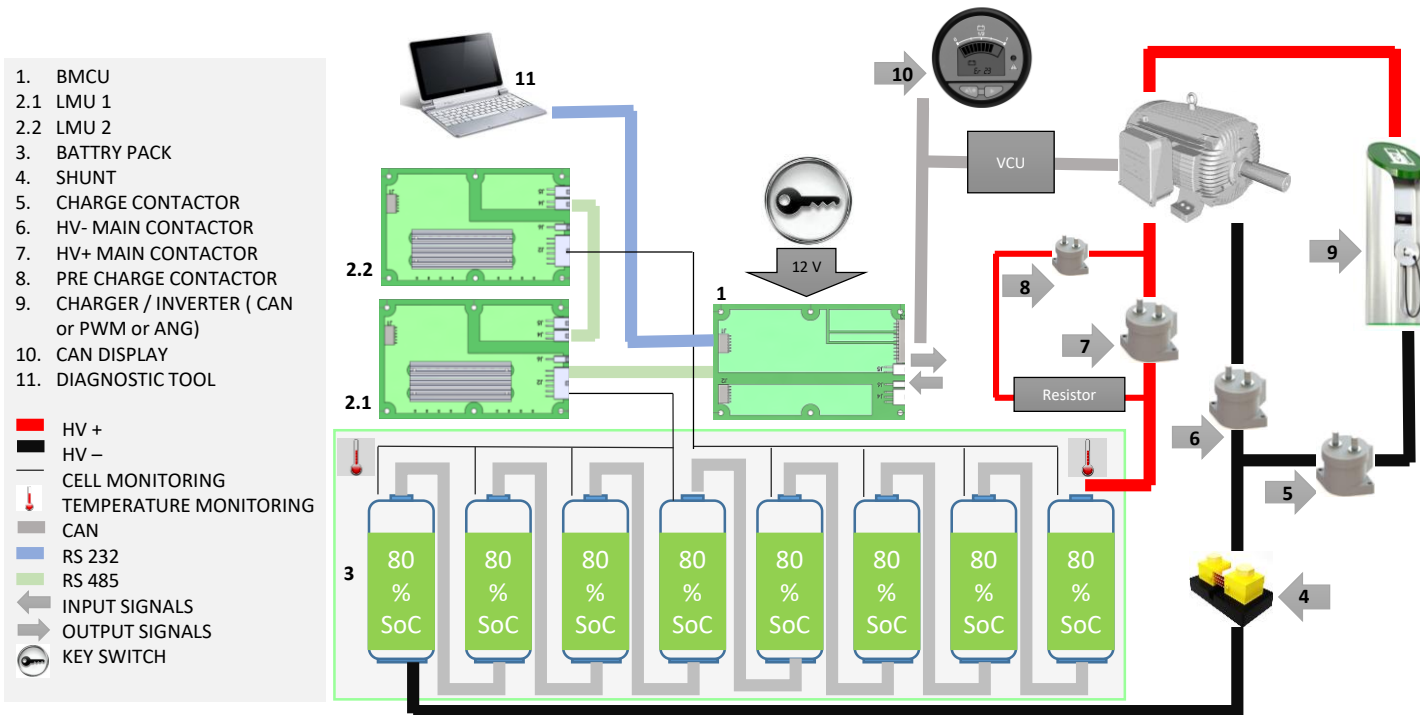


- The s-BMS PC toolbox license is supplied as a "Softkey" that contains both licence key and the PC software
- The softkey is locked to a licensed PC.
- Along with the PC software tool 5 hours of application support is offered free of charge (remote)
- The connection to the PC is done via RS232 and the package contain a robust and proven USB/RS232 converter:



- The s-BMS PC toolbox comes in 2 versions:
 - PRO: All funtions are both "READ" and "WRITE", which means that all parameters can be freely configured
 - SERVICE: All parameters are only READ accessible. Logging, and bootloading can be performed

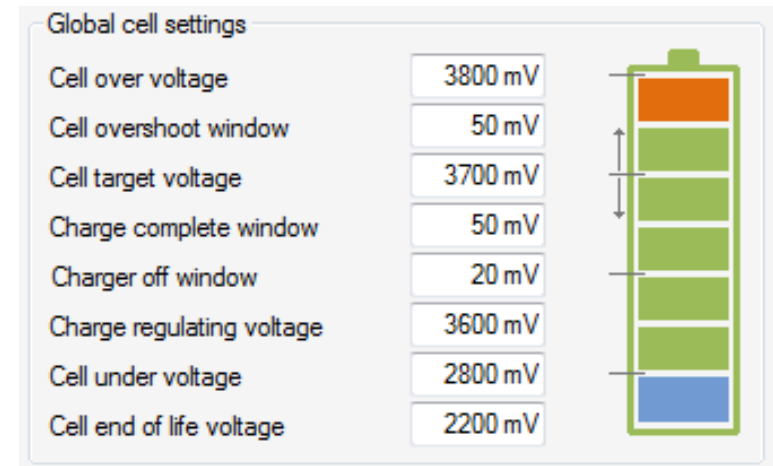
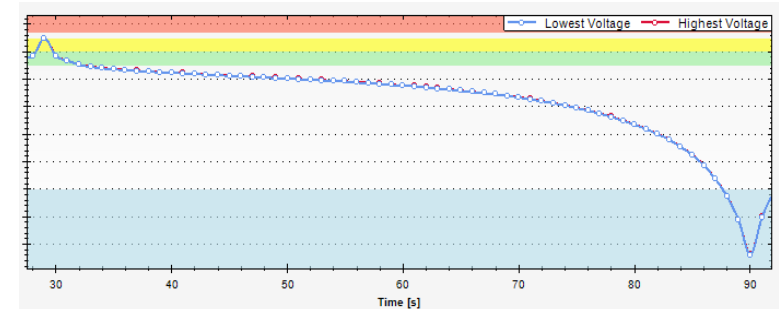
s-BMS System architecture (example)



Cell management



- Cell-overshoot window defines normal charger overshoot.
- Charger-off window defines a window inside the charge complete window for balancing.
- These settings can be used to configure any type of Lithium-ion cell chemistry.
- Communication protected with 16 bit Checksum – ASIL D level which ensures no impact with misread Data enhancing the Data to Data integrity.

