SUPER B lithium batteries

Manual

Version
February 2024

BATTERY COMMUNICATION INTERFACE (BCI)

User Manual Battery Communication Interface (BCI)

Dear customer,

This manual contains all the necessary information to install, use and maintain the Battery Communication Interface (BCI). We kindly ask you to read this manual carefully before using the product. In this manual the Battery Communication Interface will be referred to as the BCI. This manual is meant for the installer and the user of the BCI. Only qualified personnel may install and perform maintenance on the BCI. Please consult the index at the start of this manual to locate information relevant to you.

During the use of the product, user safety should always be ensured, so installers, users, service personnel and third parties can safely use the BCI.

Table of content

1. Safety guidelines and measures

1.1. General

- Treat the BCI as described in this manual.
- Do not disassemble, crush, puncture or shred the BCI.
- Never install or use a damaged BCI
- Do not expose the BCI to heat or fire.
- Do not remove the BCI from its original packaging until required for use.
- The BCI shall not be used outside the electrical and mechanical specifications as specified in this manual.
- Do not mix Li-ion batteries of different capacity, size or type. Only use Super-B Li-ion traction batteries with the BCI.
- Retain the original product documentation for future reference.
- Always take safety precautions when working on battery systems.
- Never short circuit the Li-ion battery.

⚠ **Warning!** Only trained experts shall handle or install a BCI and/or the related battery systems. These systems can deliver very large currents and/or high voltages.

⚠ **Caution!** A caution sign indicates problems may occur if a procedure is not carried out as described. It may also serve as a reminder to the user.

2. Introduction

2.1. Product description

The Battery communication Interface (BCI) is a device intended to control contactors or relays that must be used to protect Super B Li-ion batteries from improper use. The BCI collects data from one or multiple Li-ion batteries by a CANopen communication bus. This data contains information about the status and the current use of the Li-ion batteries. If one or more Li-ion batteries reports an issue, the BCI will turn off the contactors and protect the Li-ion batteries. Although the BCI can be used to manage a single Li-ion battery, it is intended to collect data from multiple Li-ion batteries in series and/or parallel for controlling contactors. Other typical functions are:

- Control pre-charge functionality. Therefore, an additional contactor and resistor is needed tailored to the application.
- Protocol conversions (depending on BCI software version).
- Control charger by CAN or charge enable signal (depending on BCI software version).
- Manage the heaters of Super B Li-ion batteries outfitted with heating elements.

2.2. Intended use

Potential applications to use the BCI in combination with Li-ion batteries from Super B are:

- Off grid applications
- Marine applications
- Medium for (renewable) energy storage (traction)
- Battery for vehicles.

Depending on the application it can be necessary that additional components are used to assure that the installation is compliant with the applicable regulations. See chapter 5.6 for information on electrical installations.

The BCI is sold as a single device, the customer is expected to source necessary components for protecting the Li-ion batteries. Super B cannot be held responsible for installations made by the customer.

Super B also offers the option of supplying the complete installation. This can be a standard solution or a custom solution. The standard solution can be found on our website or by contacting sales. The custom solution needs to be aligned with your sales and application engineering contact.

If this manual does not cover or address your application, please contact Super B.
Only qualified personnel may install and perform maintenance on the complete system - always refer to chapter 1 of this manual for safety guidelines.

The boundaries of the BCI use, as described in this manual should always be upheld. The BCI may not be used in medical, or in aviation related applications. The BCI may not be used for any purposes other than described in this manual. Using the BCI for any other purposes will be considered improper use and will void the warranty of the product. Super B cannot be held responsible for any damage caused by improper, incorrect, or unwise use of the product. Please read and understand this entire manual carefully before using the product.

2.3. Glossary of Terminology

BMS	Battery Management System
BIB	Battery Interface Box
BCI	Battery Communication Interface
LiFeP04	Lithium Iron Phosphate
Be in Charge Software	PC application for monitoring control and configuration

DC-bus	Load / charger side of main contactor(s)
SoC	State of charge
CANopen	CAN bus protocol
48V system	A system that consists of 4 batteries in series
24V system	A system that consists of 2 batteries in series

Table 1. Glossary of Terminology

2.4. Used symbols

The following icons will be used throughout the manual:

⚠ **Warning!** A warning indicates severe damage to the user and/or product may occur when a procedure is not carried out as described.

⚠ **Caution!** A caution sign indicates problems may occur if a procedure is not carried out as described. It may also serve as a reminder to the user.

3. Product specifications

3.1. Typical setup of the BCI

Figure 1, depicts a typical setup of the BCI. The circuit shows the interconnections of the BCI in an installation to protect the Li-ion battery (bank).

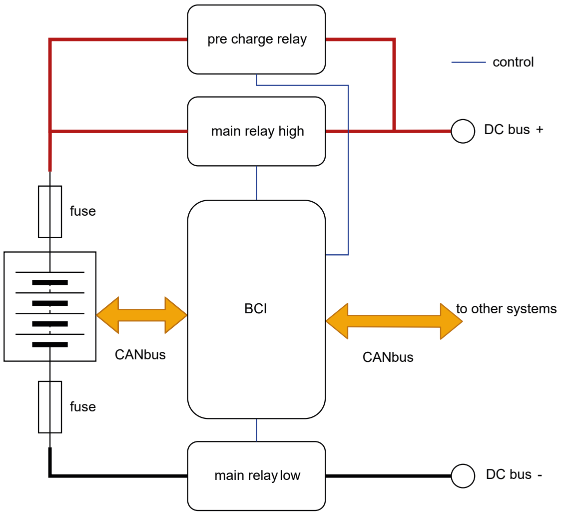

Figure 1. Typical BCI setup

3.2. Product features

- Three dry outputs to control the minus, the plus, and the pre-charge contactor of the Li-ion battery bank.
- Four galvanic isolated inputs for manual operation (not shown in Figure 1).
- Collecting the status and alarm messages of all the Li-ion batteries connected to the CAN bus. In case of an alarm from one of the Li-ion batteries the BCI will control the contactors to disconnect from the DC bus.
- Scanning the CAN bus to see if all the Li-ion batteries that are configured are present. In case of a missing Li-ion battery, the BCI will go in alarm state and will control the contactors to disconnect the Li-ion battery bank from the DC bus.
- Collecting information of all Li-ion batteries in the battery bank and presenting it as one Li-ion battery on the CAN bus.
- Programmable power down on user adjustable Li-ion battery (bank) SoC level.
- Programmable Auto-On function.
- Up to sixteen Li-ion batteries can be connected to the BCI Master side CAN bus without the need of external CAN power (Super B Li-ion batteries need power on their CANOpen Interface).
- Up to 100 Li-ion batteries can be connected to the BCI with use of external CAN power.
- Drive a Pre-charge contactor to switch a capacitive load and prevent inrush currents.
- A mechanism that allows temporary reconnection of the Li-ion battery bank to the DC-bus in an undervoltage situation.
- Logging function of diagnostics.
- Complete power down in case of an undervoltage of the Li-ion battery bank ($I < 1\ \mu A$).
- The BCI has an open collector output/input for various additional applications.
- The BCI is a standalone device.
- The BCI must be configured using a CAN-USB (see Table 11) converter and the Be in Charge software.
- Three status LEDs to indicate the status of the BCI and the Li-ion battery bank.
- Real time clock for accurate time stamped function, statistics and error logging.
- Two power supply inputs
  1. To power the BCI from an external supply or supply from the DC bus.
  2. To power the BCI from the battery bank, this power input has a self-disconnect feature.
- Two CAN communication ports
  1. The master port indicated by J1. This port is dedicated for the Li-ion batteries. The communication protocol is CANopen.
  2. The slave port indicated by J2. This port is to communicate with an external network. It can also be used for other CAN protocols.

All the Li-ion battery (bank) values can be monitored on both ports. The Li-ion battery bank can also be controlled by both ports. If the slave port (J2) is used for another protocol than CANopen, monitoring and control of the Li-ion battery bank using the Be in Charge software can only be done on the master port (J1). Though controlling on both sides is possible, changes are not forwarded to the other port. Hence, this is not advisable.

3.3. Real Time Clock (RTC)

Compatible BCIs (Hardware version V1.7 and above) are delivered fitted with an CR1216 coin cell, which is used to power the internal RTC (Real time clock). This provides several additional functions for when external/battery bank power is lost or not present:

- Accurate time-stamped error logs (available in software version ≥ V2.40)

3.4. BCI functional behaviour

3.4.1. General

The BCI monitors all connected Li-ion batteries through the CAN bus. Whenever one or more Li-ion batteries reports an alarm, or is missing on the bus, the BCI will drive the contactors to disconnect the Li-ion battery (bank) from the DC bus to avoid misuse of the Li-ion battery or to prevent an unsafe situation. The alarms from the Li-ion battery can differ with each battery type. Because the alarm is indicated to the BCI as a general alarm, any Super B Li-ion battery with CANopen communication can be used in combination with the BCI. For alarms detected and signaled by the Li-ion battery consult the manual of the Li-ion battery.

3.4.2. Functionality of the power inputs

The BCI can be powered by an external power supply or, by the Li-ion battery bank. However, when powered from the Li-ion battery bank, the maximum number of Li-ion batteries in series is limited to four.

⚠ **Caution!** The BCI can only be powered by a Li-ion battery bank if the bank consist of 4 or less Li-ion batteries in series.

The BCI has two supply and one GND/minus input, see chapter 4.5:

1. The battery supply input, J4 pin 9
2. The DC-bus / external supply input, J4 pin 10
3. GND/minus, J4 pin 1

The DC-bus / external supply input can be used if the Li-ion battery bank consists of more than 4 Li-ion batteries in series or when the self-shutdown functionality is not used. In that case the Li-ion battery supply input is not to be connected.

The Li-ion battery supply input has internal disconnect functionality to minimize self-consumption in case of a shut down. If the Li-ion battery bank is drained and there is a risk of damaging the Li-ion batteries, the BCI disconnects the Li-ion battery bank from the DC-bus and shuts down itself to no longer drain the Li-ion batteries. Refer to Figure 2 and Figure 3 simplified connection diagrams, depicted with focus on how to supply the BCI.
Only when the BCI is powered from the Li-ion battery bank the self-shutdown functionality is used. For this functionality, refer to chapter 5.6.

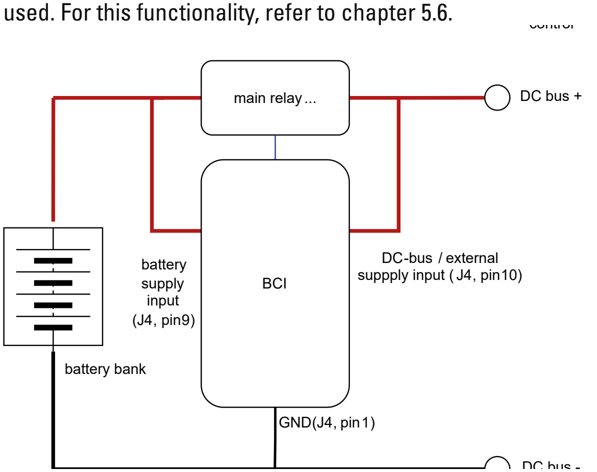

Figure 2. BCI supplied by the Li-ion battery bank

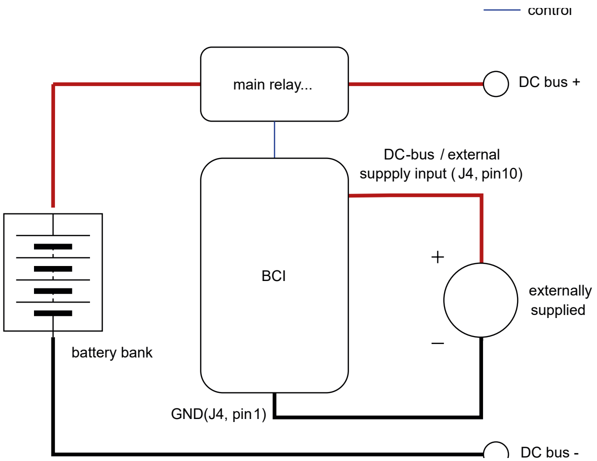

Figure 3. BCI supplied by external power supply

⚠ **Caution!** If Li-ion battery banks with a setup depicted in figure 2 are put in parallel by connecting the DC-bus, the self-shutdown functionality will only occur when all BCI's power is off. Until that happens the BCI will be fed by the DC-bus and is not able to self-shutdown.

