Advanced Battery Simulator

User Manual

8700-00063 Rev A– March, 2025

WARNING

While the ABS-800-5-5 does not inherently produce any high voltages, it may be used in such a way that high voltages are present on its terminals.

Exercise sound engineering principles and habits when using the ABS and observe best practices for dealing with high-voltage DC sources.

If the equipment is used in a manner not specified, the protection provided by the equipment may be impaired.

Revision	Date	Description	Prepared By	Reviewed By	Approved By
1	2024-10-18	Initial Release	Grant Gothing	Bill Eccles	Tim Burroughs
A	2025-03-13	Update Soft Front Panel usage details	Caitlin Eaton-Robb	Paul Totora Prithvi Basak Will Eccles	Grant Gothing

0 Foreword

The Bloomy Advanced Battery Simulator (ABS) is the world's leading high-current, high-voltage battery cell simulator. It provides a safe and efficient means to simulate a broad range of battery cell and pack conditions to test battery management systems and other battery-sensitive electronics without the hazards of real batteries. The eight cell channels provide individually-programmable cell voltages and currents to create an extremely wide variety of test conditions to comprehensively exercise the functionality of the device under test. Furthermore, the ABS simulates conditions that may be difficult, time consuming, unsafe, impractical or impossible using real battery cells. It is a fundamental building block of many automated test systems, including Bloomy's own family of BMS test systems.

Housed in a 19-inch, 1U (1.75") rack-mount enclosure, the ABS is ideal for benchtop use as well as rack mounting in a test system. Isolated cell channels from multiple units may be connected in series to simulate modules, strings or complete battery packs—up to 1,000V—while auxiliary analog and digital outputs may be used to simulate thermistors, current sensors and contactors. Remote control from a computer or CAN controller is possible via its Ethernet, RS-485, or high-speed CAN communications interfaces.

This manual covers the basic operation of the ABS. The user must be knowledgeable in the application and testing of battery systems and the nature of high-voltage systems in order to use the device properly.

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1 Introduction

The Bloomy Advanced Battery Simulator (ABS) simulates eight high current, high voltage battery cells for testing battery management systems or other battery-centric control system in research, integration, validation, and end-of-line test applications. With its 1,000V-rated reinforced isolation, it is capable of being used with other ABSs to simulate battery packs of over 270 advanced-chemistry cells.

Each ABS unit provides eight channels (cells) of isolated power, each channel capable of programmable voltage output of 0-5VDC and the ability to sink and source up to 5ADC. Built-in voltage and current readback for each cell provide highly accurate simulation as well as live feedback without the need for external monitoring equipment. Integrated faulting relays enable the ABS to inject open circuit, short circuit, and reverse polarity faults. And its onboard auxiliary analog and digital I/O can be used to simulate and monitor additional signals, including thermistors, pack current, safety, and environmental controls.

1.1 Key Features

- Cell Simulation
  - 8 independently-controlled cell channels
  - 0 to 5VDC output, sink/source up to 5A/channel
  - 1,000VDC channel-to-earth ground reinforced/double isolation
  - 1,000VDC channel-to-channel basic isolation
  - Built-in fault insertion for each cell channel (open, short, reverse polarity)
  - 5-wire channel output for 4-wire sensing mode or for local cell stacking mode
- Auxiliary I/O
  - 8x auxiliary analog inputs (±10V)
  - 8x auxiliary analog outputs (±10V)
  - 4x digital inputs (3.3V or 5V)
  - 4x digital outputs (5V)
- Safety
  - Safety compliant to IEC 61010-1 (Third Edition)
  - TTL remote shutdown
- Control
  - 1kHz cell control update rate
  - 100Hz auxiliary I/O update rate
  - Ethernet TCP/IP, UDP, RS-485, and high-speed CAN
  - NI LabVIEW and Python drivers
  - CAN .dbc file
- Physical
  - 1U rackmount enclosure, 17.4"W x 1.72"H x 16.6"D, 17lbs
  - 0°C to 35°C, 20% to 80% relative humidity
  - 100-240VAC 50/60Hz input, 400W max.

1.2 Intended Uses

- Simulation of battery cell voltages, thermistors, and pack current for BMS production and design validation test
- Cell balancing current simulation up to 5A sink/source for passive/active balancing
- Simulation of complete battery packs
- Monitoring BMS outputs (analog ±10V and digital 5V)
- Cell-level charging and discharging at up to 5A

2 General

2.1 Safety

Observe and follow all safety precautions while installing, operating, and servicing this equipment. Failure to comply with the safety precautions and warnings in this manual as well as safe engineering practices may result in injury to personnel or damage to the equipment.

2.2 Electrical

This equipment must be operated only by qualified personnel who understand these instructions, who recognize and can prevent electrical hazards, and who design and implement the necessary precautions and safeguards to prevent injury to personnel and damage to the equipment.

This instrument produces nonhazardous voltages, but the user may connect the unit in ways which may be hazardous. Appropriate precautions must be taken to protect personnel from hazardous conditions.

2.3 AC Input

Do not use an AC supply which exceeds the input voltage and frequency rating of this instrument. (See *Specifications*.)

2.4 Grounding

This product is a Safety Class I instrument. The instrument chassis must be connected to an electrical ground to minimize shock hazard. The instrument must be connected to the AC mains through a three-conductor power cord with the ground wire firmly connected to the electrical safety ground of the AC mains.

2.5 Unit Ratings

Inputs and outputs of the equipment must not exceed the individual rating stated for each interface as specified herein or elsewhere. Exceeding these ratings will potentially damage the equipment.

2.6 System Usage

The ABS is intended to be used as an instrument for the simulation of series-connected cells associated with the testing of battery management systems and associated electrical components in a laboratory environment. Use the ABS only for its intended purpose. Observe and comply with all operating conditions stated in the data sheet, specification sheet, and user manual.

The ABS is to only be operated by qualified persons.

Use the ABS only with electrical signals for electrical measurement, control, and data. Do not connect the ABS outputs to mains or high transient voltages.

2.7 Environment

The ABS is designed for indoor use only in a laboratory environment and is not for home or residential use. It is rated for a Pollution Degree 2. Air temperature, humidity, and altitude must be maintained as specified in the *Specifications*.

2.8 Ventilation

The ventilation openings on the front, rear, and sides of the system must not be covered or obstructed. See the installation instructions (below) for clearance requirements.

2.9 Sound

Multiple units may create sound pressure levels exceeding 85dB. Wear appropriate hearing protection when using multiple units, or install the units in a sound-isolating equipment rack.

2.10 Installation

Installation of the equipment must be in accordance with these instructions. Safety for the use and incorporation of the equipment is the responsibility of the user.

Care and attention must be given to the following installation aspects of installation:

- Enclosure clearances and spacing (see Section 5.1)
- Backshell/rear cover installation (see Section 5.4.2)
- Earth ground provided via the AC line cord.
- High-voltage cell connections (refer to Section 5.4.2)

2.11 Connections

Make connections to the ABS only while the unit and any other connected equipment is unpowered. Making connections while the unit is powered may cause serious injury or damage to the unit.

When the cell outputs are referenced to a voltage of greater than 120VDC, the mass connection cover or individual backshells must be used. (See Section 5.4.2.). Below 120VDC, use of the backshells or the cover is optional.

Use only the cell connector specified in Section 5.4. Other connectors may mate properly to the unit but may not provide safe operation for voltages greater than 120VDC.

Use insulation and gage wire appropriate for the output load current and voltage.

Cables connected to the unit must be less than 30 meters in length.

2.12 Accessories

Use only accessories which meet manufacturer's specifications as defined in this manual, data sheet, and specification sheet.

2.13 Instrument Handling

Do not drop or impact the instrument. Transport the unit flat and upright in appropriate packaging.

2.14 Cleaning

Do not use water, solvents, chemicals, or other cleaning agents to clean the unit.

2.15 Service

The ABS is not user serviceable. Return the unit to Bloomy for maintenance or repairs. Removing the lid of the ABS may invalidate its isolation rating of 1,000VDC and safety rating.

2.16 Critical Component Rating

The ABS is not rated for use as a critical component in a nuclear control system, life support system, or safety control system.

2.17 Safety Symbols

The following symbols are present on the ABS.

Caution is necessary when operating the device near the symbol.

This symbol is present on the rear panel of the unit, the backshell, and rear cover.

High voltage of up to 1,000V may be present based on certain applications. Read user manual to ensure safe operation

2.18 Compliance

This device complies with the essential requirements of the following applicable European Directives and carries the CE marking accordingly:

- Electromagnetic Compatibility (EMC) Directive 2014/30/EU
- Low Voltage Directive (Safety) 2014/35/EU
- RoHS Directive 2011/65/EU

Additionally, the ABS is compliant with the following standards:

IEC/EN 61010-1	Safety
EN 55011/FCC Part 15 Class A	Radiated Emissions
EN 55011/FCC Part 15 Class A	Conducted Emissions
EN 61000-3-2	Voltage Harmonics
EN 61000-3-3	Voltage Flicker
EN 61000-4-2	ESD Immunity
EN 61000-4-3	Radiated Immunity
EN 61000-4-4	EFT Immunity
EN 61000-4-5	Surge Immunity
EN 61000-4-6	Conducted Immunity
EN 61000-4-8	Magnetic Immunity
EN 61000-4-11	Voltage Dips and Drops

2.19 Warranty and Repairs

Bloomy Controls Inc. warrants this unit to be free of manufacturing defects for one year from the date of shipment from the factory.

Before returning the unit for service, contact Bloomy's customer support team and file an RMA request and provide a description of the problem with the unit as well as the serial number of the unit.

Estimates for non-warranty repairs will be provided for approval before repairs are performed.

2.20 Support and Feedback

For support with the Advanced Battery Simulator or any other Bloomy product, please submit a request through www.bloomy.com/request-support

Feedback on this manual and the ABS is encouraged. E-mail suggestions and feedback to: support@bloomy.com.

All technical support, including warranty and repair support will be provided by:

Bloomy Controls, Inc
68 Nutmeg Rd S.
South Windsor, CT 06074

2.21 Related Documentation

Manual (this document)

Describes installation and use of the ABS, including detailed descriptions of unit installation, operating modes and functions, and intended use.

Specification Sheet

Provides detailed technical information on the performance characteristics of the ABS

SCPI Command ICD

Contains detailed command structures and examples for communicating with the ABS via TCP, UDP, RS485 using the SCPI-based communications interface.

CAN Command ICD

Contains detailed communications definitions for communicating with the ABS via CAN bus.

2.22 Related Software

ABS Client

Soft front panel for Ethernet, RS485, and CAN (NI XNET-based) communications and control of one or more ABS units.

Drivers

Multiple driver sets are available for the ABS including C, Python and LabVIEW. In addition, CAN database (.dbc) files may also be provided.

3 Product Information

3.1 Block Diagram

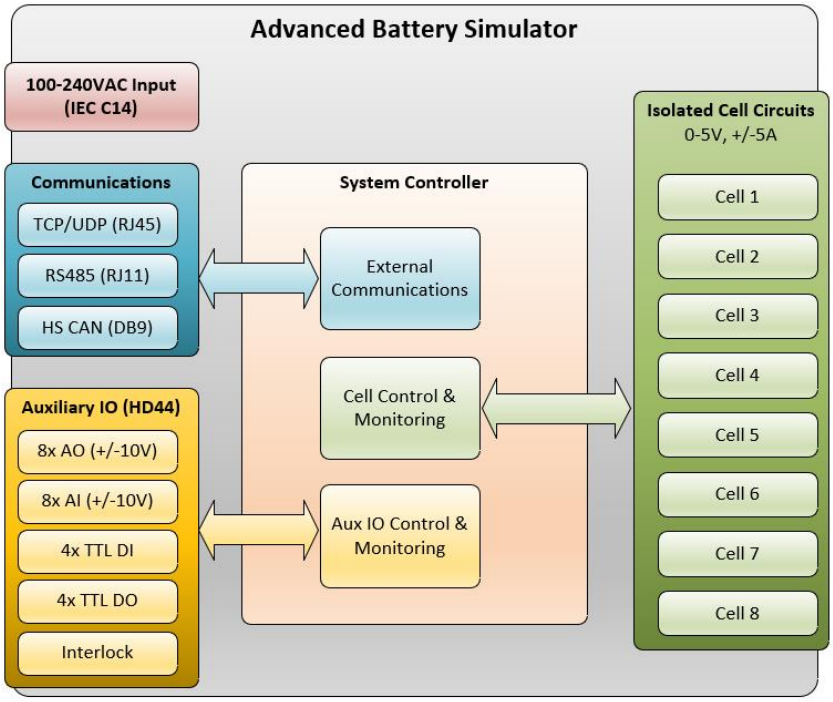


Figure 1: Block diagram of the ABS 800-5-5

3.2 Equipment Ratings

3.2.1 Supply Rating

The Advanced Battery Simulator has been designed to be used with single phase AC power of 100-240VAC, at 50/60 Hz frequency. The maximum power that may be consumed by the unit is 400 W. It is recommended to use the power supply cable that has been provided with the unit. An IEC/VDE certified replacement cable may be used.