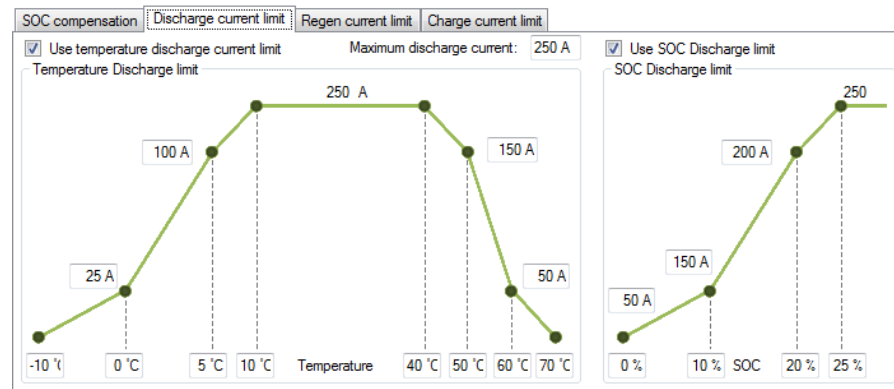


Benefit: Compatibility with any Li-ion chemistries and/or cell type.
Improved sourcing. Bargaining power.

Current monitoring



- High resolution current measurement (0.1A resolution)
- Calibrated measurement shunt (Class 1 or 0.5)
- Auto calibrated measurement input circuit
- Calibration for linearity faults and offset errors gives 0.1A accuracy at room temperature.



Max discharge current settings in s-BMS PC toolbox

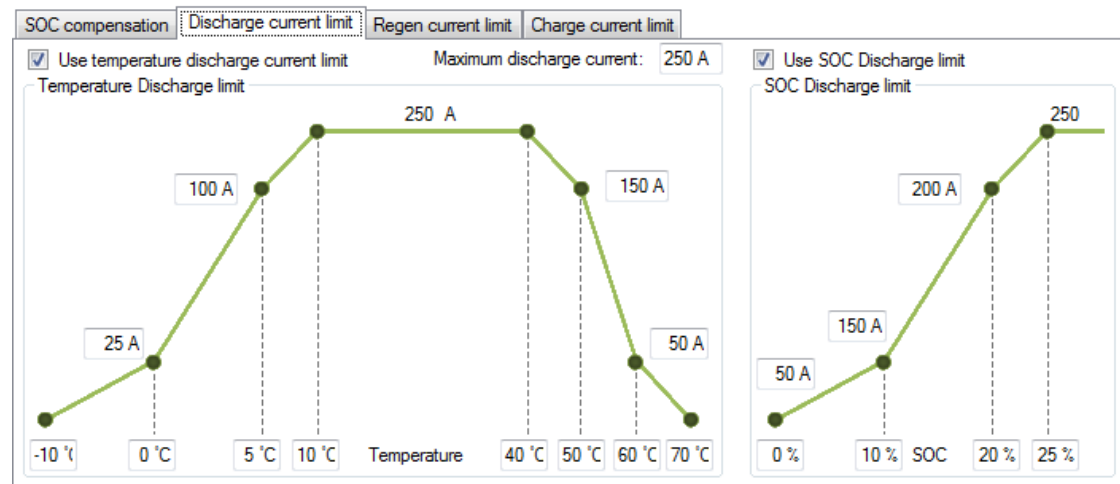
Temperature monitoring



- 4 temperature sensors per LMU board
- Noise robust passive sensors
- Auto calibrated inputs

Cell temperature	
Min. charge temperature	0 °C
Max. charge temperature	0 °C
Min. discharge temperature	0 °C
Max. discharge temperature	0 °C

