BOSS – Bidirectional Optimizer for Storage Systems

A unique DCDC Optimizers to help medium and large Energy Storage Systems (ESS)

Installation, Operation and Maintenance Manual for use with the BOSS-V7-1000 or BOSS-V7-1500

Alencon Systems – Passionate About Power

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2 General Information

All efforts have been made to ensure the accuracy of material provided in this document at the time of release. Items are subject to continuous development and improvements. All specifications and descriptions are subject to change without notice.

2.1 Purpose

This manual provides information about installing, operating, maintaining, and troubleshooting the Alencon BOSS device.

Who Should Read this Manual?

This manual should be read by anyone who needs to:

- Understand the product
- Plan the installation
- Install the product
- Commission the product
- Operate the product
- Maintain the product, if necessary

2.2 Product Warranty

Alencon Systems warrants to you, the original purchaser, that each of its products will be free from defects in materials and workmanship for three years from the date of purchase. Extended warrantees of an additional five (5), ten (10) and twenty (20) years are also available for purchase.

This warranty does not apply to any products which have been repaired or altered by persons other than repair personnel authorized by Alencon System, or which have been subject to misuse, abuse, accident, or improper installation. This warranty does not cover the repair or replacement of any goods which fail as a result of damage in transit, misuse, neglect, accident, Act of God, abuse, improper handling, misapplication, modification, improper storage, excessive stress, faulty or improper installation, testing or repair, negligent maintenance, or failure to comply with the written instructions for installation, testing, use or maintenance (if any) provided by Alencon Systems. Alencon Systems assumes no liability under the terms of this warranty as a consequence of such events.

Because of Alencon Systems' high quality-control standards and rigorous testing, most of our customers never need to use our warranty service. If an Alencon Systems product is defective, it will be repaired or replaced at no charge during the warranty period. For out-of-warranty repairs, you will be billed according to the cost of replacement materials, service time and freight. Please consult Alencon Systems for more details. If you think you have a defective product, follow these steps:

- Collect all the information about the problem encountered. (For example, issues you are encountering in your PV array) Note anything abnormal when the problem occurs.
- Call Alencon Systems or your licensed Alencon Systems dealer and describe the problem. Please have your manual, product, and any helpful information readily available.
- If your product is diagnosed as defective, obtain an RMA (return merchandise authorization) number from Alencon Systems. This allows us to process your return more quickly.
- Carefully pack the defective product (preferably in the original packaging material it was shipped in), a fully completed Repair and Replacement Order Card and a photocopy proof of purchase date (such as your sales receipt) in a shippable container. A product returned without proof of the purchase date is not eligible for warranty service.

2.3 Warnings, Cautions and Notes

	***Warning!***	*Warnings indicate conditions, which if not observed, can cause personal injury!*
	***Caution!***	*Cautions are included to help you avoid damaging hardware or losing data.*
	***Note!***	*Notes provide optional additional information.*

2.4 Packing List

The BOSS is assembled and fully tested at the ALENCON factory. Before installation, please ensure the following items have been shipped:

- Commensurate # of BOSS units specified for your project.
- 4 AWG Single Wire Grounding Mechanical Lug per BOSS unit
- 1 x Warranty Card

FIGURE 1: PICTURE OF A BOSS UNIT

2.5 Ordering Information

Model Number Description

Model Number	Description
BOSS-V7-1000	Alencon Bidirectional Optimizer for Storage Systems 1000VDC max
BOSS-V7-1500	Alencon Bidirectional Optimizer for Storage Systems 1500VDC max
BOSS-V7-1000/1500	Alencon Bidirectional Optimizer for Storage Systems 1500VDC max on high side, 1000VDC max on low side

3 Important Safety Instructions

SAVE THESE INSTRUCTIONS– This manual contains important instructions for use with the BOSS 1000 and 1500 that shall be followed during installation and maintenance of these devices.

FIGURE 2: THE GRAPHIC ABOVE INDICATES THAT THE BOSS IS A GROUNDING CONDUCTOR

WARNING! Always ground the BOSS chassis before energizing the unit.

WARNING! Battery can present a risk of electrical shock, burn from high short-circuit current, fire or explosion from vented gases. Observe proper precautions.

FIGURE 3: THE GRAPHIC ABOVE INDICATES THAT THE BOSS ACTS AS A DIRECT CURRENT SUPPLY

Installation of this equipment must be performed by an authorized electrician in accordance with the local and NEC ANSI/NFPA 70 and OSHA requirements.

1. Before installing and using the BOSS, read all instructions presented in this manual and the cautionary markings shown on the enclosure.

2. The BOSS contains no user-serviceable parts. For service and maintenance, the BOSS should be returned to Alencon Systems LLC or a certified Alencon Systems service center. Opening the device or attempting to perform a non-authorized repair will void warranty.

3. During operation, hazardous voltages and currents may be present. Only authorized and qualified personnel should perform servicing/installation.

4. Disconnect switches or contactors must be used between BOSS primary/secondary and connected equipment.

5. Do not disconnect output (direction dependent) contactors or switches while equipment is operating. Shutdown the DCDC converter by sending "Shutdown" command using the controller (see Section 11.3).

6. The BOSS requires external fusing. This requirement is explained in detail in Section 8.4 "Fusing for Primary and Secondary Wiring"

7. Disconnect BOSS primary and secondary switches or contactors before performing any work on the BOSS. Test any wire or terminal for voltage before touching them. Check if any current is flowing through the strings before disconnection.

8. BOSS operates as a "slave" to an external controller or SCADA system. BOSS is not designed to control any other equipment or system components.

9. Only use accessories recommended or approved by the manufacturer.

10. Ensure that wiring is in good conditions and that all wiring is sized according to NEC 310-16 specifications. Ignoring to do so may result in a risk of fire.

11. PV modules produce electrical energy when exposed to light and thus can create an electrical shock hazard. Wiring of the PV modules should only be performed by qualified personnel.

12. Always have BOSS manual on hand, for reference.

4 Introduction

4.1 Energy Storage Systems Benefits

Energy Storage Systems (ESS) are actively advancing into the portfolio of equipment being offered by the Renewable Energy Industry. In both new and existing PV installations, ESS helps to overcome intermittency – a major shortcoming of solar and wind as sources of energy. With ESS, solar power becomes available on demand, just the same as conventional generation means like coal and gas. Today, the majority of ESS deployed and being deployed utilizes Lithium-Ion battery technology. The cost of batteries has significantly fallen in the past few years while the need for energy storage capacity has increased due to the increased levels of renewables on the grid. These dynamics have made the case for ESS adoption very attractive.

4.2 Energy Storage Systems Challenges

Many megawatt-hours of alternative energy can be stored in large containers filled with Lithium-Ion batteries. Individual battery cells are assembled into modules, modules into racks (stacks) and racks into containers. A large amount of energy is packed in one space and presents a danger of a potential explosion if conditions of safe charge and discharge are violated, or general deterioration of battery condition is not detected.