3.3 Environmental conditions

The ABS is designed for indoor use in the conditions shown in the table below.

Operating Parameter	Operating Condition
Temperature	5°C – 35°C
Humidity	20% – 80 % (non-condensing)
Altitude	Up to 2000 meters
Pollution Degree	Pollution Degree II
Impact Rating	Impact resistance of 5J

Table 1: Environmental Conditions

3.3.1 Cell Connectors

Each cell is designed to output 5V at 5A, maximum. Each cell can be controlled individually to sink or source power, up to a maximum of 25W. Cells can be connected in series up to 1000V.

> ⚠ Make cell connections **only** with the provided connectors and backshells to maintain 1,000V rating.
>
> **Use of any other connector may result in a hazardous condition.**
>
> **Do not use a different connector.**

Cell connections must be made while the unit is off.

The connector plug provided is made of material with a Comparative Tracking Index of 600.

Wiring of external circuits to the cell connectors must be rated for the maximum voltage of the series-connected cells.

Component	Rated Voltage	Nominal Current	CTI
Cell Plug (CBF050D8 or CTF050V8)	120VDC	5A	600
Cell Backshell	1,000VDC	N/A	600
Rear Mass Cover	1,000VDC	N/A	N/A

Table 2: Insulation ratings of connectors

3.4 Accessories

The table below provides a list of compatible accessories.

Accessory	P/N	Description
Power Cord (Included)	Qualtek 312008-01	Power Cord Black NEMA 5-15P To IEC 320-C13 SJT, 7.5ft, UL, cUL
Cell Connectors (Included) *See Section 5.4.1*	Sauro CBF050D8 (Bloomy 3310-00664)	Pluggable terminal block, 5 position, spring tightening, 3.5mm pitch, 600 CTI. 8x required per ABS
Ferrite Clamps (Included) *See Section 5.12*	Laird 28A0593-0A2	Ferrite clamp for EMC suppression on cell connectors. 8x required per ABS.
Cell Cable Kit **(4-wire)** *See Section 5.8 (4-Wire Mode)*	2900-00173	Kit of 8x 4-wire cell interface cables, 1M long, 1000VDC
Cell Stacking Harness *See Section 5.8 (1-Wire Mode)*	2500-00860	Harness for stacking 8x cell of an ABS, with connectivity for stacking to additional units
Rear Safety Cover *See Section 5.6.1*	2900-00141	Safety cover for rear cell connectors to provide strain relief and restrict access to high voltage cell cables. Required for applications exceeding 120VDC unless individual cell backshells are installed
Cell Connector Backshells Kit *See Section 5.6.2*	2900-00146	Kit of 8x Individual backshells for cell connectors. Required for applications exceeding 120VDC unless rear safety cover is installed.
CAN Daisy Chain Cable Kit *See Section 5.13*	2900-00171	Cable kit for daisy-chain CAN communications for up to 4 ABS units
RS485 Daisy Chain Kit *See Section 5.14*	2900-00174	Cable kit for daisy-chain RS485 Communications for up to 4 ABS units
Aux I/O Breakout Kit	2900-00172	HD44 breakout board with 1M cable

Table 3: ABS Accessories

4 Specifications

Refer to the ABS datasheet for specifications.

5 Installation

5.1 Inspection

Before installation of the ABS, perform a visual inspection of the unit.

> ⚠ Ensure there are no cracks or deformations to the unit, rear connector cover, and connector backshells. Damage may void the 1,000V isolation rating of the unit.
>
> If any cracks or visible deformations are seen, do not use the unit. Contact Bloomy Controls for support.
>
> Operating the unit with cracks or visible defects may cause injury or equipment damage.

5.2 Equipment Mounting

> ⚠ The ABS must be positioned horizontally and upright. Other orientations derate the isolation and capability of the unit and may be hazardous or cause damage to the unit.

> ⚠ The ABS must be positioned and installed so as not to obstruct access to, or prevent disconnection of, the AC input power cord.

> ⚠ Use hearing protection or a closed equipment rack when using multiple unitsto mitigate fan noise. When using a closed rack, ensure that ventilation is properly maintained.

When installing the unit in an EIA-standard, 19" equipment rack, observe the following precautions and design requirements:

- Provide each unit with adequate ventilation. Keep intake and exhaust vents clear of all obstructions.
- Ensure that the front panel remains user accessible and faces the outside (front or rear) of the rack.
- Provide easy access to the power switch and ensure that the front panel indicators are visible to the user at all times.
- Airflow through the unit is into the front panel and out the rear panel. Ensure that fresh air is available to the front of the unit and that the warm air from the rear of the unit is exhausted from the rack.

See *Figure 1: Unit clearances for intake and exhaust* for clearance requirements.

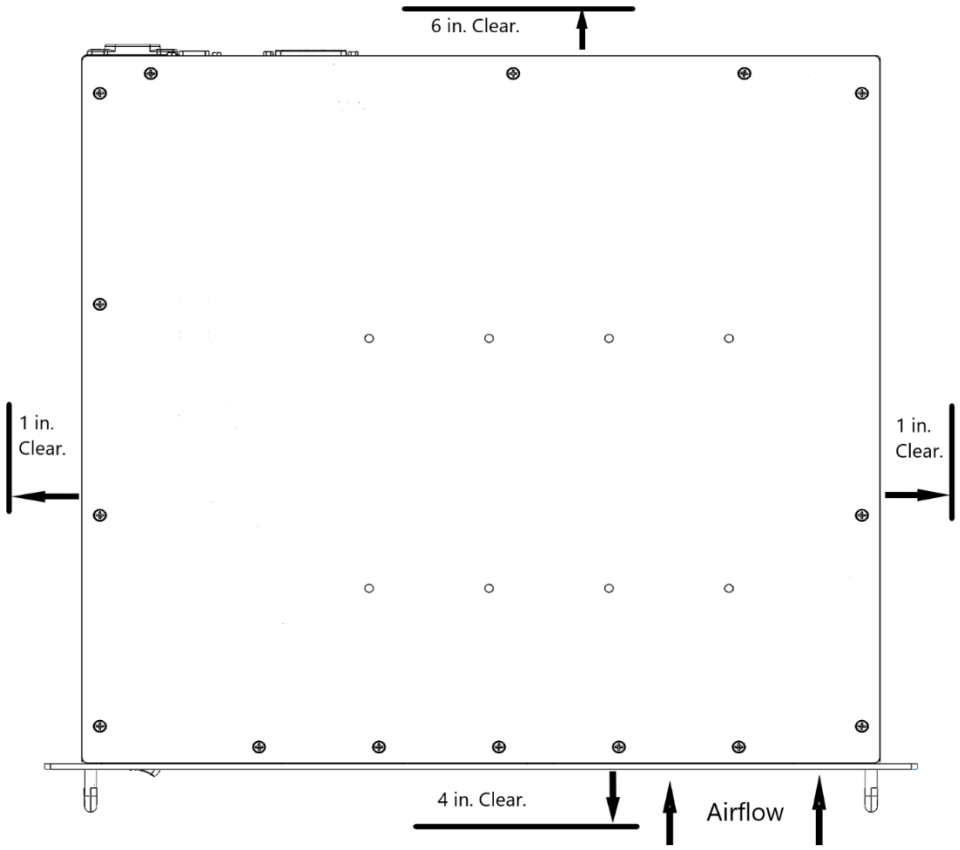


Figure 1: Unit clearances for intake and exhaust

5.3 Unit Overview

The sections below describe the key components and connectors of the unit.

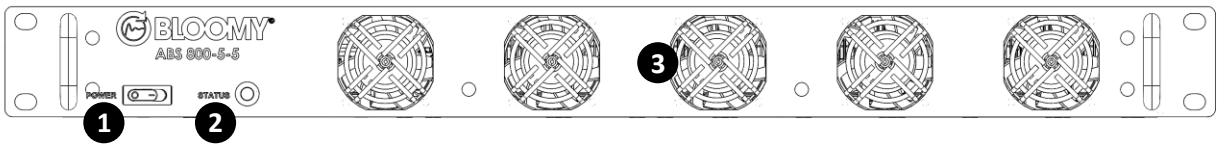


Figure 2: ABS Front View

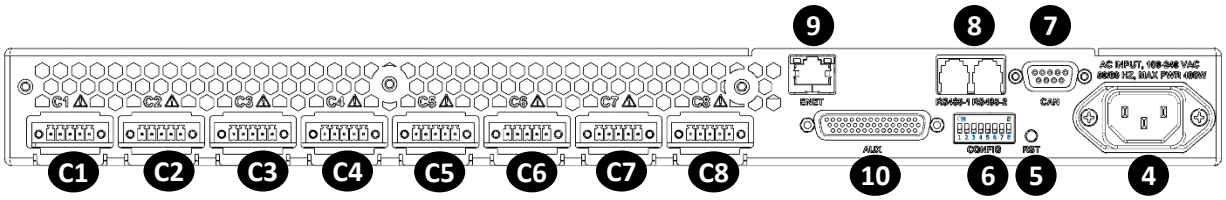


Figure 3: ABS Rear View

Item	Name	Details	Description
1	Power Switch	Toggle Switch	Turns unit on/off
2	Status LED	Tri-color LED	Displays unit status. See Section 5.4.6.2.
3	Intake Fans	5x intake fans	Provide fresh air for unit cooling.
4	AC Input Connector	IEC C14	Provides power to the unit
5	RST	Push button	Resets unit to factory defaults. See Section 6.8.
6	ADDR	8 position switch	Assign unit address. See Section 5.4.6.
7	CAN	D9, female	CANbus for device control and monitoring
8	RS485-1, RS485-2	2x RJ11 connectors	RS485 connectors for device control and monitoring. RS485-1 is the input, RS485-2 is the output for daisy chaining
9	ENET	RJ45	Ethernet connector for device control and monitoring
10	AUX	HD44, female	Auxiliary I/O connector for AIO and DIO. See Section 0 for details
C1-C8	8x cell connectors	Suaro CTM059V8, 5pin pluggable terminal blocks	Cell connections

5.4 Connectors, Switches, Indicators

5.4.1 Cell Connectors

The eight cell connectors provide the cell simulation outputs of the ABS. Refer to Sections 5.5 and 5.8 for detailed instructions on cell wiring and series cell connection.

Connector	Part Number	Details
Unit Connector	Sauro CTM059V8	5-position, 1 level, PCB mount
Standard Mating Connector	Sauro CBF050D8	5-position, 1 level, 3.5mm pitch, Spring, 14AWG max.
Optional Mating Connector	Sauro CTF050V8	5-position, 1 level, 3.5mm pitch, Screw, 14AWG max. *Individual backshells will only work on spring connectors, for screw connectors over 120VDC, the rear mass cover must be used

⚠ Use only the mating connectors specified above.

Use of this connector along with the rear safety cover or backshells is required for stacked (series-connected) cell outputs greater than 120V.

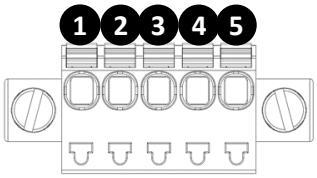


Figure 4: Sauro CBF050D8 Cell Mating Connector, Wire Side

Pin	Function	Description
1	V_{sense}-	Negative sense
2	V-	Negative cell output
3	BMS	Positive cell output w/ faulting
4	V+	Positive cell output
5	V_{sense}+	Positive sense

Table 4: Cell Connector Pinout

5.4.2 Auxiliary (Aux.) I/O Connector

The Aux. I/O connector exposes the auxiliary analog and digital I/O and interlock signals of the ABS. See Sections 6.6 and 6.7 for detailed usage information of the Auxiliary I/O and interlock signals.

Connector	Part Number	De-tails
Unit Connector	Harting 09563527613	HD44 Fe-male
Mating Connector*	COTS HD44 Male	HD44 Male Crimp

* There are no specialty signal requirements for this connector. In general any commercial HD44 Male connector should mate with the Aux I/O connector.