System level temperature settings in s-BMS PC toolbox

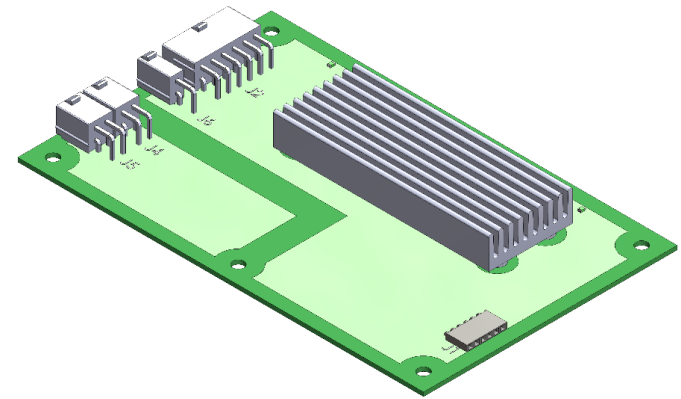


Advance temperature settings in s-BMS PC toolbox

Cell balancing



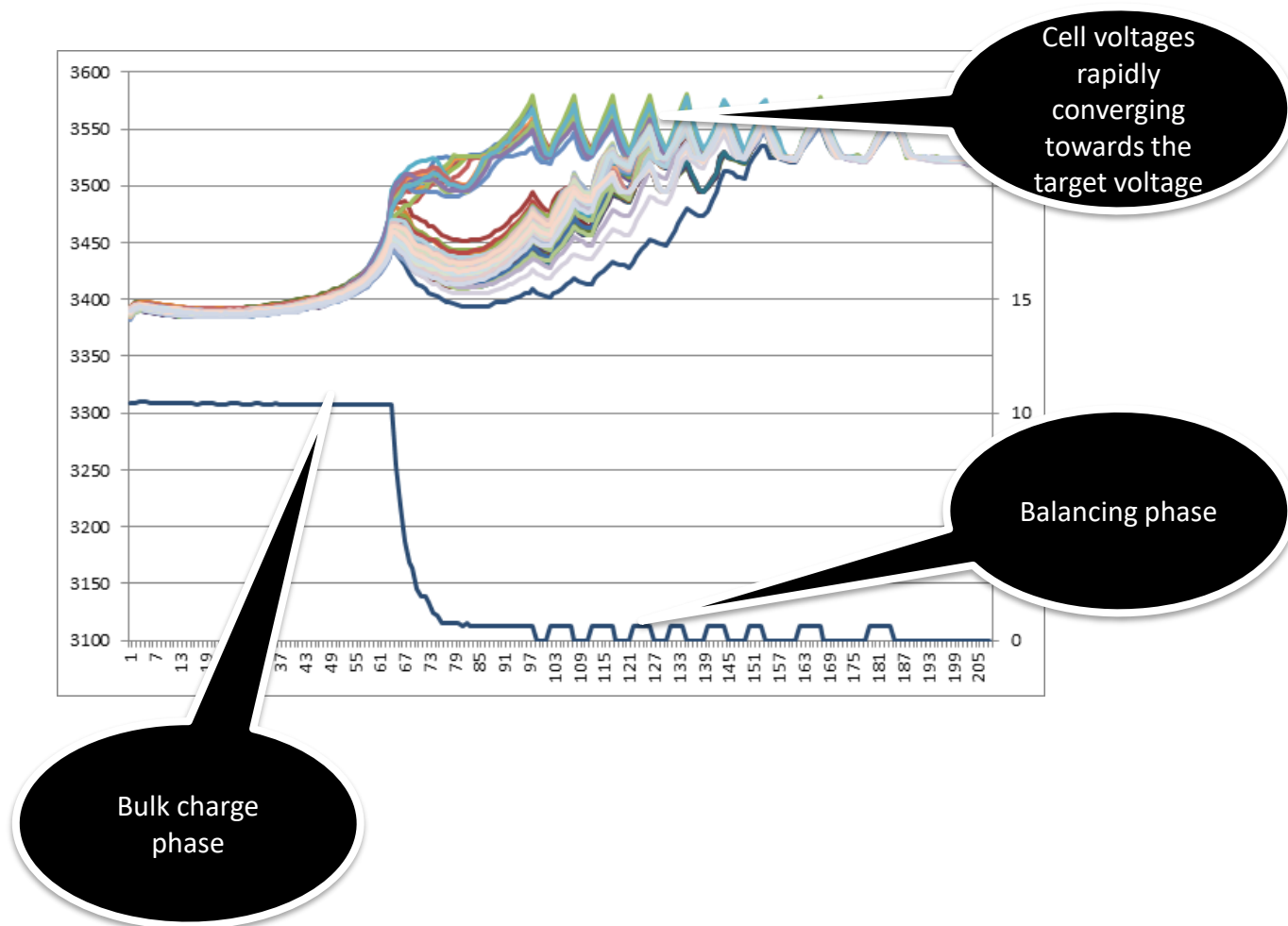
- Passive cell balancing with maximum 840mA @4.2 VDC.
- Multiple cell bleeding operations for faster completion of balancing process.
- Add-on heat-sink option further a balancing time.
- Mininized wear and tear on cells



#	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6	Cell 7	Cell 8	Bat 1 °C	Bat 2 °C	Pcb 1 °C	Pcb 2 °C
1	3608	3609	3609	3608	3610	3612	3610	3613	17	-	42	39
2	3556	3346	3559	3556	3555	3556	3558	-	17	-	42	41

Benefit: Unmatched cell balancing performance. Faster charging.

Charger control



Charger interface



Charger

Trickle charge current	0,2 A
Trickle charge temperature	0 °C
Charge current	5 A
Charger minimum current	0,1 A
Charge voltage	925 V
Charger regulation loop time	1 sec
Charger regulation type	Lin
Number of chargers	1
Charge current low power mode	5 A
Charge complete only when balanced	<input type="checkbox"/>



CAN control:

- CAN 2.0A or 2.0B
- 125 kbps to 1Mbps speed
- Bit level configuration
- Preconfigured for supported chargers