4.3 Potential Hazards

Each high voltage battery rack has a positive and negative terminal isolated from the battery case. If all the positive terminals are connected together and all the negative terminals are connected together then in the case of a short on one of the battery racks, the rest will rapidly discharge their stored energy into a shorted component causing a huge current reaching tens of thousands of amperes and risking an explosion. The isolation deterioration of the battery cells to the grounded case is one of the major factors in the battery rack that may cause fault current.

4.4 State-of-Charge and State-of-Health

The capacity of lithium-ion batteries to store and discharge electrical energy is measured in MWh or kWh. The amount of *releasable* charge the battery contains at any given time relative to full capacity of a battery is called State-of-Charge (SOC) and is measured in percentiles:

$$SOC = \frac{\text{C releasable}}{\text{C max}} 100\%$$

As batteries age over time as they experience a number of charge/discharge cycles. As such, their capacity to hold charge diminishes. The degree of degradation of the battery measured as a percentage of current full capacity to the initial rated capacity is called State-of-Health (SOH) and is measured in percentiles:

$$SOH = \frac{\text{C max}}{\text{C rated}} 100\%$$

To prevent overcharge of full discharge all battery racks should maintain the same SOC. This means that charge/discharge current should be controlled according to their SOH.

5 BOSS Features

5.1 BOSS- Bi-Directional Optimizer for Storage Systems

The BOSS is a set of 4 galvanically isolated bidirectional DC-to-DC converters that operate between a variety of possible DC sources/loads (PV, batteries, fuel cells, inverters, motors, etc.).

5.2 Galvanic Isolation

The main safety feature of the BOSS is the galvanic isolation incorporated in each DCDC. Due to galvanic isolation the primary source/load is isolated from the secondary source/load and the common earth ground, up to 2500 VDC potential. This means that in case of a fault in one rack, it stays completely isolated from the other racks preventing catastrophic fault currents.

5.3 Communication

The BOSS DCDC units communicate among themselves and with a SCADA controller via an industry standard MODBUS protocol via the PODD communication device. When used to control a BESS at the rack level, a customer provided ESS controller collects the SOC and SOH information from the BMS associated with batteries in the racks as well the power information from the inverter and DC Bus. Based on this information the ESS controller assigns the magnitude of the charge or discharge current through each DCDC via MODBUS communication. The purpose is to keep the same SOC on each rack regardless of its SOH. This way all battery racks can be fully charged and discharged at the same time, thus assuring full utilization of battery capacity.

5.4 Parallel Operation

Each DC-DC converter autonomously controls the charge and discharge of current through it and is designed for a specific maximum current. If a load requires more current than a DCDC can provide, two or more DCDCs can be used in parallel.

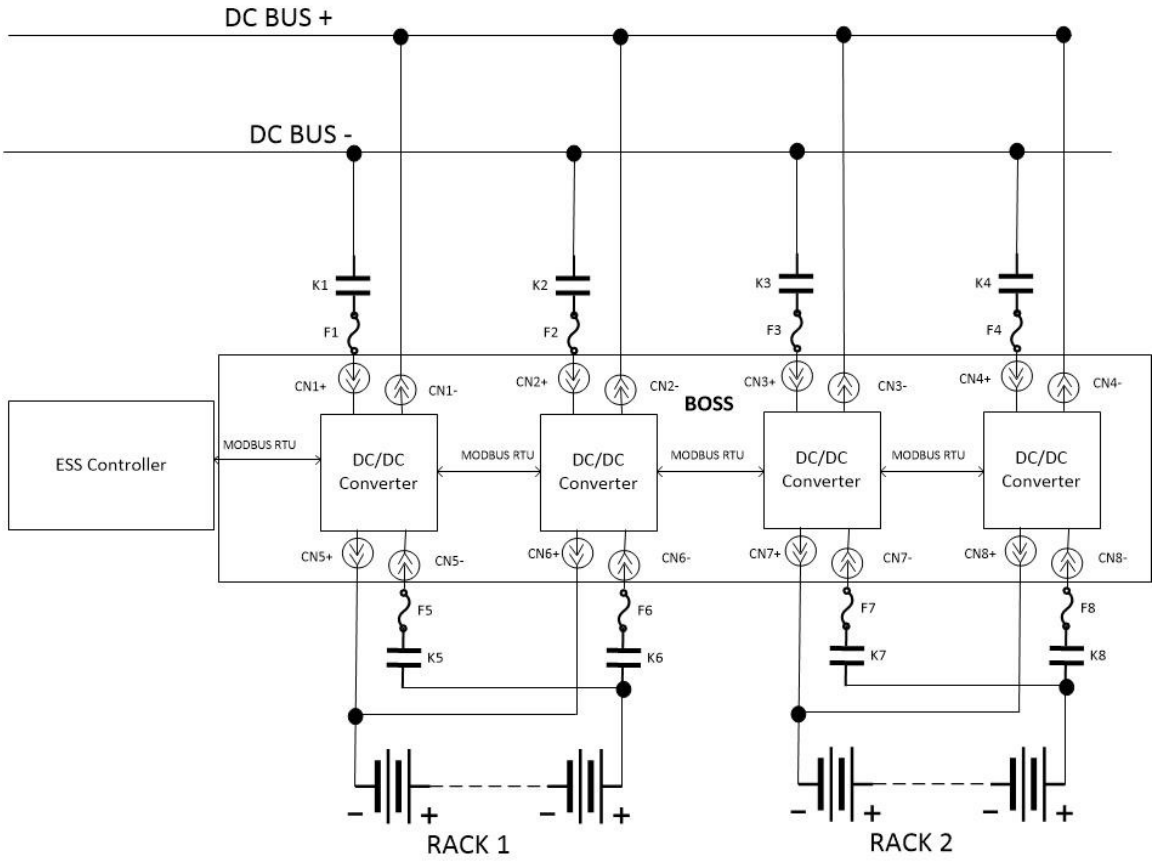


FIGURE 4: PARALLEL CONNECTION OF DCDC - 2 DCDC'S CONNECTED TO A SINGLE BATTERY RACK

6 BOSS Applications

There are a continually growing number of applications in which the BOSS device can be used, some of the most common include:

- Integration of an Energy Storage System (battery) with solar power infrastructure (existing or new) via DC coupling
- Interfacing different battery storage systems to a DC bus

6.1 DC Coupled Solar + Storage

The BOSS is a unique solution for DC-coupling of PV and Storage. When deployed with storage systems (typically batteries), the DC bus may be shared with the storage terminal via the BOSS as shown in Figure 5. In this case, the inverter typically operates in an MPPT mode when exporting power. The BOSS will manage the flow of energy to the battery when charging from PV and to the inverter when discharging.