3.4.3. BCI States

The BCI different states, are listed in Table 2 BCI states below:

State	Main relay	Pre-charge relay	Description
ON	On	Off	Bank is connected to the DC-bus
OFF	Off	Off	Bank is disconnected from the DC-bus
Pre-charge	Off	On	Bank is pre-charging the DC-bus
Alarm	Off	Off	An error occurred
Shutdown	Off	Off	BCI is in power down mode
Undervoltage reboot	On	Off	BCI is turned on again after an undervoltage shutdown

Table 2. BCI States

3.3.3.1 ON state

The BCI is in or can be set to the ON state when there are no active errors. In this state the BCI enables the main contactor(s), the Li-ion battery bank is connected to the DC bus. The BCI can be set to ON state using the Be in Charge software, or automatically when the Auto-On feature is enabled. The BCI can only reach the ON state via the Pre-charge state first.

3.3.3.2 OFF state

In this state the BCI disables all contactors, the Li-ion battery bank is disconnected from the DC bus. The BCI boots in the OFF state. In addition, the BCI can be set in OFF state manually by the Be in Charge software.

3.3.3.3 Pre-charge state

A contactor that must switch a large capacitive load can be exposed to high electric current during initial turn-on. This current, if not limited, can cause considerable stress or damage to the system components. Pre-charging is implemented to increase the lifespan of electronic components and increase reliability of the contactor. In the pre-charge state the main relay is disabled and the pre-charge relay is enabled. Refer to paragraphs 3.3.4.2 and 3.3.4.3 for details about the behavior on voltage dependent or time dependent pre-charge settings.

3.3.3.4 Alarm state

When the BCI is in alarm the following may have occurred:

- The number of Li-ion batteries that respond to a present request does not match the number of Li-ion batteries configured in the BCI. If the error is not resolved within 20 seconds, the BCI goes to OFF state.
- One or more of the Li-ion batteries reports an alarm. When the alarm of the Li-ion battery is cleared the BCI stays in OFF state. Depending on which type of alarm the Li-ion battery signaled, this alarm can be cleared automatically. Refer to the battery manual for the type of alarm and how to resolve it.

If the alarm state is cleared and the Auto-On feature is enabled, the BCI can go back to the ON state.

3.3.3.5 Undervoltage off state - BCI externally powered

In case of an undervoltage event when the BCI is powered by an external power supply, it will go into OFF state instead of shutdown. The rest of the behavior as described for systems below 60 Vdc remains the same (see 5.4.1.4).

The BCI can be turned on again by power-cycling it (removing the power supply and powering it gain) or by forcing the relay ON via software or by reset. When this happens, the BCI will go into the undervoltage reboot state.

3.3.3.6. Undervoltage reboot state - BCI externally powered

In the undervoltage reboot state the Li-ion battery (bank) will be connected to the DC-bus, but discharging is limited regarding capacity to 0.1 Ah. This allows chargers that need to see a battery voltage, to start charging. The BCI will now allow the Li-ion battery bank to be discharged with 0.1 Ah before it will go to OFF state again. When the Li-ion battery bank is charged with 1 Ah, the BCI will switch to the ON state. The BCI will also go to the OFF state after 10 minutes spent in the undervoltage reboot state, which implies that the Li-ion battery bank should be charged with at least 1 Ah to avoid unnecessary shutdown.

3.3.3.7. Shutdown state - BCI battery bank powered

In this state the main relays and the pre-charge relay are disabled, the BCI doesn't take any power from the Li-ion battery bank and will turn off. However, if there is power on the DC bus the BCI will stay on and takes only power from the DC-bus.

3.3.3.8. Undervoltage Shutdown - BCI battery bank powered

When a Li-ion battery indicates an undervoltage, the BCI will go into the shutdown state to prevent draining the Li-ion batteries further. The BCI can be turned on again by a power cycle or by applying voltage on the load side (i.e. turning on a charger). When this happens, the BCI will go into the undervoltage reboot state.

3.3.3.9. Undervoltage reboot state - BCI battery bank powered

In the undervoltage reboot state the Li-ion battery (bank) will be connected to the DC-bus, but discharging is limited regarding capacity to 0.1 Ah. This allows chargers that need to see a battery voltage, to start charging. The BCI will now allow Li-ion the battery bank to be discharged with 0.1 Ah before it will go to shutdown state again. When the Li-ion battery bank is charged with 1 Ah the BCI will switch to the ON state. The BCI will also go to the shutdown state after 10 minutes spend in the undervoltage reboot state, which implies that the Li-ion battery bank should be charged with at least 1 Ah to avoid unnecessary shutdown.

The BCI behavior during undervoltage shutdown is different from other error states. This was implemented specifically to prevent draining of the Li-ion battery bank and allow the automatic recovery as soon as a charger is connected. Refer to paragraph 5.4.1.4 (systems ≤ 60Vdc) and parapgraph 5.4.2.4 (systems > 60Vdc) for details about undervoltage behavior of the BCI.

⚠ **Caution!** In case of an undervoltage shutdown, charge the Li-ion batteries immediately.

⚠ **Warning!** In the case where a load and a charger are used simultaneously, and the charger cannot supply enough current for the load, the Li-ion batteries will be discharged. When the Li-ion batteries are empty the BCI wants to shut down due to an undervoltage event, but it can't since its powered by the charger on the load side of the BCI.

In this situation the BCI will remain in this state (relays off, but BCI on) if it is powered from the load side by the charger. It is not possible to charge the Li-ion batteries.

To resolve this situation all loads and the charger should be shut down, this will shut down the BCI. And then the charger should be turned on again, allowing the BCI to reboot. Now the Li-ion batteries can be charged. In case of parallel Li-ion battery banks, all other BCI's must first be off.

3.4.4. Driver behaviour

The BCI can control 2 protection contactors and a pre-charge relay:

- Main High Side (+)
- Main Low Side (-)
- Pre-charge

3.3.4.1. Turn on driver behaviour

When the BCI is set to ON state the drivers turn on in a certain sequence which is depicted in Figure 4.

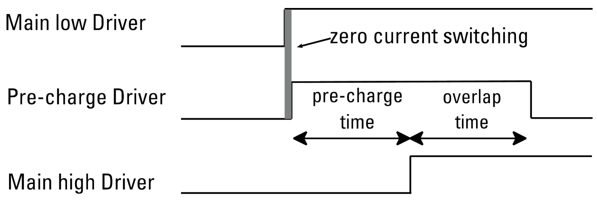

Figure 4. Turn-on sequence of drivers

When the system switches ON, the main low side driver and pre-charge driver are active immediately. The main high side driver will be active only after the pre-charge sequence is completed. See following paragraphs for Pre-charge behavior.
For systems ≤ 60Vdc, typically only the Main High Side contactor is used.

3.3.4.2. Pre-charge driver behaviour - BCI battery bank powered
To minimize the inrush current, the main high side contactor will only be closed if the voltage difference measured over this contactor is less than 1.25V x [number of Li-ion batteries in series]. An external pre-charge contactor should be connected to Pin 3 and 4 of connector J4 (see Figure 11). For example, for a 48V system (4 Li-ion batteries in series) the voltage across the relay should be less than 5V. The BCI will remain in overlap state 1 seconds after the main contactor has been enabled.

3.3.4.3. Pre-charge driver behaviour - BCI externally powered
For limiting the inrush current for systems > 60Vdc an external pre-charge relay should be connected to Pin 3 and 4 of connector J4 (see Figure 12).

However, the switching behavior is different, and solely depends on time, because the voltage difference over the contactor cannot be measured by the BCI. With the Be in Charge software it is possible for the user to select a pre-charge duration > 3 seconds. By default, it is set to 3 seconds.

The value of the pre-charge resistance and power rating is best calculated based on the knowledge of the capacitive load of the system.

3.3.4.4. Turn off behaviour
When the BCI is set to OFF state, all drivers become inactive immediately.

3.5. BCI control functions

3.5.1. Auto-on

The Auto-On function automatically sets the BCI into ON state when the BCI is powered up. Also, if a battery alarm has occurred and this alarm is cleared (see 3.4.3.4), the BCI automatically goes to the ON state if the auto-on function is enabled. The Be in Charge software can be used to control the auto-on function refer to 6.3.6. This functionality only works with at most 4 Li-ion batteries in-series.

3.5.2. SoC shutdown/Switch-OFF

The SoC switch-OFF is a function that makes it possible, at a certain level of state of charge, to put the BCI in:

- Shutdown state: if the BCI is powered by the Li-ion batteries,
- OFF state: if the BCI is powered by an external power supply.

The level can be set by the user and this function can be enabled or disabled. By default, it is disabled. Control of this function is done by the Be in Charge software see 6.3.7.

When Li-ion the battery bank reaches the SoC set level, the BCI will go into shutdown or OFF state. It is activated only with descending SoC level. If the BCI is in SoC shutdown/OFF state it can be turned on again by power-cycling it. When the BCI is turned on again, it’s in the SoC recovery state, during which it will not shutdown on SoC again unless the SoC of the Li-ion battery (bank) is charged 1% above the set level. This re-enables the functionality. Once the SoC shut down/off state has occurred and the BCI is turned on again, the Li-ion battery bank can be discharged further until an undervoltage occurs.

The BCI will report a warning that the SoC is running low when the reported SoC is within 10% over the set shut down level.

Note: It is possible – with BCI software version 2.35 or higher and the latest Be in Charge software - to configure the BCI to display and use the average SoC of the bank vs the lowest. Super B recommends using the lowest.

3.5.3. Reset

Even with Auto-On enabled, some alarm types of the Li-ion battery can only be cleared by a reset. To perform a reset, the user can select either to add an external hardwired reset button on the BCI inputs (J3 pins 3-4, see 5.6.3) or reset by CANopen with use of the the Be in Charge software.

4. General product specifications

Product name:	BCI
Product designation:	2CAN/115/80/29
Producer:	Super B
Product type:	Battery Communication Interface
Product Lifespan:	>10 years

Table 3. General product specifications

4.1. Electrical specifications

Description	Value	Unit
Power supply	7.5...60	Vdc
Power supply required if BCI is powering the CAN bus	15…60	Vdc
Power draw excluding CAN power	<1	W
Current draw “full shut down”	<1	μW
Internal Relay switch current (max, all 4)	4	A
Internal Relay switch voltage (max, all 4)	60	Vdc
Internal Relay isolation voltage	60	Vdc
Input voltage for manual control inputs	0...60	Vdc
Input high level	6.4...6.8	Vdc
Input isolation voltage	60	Vdc
Generic IO open drain, referring to BCI ground	60	Vdc
	100	mA

Table 4. Electrical specifications

4.2. Mechanical specifications

Height (H)	28.5 / 29.5 mm
Width (W)	114.5 / 115.5 mm
Thickness (T)	79.5 / 80.5mm
Weight	136g ± 10 g
Case material	PC / ABS (FR3010)

Table 5. Mechanical specifications

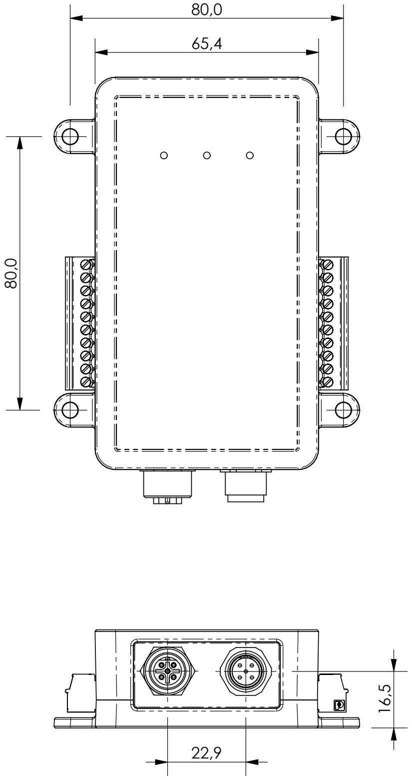

Figure 5. Dimensions

4.3. Environmental specifications

Operating temperature range	-40°C to 85°C / -40°F to 185°F
Recommended storage temperature range	-40°C to 85°C / -40°F to 185°F
Relative humidity	5-85%, non-condensing
Ingress protection	IP20
Shock and vibration	Tested according to DNV requirements

Table 6. Environmental specifications

⚠ **Warning!** The BCI may only be used in conditions specified in this manual. Exposing the BCI to conditions outside the specified boundaries may lead to serious damage to the product and/or the user.