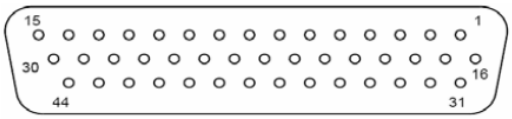


Figure 5: Aux I/O connector pinout (face view of socket on unit)

Pin	Function	Pin	Function	Pin	Function
1	AI2	**16**	AI1	**31**	GND
2	AI4	**17**	AI3	**32**	GND
3	AI5	**18**	GND	**33**	GND
4	AI7	**19**	AI6	**34**	GND
5	GND	**20**	AI8	**35**	GND
6	AO2	**21**	AO1	**36**	GND
7	AO4	**22**	AO3	**37**	GND
8	AO5	**23**	GND	**38**	GND
9	AO7	**24**	AO6	**39**	GND
10	GND	**25**	AO8	**40**	GND
11	DI0	**26**	Interlock	**41**	GND
12	DI2	**27**	DI1	**42**	GND
13	GND	**28**	DI3	**43**	+5V
14	DO1	**29**	DO0	**44**	+10V
15	DO3	**30**	DO2		

Table 5: Aux. I/O Connector Pinout

5.4.3 CAN Connector

Provides CANbus control and monitoring of the ABS.

Connector	Part Number	Details
Unit Connector	Assmann WSW A-DF 09 A/KG-T2S	DB9 Female
Mating Connector*	COTS DB9	DB9 Male Crimp

* There are no specialty signal requirements for this connector. In general any commercial DB9 Male connector should mate with the CAN connector.

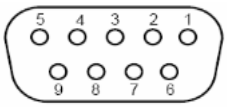


Figure 6: CAN connector pinout (face view of socket on unit)

Pin	Function	Description	Pin	Function	Description
1	N/C	N/C	6	CAN_GND	CAN Ground
2	CAN_L	CAN Low	7	CAN_H	CAN High
3	CAN_GND	CAN Ground	8	N/C	N/C
4	N/C	N/C	9	N/C	N/C
5	Chassis	Chassis GND/Shield	SH	Chassis	Chassis GND/Shield

Table 6: CAN Connector Pinout

5.4.4 RS485 Connector

Provides RS485 daisy-chain control and monitoring of the ABS in Half-Duplex mode

Connector	Part Number	Details
Unit Connector	Molex 0438146621	Dual RJ11 Modular 6p6c Socket C1 – RS485 In C2 – RS485 out (for daisy-chain)
Mating Connector*	COTS RJ11 Plug	COTS RJ11 6p6c Plug

* There are no specialty signal requirements for this connector. In general any commercial RJ11 cable/connector will connect to the RS485 interface

⚠ To reduce EMI communications disruption, RS-485 Cabling must not exceed 3 meters

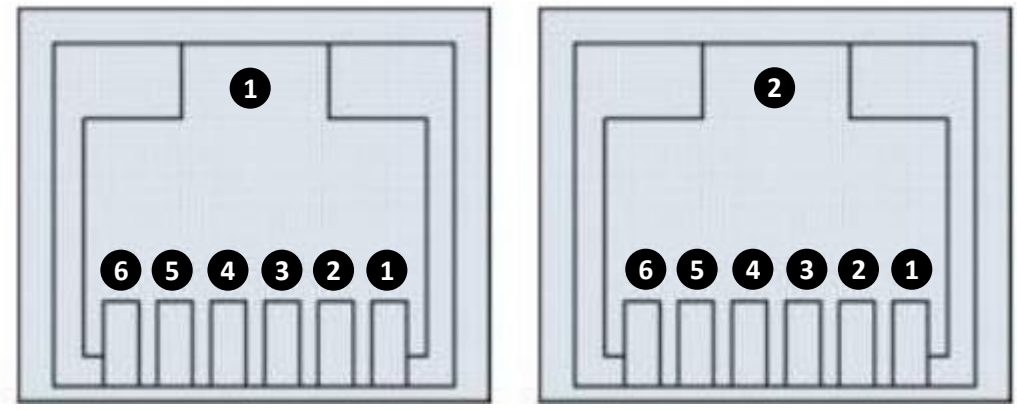


Figure 7: RS485 Connector Pinout (face view of socket on unit)

Pin	Function	Description
1A	Data+ A	RS485 Data + Connector A
6A	Data- A	RS485 Data – Connector A
1B	Data+ B	RS485 Data + Connector B
6B	Data- B	RS485 Data – Connector B
5A/5B	GND	RS485 GND

Table 7: RS485 Connector Pinouts

Ports 1 and 2 are internally shorted to enable daisy-chaining ABS units.

5.4.5 Power Switch

The power switch is a rocker switch on the front of the unit.

5.4.6 Configuration Switches

The CONFIG switches are used to assign a device address to each unit and set its configuration. Switches are latched at power on, so any changes to the DIP switches requires a power cycle.

Switch	Function
1	Device ID Bit 1 (LSB)
2	Device ID Bit 2
3	Device ID Bit 3
4	Device ID Bit 4
5	Device ID Bit 5 (MSB)
6	Interlock Active State
7	Auto IP Address Override
8	Reserved

Device ID	SW1-5
0	↓↓↓↓↓
1	↑↓↓↓↓
2	↓↑↓↓↓
3	↑↑↓↓↓
4	↓↓↑↓↓
5	↑↓↑↓↓
6	↓↑↑↓↓
7	↑↑↑↓↓
8	↓↓↓↑↓
16	↓↓↓↓↑
31	↑↑↑↑↑

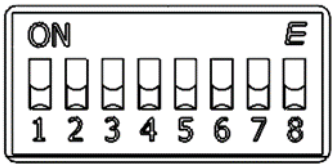


Figure 8: DIP Switches Layout

5.4.6.1 Device ID Switches

The Device ID is used for CAN and RS485 communications to address each unit on the bus. On the Configuration DIP switches, the first 5 switches are used to define the Device ID. Up represents a binary 1 and down represents a binary 0. The Device ID table above shows typical ID configurations. Note that only the least significant 4 bits are used for CAN addressing. As a result, only up to 16 units may share a CAN bus, though these many units will oversaturate the bus and the practical limit is less than 16. When using CAN, the unit with the lowest unit ID will have the highest arbitration priority, and vice versa. The ID of a unit may be queried over Ethernet, but only assigned via the DIP switches

5.4.6.2 Interlock Active State Switch

Switch 6 of the Configuration DIP Switches defines the active state of the interlock feature. Refer to Section 6.7 for details of how to use the interlock.

5.4.6.3 Auto IP Address Switch

Switch 7 of the Configuration DIP Switches provides the ability to automatically assign a default IP address to the unit without requiring communications to the unit. When Switch 7 is LOW, the unit

will use the communications-assigned IP Address (either set via the Client user interface or via SCPI communications). When Switch 7 is HIGH, the unit will automatically assign an IP Address at startup based on the Device ID (first 5 DIP switches), as 192.168.1.(100+Device_ID).

For example:

- Device ID = 0 IP Address = 192.168.1.100
- Device ID = 4 IP Address = 192.168.1.104
- Device ID = 31 IP Address = 192.168.1.131

5.4.6.4 Status LED Indicator

The Status LED on the front of the ABS provides insight into the state of operation of the ABS. The LED is tri color. The color and blinking pattern indicates the device status, per the table below.

LED Indication	System State
Solid Amber	Bootup and configuration
Solid Green	Normal execution
Solid Red	Interlock, recoverable alarm (may be queried and cleared via communications
Blinking Red 1s on, 1s off	Critical alarm (may be queried via communications)
Blinking Red 0.5s on, 0.5s off	Fatal alarm (may be queried via communications)
Blinking green	Reserved

5.5 Cell Wiring

Bloomy Controls Inc. may provide standard cell output cables. It is expected, as the intended use of the equipment includes research and development, that custom wiring may be necessary. The following instructions must be followed to wire the unit safely.

Refer to Section 5.4.1 for cell connector pinouts.

⚠ The use of ferrules or tinned wire is mandatory when creating custom cable connections to the cell connectors. Using bare wire has potential of compromising the isolation of the back shell, and rear covers.

⚠ Follow all manufacturer recommendations for installation, per Sauro CBF050D8 specifications.

⚠ Use of strain relief is mandatory when using the back shell or mass cover. Not using a strain relief can compromise the isolation of the mass cover and the back shell.

⚠ The use of UL rated wires is recommended. It is recommended to use wires that are rated to the maximum stack up voltage of the application. V+, V-, and BMS wires must be rated for the full BMS

balancing current (Minimum 18AWG recommended, 16AWG preferred). S+ and S- wires may be 22AWG or smaller.

⚠ The use of ferrite clamps (Laird 28A0532-0A2) is required on each cell connection for EMI suppression

5.6 Cover and Backshell Installation

5.6.1 Mass Cover Installation

1. Ensure the unit is powered off throughout the installation process.
2. Install the lower mass cover on the enclosure.
3. Plug and screw in the cell cables to the cell connectors on the unit. Screw. Strain relief the cables to the tie downs, and optionally ground the cell cables if using a shielded cell cable.
4. Verify none of the terminals are loose with a pull test.
5. Slot in the top mass cover

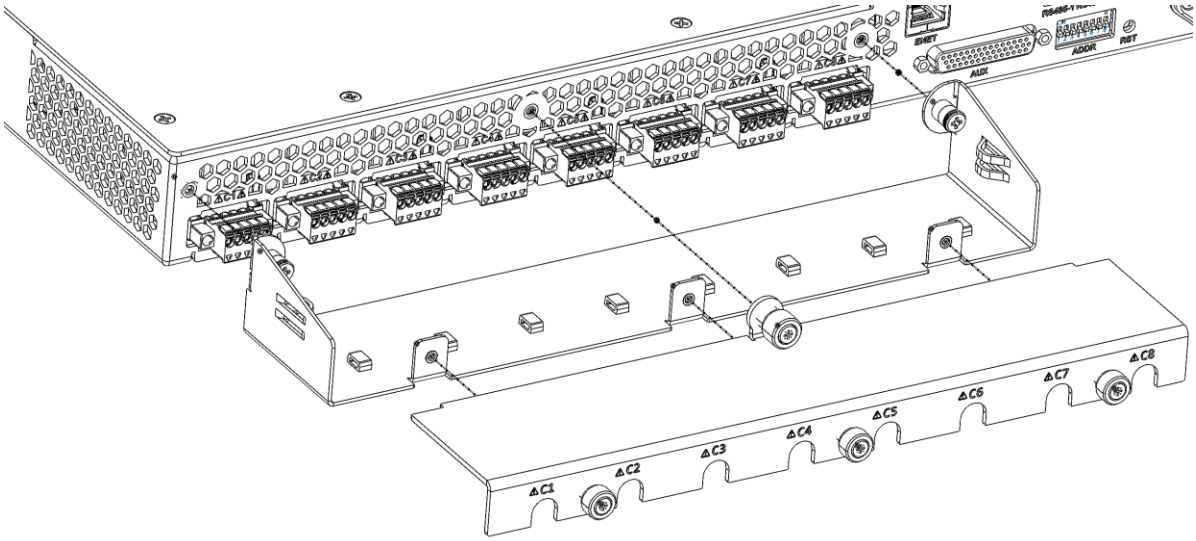


Figure 9: Rear mass cover installation

5.6.2 Backshell Installation

Use the following procedure to install backshells on individual cell connectors.

1. Bloomy recommends using pre-built cables with the backshells.
2. For any custom cable work involving the backshell, prepare custom cable as is, and place cell plug on the slot of the bottom half of the backshell. Strain relief the cable to the slot provided.
3. Snap together the top half of the backshell to the bottom half of backshell.
4. Plug and screw the cell connector into the unit.

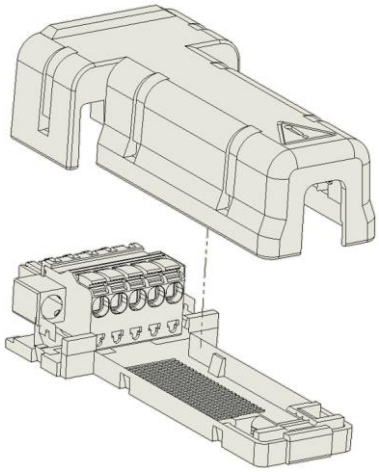


Figure 10: Individual Backshell installation

5.7 Stack Voltage Safety Requirements

The channels of the ABS are intended to be stacked in series to simulate a battery pack or module. Cell stacking must be accomplished via external wiring. Safety requirements and rear cover installation are different depending on the overall stack voltage.

5.7.1 Standard Voltage (<120 VDC)

Recommended individual backshells or rear mass cover. Usage here is optional, and can be used to provide strain relief, or uniformity with setup for test cases that would exceed 120V.