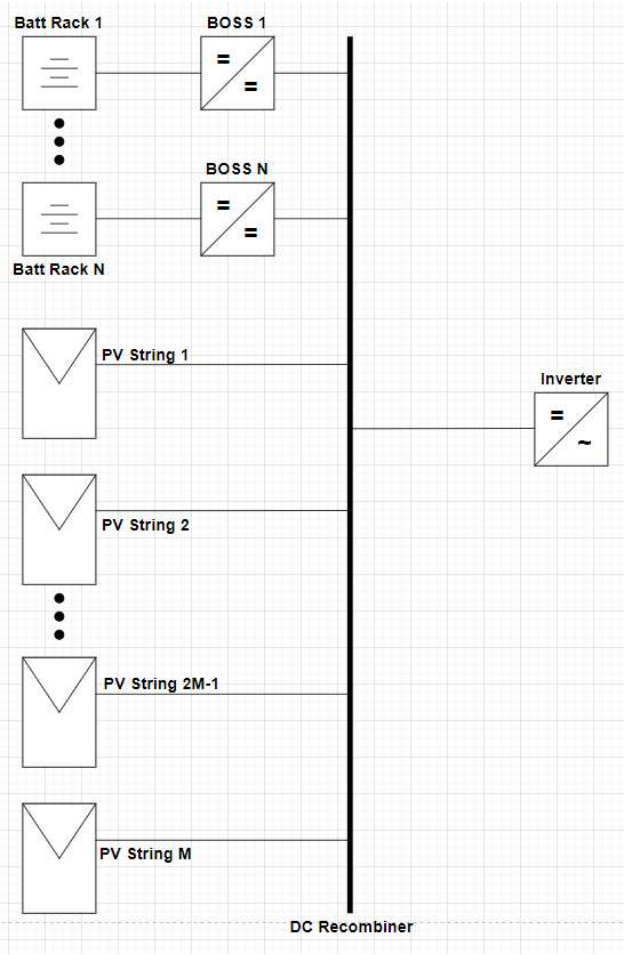


FIGURE 5: DIAGRAM OF A DC-COUPLED SOLAR + STORAGE SYSTEM USING THE BOSS

6.2 Battery Augmentation

The BOSS can be used to map differing voltage ranges from two battery storage systems and manage the power flow (charging/discharging) of each to the other.

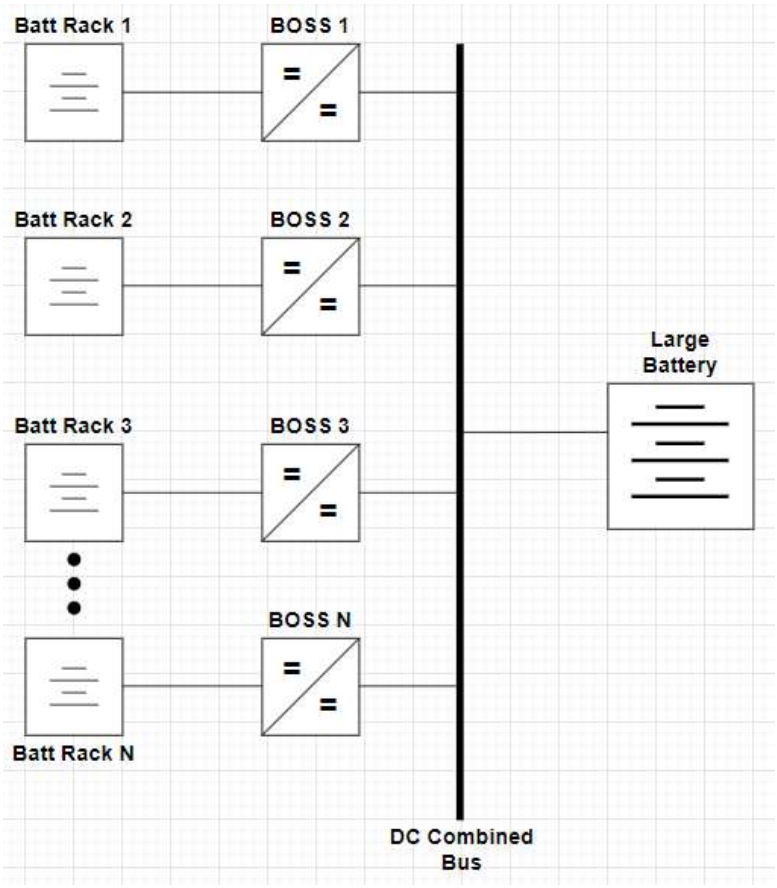


FIGURE 6: DIAGRAM OF BATTERY AUGMENTATION UTILIZING THE BOSS

7 Technical Specifications

Model	BOSS – 1000	BOSS – 1500/1000	BOSS – 1500
Standard Primary Side Voltage Specifications			
Maximum Voltage	1000 VDC	1500 VDC	1500 VDC
Operating Voltage Range[1]	200 - 950 VDC	300 - 1425 VDC	300 - 1425 VDC
Max Current[3] – 25 C°	100 A	74 A	74 A
Max Continuous Current[3] – 25 C°	88 A	74 A	74 A
Standard Secondary Side Voltage Specifications			
Maximum Voltage	1000 VDC	1000 VDC	1500 VDC
Operating Voltage Range[2]	200 - 950 VDC	200 - 950 VDC	300 - 1425 VDC
Max Current[3] – 25 C°	100 A	100 A	74 A
Max Continuous Current[3] – 25 C°	88 A	88 A	74 A
Unit Power Specifications[3]			
Maximum Power @ 25 C°	88 KW	80 KW	80 KW
Maximum Power @ 50 C°	65 KW	60 KW	60 KW
Efficiency[2]			
Peak Efficiency	98.5%		
CEC Weighted Efficiency	98.0%		
Isolation			
Galvanic Isolation	Yes		

[1] Can be configured to end user requirements using Alencon Systems' mass customization manufacturing approach.

[2] Can vary based on input and output voltages being mapped, see note above.

[3] The max current represents the level of current to which the unit is UL listed, while the max continuous current represents the level of current that can consistently be achieved across the nominal voltage mapping range of a battery energy storage system. Max current varies based on input and output voltage. Units configured for low nominal voltages (<500V) can have higher max current (up to 100A).

Standards & Compliance	
Certifications	UL1741, IEC 62109-1, CSA C22.2
Environmental	
Storage Temperature	-40°C to 60°C
Cooling	Forced Air
Humidity	0-95%
Environmental Rating	NEMA 3R
Operating Ambient Temp.	-40°C to 50°C
Form Factors	
Packaging	Rack (Horizontal) or Rail Mounted (Vertical)
Size (H x W x D)	Rack Mount: 8U – 353MM x 486MM x 637MM (H: 9U with FEED) Rail Mount: 643MM x 416MM x 311MM (D: 395 MM with FEED)
Weight	Rack Mount: 57 kg Rail Mount: 54kg (With FEED: Add 14 kg)
Additional Features	
Aux Power	24 V available
Communications	Modbus TCP Protocol - Requires wired connection to Alencon PODD

8 BOSS Hardware

Each BOSS is assembled into a hermetically sealed NEMA 3R enclosure as shown in Figure 7 below. The FEED add-on product comes is typically required with the BOSS (see FEED manual for more details).