4.4. Scope of delivery

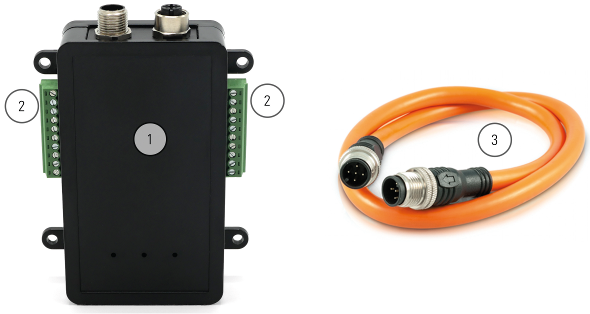

Figure 6. Scope of delivery.

1. (1x) Battery Interface Box
2. (2x) Phoenix plug 10 MC 1,5/10-STF-3,81 1827787
3. (3x) CAN Cable male to male 0.6m

4.5. Connections, indicators and controls

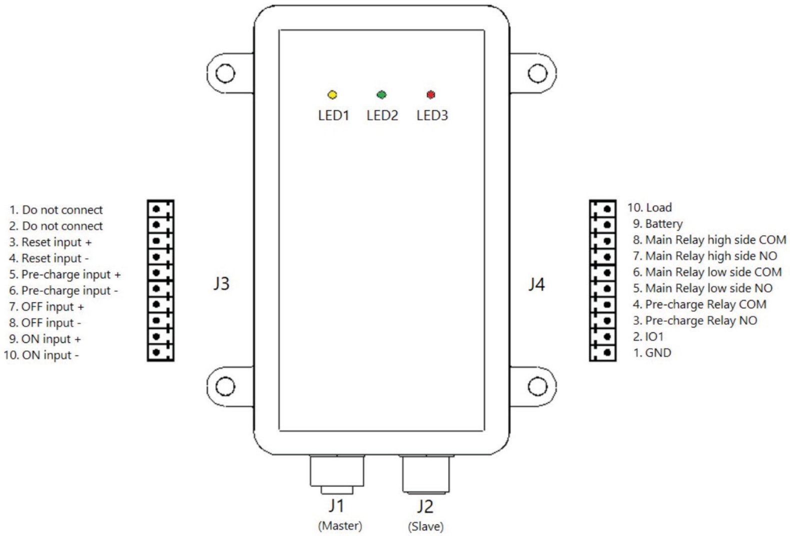

Figure 7. Connections, Indicators and controls

2. J1, CAN Master connector; 5-pin CANopen micro style connector female
3. J2, CAN Slave connector; 5-pin CANopen micro style connector male
4. J3, I/O Connector, 10 pole; Phoenix MPE030-38110
5. J4, I/O Connector, 10 pole; Phoenix MPE030-38110
6. LED 1 - Yellow
7. LED 2 - Green
8. LED 3 - Red

4.5.1. CAN connector pinout (Master/Slave)

PIN #	Signal	Master side	Slave side
1	CAN_SHLD	Optional CAN Shield	Optional CAN Shield
2	CAN_V+	CAN bus supply voltage 12V	Not connected
3	CAN_GND	Ground / 0V	Ground / 0V
4	CAN_H	CAN_H bus line (dominant high)	CAN_H bus line (dominant high)
5	CAN_L	CAN_L bus line (dominant low)	CAN_L bus line (dominant low)

Table 7. CAN connector pinout

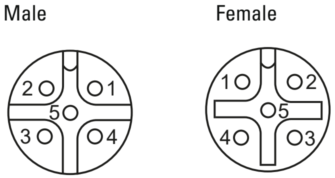

Figure 8. CAN Connections Male and Female

4.5.2. J3 (I/O Connection 10)

PIN	Description
1	Not used
2	Not used
3	Reset input +
4	Reset input -
5	Pre-charge input +
6	Pre-charge input -

7	Main Relay/Contactor Off input +
8	Main Relay/Contactor Off input -
9	Main Relay/Contactor On input +
10	Main Relay/Contactor On input -

Table 8. J3 (I/O Connection 10)

4.5.3. J4 (I/O Connection 10)

PIN	Description
1	GND
2	IO1
3	Pre-charge relay NO
4	Pre-charge relay common
5	Main relay, low side NO
6	Main relay, low side common
7	Main relay, high side NO
8	Main relay, high side common
9	Battery +
10	Load +

Table 9. J4 (I/O Connection 10)

4.5.4. Indicators

LED 1 (Yellow)	LED 2 (Green)	LED 3 (Red)	Mode
Flashing	Off	Off	Pre-charge
Off	On	Off	Main relay On
On	On	Off	Main relay Off
On	On	On	Battery in error mode or communication error
Off	Flashing	Off	CAN network scanning

Table 10. Indicators

4.6. Peripheral equipment

The BCI can be used in combination with several Super B products

Article name	EAN code
Nomia 12V100Ah	8718531360662
Nomia 12V160Ah	8718531360570
Nomia 12V210Ah	8718531361645
Nomada 12V105Ah	8718531361799
Relay GX14BA 12V 350A	8718531361157
Relay GX14CA 24V 350A	8718531361164
Relay GX14FA 48V 350A	8718531361171
Relay GX16BE 12V 600A	8718531361096
Relay GX16CE 24V 600A	8718531361102
Relay GX16FE 48V 600A	8718531361089
Relay TBS RBS 12V500A	8718531362031
Relay TBS RBS 24V500A	8718531362048
Relay LIR250 12V/24V 500A	8718531361126
CAN Terminator Female Low Profile	8718531362000
CAN Terminator Male Low Profile	8718531361997
CAN Cable 0.6m Male to Female	8718531360716
CAN Cable 1m Male to Female	8718531360723
CAN Cable 2m Male to Female	8718531360730
CAN Cable 5m Male to Female	8718531360747
CAN Cable 10m Male to Female	8718531360754
CAN Cable 0.6m Female right angled to Male straight	8718531361492
CAN Splitter Male to 9x Female	8718531361065
CAN T-Splitter Male to Male + Female	8718531360761
CAN power cable 2m	8718531360792
CAN to USB Converter	8718531361201
Be in charge Monitoring Kit	8718531362086

Table 11. Optional peripheral equipment

5. Installation

5.1. General information

⚠ **Warning!** Never install or use a damaged BCI.
⚠ **Caution!** Do not reverse connect the BCI.
⚠ **Caution!** Use the BCI within the specifications.

5.2. Unpacking

Check the BCI for damage after unpacking. If the BCI is damaged, contact your reseller or Super B. Do not install or use the BCI if it is damaged!

5.3. Required tools for installation

- Screwdriver flat 5 mm

5.4. Placement of the BCI

Before it is used, the BCI must be positioned in such a way that it will not move during use. The BCI may be fixed in place by using the mounting holes (Figure 9).

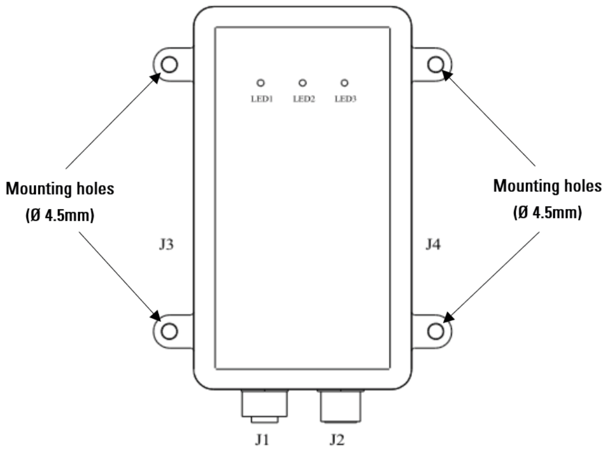

Figure 9. Mounting the BCI

5.5. Connection wires

Use appropriate wire for the connection wires to ensure no overheating or unnecessary losses occur. Consult the SAE-J378 or ISO 10133:2012 standards to determine the appropriate wire properties. Use appropriate fuses matching the wires and load.

5.6. Electrical installation

⚠ **Caution!** High voltages may be present in the Li-ion battery system. Access to the battery system is only allowed by trained professionals!

Safety components selection and design (fuses, cable thickness etc.) should be done following safety guidelines especially for systems > 120Vdc. Super B is not responsible of the overall system integration.

⚠ **Warning!** Always take safety precautions when working on battery systems.

In certain applications, the below components / functionalities might be necessary:

1. Ground Fault Detection device – required for ungrounded systems.
2. Emergency stop – depends on the user preference but can also be a safety requirement.
3. EMC Filter – the need should always be evaluated especially in installations which include high frequency drives.
4. Manual battery switch – is necessary during maintenance, to isolate the battery voltage from the rest of the system during human intervention.

If the BCI is used with a Li-ion battery bank that consists of 4 or less Li-ion batteries in series (48V or less) the battery supply power input of the BCI and its functionality can be used. If the BCI is used with a Li-ion battery bank with a higher voltage it needs to be powered by an external power supply. This supply can be between 15 and 60Vdc, typical 24 Vdc .
Note: For systems ≤ 60Vdc, Super B offers a complete solution: the Battery Interface Box (BIB).

The below will describe in detail the differences and show examples of complete installations for each of those systems.

5.6.1. Electrical installation - BCI power from battery bank

Figure 10 depicts a typical setup drawn of a 48 V or less Installation.

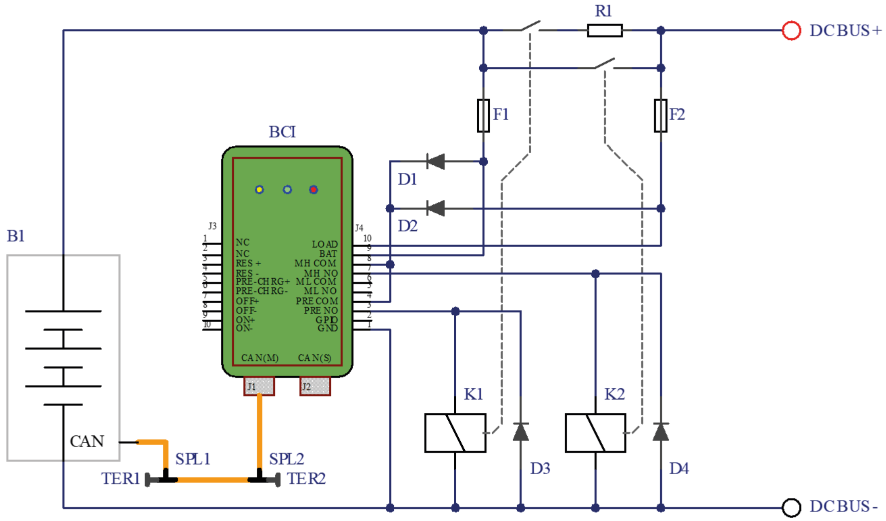

Figure 10. BCI powered from battery bank

Circuit description

The BCI Is powered by the battery bank through the pin 1 (minus) and pins 9 & 10 (plus). If the main contactor is closed the BCI uses the power from pin 10, if the main contactor is open it uses power from the battery bank through pin 9. This is internally controlled by the BCI. The coils of contactors K1 and K2 are connected to the pre-charge driver and the main contactor high driver of the BCI. D3 and D4 are to absorb the back-EMF of the contactor coils. Some contactors have built-in back-EMF diodes or transient diodes. In that case it is advised not to install D3 and D4. D1 and D2 are needed to provide power for the contactor coils. Fuses F1 and F2 should be placed close to the main contactor's terminals. The pre-charge resistor should be tailored to the application. See 5.6.4 for calculating the pre-charge.

Component	Specification	Remark
D1	100 V 3 A	
D2	100 V 3 A	
D3	100 V 3 A	might not be needed depends on relay

D4	100 V 3 A,	might not be needed depends on relay
F1	5A 100 V	
F2	5 A 100 V	
K1	Na	Depends on application
K2		Depends on application
R1		Depends on application, see 5.6.4

Table 12. Circuit description

5.6.2. Electrical installation - BCI externally powered

Figure 13 depicts a typical setup drawn of an externally powered Installation usually higher than 48 V.