5.7.2 Extended Voltage Mode (120 VDC – 1000 VDC)

Individual backshells or rear mass cover required Usage of backshell/mass cover is required for voltages exceeding 120VDC from ground.

Wire Ratings: Use the appropriate UL rated wires, that meet the maximum stack voltage in the system.

5.8 Cell Stacking

The intended purpose of the ABS is to simulate the series connected cells of a battery pack. The figures below show how multiple cells of an ABS may be connected in series to simulate the cells in a battery pack. Two modes are shown below:

Mode	Description	Usage	Pros	Cons
1-Wire	Individual cells are stacked local to the ABS. BMS Tap wires run to the "BMS" pin on each cell. Pack N and Pack P are pulled from the bottom and top cells	HIL, Validation, mimicking "real world"	Quick connectivity More like a real-world battery connection	No line loss compensation at BMS Bigger voltage drop during balancing Recommend short wires on BMS line
4-wire	Voltage and Sense lines are run to BMS. Stacking is performed at the BMS.	Production Test, BMS Calibration	Line loss compensation Higher voltage accuracy at BMS	Requires pinning 4-wires into single pin on BMS More difficult connectivity

The figures below show how to connect the ABS to a 4-cell BMS in 1-wire and 4-wire modes.

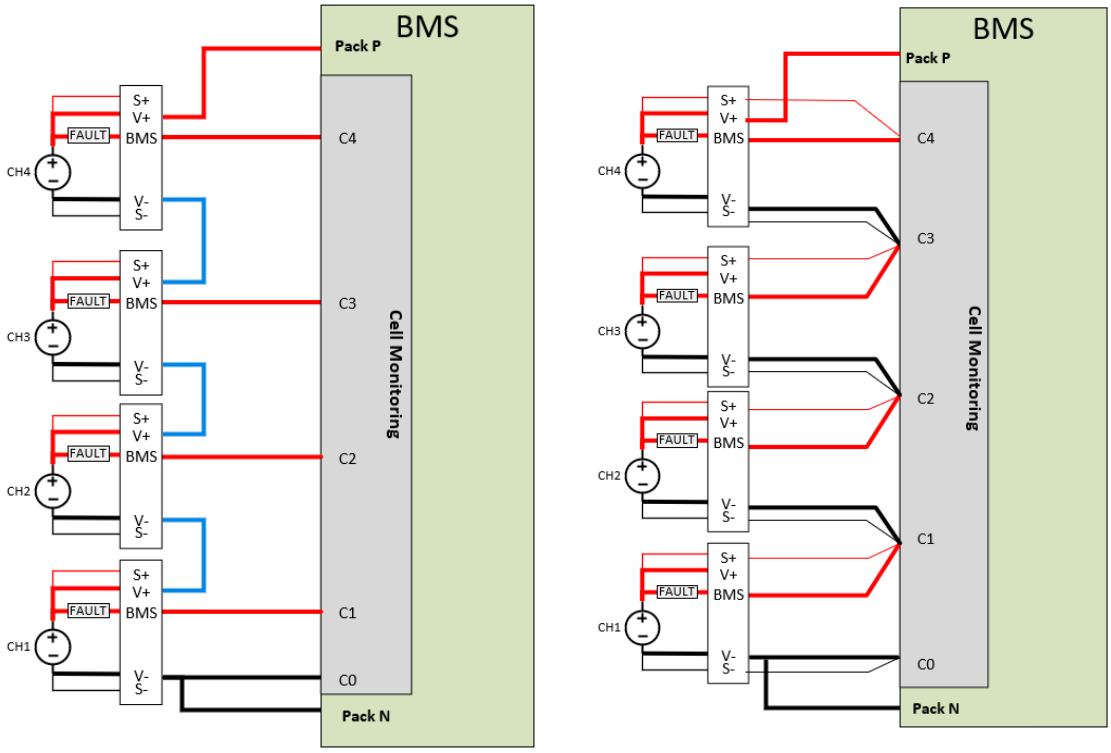


Figure 11: Cell Stacking Connectivity: 1-wire mode (left) and 4-wire mode (right)

5.9 Stacking multiple ABSs

The cells from multiple ABS units may be stacked to create packs of >9 cells. When stacking multiple ABSs, simply stack Cell 8 of the lower ABS to Cell 1 of the upper ABS, as shown in the figure below:

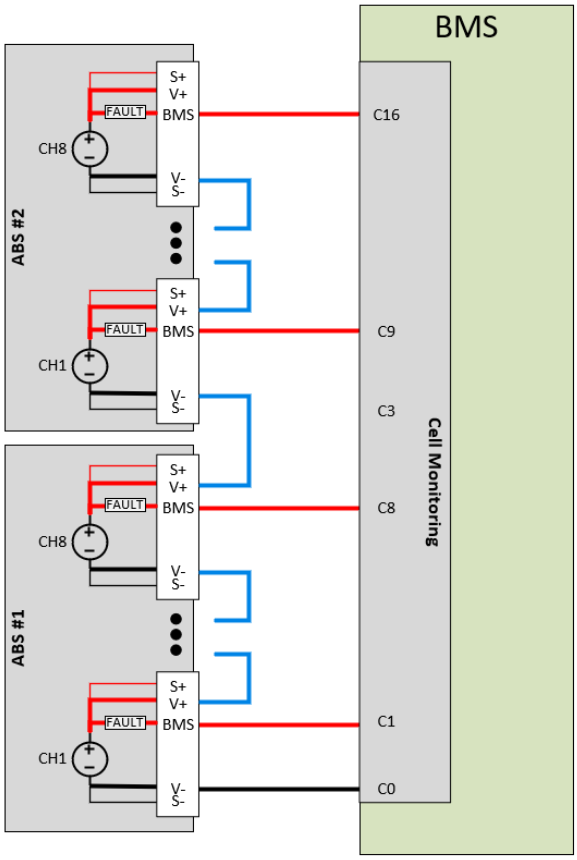


Figure 12: Stacking of multiple ABS units

5.10 Series Stacking with an External Voltage Source

ABS cells may be stacked in series with an external voltage source. When stacking with an external voltage source the following conditions must be met:

- External source current must be limited to 5ADC
- External source must be CE or UL certified
- External source + stack voltage must not exceed 1,000VDC from ground, including any transients
- External source noise and ripple may affect individual cell noise. A low noise/ripple source is recommended for sensitive applications.

5.11 Parallel Connectivity

Parallel connection of cells is ***not*** supported. Do not connect cell outputs in parallel.

5.12 Cell EMI Suppression

The use of ferrites (Laird 28A0532-0A2) is required on each cell connection for EMI suppression. The Figures below show the expected ferrite installation for 4-wire and 1-wire connectivity.

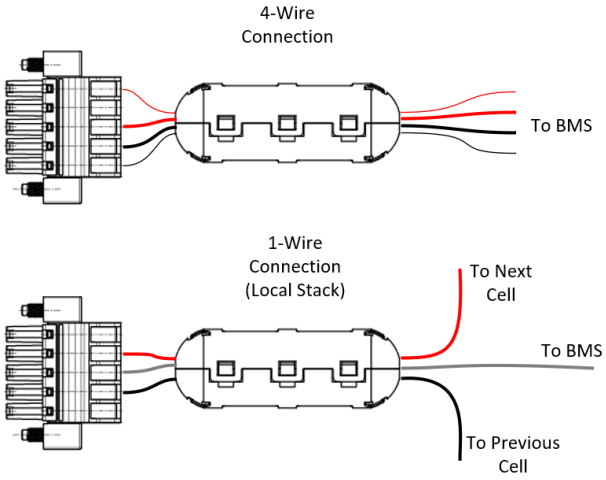


Figure 13: Ferrite Installation

5.13 CAN Daisy Chain Cabling Instructions

CAN communications may be daisy-chained between multiple units to control them all with a single test equipment CAN port. When connecting multiple units on the same CAN bus, each unit on the bus must have a unique Device ID. Device ID can be controlled using the DIP switches defined in Section 5.4.6. Bloomy can provide a CAN Daisy Chain Cable Kit (P/N 2900-00171) to enable a single CAN port to control 4x ABS units. The figure below shows the associated connectivity where DB9 F-M-M splitter cables can be used to daisy chain each subsequent ABS unit. Note that a CAN 120Ω Terminator must be placed on the last unit in the daisy chain.

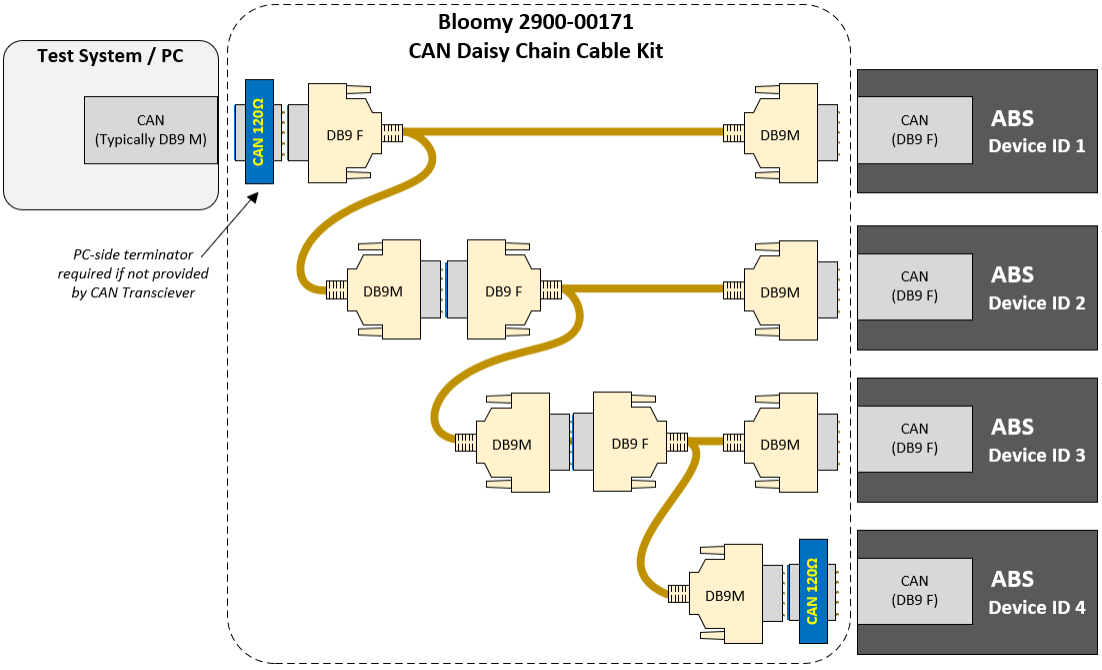


Figure 14: CAN Daisy-Chain Cabling

5.14 RS485 Daisy Chain Cabling Instructions

RS485 communications may be daisy-chained between multiple units to control them all with a single test equipment RS485 port. When connecting multiple units on the same RS485 bus, each unit on the bus must have a unique Device ID. Device ID can be controlled using the DIP switches defined in Section 5.4.6. Bloomy can provide an RS485 Daisy Chain Cable Kit (P/N 2900-00174) to provide a USB to RS-485 converter with RJ12 end, along with 3x 1ft RJ12 cable assemblies to enable a single USB-RS485 port to control 4x ABS units. The figure below shows the associated connectivity. Note that a CAN 120Ω Terminator must be placed on the last unit in the daisy chain.