The unit is designed to be mounted vertically or horizontally depending on the deployment:

- Horizontal mounting – BOSS is typically installed horizontally in a rack system (standard configuration)
- Vertical mounting – hung using Unistrut (non-standard configuration includes a back plate for hanging)

The heat generated within the enclosure is extracted via an external passive heat exchanger. Ensure that the external cooling fans have enough clearance for air flow.

FIGURE 7: BOSS WITH FUSED ELECTRICAL DISCONNECT (FEED)

8.1 BOSS with FEED Dimensions

The images below provide the dimensions to which the BOSS with FEED is designed and built. A BOSS of this configuration weighs 69 kg or 153 lbs.

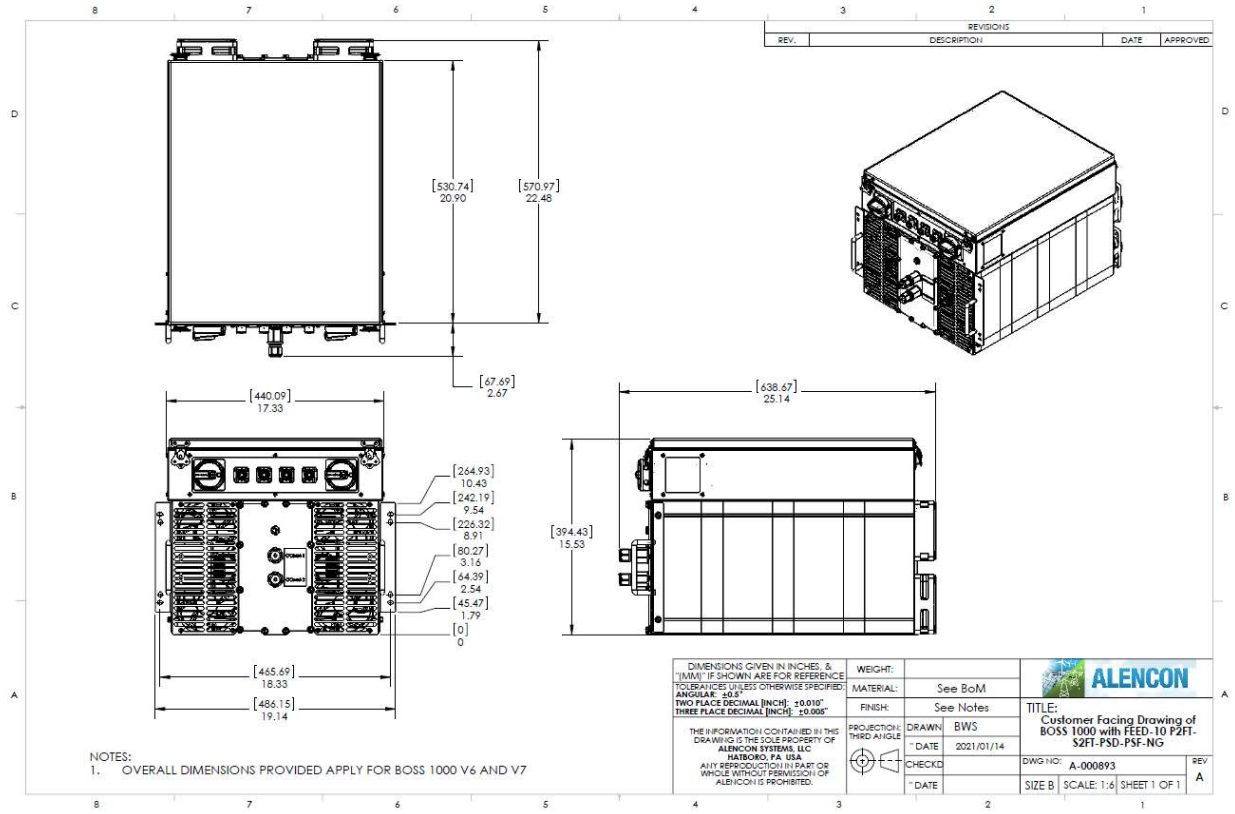


FIGURE 8: BOSS WITH FEED DIMENSIONS

8.2 Primary and Secondary Cable Termination

The BOSS input and output cables have been labelled as Primary and Secondary. There are 4 DCDC's within each BOSS labelled serially as A, B, C, and D. Each DCDC contains a single primary and single secondary channel, these can be kept separate or be bonded together in the FEED such that a full BOSS unit has 1 primary pair and 1 secondary pair.

See FEED user manual for more information on front plate connector options.

8.3 Communication Ports

Each BOSS unit has 2 * RJ45, shielded Ethernet jacks. BOSS units are typically co-located and easily daisy chained to a PODD. The BOSS system architecture using a Single PODD configuration is shown below in Figure 11.

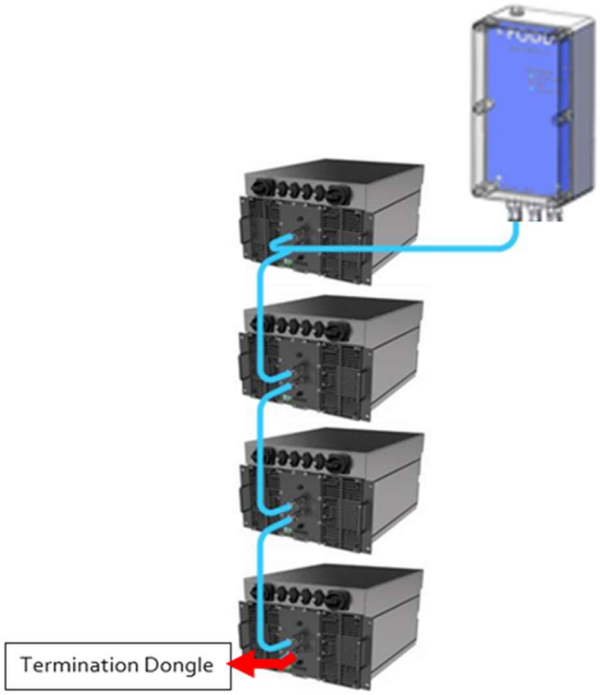


FIGURE 9: BOSS COMMS DAISY CHAIN WITH PODD

8.4 Fusing for Primary and Secondary Wiring

The BOSS primary and secondary wires need to be fused as per BOSS specification. The fusing on the primary and secondary of the BOSS is critical for overcurrent protection and short circuit protection.

Fuses need not be used as a safe disconnect method for maintenance (see Section 9) but can serve as an added redundancy for disconnecting the BOSS primary or secondary from source/load.

The recommended current rating of the fuses and disconnects is 1.5 times the rated current of the BOSS per channel:

- For 25 Amp rated input, 25 x 1.5 = 37.5, therefore use 40 Amp rated fuse and disconnect per channel.
- For 18.5 Amp rated input, 18.5 x 1.5 = 27.75, therefore use 30 Amp rated fuse and disconnect per channel.

Note: FEED can be specified to include fuse holders within, however fuses are not provided with the FEED

8.5 Powering the BOSS

There are two ways to power on the BOSS, internal and external. The standard build for a BOSS will have both internal and external powering options available. If preferred, BOSS can be specified for one method of powering on only. This should be requested in advance of the device manufacturing.