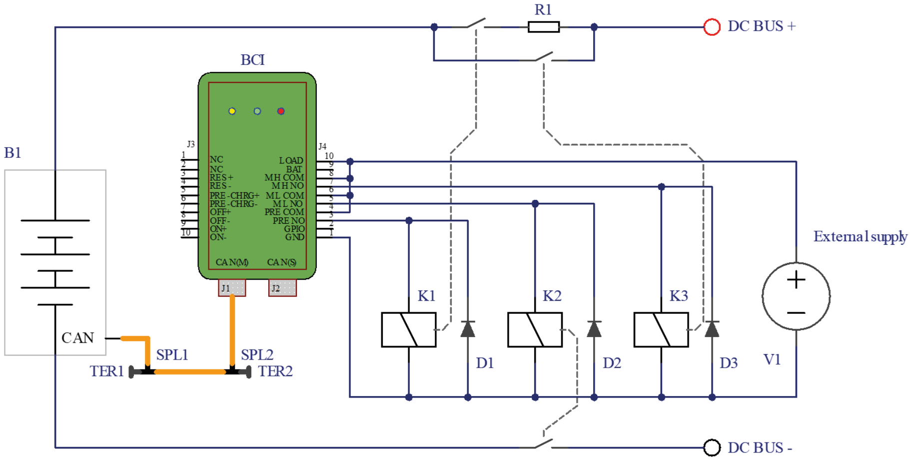

Figure 11. BCI externally powered

Circuit description

The BCI Is powered by the external power supply, through pin 1 (minus) and pin 10 (plus). The coils of contactors K1, K2 and K3 are connected to the pre-charge driver, the main contactor low and the main contactor high drivers of the BCI. D1, D2 and D3 are to absorb the back-EMF of the contactor coils. Some contactors have built-in back-EMF diodes or transient diodes. In that case it is advised not to install D1, D2 and D3. The pre-charge resistor should be tailored to the application. See 5.6.4 for calculating the pre-charge.

Component	Remark
D1	Depends on contactor
D2	Depends on contactor
D3	Depends on contactor
K1	Depends on application
K2	Depends on application
K3	Depends on application
R1	Depends on application, see 5.6.4
	Depends on application
External supply	24 V 1 A, power for the contactors should be added

Table 13. Circuit description

5.6.3. Manual control

The BCI can be controlled manually with external hardwired control buttons. The manual inputs can be normally open contacts or normally closed contacts. A typical setup is depicted in Figure 12.

The manual inputs are default configured for “active high”, so normally open contacts can be used. This can be configured under Input level configuration, see chapter 6.3.3.

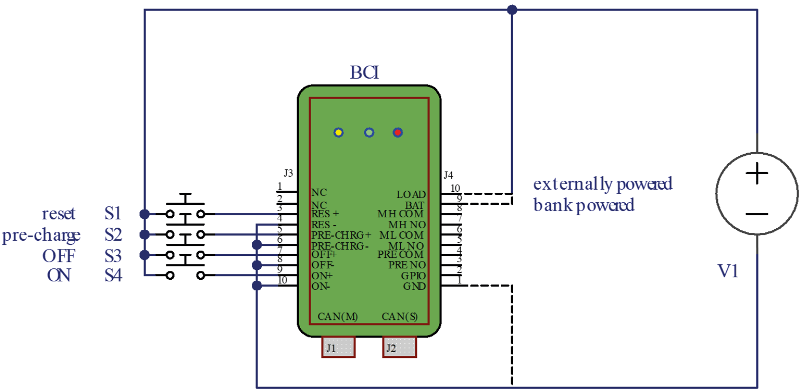

Figure 12. Manual control

Note: the off signal overrules the on and pre-charge signal.

5.6.4. Pre-charge selection

A contactor that must switch a large capacitive load can be exposed to high electric current during initial turn-on. This current, if not limited, can cause considerable stress or damage to the system components. Pre-charging is implemented to increase the lifespan of electronic components and increase reliability of the contactor. In the pre-charge state the main relay is disabled and the pre-charge relay is enabled. Refer to paragraphs 3.3.4.2 and 3.3.4.3 for details about the behavior.

When pre-charging a DC-bus, usually not only the capacitive load needs to be considered. Often the DC-bus has a more complex impedance and there is some resistive load that has to be taken into account choosing the pre-charge resistor.

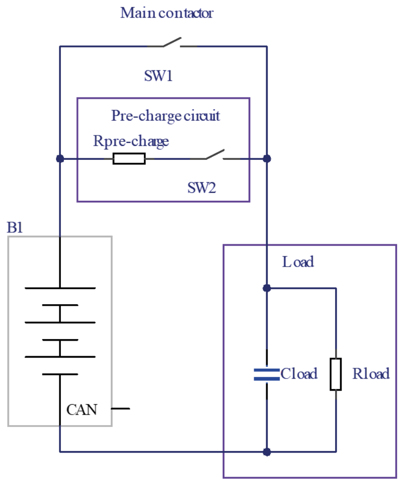

Figure 13. Simplified circuit

In Figure 13, a possible load configuration is depicted. The purpose of the pre-charge circuit is to charge the DC-bus so that the voltage across the main contactor is small enough to turn it on without damaging it. When the main contactor is about to close, the voltage across it must be less than:

Equation 1 $$U_{contactor} < I_{make} \cdot R_{battery\ bank}$$

This means that the value of the pre-charge resistor needs to be large enough to limit the maximum current (when the load is at 0 V):

Equation 2 $R_{pre-charge} > \frac{U_{battery\ bank}}{I_{\max pre-charge\ relay}} - R_{battery\ bank}$

The maximum current is the limit in this equation, it is given for any of the components in the pre-charge path, such as the relay or the load itself.
If the load has a resistive impedance as well, the steady-state voltage won't become equal to the battery voltage. This means that the value of the pre-charge resistor needs to be low enough to make the voltage across the main contactor as low as stated in Equation 1. Which leads to the following:

Equation 3 $R_{pre-charge} < R_{load} \frac{U_{contactor}}{U_{battery\ bank} - U_{contactor}}$

Equation 2 and Equation 3 are the limits for selecting the resistance value of the pre-charge resistor.
Below an example of how to select a pre-charge resistor and set the pre-charge duration for a system consisting of 32 batteries in series:

Considering:
System voltage 460V (32 charged batteries in series, at end of charge voltage).
A capacitive load of 10mF.
A resistive load of 1 kOhm.
The maximum switching current of the contactor is 600A.
The battery bank total internal resistance is 160mΩ.
The maximum acceptable voltage difference across the contactor is 96V (600A x 160mΩ).

The pre-charge resistor must be smaller than: 263 Ohm. The closest standard value is 220 Ohm.
The inrush current is reduced significantly after approximately a time of 5 x τ.

$$\tau = R \cdot C = \frac{1000 \cdot 220}{1000 + 220} \cdot 10mF = 1.8\ s$$

5 x τ = 9 seconds
It is advised to set the pre-charge time to 10 seconds or more see 3.3.4.2.
The resistor needs to dissipate as much energy as the energy stored in the load's capacitors:

$$E = \frac{C \cdot V^2}{2} = \frac{10\ mF \cdot (460V)^2}{2} = 1058\ Joules.$$

$$P = \frac{E}{5 \cdot \tau} = \frac{1058\ J}{9\ s} = 117.5\ W$$

This power is dissipated for a relative short time. The pre-charge resistor must be chosen to be able to handle this power/ energy.

Note: If needed please contact Super B for selecting the ohmic value of the pre-charge circuit and the maximum current the pre-charge circuit can deliver.

Note: If the BCI is measuring the voltage across the contactor, it only activates the main contactor if the voltage difference is small enough. Refer to 3.3.4.3.

⚠ **Caution!** If the load draws more current than the pre-charge current, the BCI will not be able to engage the main relay, since it cannot properly pre-charge the system.
It is important that the load is not engaged before the BCI is done pre-charging.

5.6.5. Coin Cell

Compatible BCIs (Hardware version V1.7 and above) are delivered fitted with an CR1216 coin cell, which is used to power the internal RTC (Real time clock). After installing into an application, remove the coin cell insulator tab to power the RTC.

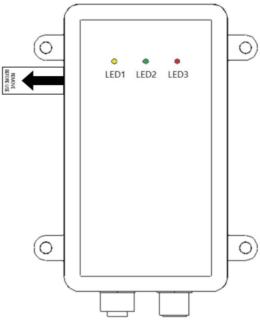

Figure 14. Remove the plastic battery insulator tab before use

5.7. CAN Bus

5.7.1. General information

To use the BCI, the CAN Master bus needs to be connected to the Super B Li-Ion batteries. More information on the CANopen bus can be found at the CiA website: www.can-cia.org. The required documentation can be found in the following CiA documents: (or in a future version of these documents.)

- CiA 301
- CiA 303_1 V1.8.0; Sections 5 (AC and DC parameters) and 7.2: (5-pin “micro” style connector)

5.7.2. Connecting the CAN network cables

The Li-ion batteries should be connected to the BCI via the CAN interface. Start creating the CAN bus connection as shown in Figure 14.

The BCI must be connected to the male-to-male cable to the first splitter and from there the rest of the battery bank can be connected. For further information about the CAN network, read the manual of the batteries that will be connected to the BCI.

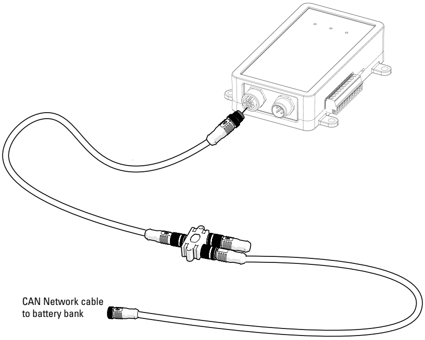

Figure 15. CAN Connection J1 to BCI

5.7.3. CAN Bus network topology

The CAN Bus must be used in a bus network topology. Do not use a ring- or a star topology. The maximum CAN bus length is limited. All Super B Li-ion batteries have a factory default bitrate of 250kbps

Bit rate	Bus length (L)	Max. stub length (S)	Accumulated stub length
250 kbps	250 m	11 m	55 m

Table 14. CAN bus speed

A high-speed bus requires termination at the two ends of the bus

5.7.4. Termination Resistors

Use termination resistors at the end nodes to prevent reflections on the line. The value of this resistor should be +/- 120Ω. More information on termination resistors can be found in CiA document 303_1 V1.8.0, section 5.

5.7.5. CAN bus power

Due to the galvanic isolation the CAN interface of the Li-ion batteries needs power. The BCI can provide this on the CAN master bus. This can be done up to 16 Li-ion batteries. If more

Li-ion batteries are connected the CAN bus must be powered externally, using a CAN power cable.

The CAN bus power should be at least 10V and should not exceed 30V! Therefore, in any 12V or 24V system the CAN bus can be powered directly by the system power.

A 12V system always needs an additional CAN power cable.

The CAN slave bus is not powered by the BCI!

There are multiple possible ways to connect the CAN power cable to the BCI and Li-ion batteries:

1. The first option is to connect the (+) terminal (red wire) of the CAN power cable to the load side of the main relay. There is a disadvantage to this setup; when the main relay opens the CAN power is cut-off. This causes the loss of CAN communication between the Li-ion batteries and the BIB. The load side of the BIB must be powered to have CAN communication while the main relay is OFF. Without CAN communication the BIB cannot turn on.

2. The second option is to connect the (+) terminal of the CAN power cable to the batteries side of the main relay. In this case the CAN communication is always available. There is a disadvantage to this setup; the CAN bus is always powered, therefore; it will drain the Li-ion batteries slightly even when the main relay is turned off (the draining current depends on the amount and type of batteries connected to the CAN bus). When using this setup, Li-ion batteries can be deeply discharged. Make sure that the Li-ion batteries will be charged immediately when they are empty.

5.7.6. Integrating CAN Protocol

For integrating the Super B CAN protocol please contact your Super B sales representative or Super B application engineering.

5.7.7. General purpose I/O

The BCI has an output function that as of software version 2.36 provides a signal for chargers. It can only be used in combination with Li-ion batteries that support this feature also. Contact Super B for the right software version.

This mechanism controls chargers by using the pin IO1 to allow to charge if it is pulled low by the BCI. The BCI will inquire the Li-ion batteries if charging is allowed. This function does not control the state of the BCI (like ON state or OFF state) should charging not be allowed, it only signals towards the charger. Refer to 4.1 or the electrical specification.