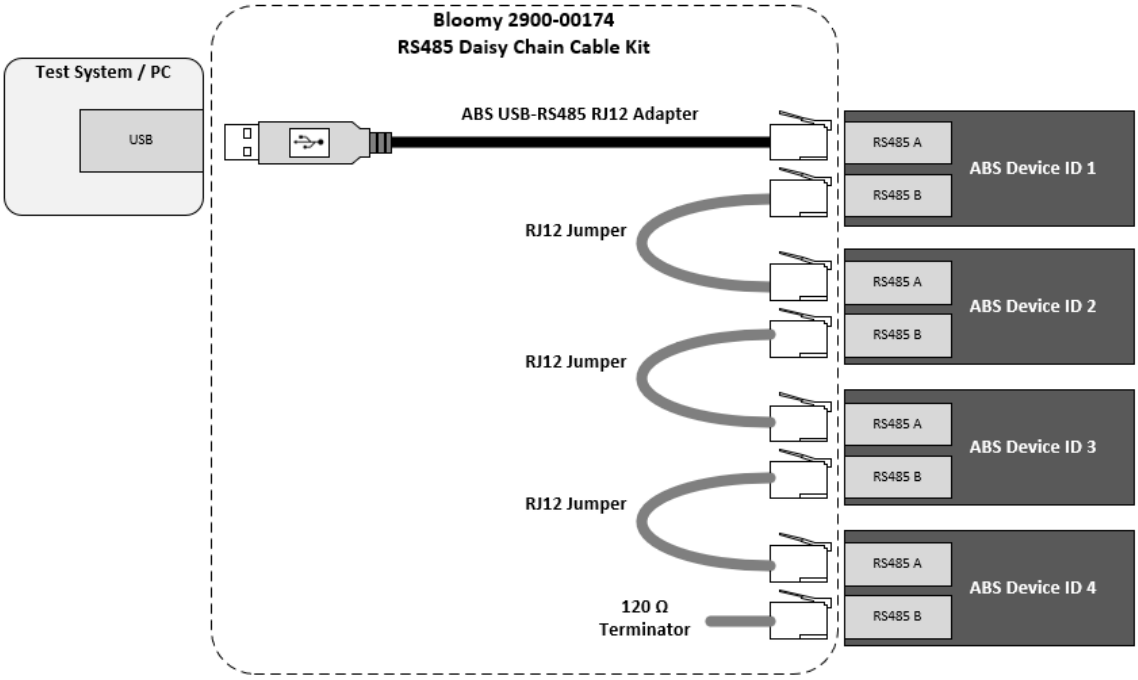


Figure 15: RS485 Daisy Chain Cabling

6 Operation

The ABS must be connected to a computer for external control. All control of the instrument is performed via remote communications. A Windows-based soft front panel is provided for ease of unit setup and testing, however many applications make use of the command ICDs or supplied drivers for automated control of the instruments. This section describes the operating modes of the instrument.

6.1 Cell Output

The eight ABS cell outputs act as individual isolated sink/source programmable power supplies capable of 0-5VDC and ±5A. Cell setpoints may be controlled individually or in bulk by using the messaged defined in each communication protocol. Control parameters include:

- Cell Voltage – The desired output voltage of the cell
- Cell Source Current Limit – the maximum current limit of the output when sourcing
- Cell Sinking Current Limit – the maximum current limit of the output when sinking
- Enabled State – On/off state of the cell
- Fault State – the fault state of the cell (normal, open, short, reverse polarity)

The ABS can operate in one of three modes, and will automatically switch between modes based on external conditions:

6.1.1 Constant Voltage

Constant Voltage (CV) is the intended operating mode in almost all applications. In CV mode, the ABS is regulating output voltage, while monitoring voltage and current readback. In order to maintain CV mode, the sourcing and sinking current limits must exceed the expected external stimulus current. During CV mode, the unit may source or sink current based on the output stimulus.

- **Sourcing**: If the applied stimulus is a resistive load or a lower voltage than the setpoint, the unit will source current.
- **Sinking**: If the applied stimulus is a higher voltage than the setpoint, the unit will sink current.

The unit will automatically cross over between sourcing and sinking as the external stimulus changes.

6.1.2 Constant Current

When the current required by external stimulus exceeds the sourcing or sinking current limit setpoints, the ABS will transition to a constant current (CC) mode. In CC mode, the ABS is regulating output current, while monitoring voltage and current readback. CC mode is valid for both sourcing and sinking outputs, with different limit setpoints for each.

6.1.3 Remote Sense

When regulating voltage in CV mode, the remote sense wires of each cell output can compensate for up to 0.5V of drop in the cell wiring.

6.1.4 Limitations

5V, 5A maximum per cell (sinking or sourcing)

For applications using sinking on cells, all cells can simultaneously dissipate up to 5 A at 5 V per cell within the power dissipation limit.

Remote sense compensation is automatically enabled if 4 wires connect to the external stimulus.

Refer to Specifications for power generation and dissipation ratings, and dynamic characteristics

6.2 Cell Readback

Each cell continually measures its voltage and current. Cell voltages and currents are reported back over each of the communications interfaces (see Section 6.12).

Cell readback data is reported in one of two ways, depending on the communications method. Refer to the individual communications ICDs for details of each method and message.

- **Query/Response**: In SCPI-based communications methods, cell readback values must be queried from the unit as required
- **Streaming**: in streaming communications methods (eg. CAN), the cell readback values are periodically broadcast at a set rate.

See the ABS specification sheet for accuracy, sampling rates, dynamic characteristics.

6.3 Cell Enable/Disable (Sleep)

Through each of the control modes defined in Section 6.12, a user may enable and disable individual cells or all cells simultaneously. Disabling the cells is equivalent to setting all limits to zero and setting the fault insertion relays to their nominal state. Internal power to the cell is maintained with software enable/disable. This allows for rapid boot back into cell functionality.

Upon re-enabling a cell, the cell will automatically return to the commanded voltage and current set-points.

Note: Only upon a hardware reset, or alarm/fault condition will power be removed from internal cell components. See Section 6.10 for more details.

6.4 Cell Power On/Off

In the case of active interlock, e-stop, a recoverable alarm or a fatal alarm, the hardware will remove power to the entire cell, including measurement devices.

Upon return to normal operation, the system is effectively in a power on state, and does ***not*** resume operating with its last configuration. Therefore, new setpoints and enabled states must be commanded to the unit in order to resume operation.

6.5 Cell Faulting

Every cell in the ABS has the capability to inject hardware faults on an individual cell basis. The following fault states can be commanded to the unit. Note that only one fault state may be commanded at a time for each cell.

Mode ID	Mode Name	Description	Relay States
0	No Fault (normal)	Normal operation	Open – Energized Short – De-energized Polrev – De-energized
1	Open Circuit	Simulate broken wire fault. BMS (Pin 3) is disconnected from the UUT V+/V- are not affected such that the battery stack is maintained	Open – De-energized Short – De-energized Polrev – De-energized
2	Short Circuit	Simulate shorted cell fault. BMS (Pin 3) is shorted to V- V+/V- are not affected such that the battery stack is maintained	Open – De-energized Short – Energized Polrev – De-energized
3	Reverse Polarity	Simulate reverse polarity of cell. V+ and V- are reversed at the connector, reversing the targeted cell's polarity in the overall battery pack under test. The BMS polarity will also invert. Cell readback is disabled. **Not recommended for current sinking mode.**	Open – Energized Short – De-energized Polrev – Energized

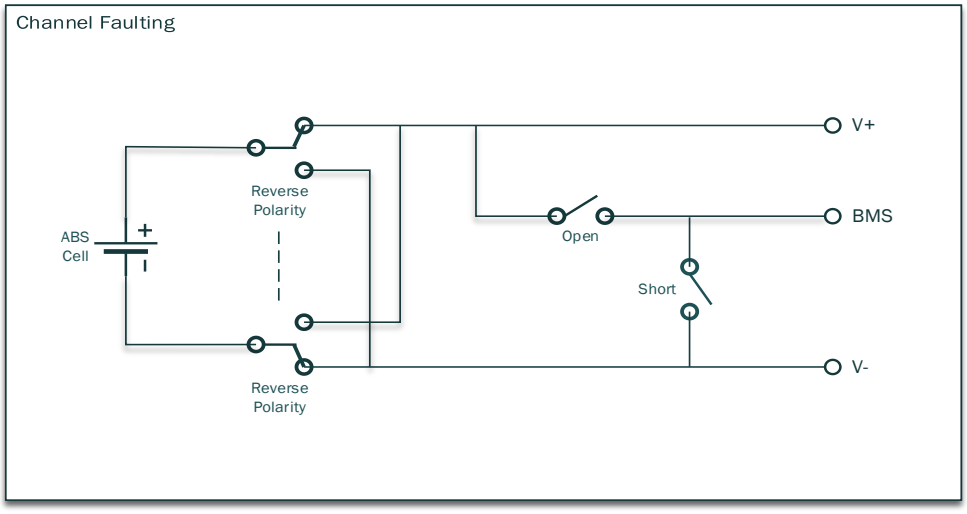


Figure 16: Cell faulting diagram

6.6 Auxiliary I/O control

The ABS includes an auxiliary I/O connector with analog and digital inputs and outputs. See Section 0 for connector pinout information. This section provides basic usage details for each of the I/O types. See Specification document for accuracy, update rates, and detailed specifications. Note that auxiliary I/O is not isolated from ground.

- Analog Inputs
  - Quantity: 8
  - Signal Level: ±10VDC
  - Usage: monitor external voltages. Measured voltages are reported back over each of the communications interfaces
- Analog Outputs
  - Quantity: 8
  - Signal Level: ±10VDC
  - Usage: control external voltages. Voltages may be commanded via each of the communications interfaces. These outputs may be used to simulate thermistors, pack current, or other system-level signals.
- Digital Inputs
  - Quantity: 4
  - Signal Level: 0VDC (logic low), 5VDC (logic high)
    - Any signal ≥1.8V is interpreted as logic high
  - Usage: monitoring external digital TTL signals. Digital state is reported back over each of the communications interfaces.
- Digital Outputs
  - Quantity: 4
  - Signal Level: 0VDC (logic low), 5VDC (logic high)
  - Usage: control external digital TTL signals. Digital signals may be commanded via each of the communications interfaces.

- OUTREF 1, 2
  - 5V and 10V voltage output references, max 20mA
  - Signals provide for flexible system integrations where additional external sensors may need a stable reference. For example, real thermistors, or as a source voltage for dry contacts.

6.7 Interlock

The interlock input to the ABS provides external control of the power state of all cells of a single unit. The interlock is actuated by using the Interlock pin (pin 6) of the Auxiliary I/O connector (see Section 0 for complete pinout). The Interlock Pin 6 may be left open, or shorted to ground (Aux I/O Pins 31-42). The Interlock Active State Switch on the DIP Switches on rear of the unit dictates the behavior of the interlock, as described in the table below.

Interlock State Switch	Interlock Pin Physical Connection	State	Details
Down	Open	Normal	Default shipping state. By default, unit operates without any Interlock connections
Down	Short to Ground	Interlocked	
Up	Open	Interlocked	Safest operation. If Interlock connection to ground is broken, outputs are disabled
Up	Short to Ground	Normal	

Interlocked: All cells are powered off and all Aux I/O are set to default outputs
Normal: Normal operating mode

Interlock is disabled (normal state) by default. Upon exiting the interlock state (returning to normal operation), the system is effectively in a power on state, and does ***not*** resume operating with its last configuration. Therefore, new setpoints and enabled states must be commanded to the unit in order to resume operation.

6.8 Reset Button

The Reset button on the ABS provides the ability to restart the unit as well as to reset the unit to factory defaults. Press the Reset button momentarily to reboot the unit. Press and hold the Reset button for over five seconds to reset the unit's IP address to the factory default and restart the unit.

6.9 Fan Operation

The fan cooling the power supply, power delivery circuitry, and microcontroller will be set to a static 100% fan speed at boot. The fans cooling the cells will react based on the maximum dissipated power between the cells and will reach a maximum speed of 45%. If one of these four fans faults, the two cells directly in front of it will be disabled and modeling will be stopped and disabled. If the fan cooling the power supply fails, all unit functionality will be disabled and the cell hardware will be shut off. In either case, the unit may be queried over any of the communications networks to explain the cause of the alarm and the front panel LED indicator will be updated accordingly.

6.10 System Faults

The system has two types of faults: error codes and alarms. Error codes are non-critical events raised when certain conditions are met. These can be queried over SCPI, and querying one immediately removes it from the error queue.

Alarms have immediate, visible effects on the operation of the system. There are three types of alarms:

- **Recoverable alarms**: these are temporary alarms which put the unit into interlock (regardless of the state of the interlock input). Once cleared by the operator, the system will exit the interlock if the interlock input is not asserted and will be reset to its power on idle state.
- **Critical alarms**: these are permanent alarms which will be set until the unit is powered cycled. When a critical alarm is triggered, the unit's functionality will be limited, but it will still be usable. During critical alarms, modeling is disabled, and other functionality may be limited depending on the alarm. For example, if one of the cell cooling fans fails, the two cells directly in front of the fan will be permanently disabled, but the rest of the cells will continue to work.
- **Fatal alarms**: these are permanent alarms which will disable the unit until it is power cycled. Cells will be powered off, modeling will be disabled, and auxiliary outputs will be disabled. Fatal alarms signal events which indicate damaged/faulty hardware.

If the unit raises a critical or fatal alarm which recurs after a power cycle, this is indicative of a faulty or damaged unit and the unit must be returned to the manufacturer.

6.11 Error Codes and Alarms

6.11.1 Error Codes

The ABS uses SCPI error codes to report errors that occur during SCPI command handling (such as invalid commands) or during unit control (such as an invalid IP address being commanded). In accordance with the SCPI 1999.0 standard, the unit may respond with the standard negative error codes. A response of 0 indicates no error. When querying any error, the error code and a short description will be included in the response in accordance with the SCPI standard.