8.5.1 Internal 24V

When applying ≥ 200V to the BOSS Primary connector, an internal converter will create the auxiliary 24V signal.

As long as the primary voltage is sufficiently large, the BOSS will function in either direction without interruption. In the event, the primary voltage goes below the 200V limit; the BOSS will turn OFF.

If voltage on the primary is low, the BOSS will need to be powered via an external 24V supply. As soon as the primary voltage is ≥ 200V, the auxiliary will kick in and provide the necessary power to keep the board ON.

8.5.2 External 24 V Connector

Power coming from an external 24V supply can be connected via an M12 receptacle on the back endcap of the BOSS (see figure 10). Corresponding M12 plug with pre-cut cables is included with the BOSS device (see figure 11).

FIGURE 10: BOSS EXTERNAL 24V SUPPLY CONNECTOR (RECEPTACLE SIDE)

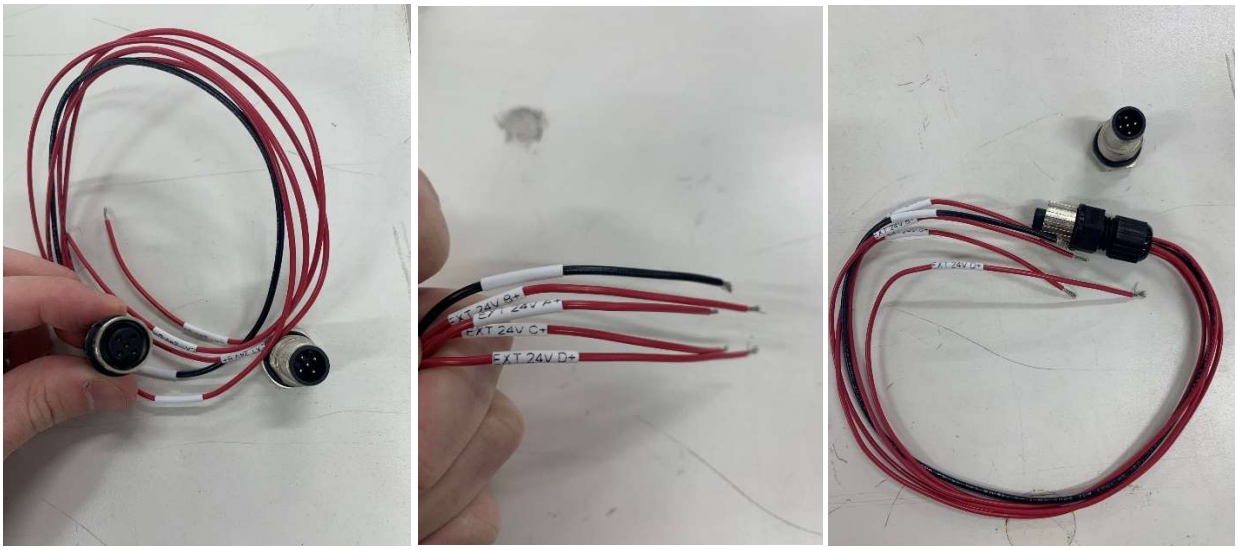


FIGURE 11: BOSS EXTERNAL 24V SUPPLY CONNECTOR (PLUG SIDE)

If voltage on the Battery is low, the customer will have to power the board via an external 24V power supply. As soon as the Battery is charged to ≥ 200V, the auxiliary will kick in and provide the necessary current required to keep the board ON.

To protect the BOSS from transient voltage spikes that result from noise interference or poor-quality power supplies, Alencon recommends adding a capacitance of 1000 µF in parallel to the external power supply connection (talk to your Alencon representative for more information).

9 Isolators and Disconnects

Alencon requires using disconnects (or contactors) to enable an electrical cut-off of the BOSS from its primary and secondary power sources. Prior to disconnecting the BOSS primary and secondary terminals, the device should be shutdown (see Section 12).

Always disconnect BOSS from both power sources before performing maintenance.

Disconnects must be rated to the max input voltage and UL approved.

Do not disconnect the BOSS output (direction dependent) while under load.

Always use an appropriately rated disconnect to isolate BOSS from input power source (direction dependent) before disconnecting the output.

You may select from one of three options:

1. Alencon **F**used **E**lectrical **D**isconnect (FEED)
2. Built-in disconnects on integrated power equipment (battery, inverter, etc.)
3. Third party disconnects

9.1 Alencon Fused Electrical Disconnect (FEED)

Alencon's FEED™ (Fused Electrical Disconnect), see Figure 12, provides a configurable add-on device to BOSS primary and secondary. Mounted directly onto the BOSS, the FEED will provide the primary and secondary ports for the BOSS connections.

FEED can be specified to add primary and secondary disconnects as desired. As well, fuses for over-current protection can be included in the FEED.

FEED is only available for deployment indoors as it is not weather rated.

See more about FEED options in FEED Manual.

FIGURE 12: ALENCON BOSS WITH FUSED ELECTRICAL DISCONNECT

9.2 Built-in Disconnects

Most inverters and battery energy storage systems have mechanical disconnect switches and or electrical relays that will isolate the devices in question from the BOSS. If these are present on the source devices for the BOSS primary or secondary, an additional disconnect is not required.

9.3 Third Party Disconnects

Third party disconnect switches can be used such as IMO's DC isolators, though the other options are recommended instead. A typical IMO DC-isolator is shown below in Figure 13.

FIGURE 13: AN IMO MANUAL DC ISOLATOR

9.4 Avoiding Inrush Currents to the BOSS

In cases where large amounts of stored energy are connected to or disconnected from the BOSS, special considerations may be required to avoid harmful current transients when operating or performing maintenance on the system. Additional external hardware may be recommended by Alencon if your BOSS system has any of the following:

- Electronically controlled disconnect switches (relays) on BOSS primary or secondary
- Long cable runs (over 100ft) to BOSS primary or secondary

Talk to your Alencon representative for more information on these concerns.

10 Installation

Only skilled professionals with experience installing electrical systems should perform installation of the BOSS. Persons installing the BOSS should be able to lift 50 lbs. without assistance. At least 2 persons are required to install the BOSS.

Installation instructions should be followed exactly; improper installation of the BOSS could void the warranty of the BOSS and any or all its component parts. Thoroughly read any project specific setup or commissioning instructions from Alencon Systems before beginning the installation.

If any instructions are unclear, or any additional information is required during the process, please contact Alencon Systems LLC for assistance (see Appendix C).

10.1 Installation Criteria

The following information should be considered when selecting the topology and the locations for installation within the BESS.

Disconnect BOSS primary and secondary from power sources while performing the installation to reduce the risk of shock during the process. Test any wire or terminal for presence of high voltage before touching them.

The primary or secondary voltage at the BOSS converter must never exceed its rated voltage, (i.e., 1000V for the BOSS 1000). Exposure to voltage higher than that may cause damage to the BOSS and will void the warranty.