Pin 1 (J4)	GND
Pin 2 (J4)	IO1

Table 15. General purposel I/O

6. BCI use

6.1. General information

⚠ **Caution!** In case of an undervoltage shutdown, charge immediately.

⚠ **Warning!** Follow the safety guidelines and measures of chapter 1.

If a preconfigured BCI has been ordered at Super B, the steps in chapter 6.2 are not necessary. If this is not the case, configuring can be done as described in chapter 6.2.

All the battery (bank) values can be monitored on both BCI ports. The battery bank can also be controlled via both ports. If the slave port (J2) is used for another protocol than CANopen, monitoring and control of the battery bank using the Be in Charge software can only be done on the master port (J1).

6.2. Configuring the BCI and the battery bank

Before the BCI and battery bank can be used, the BCI needs to be configured and the batteries need to have a unique battery node ID. Configuring the BCI and the batteries can be done by using the Super B Be in Charge Software.
For connecting the BCI to a computer, a CAN to USB converter is required, see table 12.
Refer to Figure 15 for connecting the CAN to USB converter to the BCI.

6.3. Battery ID's

In multi-battery systems, each battery shall have a unique Node ID number. The default Node ID for a Super B Li-ion battery is 10. This number shall be changed depending on the configuration. If a complete system has been ordered at Super B, the Li-ion batteries will have been preconfigured and renumbering is not necessary. If this is not the case, renumbering can be done manually.

Any Node ID number between 2 and 100 can be assigned to a Li-ion battery. Node ID 1 should not be used for Li-ion batteries as it is reserved for the BCI. We recommend not to use Node ID 10 for multi battery configurations as it may be confusing in case a Li-ion battery is added to the system.

Multiple Li-ion batteries with the same number will result in unpredictable behavior of the system.

It is recommended to label the Li-ion batteries with their assigned node ID. Try to number the Li-ion batteries in such a way that the battery bank configuration (number in parallel, number in series) can be easily recognized. For example, in a 4 series 2 parallel system use node ID 11, 12, 13, 14 for the four Li-ion batteries in series and node ID 21, 22, 23, 24 for the other four Li-ion batteries in series.

6.3.1. Battery ID renumbering procedure

Use the following procedure to renumber the node ID for each battery in the system.

1. Connect one Li-ion battery to the CAN Master bus (see figure 15).

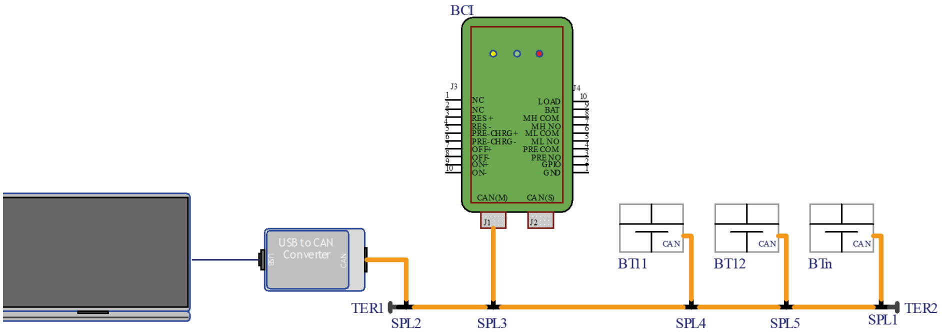

Figure 16. Renumber battery 1

2. Select the 'Scan' button to start scanning for devices. You can also select the scan/refresh icon in the top-left corner (Figure 16).

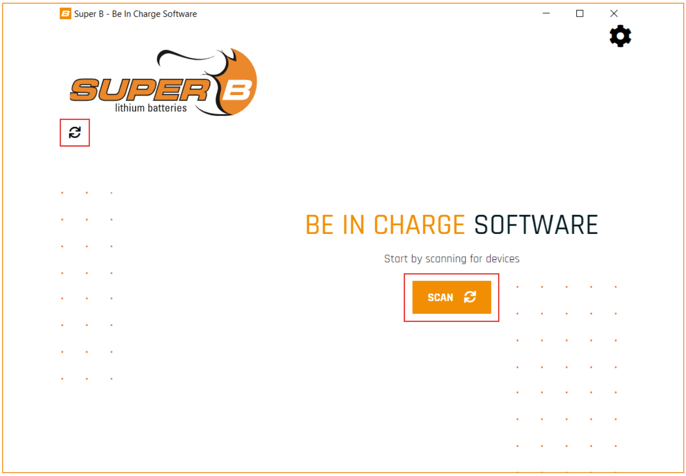

Figure 17. ‘Scan’ for devices

3. In order to make changes to battery node ID it is necessary to set the user level to ‘Expert User’ (Figure 17 and 18).

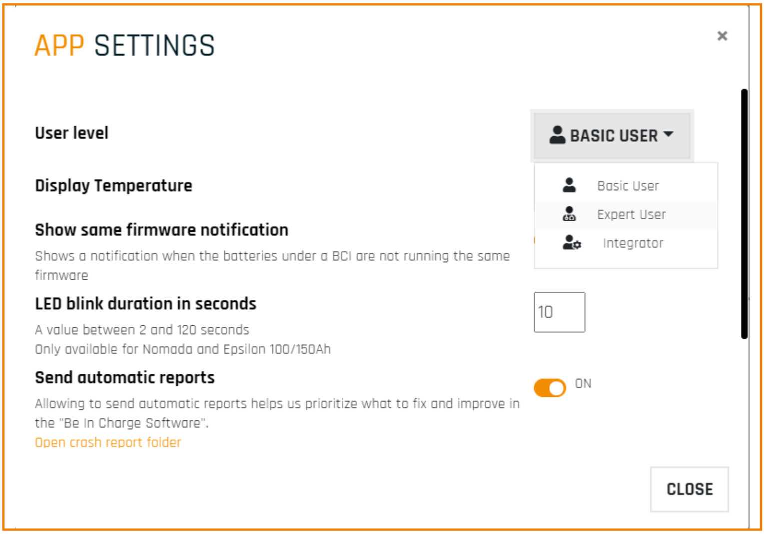

Figure 18. Set user level to ‘Expert user’

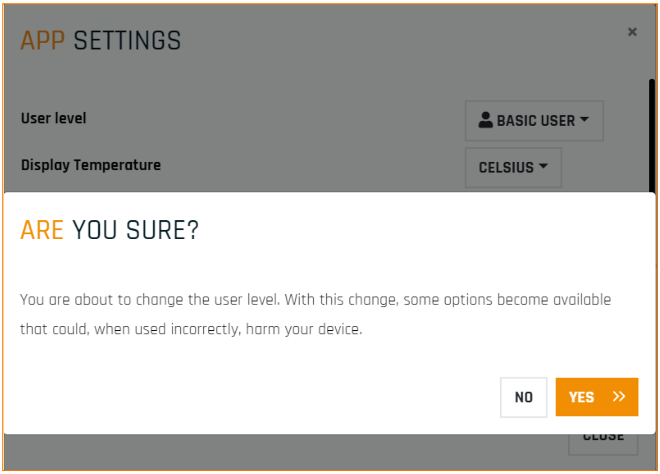

Figure 19. Confirm user level change

4. Navigate to the 'Details' page and make sure to change the battery node ID of the first battery to 11 (Figure 19 and 20)

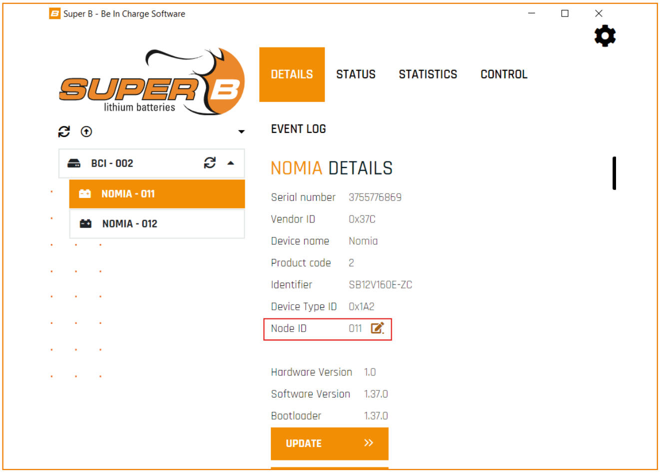

Figure 20. Change the battery 'Node ID' of the first Li-ion battery

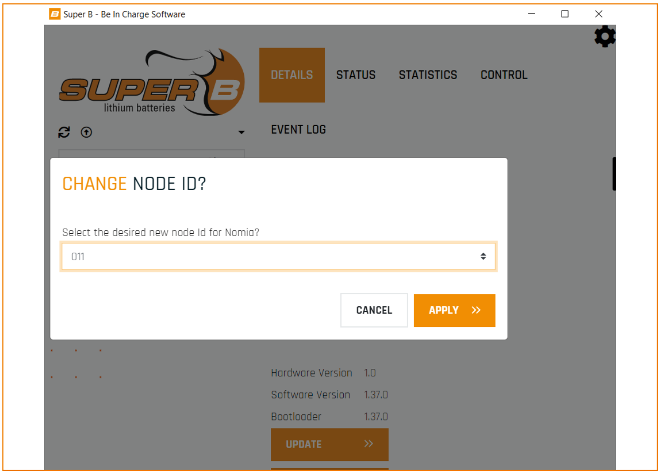

Figure 21. Select the desired new node ID from the dropdown menu

5. Verify if the correct number is assigned to the Li-ion battery by selecting the scan/refresh icon on the top-left corner.
6. Connect the next Li-ion battery and repeat step 4 and 5 until all Li-ion batteries have been assigned a unique Node ID.
7. Continue with the battery layout

6.3.2. Battery layout

The BCI represents a battery bank as one battery. To be able to do so, the BCI must be informed about the layout of the batteries. This means configuration has to be done to "tell" the BCI how the batteries are connected (parallel and/or series). The number of batteries that are connected is detected by the BCI itself by doing a full scan. If the BCI is not configured by Super B the end user must follow the procedure below to set the battery layout.

1. Connect all Li-ion batteries to the BCI via the CAN connection as described in chapter 5.7.2.
2. Perform a scan by selecting the scan button or refresh icon on the top-left corner'.
   The Be in Charge software request the BCI to scan for connected Li-ion batteries. When the scan is completed, the number of Li-ion batteries connected will be shown in the "configuration tab" in the "Total # batteries" field (see Figure 21)
3. Configure the battery bank with the slide bar in the "#Batteries in series" and "#Batteries parallel" fields. The amount of Li-ion batteries in series multiplied by the amount of Li-ion batteries in parallel should be equal to the total amount of Li-ion batteries. The Be in Charge software will not allow an

invalid configuration.

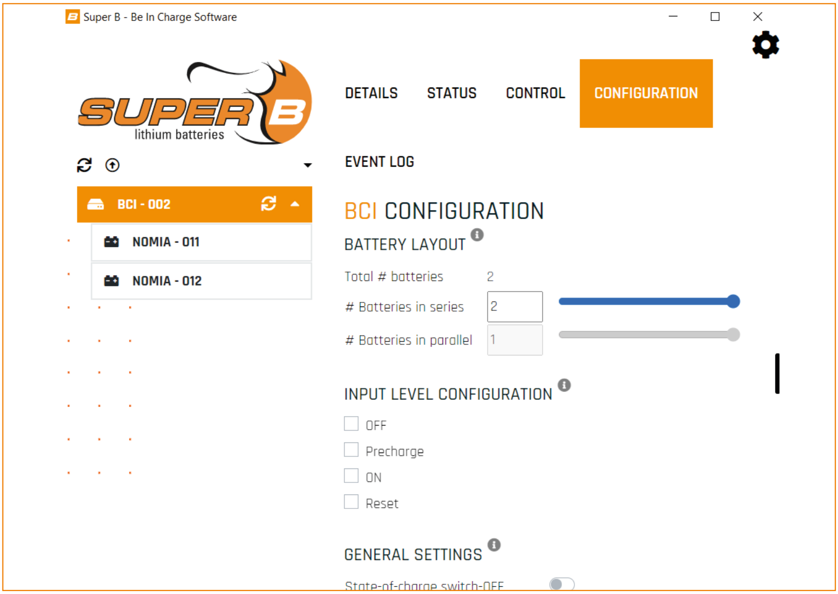

Figure 22. Be in Charge Software - configuration tab

6.3.3. Input level configuration

The BCI contains four hardware inputs: Reset, Pre-charge, OFF and ON (see Figure 22). The inputs can be used to control the BCI. With the “Input level configuration” box you can select whether the inputs should be active high or active low.