CAN Settings

CAN Options

CAN Speed: speed125kBits

CANopen compatible mode: ☐ Node ID: 0

CANopen extended frames: ☐

Chargers

CAN Charger: Brusa

TX Frame #: FirstAvailable

+ Add

	Enabled	Interval (ms)	29 bit ID	ID	DLC	Checksum	Signals	Description
1	<input checked="" type="checkbox"/>	100	<input type="checkbox"/>	618	8	None	Signals	BRUSA
2	<input type="checkbox"/>	50	<input type="checkbox"/>	0	0	None	Signals	Description He
3	<input type="checkbox"/>	50	<input type="checkbox"/>	0	0	None	Signals	Description He
4	<input type="checkbox"/>	50	<input type="checkbox"/>	0	0	None	Signals	Description He
5	<input type="checkbox"/>	50	<input type="checkbox"/>	0	0	None	Signals	Description He
6	<input type="checkbox"/>	50	<input type="checkbox"/>	0	0	None	Signals	Description He
7	<input type="checkbox"/>	50	<input type="checkbox"/>	0	0	None	Signals	Description He
8	<input type="checkbox"/>	50	<input type="checkbox"/>	0	0	None	Signals	Description He

CAN Signals

#	Enabled	Start bit	Bit count	Data type	Data identifier	Bit offset	Intel format	Description
1	<input checked="" type="checkbox"/>	0	8	Direct	2120	0	<input type="checkbox"/>	No_Description
2	<input checked="" type="checkbox"/>	8	16	Direct	196	0	<input type="checkbox"/>	No_Description
3	<input checked="" type="checkbox"/>	24	16	Direct	2112	0	<input type="checkbox"/>	Charger_Max_DC_V
4	<input checked="" type="checkbox"/>	40	16	Direct	2117	0	<input type="checkbox"/>	Charger_Max_DC_I
5	<input checked="" type="checkbox"/>	56	8	Constant	0	0	<input type="checkbox"/>	No_Description

PWM and analog ports

- One analog + PWM (hardwired) output for charger control
- One analog output for fuel gauge display
- One analog input programmable on a per-project basis

PWM and analog ports

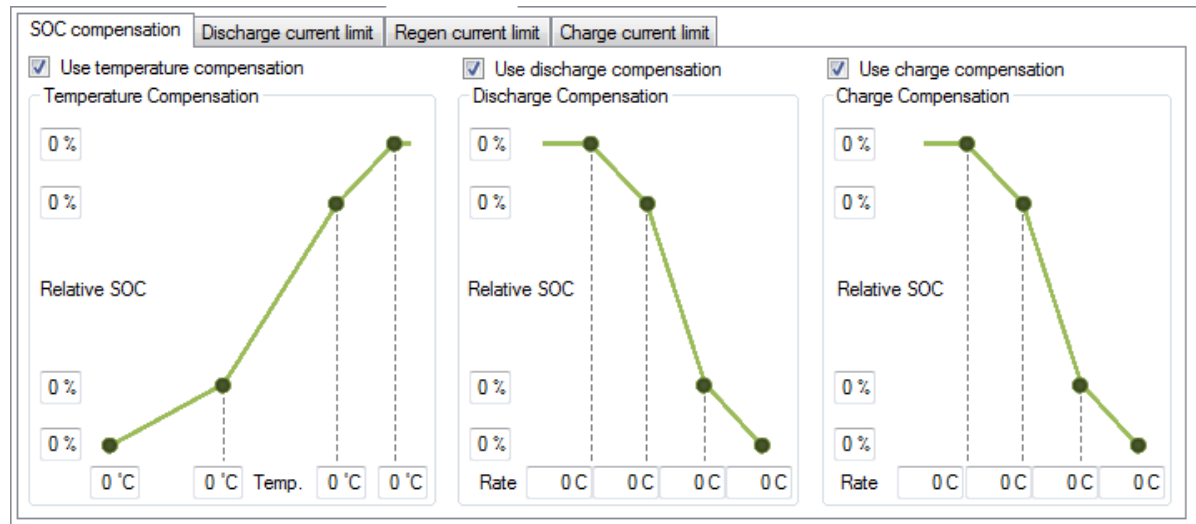
PWM/ANA settings

PWM frequency	<input type="text" value="_1_kHz"/>	Max ANA/PWM limit	<input type="text" value="0"/>
Internal analog/PWM supply	<input type="checkbox"/>	Min ANA/PWM limit	<input type="text" value="0"/>
Inverted analog/PWM signal	<input type="checkbox"/>	Max Inv. ANA/PWM limit	<input type="text" value="0"/>
Fuel gauge on ANA1/PWM1	<input type="checkbox"/>	Min Inv. ANA/PWM limit	<input type="text" value="0"/>

PWM/analog settings in s-BMS PC toolbox

Interface

State-of-Charge (SOC) calculation



- Fundamental principle is Coloumb counting using the high precision current measurement
- The Coloumb counter is reset every time the battery is fully charged and balanced (SOC=100%)
- The Coloumb counter can be enhanced by the battery model to compensate for temperature and rate of discharge effects.

State-of-Health (SOH) estimation



- Measures capacity based State of Health (SOH) each full discharge cycle
- Continuously measures pack resistance
- Measures cell resistance each charge cycle

System settings | I/O settings | CAN settings | Battery Model | LMU settings | LMU data | **Cell resistance** | Read Write Cancel

Enable cell resistances ☒ Cell resistance difference Critical cell resistance Ready