The minimum voltage, maximum voltage and maximum current ratings can be found on the BOSS serial number label (see Figure 15). The BOSS will not deliver any power if the input voltage is below minimum specified input voltage.

10.2 Installation Procedure

The BOSS has been designed to be quickly deployed in the field. Much of the configuration of the system is done at Alencon's factory prior to shipping to decrease the amount of time needed for install and commissioning the system in the field.

A summary of the steps to install and prepare BOSS units for commissioning is provided below:

1) Locate the system layout schematic provided by your system integrator. This diagram should show the location where each BOSS needs to go, including its LIN (Local Identification Number)
2) Mount the BOSS units
3) Mount any Disconnects (if separate from the BOSS).
4) Disconnects for both sides should be put into OPEN (off) position.
5) Connect primary and secondary power wires to FEED.

10.3 Locate the System Layout Schematic and/or Installation Drawing

System installers and/or integrators should supply installation drawings showing the location of where each BOSS is to be installed. As well, the single line diagram should show electrical interconnections. A simplified version of such a SLD is provided below.

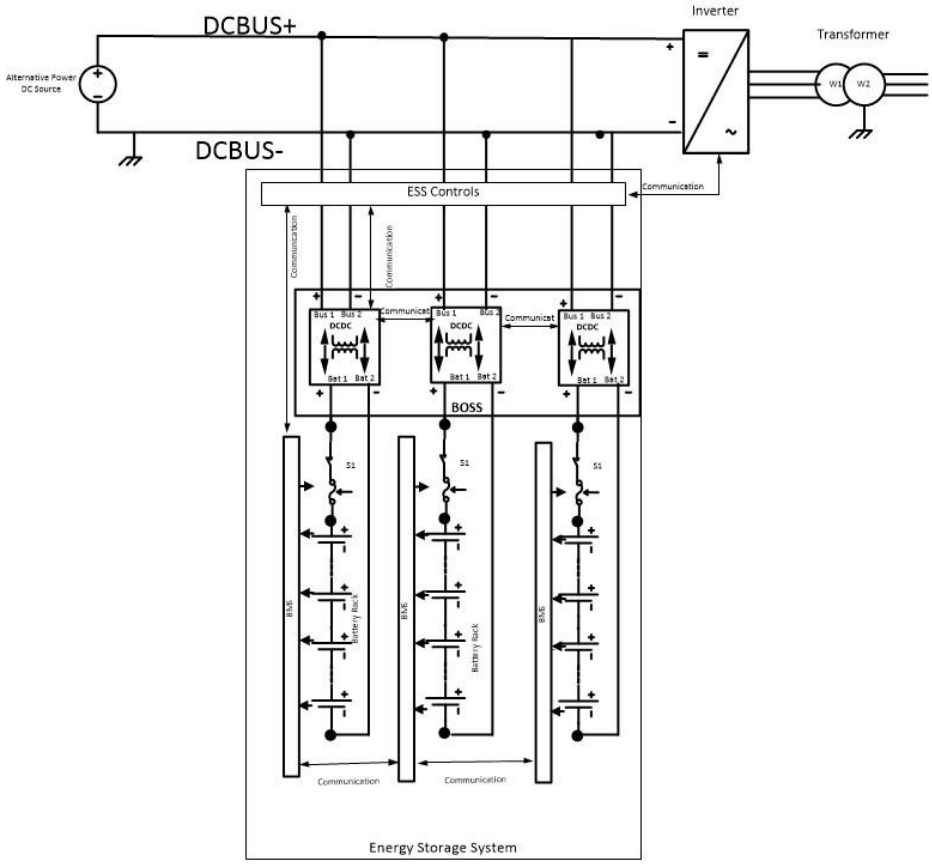


FIGURE 14: SAMPLE OF A SINGLE LINE DIAGRAM (SLD) INCLUDING BOSS

The installation drawing indicates the location of each BOSS and shows its Local Identification Numbers (LIN). Prior to shipment, each BOSS is identified with a unique serial number. Should a BOSS need to be replaced in the field, the replacement BOSS will have same LIN as the previous BOSS but a different serial number. A permanent label showing both the LIN and serial number of each BOSS are affixed to the BOSS end cap as shown below.

FIGURE 15: SAMPLE BOSS LABEL

10.4 BOSS Mounting

The BOSS uses natural convection cooling. In extreme weather conditions, the metal surface of the unit can reach temperatures over 75°C (170°F); high temperatures can cause burns if in contact with the skin. When installing, ensure that the BOSS is not located in high traffic areas.

It is possible that the device has sharp edges which can cause skin cuts or lacerations if handled incorrectly. As such, it is recommended that BOSS installers take appropriate precaution such as wearing work gloves to prevent injury when hanging the BOSS.

10.4.1 Selecting Location – Horizontal Rack Mount

The following considerations should be made when selecting the mounting location for the BOSS converter with FEED:

Indoor/Outdoor: The BOSS with FEED must be mounted indoors as the FEED enclosure is not rated for outdoor use unless otherwise stated by Alencon.

Mounting Position: The BOSS can be mounted horizontally into a rack, 19" rack-mount configuration: 9U x 22.5" Deep, 25" Overall Depth. The rack must be capable of supporting its weight (69.4 kg or 153 lbs.)

Temperature: The BOSS should be mounted in a location, where ambient temperature ranges from -40 to +60 °C. The BOSS will limit power output at ambient temperatures above 35 °C

Clearance: The BOSS should have at least 30 cm (12 inches) in front for airflow and access to the cable connectors. The BOSS should have at least 15cm (6 inches) at the back to allow for proper exhaust from the cooling fans.

10.4.2 Selecting Location – Vertical Rail Mount

The following considerations should be made when selecting the mounting location for the BOSS converter:

Indoor/Outdoor: The BOSS with FEED must be mounted indoors as the FEED enclosure is not rated for outdoors (unless otherwise indicated by Alencon).

Mounting Position: The BOSS can be mounted vertically on a wall or pole. BOSS is equipped for easy mounting on horizontal Unistrut. The BOSS should be mounted to a load bearing object capable of supporting its weight (69.4 kg or 153 lbs.).

Temperature: The BOSS should be mounted at location, where ambient temperature ranges from -40 to +60 °C. The BOSS will limit power output at ambient temperatures above 50 °C

Clearance: For optimal and safe operation, make sure that the BOSS has enough clearance around the unit. If the recommended minimum clearances in table below are not met, rated performance may not be achieved.

Direction	Recommended Clearance
Above	12 inches
Below	24 inches
In front	12 inches, more recommended to allow the access to the unit
On sides	12 inches, more recommended in hot climates to prevent thermal de-rating

10.4.3 Mounting Procedure – Horizontal Rack Mount

To properly install the BOSS into a Rack:

1) BOSS with FEED (shown in Figure 16)**Error! Reference source not found.** can be unpackaged and lifted onto a table or work bench to attach mounting brackets
2) Using (4) of the provided ¼"-20 x 3/4 Self Tapping-Type F Screws [P-005533], securely attach the left and right mounting brackets to the BOSS unit's side, so that 'wings' are flush to the front face
3) BOSS can be lifted and placed into the rack
4) BOSS may have a designated place within the cabinet, denoted by a numbered label on the front face which should be matched to the assigned location.
5) Each BOSS weighs upwards of 150lbs, to avoid injury or damage to the units, at least 2 able-bodied people should lift them into place, 3 people are recommended
6) Use 4 screws to secure each BOSS unit to the rack through the mounting brackets.