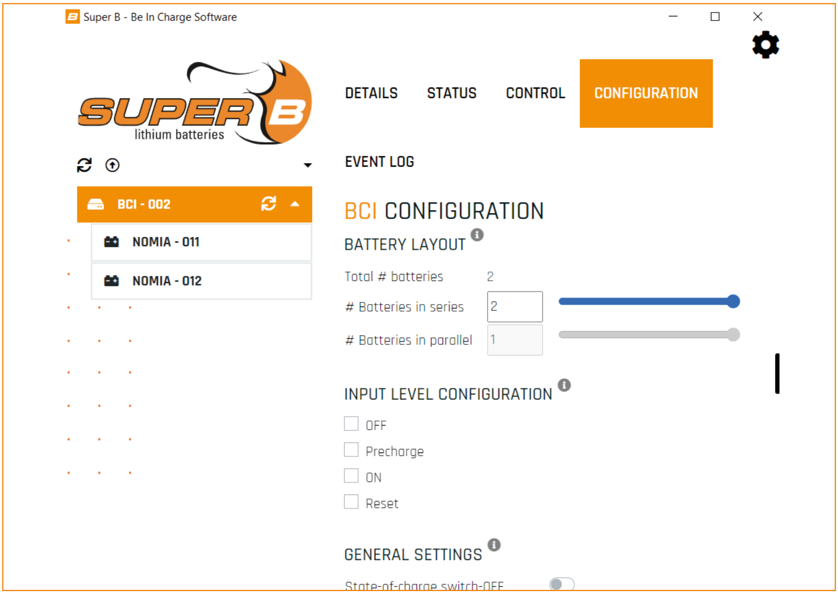

Figure 23. Be in Charge Software - Input level configuration

6.3.4. BCI Modules

The BCI Modules (see Figure 23) can be used to select the communication protocol. The default setting is CANOpen (CiA418 and Super B features). There is also an option to use proprietary protocols. This list is subject to change therefore, the list may look differently depending on the software version.

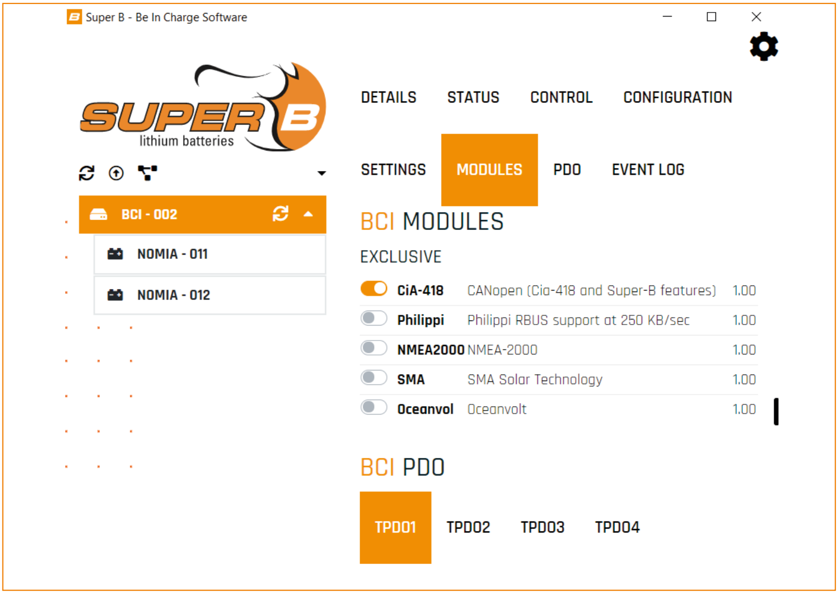

Figure 24. BCI Modules and communication protocol

6.3.5. Pre-charge adjustment

When the BCI is powered externally (paragraph 5.6.2), it is possible to adjust the pre-charge duration in the below section (see Figure 24). This can only be adjusted when "External power" is enabled.

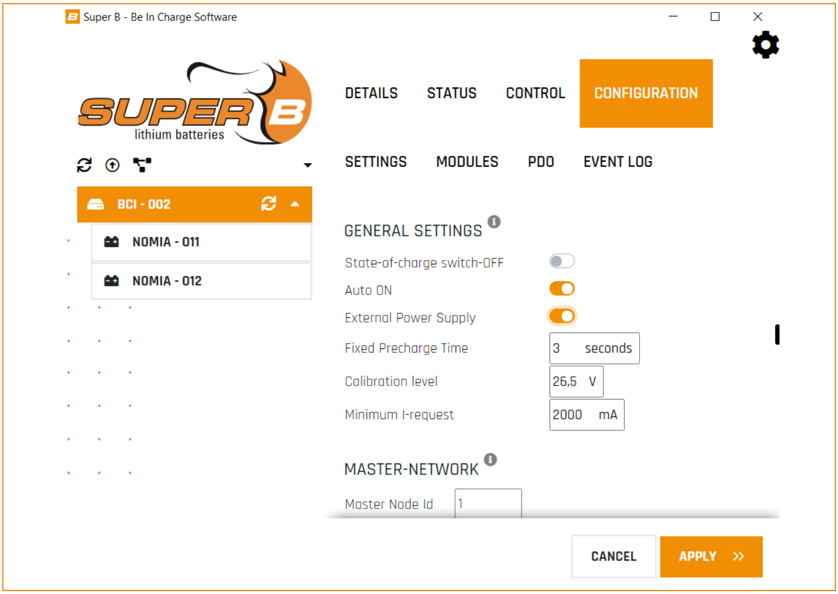

Figure 25. BCI Precharge time

6.3.6. General settings: Automatic control

The Auto On enables the automatic start up option (chapter 3.4.1). The main relay(s) will be engaged automatically when the BCI starts up or all the alarms are cleared, see Figure 25. When Auto On is disabled the Control buttons in the control tab or the external control inputs can be used.

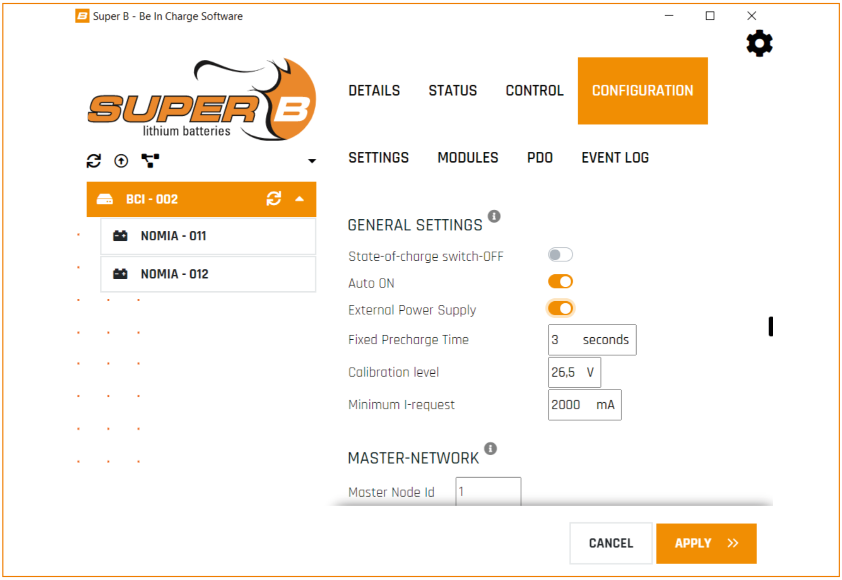

Figure 26. Auto-ON

6.3.7. General settings: State-of-charge switch-OFF level

The State of charge switch off level is a function that makes it possible to put the BIB in shutdown state (see 3.4.2) at a certain level of state of charge. This level can be set by the user (see Figure 26). By default this function is disabled.

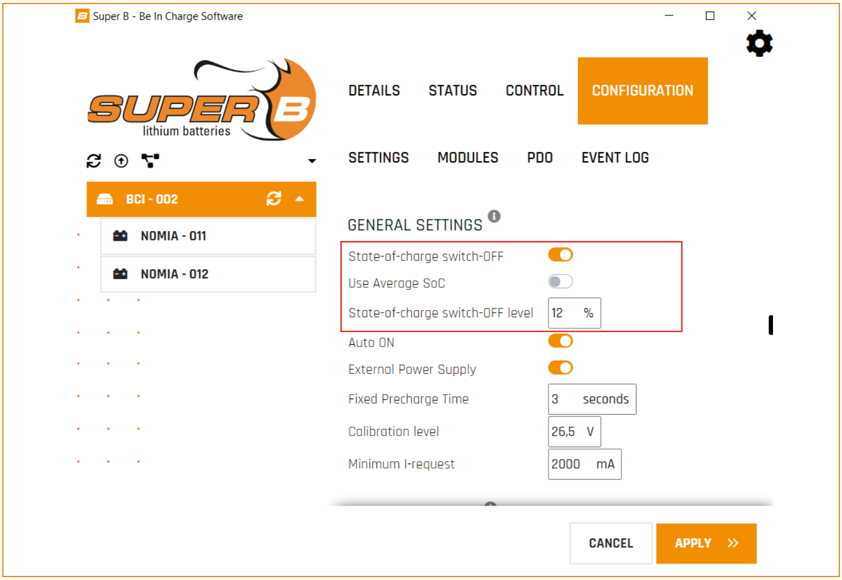

Figure 27. SoC switch OFF level

6.3.8. I-request charger compliance

I-request is the charging current requested by the BCI from the charger to properly charge the batteries. Chargers which follow the I-request are called I-request compliant chargers.

CANopen chargers should follow the I-request CANopen object (0x6070) and periodically set the object Charger Status (0x6001). Please refer to the CANopen documentation for more information.

In addition, chargers which are used with a BCI Module (See Section 6.3.4), such as the Elcon Bus module or the Studer module, are I-request compliant by design.

6.3.9. General settings: Minimum I-request

This setting allows the BCI to properly balance the batteries when using an I-request compliant charger. The value depends on the battery type used. Please refer to the battery manual or consult Super B for properly setting this value.

6.3.10. I-request Control Loop

The BCI can use a PID control loop to account for current distribution imbalances in batteries connected in parallel. In addition, the BCI can request an excess current (I-request) from the charger which can supply for any (discharge) load seen by the batteries.
Please contact Super B to properly configure the control loop as this is a system-dependent configuration.

6.3.11. Saving a configuration

To save a configuration select the "Apply" button on the bottom-right corner (see Figure 27).

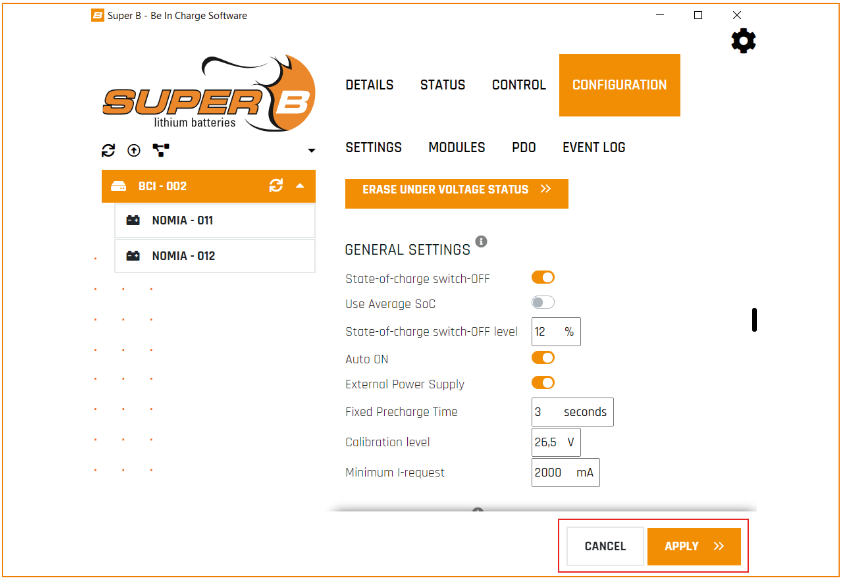

Figure 28. Saving a configuration

6.4. Status and control

The state of the BCI can be controlled by the Be in Charge software. The Be in Charge software can read and set the state of the BCI. The state in which the BCI is, is indicated by the indication bar as depicted in Figure 28.