Aside from the standard SCPI error codes, the ABS also defines several device-specific error codes, which have positive numerical values. These errors are as follows:

Error Code	Description
1	Could not update IP address
2	Invalid IP address
3	Invalid subnet mask
4	Error updating configuration
5	Configuration read error
6	Configuration write error
7	Model configuration error
8	Model error
9	Model not found
32767	Unknown error

6.11.2 Alarms

As mentioned previously, there are three types of alarms: fatal, critical, and recoverable. The following table defines each of the alarms and their consequences. More than one alarm may be enabled at once, in which case the returned mask will contain multiple alarm values. Alarms are masked such that there is one byte dedicated to each of the types of alarms. The least significant byte contains recoverable alarms, the second byte contains critical alarms, and the third byte contains fatal alarms.

Code	Alarm	Type	Description
0x000001	Soft interlock	Recoverable	User triggered soft interlock via communications
0x000100	Fan 1 fault	Critical	Fan 1 fault; cells 1-2 and modeling disabled
0x000200	Fan 2 fault	Critical	Fan 2 fault; cells 3-4 and modeling disabled
0x000400	Fan 3 fault	Critical	Fan 3 fault; cells 5-6 and modeling disabled
0x000800	Fan 4 fault	Critical	Fan 4 fault; cells 7-8 and modeling disabled
0x010000	Fan 5 fault	Fatal	Fan 5 fault
0x020000	Hardware error	Fatal	Unrecoverable hardware fault

6.12 Remote Programming

The sole interface for controlling and monitoring the ABS is via remote programming interfaces. The unit can communicate over TCP/IP, UDP, RS485, and CAN. Separate Interface Control Documents (ICDs) provide the detailed configuration and message information required to communicate with the unit. Note that when multiple units are installed on the same network, each unit must have a unique IP address. When multiple units are installed on the same CAN or RS485 bus, each unit must have a unique Unit ID.

6.13 Network Settings (TCP and UDP)

6.13.1 ABS

Factory default IP parameters are as follows:

Default IP Address:	192.168.1.100*
Subnet Mask:	255.255.255.0
Unit ID:	0

*See section 6.18 for information on changing the IP address.

6.13.2 PC Network Settings

The PC or controller network interface must be configured as follows:

Mode:	Static
IP Address:	192.168.1.XXX, where XXX is unused by other instrumentation and is not equal to 0, 1, and 255
Subnet Mask:	255.255.255.0
Open Ports:	5025 (SCPI)

6.14 Ethernet TCP/IP and UDP

See *ABS SCPI ICD* (Bloomy document 8800-00011).

6.15 RS-485

See *ABS SCPI ICD* (Bloomy document 8800-00011).

6.16 CANbus

See *ABS CAN ICD* (Bloomy document 8800-00015) for detailed CANbus message details.

A CAN database (.dbc) file is available to import CAN frames and channels into third-party applications.

6.17 PuTTY or other terminal connectivity

To connect to the ABS via PuTTy or other terminals, you must set up a raw socket connection with the unit's IP address and port 5025, as shown in the figure below. Once connected, SCPI commands and queries, as defined in the ABS SCPI ICD may be sent to the unit.

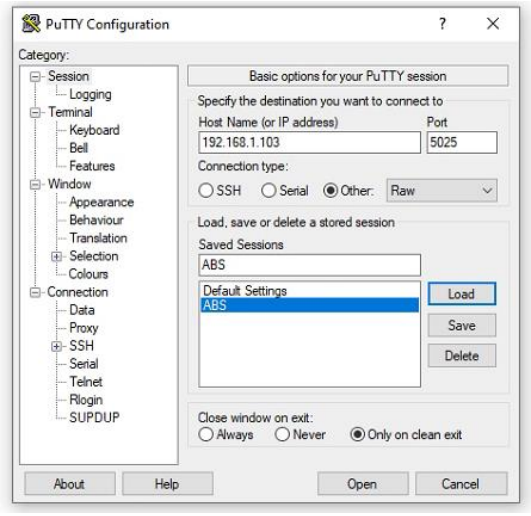


Figure 17: PuTTy connection to ABS

6.18 Updating the IP Address and Unit ID

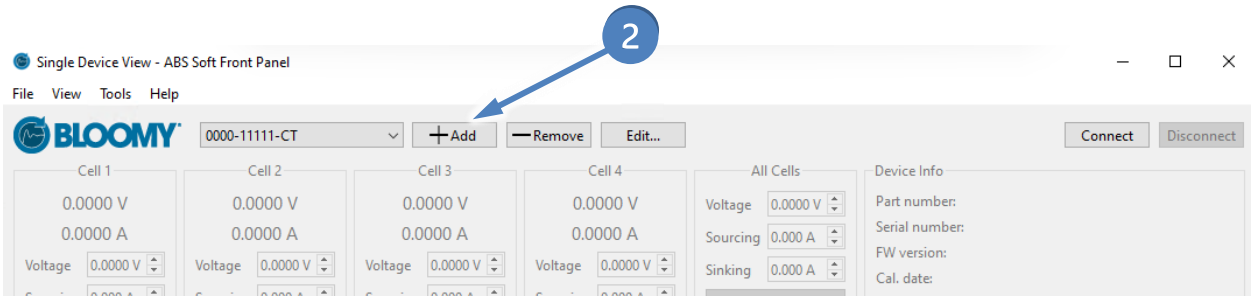
Refer to Sections 5.4.6 (Configuration Switches) and 7.7 (Set Unit IP Address (Soft Front Panel))

7 ABS Soft Front Panel

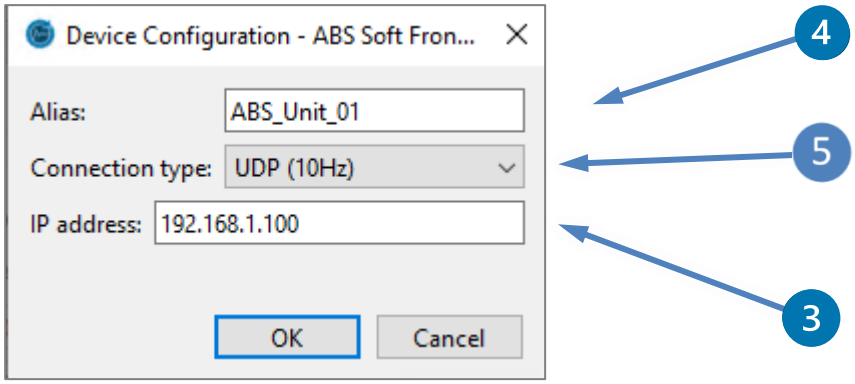
The ABS Soft Front Panel allows controlling and monitoring multiple ABS devices via Ethernet, RS485, or NI XNET CAN.

7.1 Adding Devices Individually

1. Open the Bloomy ABS Soft Front Panel from location chosen during installation.
2. Click "Add" in the top of the screen to add your device.



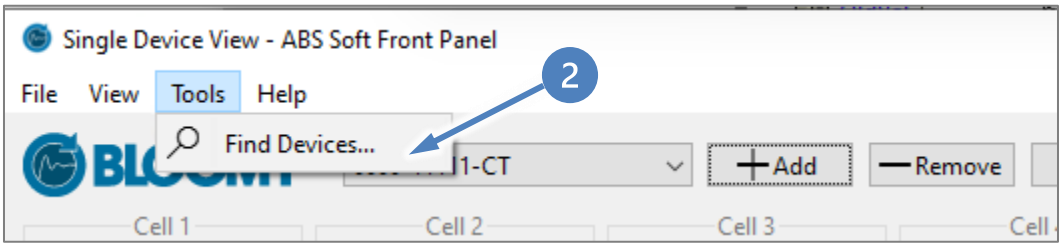
3. Enter **192.168.1.100** as the IP address.
4. Enter the desired name in the "Alias" box ensuring a different one is assigned to each different device.
5. Choose communication type (UDP (10Hz) suggested).



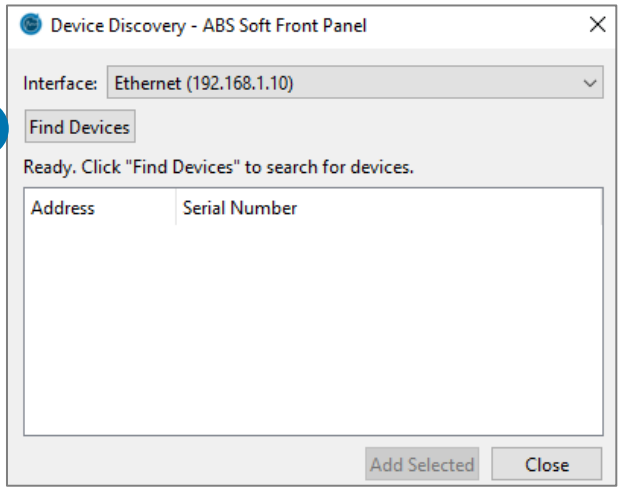
6. Click "OK" at the bottom of the dialog box.
7. Repeat this process for all units in use.

7.2 Adding Devices Automatically

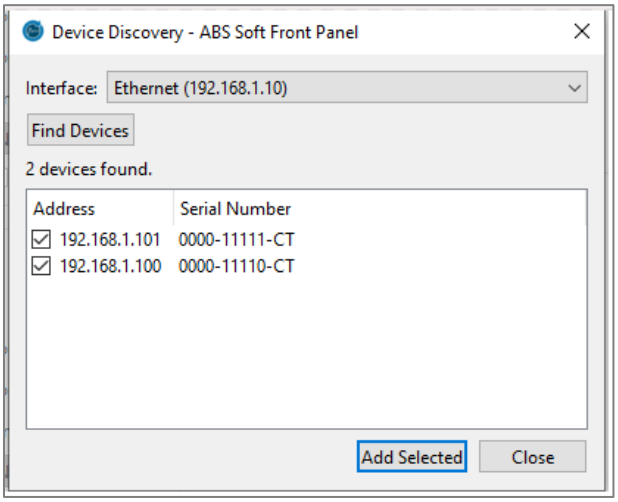
1. Open the Bloomy ABS Soft Front Panel from its location chosen during installation.
2. Go to Tools > Find Devices…



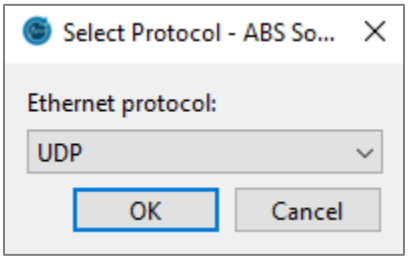
3. Click “Find Devices”