FIGURE 16: BOSS WITH FEED AND MOUNTING BRACKETS (IN RED)

FIGURE 17: BOSS UNITS IN BOX RACKING SYSTEM

When more than 1 BOSS unit is used in a project, the Alencon BOX can be used to combine primary and secondary for up to 4 units in parallel. The BOX also provides outdoor rated protection for the BOSS devices within.

See more about integrated rack options in SPOT & BOSS-BOX User Manual.

10.4.4 Mounting Procedure – Vertical Rail Mount

The BOSS can be easily mounted using standard Unistrut© along with spring loaded channel nuts. The BOSS V7 comes with a hooked backplate (if vertical mounting is specified) that allows it to be hung on Unistrut and fastened using a Hex head screw. Recommended hardware for mounting is as follows:

- Unistrut© – Any typical zinc plated or galvanized steel Unistrut
- Strut Channel Nuts with Spring, 13/16" Channel High, 5/16-18 Thread – x2 per BOSS
- Hex Head Screw, Grade 8 Steel, 5/16"-18 Thread Size, 1" Long – x2 per BOSS

Based on OSHA and safety best practices documented in the U.S., as well as others stated in Canada, Europe and Asia, the BOSS should be lifted into position by two people as it weighs approximately 69 kg (153 lbs.).

To properly hang the BOSS onto a Unistrut:

1) Ensure you have a strong base to mount the BOSS as seen in the image below.
2) The BOSS should be lifted into position by two people as it weighs approximately 69 kg. Ensure that the BOSS is resting on the floor securely. The side with the mounting plate/bracket should be facing the floor.
3) **Ensure FEED front plate connectors, cooling fans and RJ-45 connector ports are free from stress. Do not hold by any of these points when lifting.**
4) Strategically place your hands and once ready lift the BOSS
5) Lift the BOSS until the hooked mounting plate (highlighted in orange) lines up with the Unistrut.
6) Once everything is lined up you are ready to hook the BOSS in place as seen below
7) Once BOSS is secured in place you must fasten the other end of the mounting bracket it to the Unistrut using 5/16th Hex Head Screws

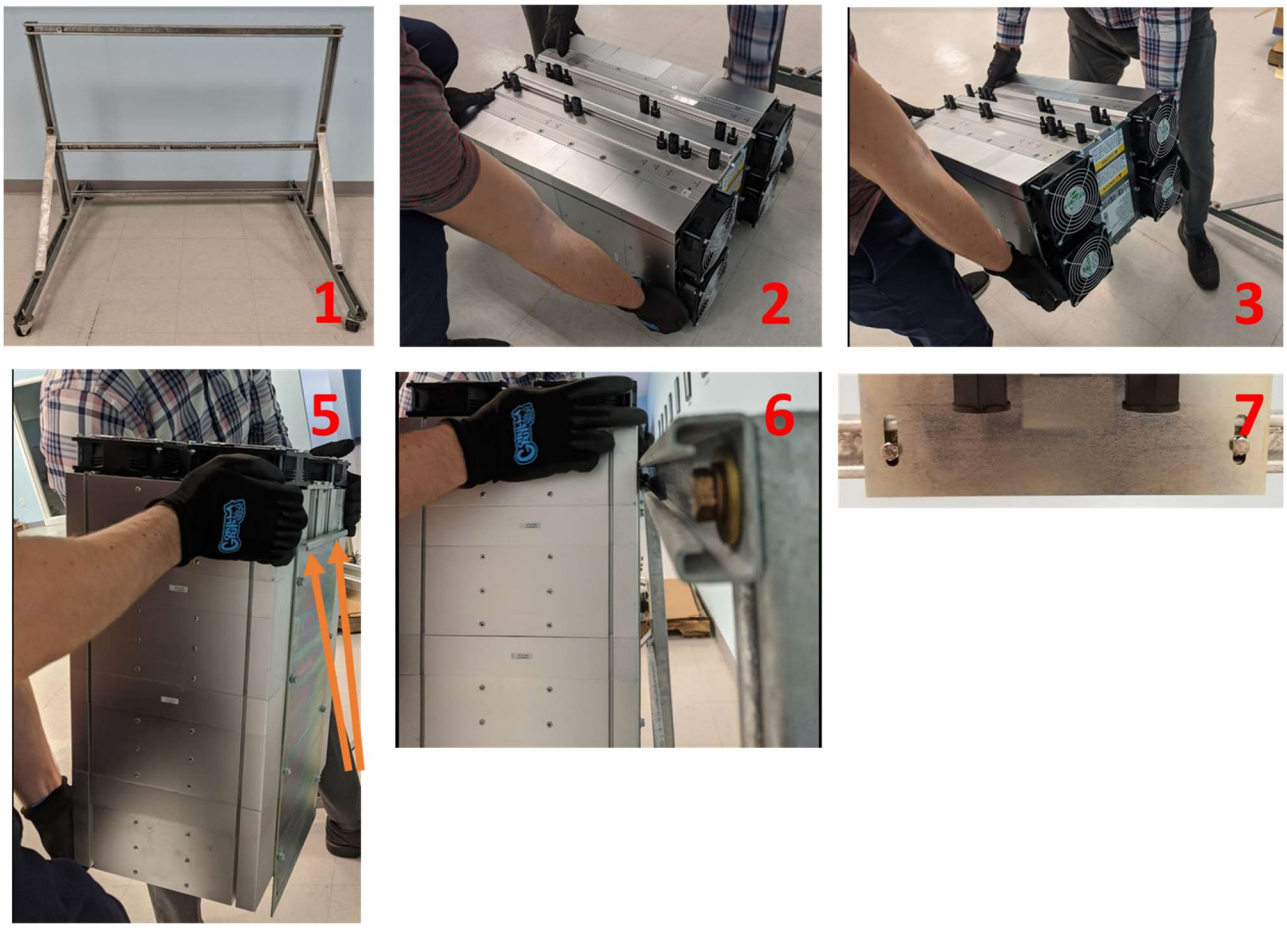


FIGURE 18: BOSS - VERTICAL MOUNTING INSTRUCTIONS

10.5 BOSS Grounding Requirements

PV Grounding

BOSS supports positive, negative, and floating grounding schemes. The chassis of the BOSS and frame of the mounting rack should be connected to main earth ground.

The size of the grounding conductor is usually based on the size of the largest conductor in the DC system.

Shock hazard

All power terminals are considered to have a high voltage potential to ground. To reduce the risk of shock during installation, treat all terminals as high voltage and test for voltage before touching exposed wiring. The work should be performed by qualified service personnel.