Enable pack resistance ☒ Pack resistance difference Critical pack resistance

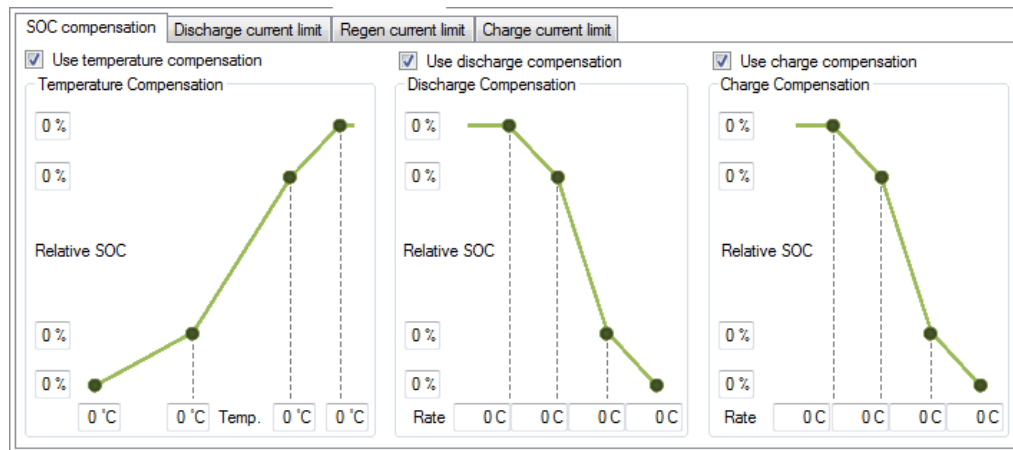
Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6	Cell 7	Cell 8
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Cell resistances in s-BMS PC toolbox

Battery Model



- Add advanced battery chemistry data to your battery management system by means of configuration.
- Enhance State of Charge calculation
- Optimize battery utilization in various temperature conditions
- Optimize battery utilization in various state of charge ranges
- Help application performance by dynamically adjusting system boundaries like allowed regen and discharge current



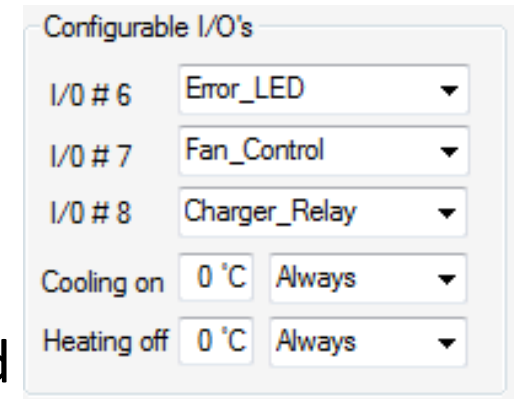
Battery model in s-BMS PC toolbox

Benefit: Performance improvement.

I/O ports

The BMCU supports 8 general purpose I/O ports

- 5 ports are pre-allocated to defined functions
- 3 ports can be configured on a per-project basis



Configurable I/O's		
I/O # 6	Error_LED	▼
I/O # 7	Fan_Control	▼
I/O # 8	Charger_Relay	▼
Cooling on	0 °C	Always ▼
Heating off	0 °C	Always ▼

I/O configuration in s-BMS PC toolbox

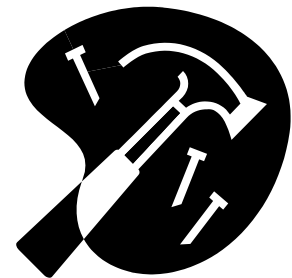


I/O monitor in s-BMS PC toolbox

CAN bus



- Interface to vehicle control units, chargers, displays etc.
- Configurable speed from 125kbit/s up to 1Mbit/s
- Configurable to run 11 or 29 bit identifiers
- Fully flexible CAN frames that can broadcast any BMS parameters with bit level control of data alignment
- Post processing functions that allows dynamic re-scaling and arithmetic operations on BMS parameters



CAN-bus interface



Basic CAN settings

Define transmit frames

CAN Settings

CAN Options

CAN Speed: speed125kBits

CANopen compatible mode: ☐ Node ID: 0

CANopen extended frames: ☐

Chargers

CAN Charger: None

TX Frame #: FirstAvailable

+ Add

CAN Charge Enable Timeout: 0 sec

CAN Discharge Enable Timeout: 0 sec

CAN Leak Detection Disable Timeout: 0 sec

RX Frames

	Enabled	ID	29bit ID	Signals
1	<input checked="" type="checkbox"/>	0	<input type="checkbox"/>	Signals
2	<input type="checkbox"/>	0	<input type="checkbox"/>	Signals
3	<input type="checkbox"/>	0	<input type="checkbox"/>	Signals
4	<input type="checkbox"/>	0	<input type="checkbox"/>	Signals
5	<input type="checkbox"/>	0	<input type="checkbox"/>	Signals

TX Frames

	Enabled	Interval (ms)	29bit ID	ID	DLC	Checksum	Signals	Description
1	<input checked="" type="checkbox"/>	100	<input type="checkbox"/>	618	8	None	Signals	BRUSA
2	<input type="checkbox"/>	50	<input type="checkbox"/>	0	0	None	Signals	Description Here
3	<input type="checkbox"/>	50	<input type="checkbox"/>	0	0	None	Signals	Description Here
4	<input type="checkbox"/>	50	<input type="checkbox"/>	0	0	None	Signals	Description Here
5	<input type="checkbox"/>	50	<input type="checkbox"/>	0	0	None	Signals	Description Here
6	<input type="checkbox"/>	50	<input type="checkbox"/>	0	0	None	Signals	Description Here
7	<input type="checkbox"/>	50	<input type="checkbox"/>	0	0	None	Signals	Description Here
8	<input type="checkbox"/>	50	<input type="checkbox"/>	0	0	None	Signals	Description Here

Post processor

	Enabled	Bytes	Operand type 1	Operand 1	Operator	Operand type 2	Operand 2	Output
1	<input checked="" type="checkbox"/>	0	Constant	0	Add	Constant	0	Output1
2	<input type="checkbox"/>	0	Constant	0	Add	Constant	0	Output1
3	<input type="checkbox"/>	0	Constant	0	Add	Constant	0	Output1
4	<input type="checkbox"/>	0	Constant	0	Add	Constant	0	Output1
5	<input type="checkbox"/>	0	Constant	0	Add	Constant	0	Output1
6	<input type="checkbox"/>	0	Constant	0	Add	Constant	0	Output1
7	<input type="checkbox"/>	0	Constant	0	Add	Constant	0	Output1
8	<input type="checkbox"/>	0	Constant	0	Add	Constant	0	Output1

OK Cancel

Define receive frames, and where to put the received data

Post processor allows data to be processed after being received or before being transmitted

Benefit: Best-in-class configuration. Reduced dev. costs.