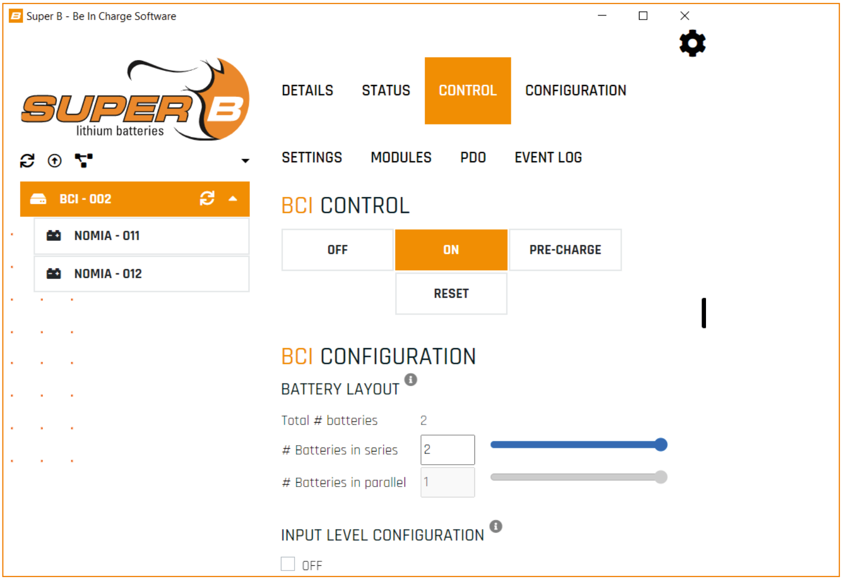

Figure 29. BCI Control tab

The state of the BCI can be manually controlled by using the buttons underneath the BCI Control tab. The reset button can be used to reset the BCI when the BIB and or a Li-ion battery is in error state.

More information about the different state and the corresponding behaviour can be found in chapter 3.4.3.

6.5. Status of the battery bank

The status of the battery bank can be seen in the status tab of the Be in Charge software (see Figure 29 to 35). The information shown in the image is subject to change depending on the Be in Charge software version. They show respectively the BCI in ON state, OFF state (due to battery error), warning state (only available as of BCI SW version 2.35 or later) and 1Ah undervoltage reboot state.

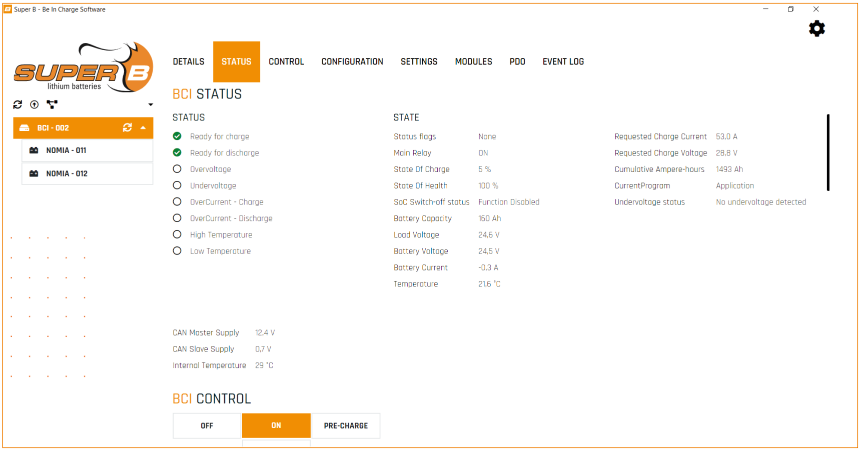

Figure 30. BCI Status tab: ON

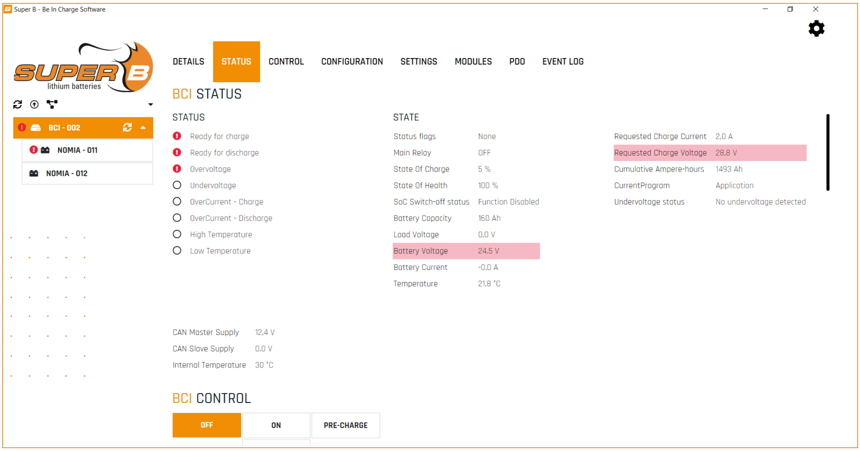

Figure 31. BCI Status tab: OFF – battery in overvoltage

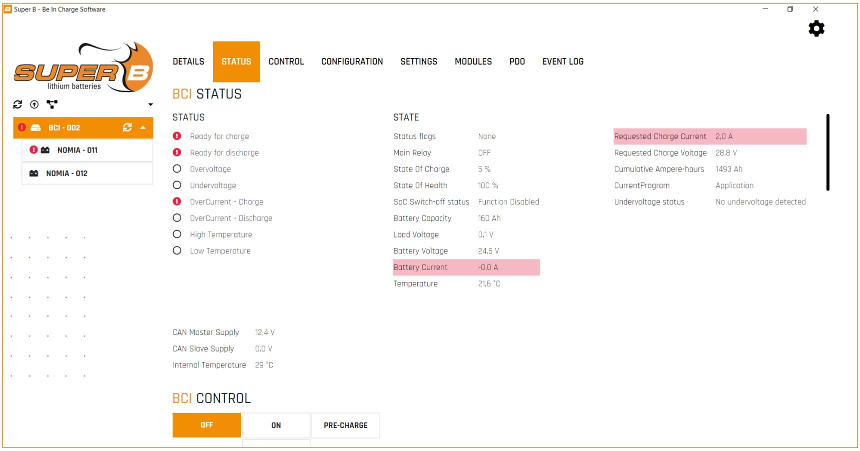

Figure 32. BCI Status tab: OFF – battery in overcurrent while charge

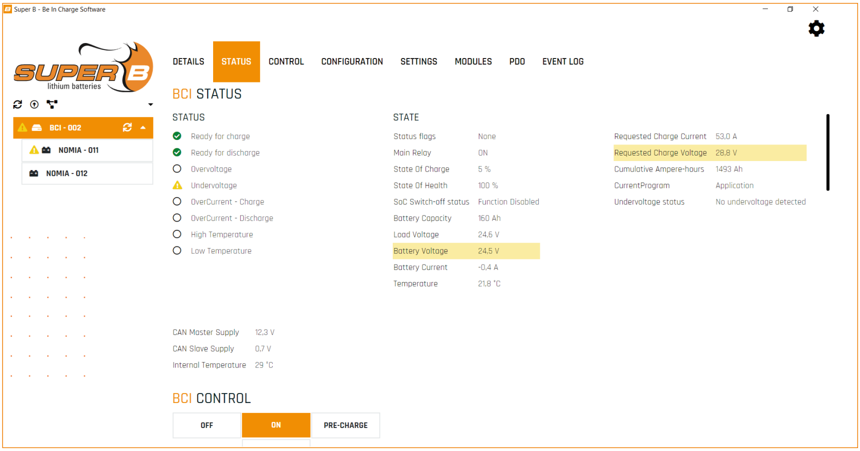

Figure 33. BCI Status tab: undervoltage warning

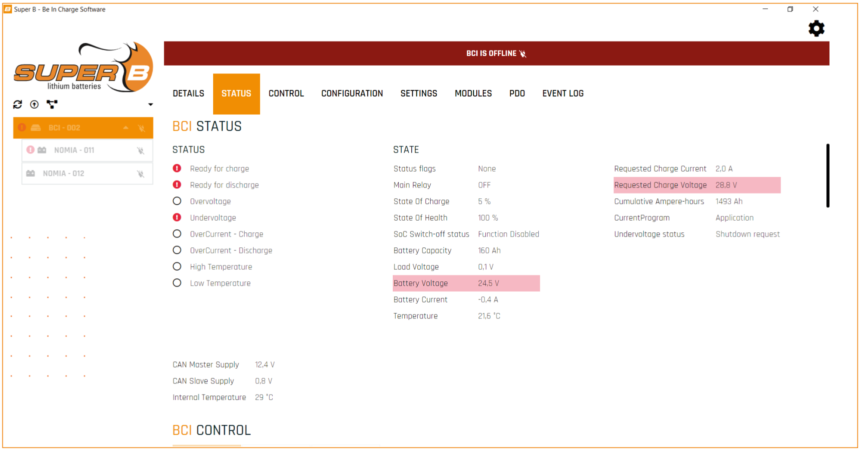

Figure 34. BCI Status tab: undervoltage complete shutdown

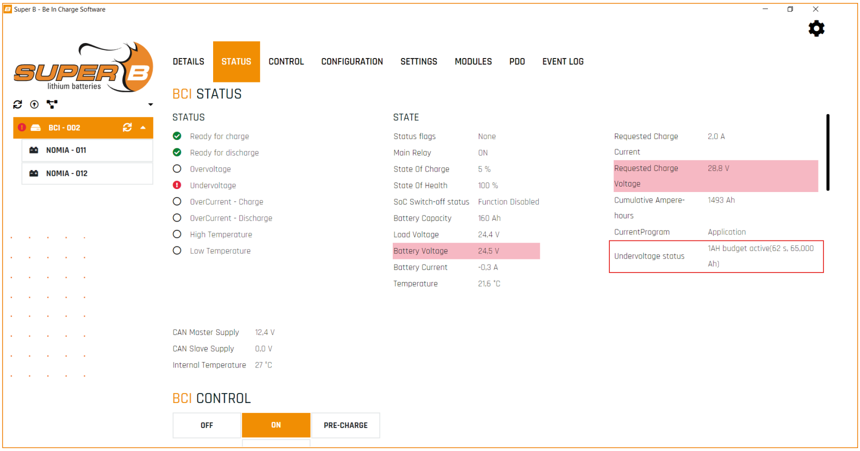

Figure 35. BCI Status tab: 1Ah undervoltage reboot state

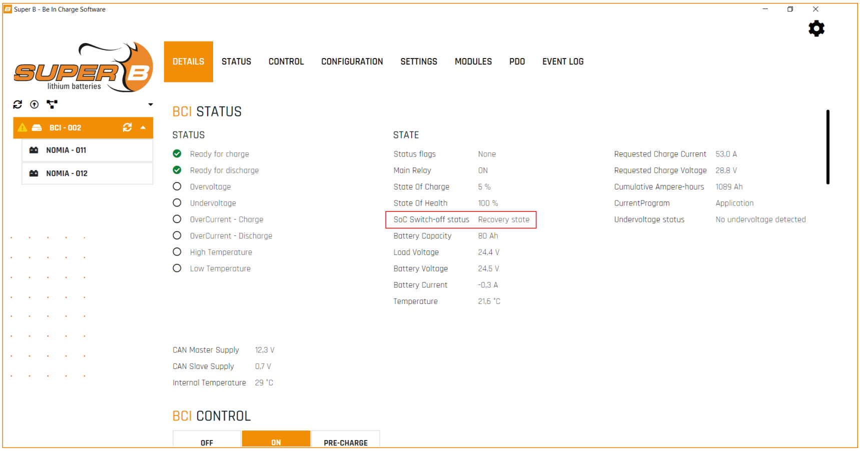

Figure 36. Be in Charge status tab: SoC recovery state as explained in section 3.4.2

6.6. Battery heating

Note: This functionality is available with system batteries with integrated heater elements.
Note: This functionality is available in software version V2.40 and higher and in the Be in Charge Software version 1.5.0 and higher.