4. Select the desired units and click “Add Selected”

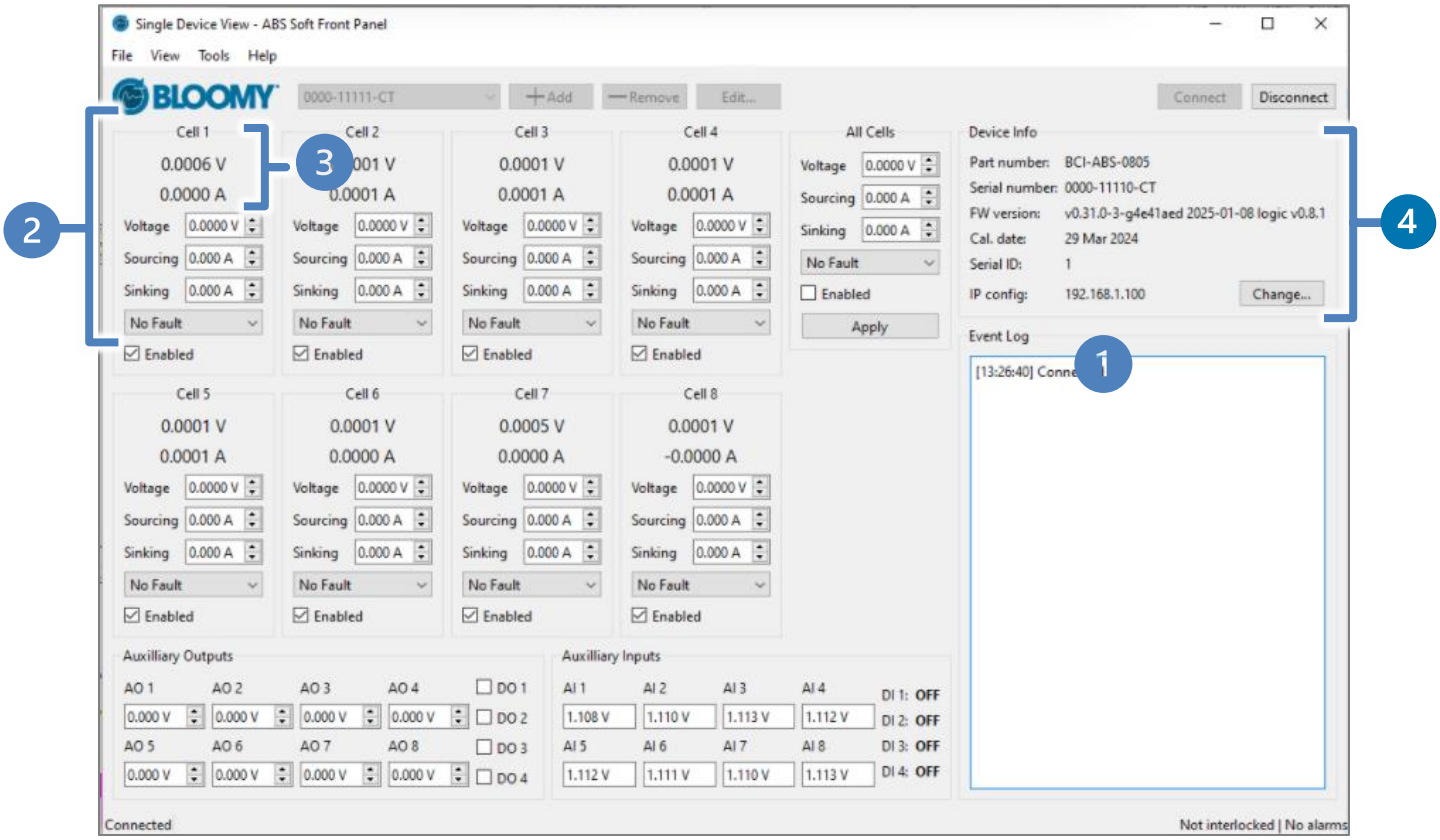


5. Select the Ethernet protocol (UDP suggested), press “OK”



7.3 Navigating the ABS Client Panel

7.3.1 Using the Device Status Panel

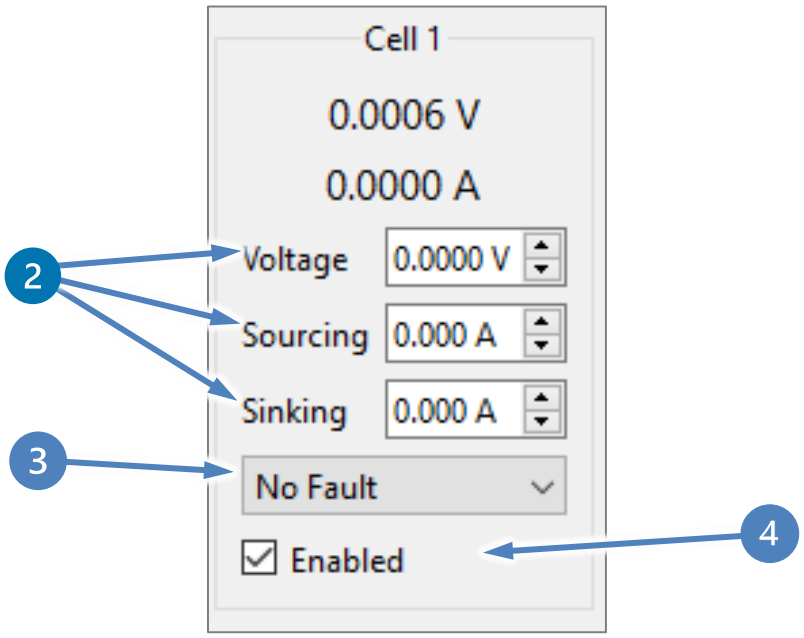


1. Click “Connect” to start interfacing with the ABS
2. At the bottom of each cell are the **controls.**
    a. **Current Sink** should be entered in **negative** values.
    b. **Current Source** should be entered in **positive** values.
3. At the top are the **readback** values.
4. Device information is on the top right of the screen.

7.3.2 Setting a Single Cell

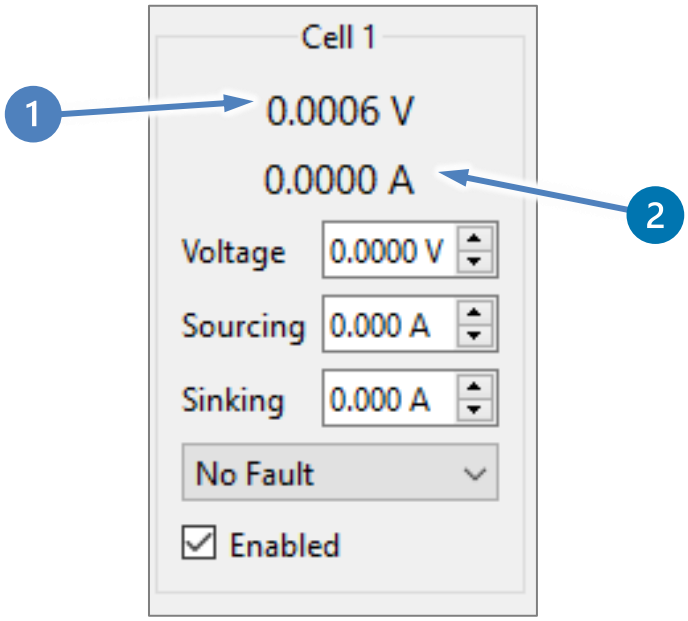
1. Verify that the device you wish to use is selected in the top drop-down menu. Disconnect and click the down arrow to choose a different device.

2. Use the arrows to adjust the associated Voltage, Sinking Current, and Sourcing Current set-points for each individual cell.



3. Use the drop down underneath the set-points to set the target fault state.
4. Finally, click on the switch labelled “Enable” at the bottom of the cell to put the cell in the enabled state.

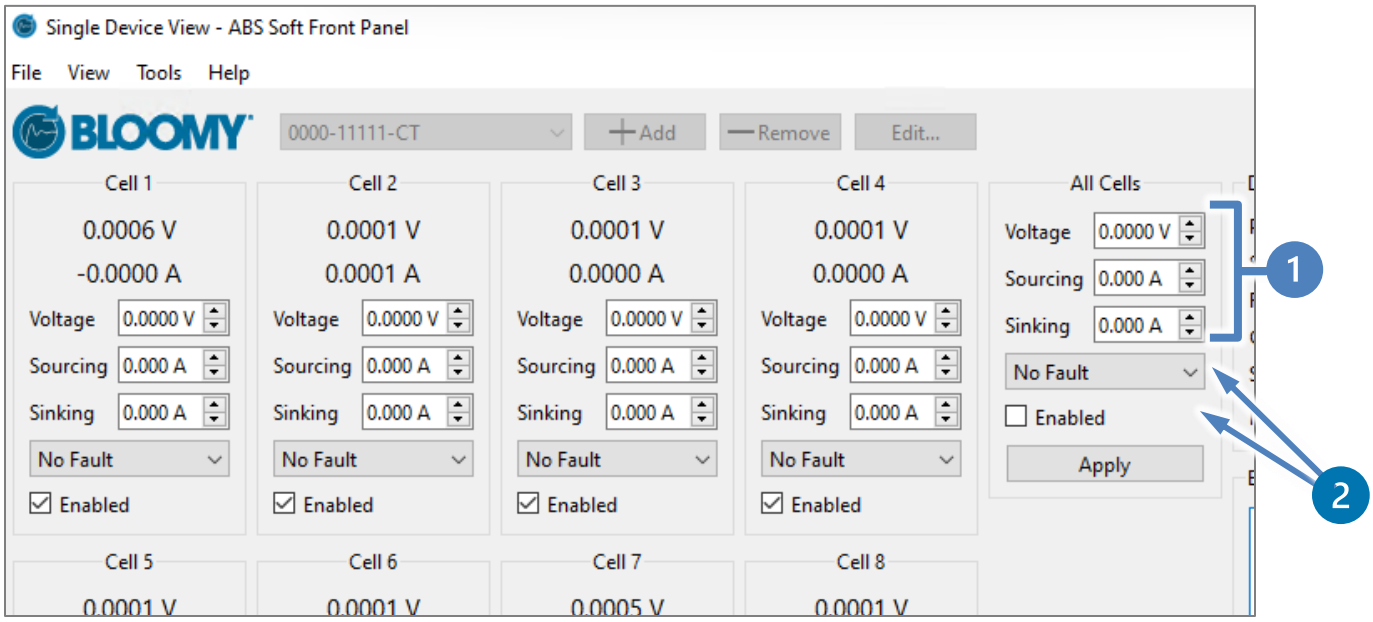
7.3.3 Monitoring Cell Readback



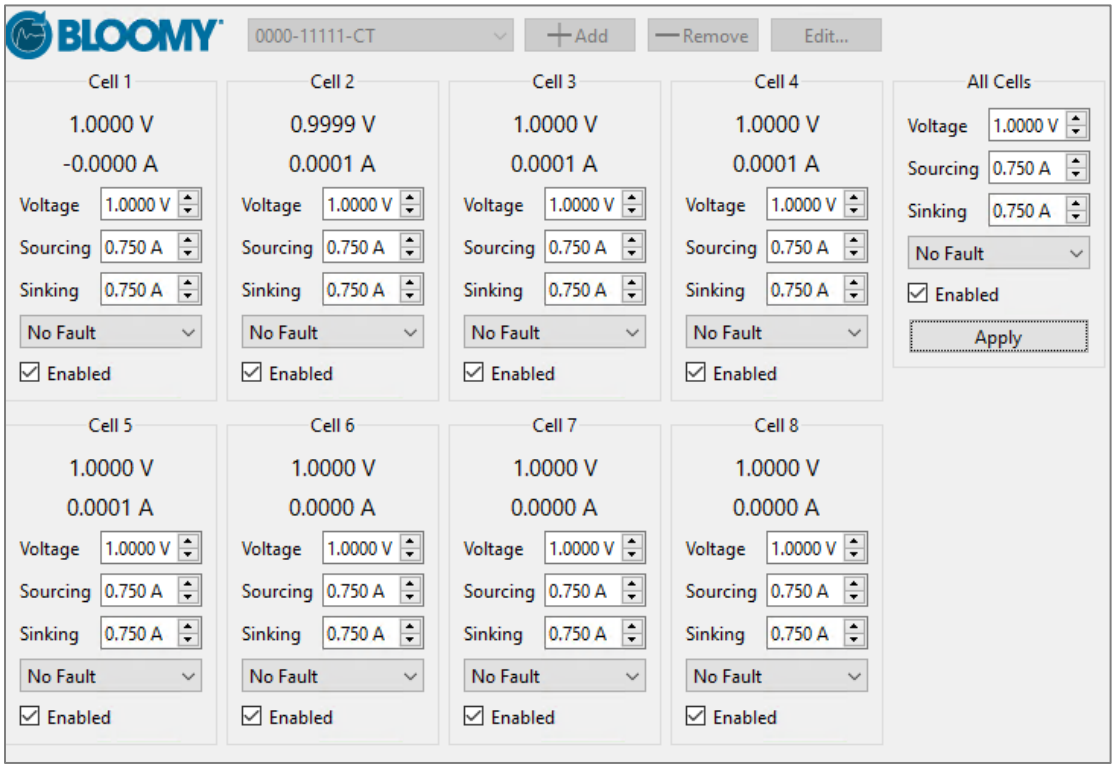
1. **Cell voltage readback** is located in the top of the cell.
2. **Cell current readback** is located right below voltage readback.

These display the output values of each individual cell at the given point in time.

7.3.4 Setting Multiple Cells

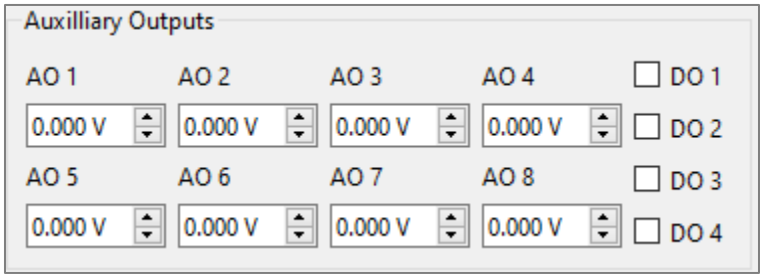


1. The section on the far right contains controls for voltage, current and target fault state for **all eight cells**.
2. Configure using the same methods as the single cells. Then click the “Apply” button.
3. View values in individual cell readback sections.
4. Remember to click "**Apply”** after making any changes to Multi-Cell Control.