Error behaviour



Appropriate contactor actions must be configured for all error conditions in the battery system for both charge and discharge state.

Contactors off (1/2)		Charge		Discharge	
1 - Cell over voltage	5 sec <input checked="" type="checkbox"/>	3 sec <input checked="" type="checkbox"/>			
2 - Cell under voltage	5 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
3 - Cell end of life voltage	5 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
4 - Cell voltage misread	5 sec <input checked="" type="checkbox"/>	8 sec <input checked="" type="checkbox"/>			
5 - Cell over temperature	5 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
6 - Cell under temperature	10 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
7 - Cell unmanaged	5 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
8 - LMU over temperature	5 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
9 - LMU under temperature	5 sec <input checked="" type="checkbox"/>	60 sec <input checked="" type="checkbox"/>			
10 - Temp. sensor open circuit	5 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
11 - Temp. sensor short circuit	5 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
12 - SUB communication	5 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
13 - LMU communication	15 sec <input checked="" type="checkbox"/>	10 sec <input checked="" type="checkbox"/>			
14 - Over current IN	5 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
15 - Over current OUT	30 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
16 - Short circuit	0 sec <input checked="" type="checkbox"/>	0 sec <input checked="" type="checkbox"/>			

Contactors off (2/2)		Charge		Discharge	
17 - Leak detected	60 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
18 - Leak detection failed	5 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
19 - Voltage difference	5 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
20 - BMCU supply over voltage	10 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
21 - BMCU supply under voltage	5 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
22 - Main positive contactor	5 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
23 - Main negative contactor	10 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
24 - Precharge contactor	5 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
25 - Midpack contactor	5 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
26 - Charger communication	5 sec <input checked="" type="checkbox"/>	5 sec <input checked="" type="checkbox"/>			
27 - Emergency Stop					

Error levels	
Min supply voltage	7,5 V
Max supply voltage	16,5 V
Min LMU temp	-40 °C
Max LMU temp	85 °C

Benefit: User defined controls strategy. Improved safety.

AUTO-off function



- Purpose: To facilitate replacement of lead/acid batteries in Forklifts, where there is no "key" function to disconnect the BMS
- The function can be enabled and the following parameters can determine AUTO-off
 - Current is low in longer times (meaning the truck driver left the vehicle without disconnecting)
 - The cell voltages are reaching a point where the battery will be destroyed (meaning driver ignore warnings and continue to engage system)
 - Charger has reached the point where balancing is complete and no other action for long time (Meaning the vehicle was left in the charger for longer time)
 - Charger is not responding. Could be disconnected or power loss to the charger (Meaning charge process should stop to prevent endless drain of battery)

Graph view System settings I/O settings Battery Model Local cell settings Cell data Cell resistance OCVModel Auto off

BMS auto off settings

Enable BMS auto off ☒

Discharge and Idle

Auto off current limit
and
Auto off current limit time

Auto off at lowest cell voltage limit
and
Auto off voltage limit time

Charge

Auto off at "Charge complete" ☐
or
Auto off at "Charger off" ☐
and
Auto off time for charge complete/charger off

Auto off charging current percentage level
and
Auto off charging level time

Discharge, Charge and Idle

Auto off at cell voltage below "Cell end of life voltage" ☒
Auto off time for cell voltage below "Cell end of life voltage"

Product Support



- The LiBAL s-BMS PRO is a very comprehensive tool. In order to facilitate the introduction Lithium Balance offer 5 hour support:
 - Configuration of basic settings such as cell voltage cut off and balancing windows
 - Guidelines for setting up safety strategy and how to utilize the warnings and error states
 - Introduction to advanced functionality such as OCV curve and battery modelling (SOC compensation).
 - Introduction to CAN configuration (Charger set-up)

Service and Maintenance

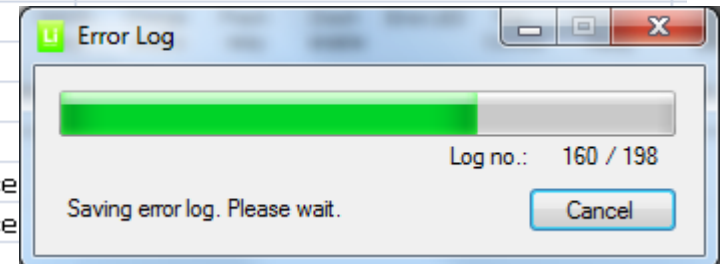


Diagnostics



- Error log reads out the last 198 recorded problems
- The output is human readable *.csv file format
- Information on the time from startup to error, the error description, and data from the error.