Typically, Li-ion batteries cannot be charged below 0°C (32°F) . There are Super B Li-ion batteries types equipped with heaters to make it possible to charge while the ambient temperature is below 0 C. The control of these heaters is carried out by the BCI. Especially with Li-ion batteries banks it is necessary to control this centralized for various reasons but mainly to keep the battery bank in balance.

Every installation has different requirements regarding heating. Therefore different types of heating strategies are implemented. The user can configure the strategy that applies best for the installation in the modules section explained in the following paragraphs.

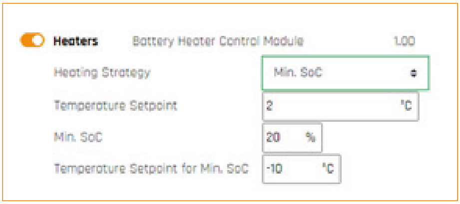

Figure 37. Be in Charge Software: Heater module configuration

There are three heating strategies, which are further explained in the sections below.

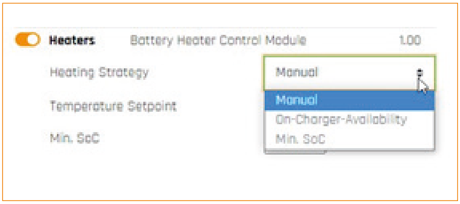

Figure 38. Be in Charge Software: Heater module strategy selection

6.6.1. Heating strategy: manual

In this mode, the user can use the Be in Charge Software or use the corresponding CANopen command to control the heaters. For the latter, please refer to the CANopen documentation of the BCI.

The batteries will be heated up to the Temperature Setpoint, which is the minimum temperature at which charge is allowed. Once the setpoint is reached, the heaters will turn off until the next manual request.

6.6.2. Heating strategy: on-charger-availability

Note: This functionality requires the I-request control loop to be enabled. Please refer to section 6.3.10 (I-request control loop).

This mode will keep the batteries at the set Temperature Setpoint when an I-request-compliant charger is present. See Section 6.3.8 (I-request charger compliance) for I-request compliant chargers.

6.6.3. Heating strategy: min. SoC

In this mode, the BCI will keep the batteries at the Temperature Setpoint for Min. SoC if the SoC requirement is met.

The BCI will heat up the batteries to the Temperature Setpoint, if the user issues a manual request by the Be in Charge Software, by a CANopen command or when an I-request compliant charger is connected and configured with the control loop - See 6.3.10 (I-request control loop).

6.6.4. Heater control buttons

There are three buttons to show the state and control the heater module in the Be in Charge Software.

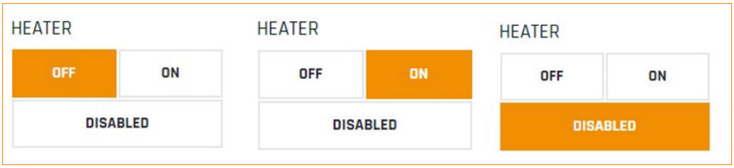

Figure 39. Be in Charge Software: Heater control buttons

The buttons are explained below.

Button state	Meaning
Off	The heaters are currently off. The BCI can re-enable the heaters based on the heating strategy (See previous sub-sections).
On	The heaters are currently on. The user can press this button to indicate a manual heating request. The heating will stop when the Temperature Setpoint is reached for all battery cells.
Disabled	In case of an automated Heating strategy (i.e. On-Charger-availability and Min. SoC), the user can explicitly request to not heat the batteries in order to save energy.

Table 16. Heater control buttons

6.6.5. Heater module errors

In case of errors related to battery heating, the BCI status will show a red mark.

More detailed information on the specific error can be found next to the heater control buttons.

See the figures below:

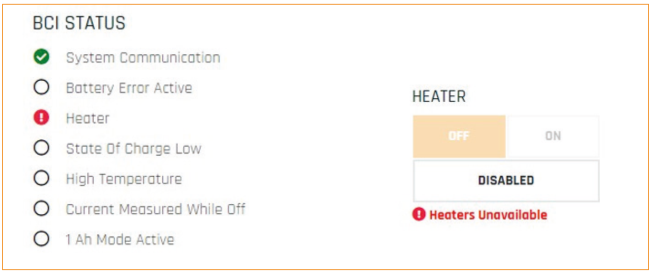

Figure 40. Be in Charge Software: Heater module status locations

All possible error messages from the heater module are explained below.

Error message	Meaning
Low SoC	In the case of the Min. SoC strategy: The SoC is too low. The user can manually request heating by pressing the ON button. Heating will stop as soon as the Temperature Setpoint is reached.
Low temperature	The battery temperature is too low, and discharging (and therefore using the integrated heaters) is not allowed
Battery status	One or more batteries have an active warning or error, which prevent heating.
High temperature	The battery temperature is too high. Heater usage is disabled.
Heaters unavailable	One or more batteries do not have integrated heater elements.
Invalid data	The BCI needs to collect data from the batteries. Common during startup and should resolve as soon as the system is operational.

Table 17. Heater module error messages

6.6.6. Saving energy using and reducing heating-to-charge times

Note: This section only applies to the Min. SoC heating strategy.
The user can configure the Min. SoC Temperature Setpoint to a value lower than the required charge temperature of the battery system. In this way, the energy used to maintain the battery temperature is reduced, because the difference to the ambient temperature is low. If this setpoint is close to the Temperature Setpoint the time needed to start charging is short but typically more energy is spent to keep the batteries warm.

Example use-cases:

Ambient temperature	Heating Temperature Setpoint	Min. SoC Temperature Setpoint	Energy Spent	Heat-to-charge time
-30°C / -22°F	2°C / 35.6 °F	2°C / 35.6°F	++	N/A
-30°C / -22°F	2°C / 35.6 °F	-5°C / 23°F	+	-
-30°C / -22°F	2°C / 35.6 °F	-15°C / 5°F	-	+

Table 18. Example use-cases

Super B recommends thermally insulating the battery system in cold environments. This significantly reduces the energy spent to keep the batteries warm using the Heater module.

7. Inspection and cleaning

7.1. General information

Disconnect the BCI from all loads and Li-ion batteries before performing cleaning and maintenance activities.

7.2. Inspection

Inspect for loose and/or damaged wiring and contacts, cracks, deformations or damage of any other kind. If damage to the BCI is found, it must be replaced. Do not attempt to use a damaged BCI.

7.3. Cleaning

If necessary, clean the BCI with a soft, dry cloth. Never use liquids, solvents, or abrasives to clean the BCI

7.4. Maintenance

7.4.1. Replacing the Coin Cell Battery (For BCI HW V1.7 and above)

The CR1216 coin cell will last approximately 3 years when no power is applied to the BCI across that entire time frame. With external power applied to the BCI, the battery capacity should last >5 years.

In applications where there are frequent power interruptions to the BCI, it is recommended to change the coin cell every 3 years.

In applications where power loss to the BCI is negligible, it is recommended to change the coin cell every 5 years.

To replace the cell in the enclosure:

1. Safely power down the application setup.
2. Remove the BCI from the application installation.
3. Remove the 4 screws on the bottom side of the enclosure using an M3 Torx screwdriver shown in Figure 37.

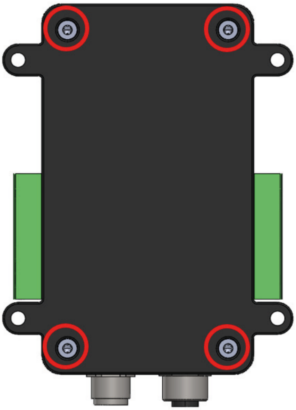

Figure 41. Remove these screws to access the PCB

4. Open the enclosure and remove the PCB.
5. On the top left side of the PCB the old cell can be located and removed as shown in Figure 38.

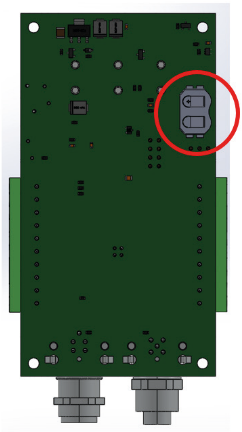

Figure 42. Coin Cell Location.

6. Ensure there is no signs of leakage from the old cell. If there is, carefully use contact cleaner to remove the corrosion in the area.
7. Replace the cell with a new high quality 30mAh CR1216 cell.
8. Reinstall the PCB back in the enclosure and screw back in the 4 M3 screws.

9. Reinstall into the application setup.
10. To synchronize the time, connect the BCI with a CAN USB interface and open the BIC software. The date and time will be initially set to 01/01/1970 when the coin cell is replaced. Click the icon next to the datetime entry to resynchronize the time on the BCI.

8. Storage

Follow the storage instructions in this manual to optimize the lifespan of the BCI during storage. If these instructions are not followed and the BCI is not functioning anymore, consider it to be damaged. Do not attempt to use it. Replace it with a new BCI . No special measures are needed for storage other than observing temperature and humidity requirements (see 4.3).

9. Transport

No special measures or restrictions apply to transport and shipment of the BCI. If it is shipped together with Super B Li-ion batteries, lithium battery legislation applies. In that case, check the manual of the Super B Li-ion battery. Contact your distributor or Super B directly in case of doubt.

10. Disposal

The BCI is classified as “Small IT waste”. The BCI is compliant with WEE and RoHS.

WEEE

The European Waste Electrical and Electronic Equipment Directive (WEEE) applies to a wide range of electronic and electrical products. WEEE encourages the collection, treatment, recycling and recovery of waste electrical and electronic equipment. WEEE makes producers and importers responsible for financing of the collection, treatment and recovery of WEEE. Reference: The Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU.

RoHS

The RoHS Directive will ban placement into the EU market of new electrical and electronic equipment containing more than designated maximum allowable levels of lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE) flame retardants, effective June 8th, 2011.

RoHS works in conjunction with the EU WEEE Directive. RoHS supports WEEE by reducing the amount of hazardous chemicals used in production. In turn it reduces the risk of exposure to recycling staff as well as reduction in recycling costs. Manufacturers will need to ensure that their products, parts and components comply with RoHS in order to be distributed and sold in the EU. Reference RoHS Directive 2011/95/EU.

11. Troubleshooting

Indicator	Meaning	Solution
Green LED blinking	BCI in bootloader	Check the BCI settings by connecting a PC with the monitor software. Perform a software flash.
Green LED blinking with short off intervals	BCI scans for Li-ion batteries	Wait 10 minutes after booting until the blinking stops.
Yellow LED blinking	BCI is in pre-charge mode	Configure BCI to ON-state
	BCI has just booted and has not yet switched the relays.	Typically the relay should be enabled within 2 minutes.
	The difference in voltage between battery bank and charger is too high to safely switch on the main relay.	Wrong configuration of pre-charge system, for example no pre-charge resistor connected or wrong resistor value. Turn off all loads before switching on the BCI. After the BCI is turned on, the loads can be enabled.
Yellow LED ON	Main contactor(s) open	Check if BCI is configured for Automatic startup option (Chapter 6.3.6).
Red LED is on	One or more Li-ion batteries are reporting an error or the BCI is not configured (first bootup)	Determine which Li-ion battery is reporting the error. Check for excessive heat, any damage, short circuits etc. Take appropriate safety precautions. If the problem has been resolved, reset the system (pushbutton or through the Be in Charge software).
	The BCI cannot find one or multiple Li-ion batteries	Check the CAN cables
		Check the CAN terminators
		In case more than 16 Li-ion batteries are connected, check if the external power supply is functional.
		Ensure bitrates are set at 250kbps for each Li-ion battery.
Red LED blinking. 1 flash in 1 second	Battery layout configuration incorrect	Doublecheck the battery layout. Does it match completely with the configuration as stored in the BCI?
	The BIB is not configured (first bootup)	Follow the steps in paragraph 6.2.
Entries in the BCI Event log time are incorrect	The coin cell is either missing or empty	Fit a new CR1216 coin cell. See chapter 7.4.1.

Table 19. Troubleshooting

If problems persist, contact your Super B representative.

12. Warranty and liability

No rights can be derived from this document. Any installation or use contrary to these instructions may void the warranty granted to you. Please refer to the sales agreement for warranty and other provisions applicable to your purchase. If the product is defective, please contact the dealer, reseller or retailer that you purchased the product from. Super B's liability for any of its products is limited to the corresponding provisions under mandatory applicable law.

SUPER B
lithium batteries

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