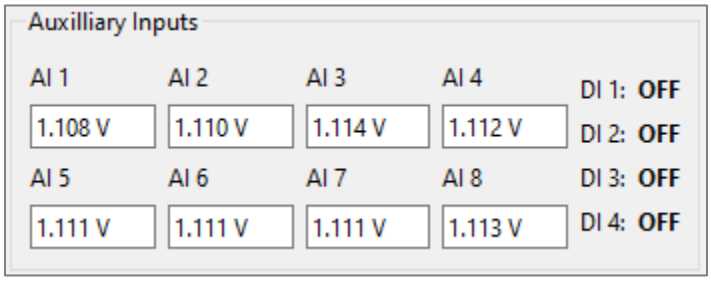
7.4 Using Auxiliary Analog and Digital Outputs

1. Use the "Auxiliary I/O Control Section" in the bottom left to set and view **analog output voltage** for each cell.
2. Use the check boxes to enable or disable **digital output.**



7.5 Using Auxiliary Analog and Digital Inputs

1. Read **analog input voltage** and the status of **digital input** in the "Auxiliary I/O Status" section on the bottom right.

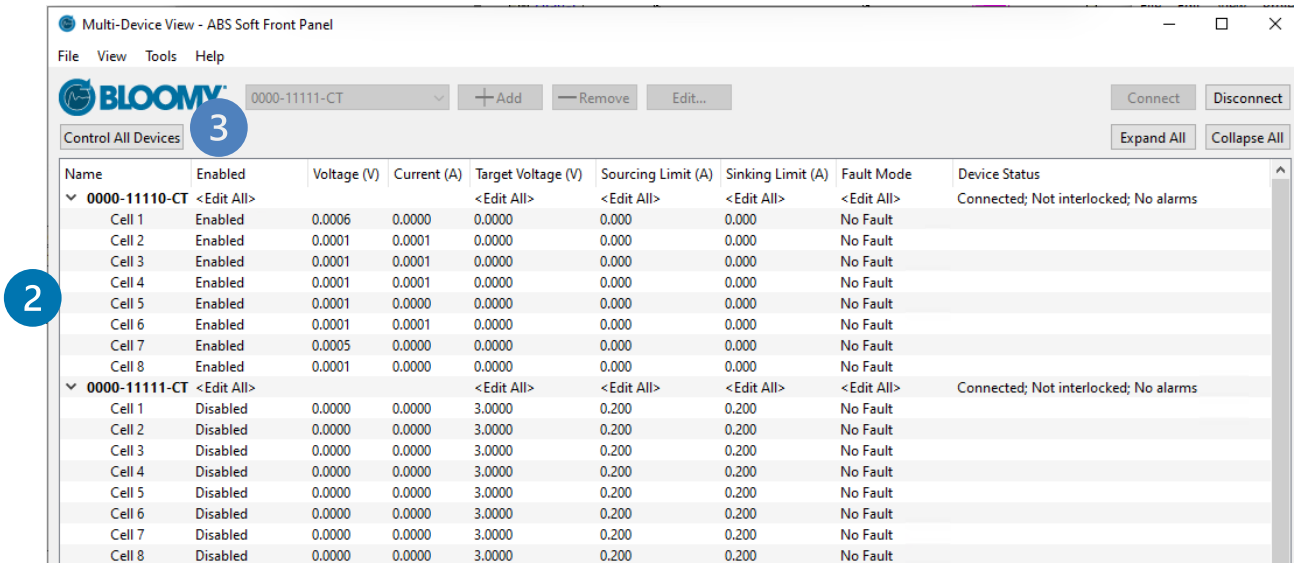


Note: All analog inputs are internally protected if left externally floating. Voltages observed for floating inputs should be disregarded, as they are an artifact of the internal protection bias. These bias voltages are "weak" and will be overridden once no longer floating.

7.6 Using the Tabular Interface

The Tabular Interface allows operators to view the setpoints and readback data for multiple ABS channels and units simultaneously.

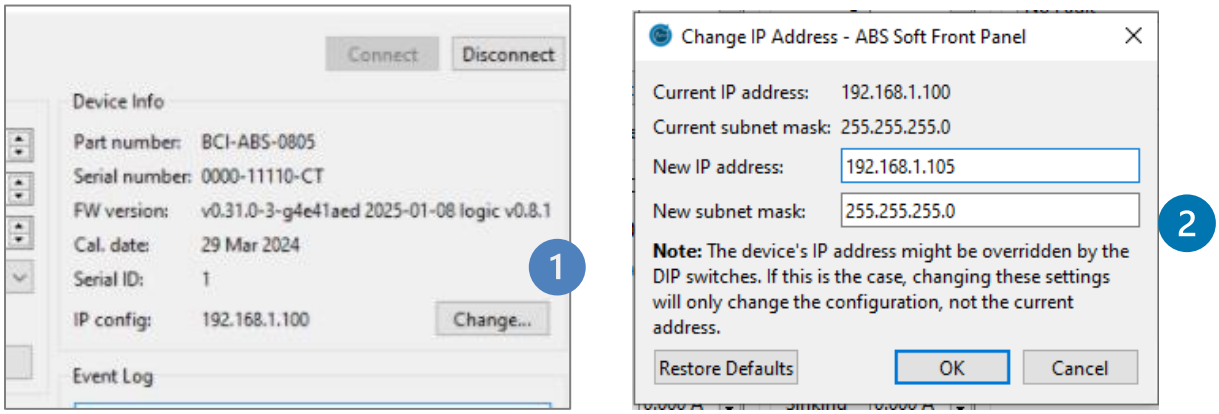
1. Click on “View”, “Multi-Device” to view the cell data in a table format.
2. Select multiple units using shift-click, then right-click to set multiple setpoints simultaneously.
3. To set all settings on all channels across all units simultaneously, use the “Control All Devices” button



Name	Enabled	Voltage (V)	Current (A)	Target Voltage (V)	Sourcing Limit (A)	Sinking Limit (A)	Fault Mode	Device Status
0000-11110-CT	<Edit All>			<Edit All>	<Edit All>	<Edit All>	<Edit All>	Connected; Not interlocked; No alarms
Cell 1	Enabled	0.0006	0.0000	0.0000	0.000	0.000	No Fault	
Cell 2	Enabled	0.0001	0.0001	0.0000	0.000	0.000	No Fault	
Cell 3	Enabled	0.0001	0.0001	0.0000	0.000	0.000	No Fault	
Cell 4	Enabled	0.0001	0.0001	0.0000	0.000	0.000	No Fault	
Cell 5	Enabled	0.0001	0.0000	0.0000	0.000	0.000	No Fault	
Cell 6	Enabled	0.0001	0.0001	0.0000	0.000	0.000	No Fault	
Cell 7	Enabled	0.0005	0.0000	0.0000	0.000	0.000	No Fault	
Cell 8	Enabled	0.0001	0.0000	0.0000	0.000	0.000	No Fault	
0000-11111-CT	<Edit All>			<Edit All>	<Edit All>	<Edit All>	<Edit All>	Connected; Not interlocked; No alarms
Cell 1	Disabled	0.0000	0.0000	3.0000	0.200	0.200	No Fault	
Cell 2	Disabled	0.0000	0.0000	3.0000	0.200	0.200	No Fault	
Cell 3	Disabled	0.0000	0.0000	3.0000	0.200	0.200	No Fault	
Cell 4	Disabled	0.0000	0.0000	3.0000	0.200	0.200	No Fault	
Cell 5	Disabled	0.0000	0.0000	3.0000	0.200	0.200	No Fault	
Cell 6	Disabled	0.0000	0.0000	3.0000	0.200	0.200	No Fault	
Cell 7	Disabled	0.0000	0.0000	3.0000	0.200	0.200	No Fault	
Cell 8	Disabled	0.0000	0.0000	3.0000	0.200	0.200	No Fault	

7.7 Set Unit IP Address (Soft Front Panel)

1. In the Device Info portion in the top right of the screen, click “Change”
2. Enter the new IP Address, then click “OK”



8 Glossary of Terms

ABS – Advanced Battery Simulator (this instrument)

AUX I/O – Auxiliary Input/Output, consisting of analog and digital input/output signals of the ABS

Cell – a single output channel of the Advanced Battery Simulator

Appendix A: Using the Advanced Battery Simulator 800 in High-Voltage Applications

A.1 Summary

The Advanced Battery Simulator 800 is rated for 1,000VDC of isolation, enabling the series-connection of hundreds of simulated cell channels across multiple instruments in order to simulate different configurations of battery strings, stacks or packs of up to 1,000VDC. However, any time high voltages are present in a system, proper safety precautions must be observed. This guide provides the factory-recommended safety precautions and simulated cell stack connection topologies for using the Advanced Battery Simulator 800 to simulate high voltage battery packs. For the purposes of this guide, "high voltage" refers to a voltage of greater than ±120V potential from earth ground to conform to IEC61010[1].

Figure A.1: A series-connected, 192-cell simulation system

A.2 Recommended Safety Precautions

The following safety precautions are recommended in applications where any of the Advanced Battery Simulator 800's simulated cell channels are operating at greater than ±120V potential from earth ground.

A.2.1 Prevent Access to All Connectors When Voltage is Applied

Physically prevent access to the Advanced Battery Simulator 800 electronic wiring terminals, including the cell connectors, network connector, and Auxiliary I/O connector, to prevent unintended contact with system voltages. Specifically, the following is recommended:

1) Minimum: Mount the Advanced Battery Simulator 800s in an enclosed rack or use one of the connector backshell or rear safety cover options to prevent operator access to the network connector, cell connectors and Auxiliary I/O connector, all of which may carry high voltages when many cells and/or other power sources are connected in series. Ensure the rack is closed during normal operation and no unintended access to the cell connectors is possible. Affix labeling to any rack doors or openings to notify operators that high voltage may be present and that the system must be powered off before servicing.

2) Preferred: In addition to enclosing the instruments, install a safety interlock which disconnects the AC power to the Advanced Battery Simulator 800 instruments and disables the outputs of other series-connected power sources in the event that the rack is opened. Install a ground-fault circuit interrupter (GFCI) which disables the system when a fault is sensed.

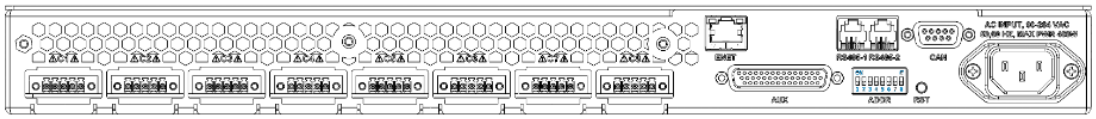


Figure A.2: The rear panel of the Advanced Battery Simulator 800 contains the network connector, cell connectors and the Auxiliary I/O connector. Prevent access to these connectors when high voltages are present.

Note that the Advanced Battery Simulator 800 will withstand abrupt power loss without damage, though any networked computer or controller will lose communication and may require an application reset, restart or reboot depending upon how the software is written to handle communication loss. Typically, CAN communications will restart automatically once the Advanced Battery Simulator 800 powers up.

A.2.2 Current Limit Series-Connected Devices

In the event of an internal or external fault, the Advanced Battery Simulator 800's internal ground bond is designed to protect the user and equipment from unintended high-voltage contact. Because the Advanced Battery Simulator 800 cell outputs are rated for a maximum of 5A of current per cell, any external series-connected power sources should also be limited to 5A if present. This limit will help to ensure that any current draw from another device will not exceed the Advanced Battery Simulator 800 cell current ratings. The current limit will also help to ensure that the Advanced Battery Simulator 800 ground bond can non-destructively shunt any current caused by a fault to ground.

A.2.4 Programmatic Safety Precautions

The Advanced Battery Simulator 800 powers on in a safe state with all cells at 0V and 0A until the cell voltages and current limits are programmed from the host computer or other control device. The Advanced Battery Simulator 800 has a programmable cell current limit parameter that is individually controllable per cell. Because power dissipation in connected circuits is proportional to both voltage and current, it is a good practice to set the individual cell current limits to the lowest current necessary for the application (e.g., activating and testing the cell-balancing functionality of the battery management system). Limiting the cell power by limiting the current reduces the risk and severity of component damage as well as of electric shock.

For more information, contact Bloomy at http://www/bloomy.com/contact-us.

A.5 Notes

1. IEC 61010 specifies safety requirements for electrical equipment for measurement, control and laboratory use. See https://www.iec.ch/homepage
2. For more information, see https://www.phoenixcontact.com/en-us/products/network-isolator-fl-isolator-1000-rjrj-2313915.
3. For more information, see https://www.peak-system.co