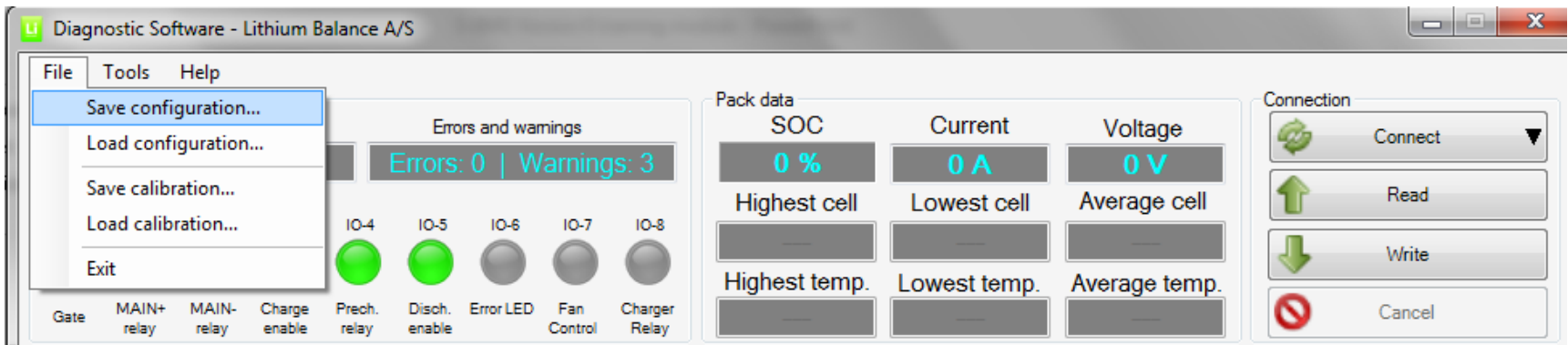
BMCU: 20000 02.05.c.005, SUB: 20000 02.05.c.000, LMUs: 02.05.c.005, 02.05.c.005, 02.05.c.005, 02.05.c.005, 02.05.c.005, 02.05					
Error Code	Power Up Time (min)	Data	Error	Description	
15		363 000C005A	Pack resistance difference	Previous: 120 mOhm, New: 900 mOhm	
15		347 000300B6	Pack resistance difference	Previous: 30 mOhm, New: 1820 mOhm	
9		347 4E204E20	Leak detected	Offboard leak detection triggered	
15		284 003B0000	Pack resistance difference	Previous: 590 mOhm, New: 0 mOhm	
15		282 005D0000	Pack resistance difference	Previous: 930 mOhm, New: 0 mOhm	
15		278 00F0003C	Pack resistance difference	Previous: 2400 mOhm, New: 600 mOhm	
17		277 01DF0000	Critical pack resistance	4790 mOhm	
15		277 3590065	Pack resistance difference	Previous: 8570 mOhm, New: 1010 mOhm	
19		275 2020000	Contactors off		
1		275 220AC000	Cell under voltage		
1		274 BF0AED00	Cell under voltage		
17		270 3590000	Critical pack resistance		
15		270 003E0674	Pack resistance difference		
15		168 005D0020	Pack resistance difference		



Configuration management

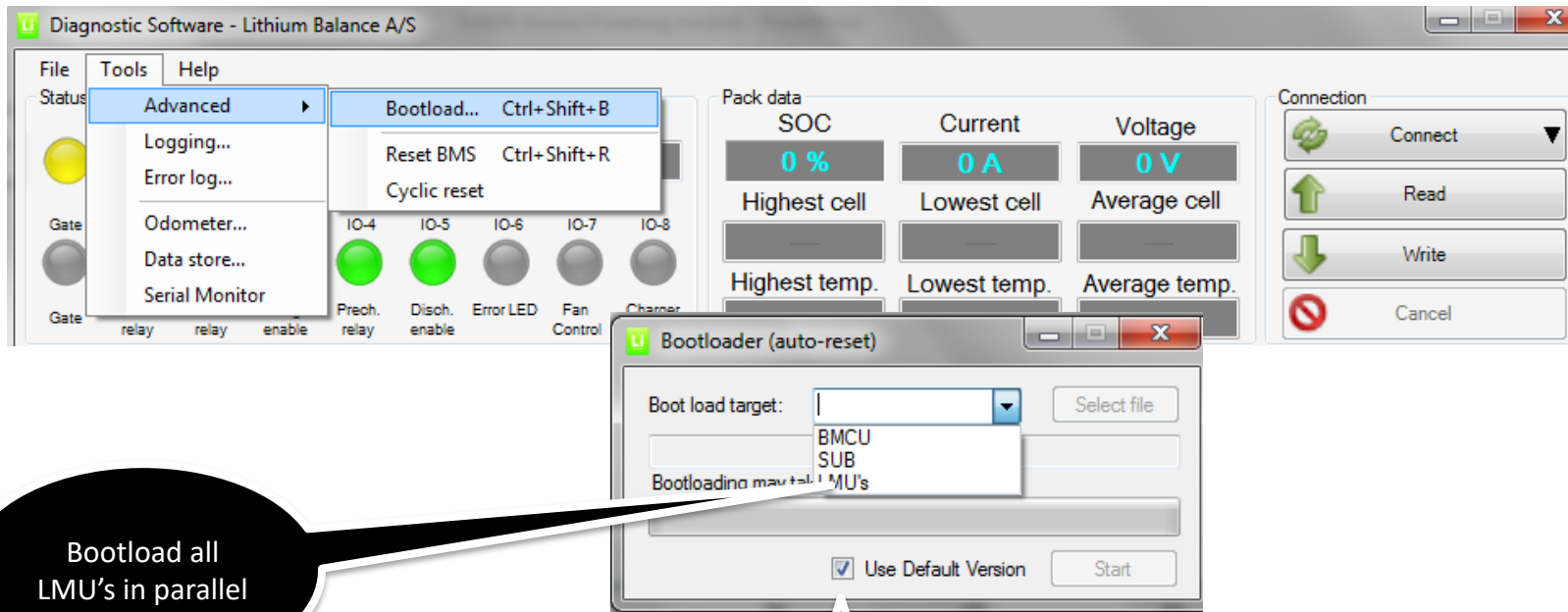


- Store and recall configurations.
- Use the “Read” and “Write” buttons to apply the settings to the connected BMS.



- a) Accessing the error log
- b) Using the service tag
- c) Using the logging facility

Bootloader



Bootload all
LMU's in parallel

Use the firmware
version included
with your
Diagnostic Software

Lifetime diagnostics



Information on usage

The screenshot shows a software window titled 'Odometer'. It contains three expandable sections: 'Charges', 'Discharges', and 'Errors'. Each section has a table with two columns: a range and a count. The '0% - 20%' range for charges is highlighted in the bottom summary bar.

Charges	
0% - 20%	0
20% - 40%	0
40% - 60%	0
60% - 80%	0
80% - 100%	0

Discharges	
0% - 20%	0
20% - 40%	0
40% - 60%	0
60% - 80%	0
80% - 100%	0

Errors	
Cell reading errors	0
EEPROM errors	0
Generic Serial Comm Err	0
Serial Chksum LMLs	0

0% - 20%	
Number of charges to between 0% and 20%	

Information on problems

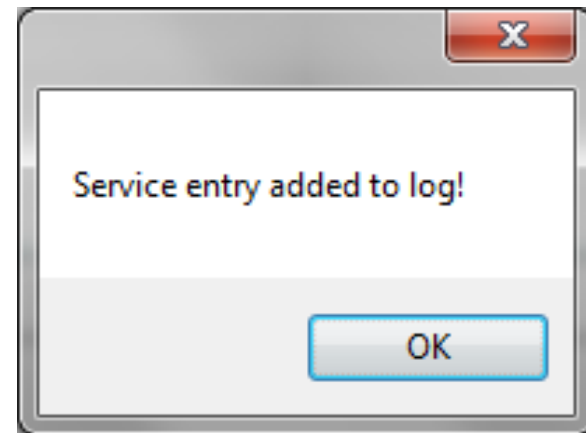
The screenshot shows a software window titled 'Error Statistics'. It contains a table of various error types and their counts. The 'Voltage Difference' error type is highlighted in the bottom summary bar.

Errors	
BMCU Supply Overvoltage	0
BMCU Supply Undervoltage	0
Cell EOL Voltage	0
Cell Overtemperature	0
Cell Overvoltage	0
Cell Undertemperature	0
Cell Undervoltage	0
Cell Unmanaged	0
Cell Voltage Misread	0
Leak Detected	0
Leak Detection Failed	0
LMU COM Error	0
LMU Overtemperature	0
LMU Undertemperature	0
MAIN- Errors	0
MAIN+ Errors	0
Midpack Contactor Error	0
Overcurrent IN	0
Overcurrent OUT	0
Precharge Contactor Errors	0

Voltage Difference	
Number of Voltage Difference errors	

Service Entry

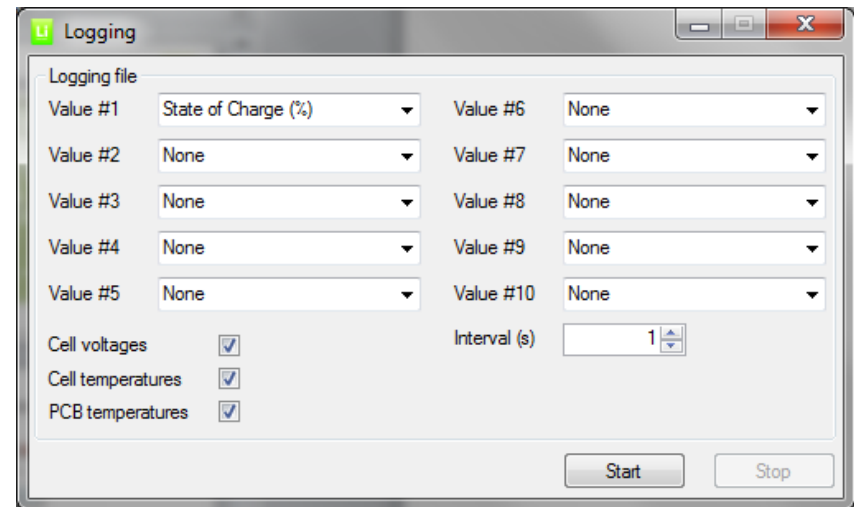
- The “Add Service Entry” function adds a service entry to the error log.
- This is useful to track how many errors that has occurred since the last service.



Logging



- The logging functions allow the Diagnostic Software to continuously log a number of parameters during operation
- The parameters are stored in a comma separated file (.csv)
- This file can be analysed for example in Microsoft Excel.



Summary



1. Unmatched cell balancing performance through configuration.
2. Possibility to integrate multiple chargers via PWM, analog or CAN-bus.
3. Internal communication protected with 16 bit Checksum – ASIL D level.
4. Battery model – improves accuracy, performance and pack life.
5. User defined controls/safety strategy and performance optimization.
6. OCV based SOC validation.
7. Facilitated warranty management.
8. Compatibility with any Li-ion chemistries.