The BOSS enclosure should always be connected to earth ground (regardless of the input/output grounding schemes). Not properly grounding the BOSS enclosure can be dangerous for operators and maintenance personnel.

Ground lugs are included with every BOSS shipment and can be attached where a ground label is found on the BOSS enclosure.

FIGURE 19: BOSS GROUND LUG LOCATION EXAMPLE (IN ORANGE)

10.6 Connecting the BOSS Primary and Secondary to Source/Load Cables

Ensure the sources are 'off' (disconnects are in OPEN positions), before making connections to the BOSS primary or secondary ports.

10.6.1 BOSS Wiring Requirements

Fire Hazard: Wiring should not be undersized. The size of the wires must be selected based on the maximum short circuit current in the node. Ensure wiring is in accordance with the NEC or applicable code.

10.6.2 BOSS Connector Terminations

The BOSS is typically sold with a configured FEED add-on which determines the connector terminations. See FEED User Manual for more information on primary and secondary termination options.

10.6.3 Primary/Secondary Wiring

Up to four sources are connected to a single BOSS via primary connectors. Up to four sources/loads are connected to a single BOSS via secondary connectors. The primary and secondary of the BOSS are polarity sensitive.

Inspect and assure that the positive and negative conductors connected to each BOSS channel correspond to the same power source/load.

Mate the cable connectors together with connectors on the FEED ensuring correct polarities are maintained and make sure they click closed. Labelling on the cables and the FEED front plate should match for each individual connection.

10.6.4 Short Circuit Check

Make sure the BOSS is in SHUTDOWN state before conducting this test

After connecting BOSS to power sources, close the primary disconnects and use a current clamp to check that no current flows to the BOSS through any of the 4 channels. If any current is measured, open the primary disconnect immediately and contact Alencon technical support.

Repeat this process with the secondary disconnects to check that no current flows to the BOSS from the other direction. If any current is measured, open the secondary disconnect immediately and contact Alencon technical support.

When finished, the disconnects should be opened and remain open until the BOSS install is finished and BOSS is ready for commissioning to begin (see Section 11.3).

10.7 Connecting Comms Cables between BOSS Unit(s) and a PODD

BOSS units require a connection to the Alencon PODD device to establish communications and operability of the BOSS. Alencon specifies the use of:

- CAT5e or better STP cable
- Male RJ45 connectors, type B crimping
- 22 AWG conductors preferred (24 AWG are acceptable)

Note: Cat cabling should be rated for outdoor use if the cable run is not indoors or enclosed within conduit.

Comms cables are connected as a daisy chain between multiple BOSS units and the PODD. A cable tester can be used to ensure the connection is sound for all 8 conductors through the entire line as shown in figure 20 below.

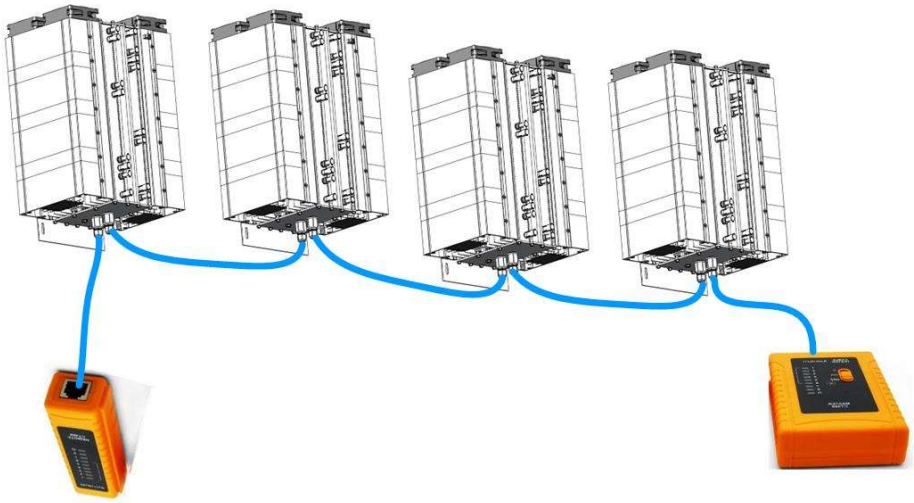


FIGURE 20: BOSS COMMS DAISY CHAIN WITH PODD

11 Turning ON and OFF the BOSS

In some cases, such as for maintenance or troubleshooting, the BOSS needs to be turned off and isolated from primary and secondary sources. Use the full procedures below for safely turning ON and OFF the BOSS.

11.1 Steps to turn ON the BOSS:

Primary and secondary disconnect switches should be in the OPEN position at the beginning of this process.

1. Connect the load to the BOSS output terminals. Close the secondary disconnect (load)to the BOSS
2. Power on the BOSS device, using internal or external power source (see Section 8.5)
    a. Close the primary disconnect if relying on input power source
    b. Keep the primary disconnect open if using external power source
3. Use the PODD or your integrated system controller to confirm that the BOSS is in SHUTDOWN state. If not, send a **Shutdown** command and see that it is enacted through the controller (see Section 12).
4. If not done previously, close the primary disconnect to the BOSS.
5. Use the PODD or other controller to check telemetry data for expected voltage measurements on both Primary and Secondary.
6. BOSS is on and ready for active control (see Section 12).

11.2 Steps to turn OFF the BOSS:

BOSS must be disconnected from the power source before disconnected from the load.

In the event of any maintenance or BOSS replacement, ensure that all BOSSs connected to the same source (primary or secondary) are turned OFF using this process.

1. Use the PODD or other controller to send a **Shutdown** command and cease power conversion on all BOSS channels (see Section 12).
2. If unable to use a controller to put the BOSS in SHUTDOWN state, the "input" switch (disconnect, contactors, etc.) should be opened such that the BOSS is isolated from power 'upstream' meaning:
    a. If operating in Primary to Secondary direction, open the Primary disconnect
    b. If operating in Secondary to Primary direction, open the Secondary disconnect
3. Only after the "input" disconnects are OPEN should the user open the "output" disconnect, so the BOSS is isolated from both primary and secondary.

4. Measure the primary and secondary DC currents using a clamp and verify no current flows to or from the BOSS. If current is still present, contact Alencon technical support directly.
5. Cables can now be disconnected from BOSS primary and secondary ports.

11.3 Additional Hardware for Safely Stopping BOSS Operation

When operating, a BOSS controls the flow of current from power source to the power load:

1. Power source can be a PV string, fuel cell, or battery, referred to as "Upstream"
2. Power load can be an inverter, battery or resistive load referred to as "Downstream"

Given that the BOSS utilizes bidirectional operation, the "upstream" and "downstream" sides will change depending on the direction of power conversion. The BOSS has a rapid response to control commands, and low amount of stored energy.

If the load is suddenly disconnected from the BOSS, the outflow current causes output voltage to rapidly increase, exceeding the device rating and resulting in fatal failure.

The built-in OVP circuit cannot react fast enough to protect the BOSS from immediate loss of the load. Typically, the BOSS is connected into network with contactors on both upstream and downstream sides controlled by a system controller.

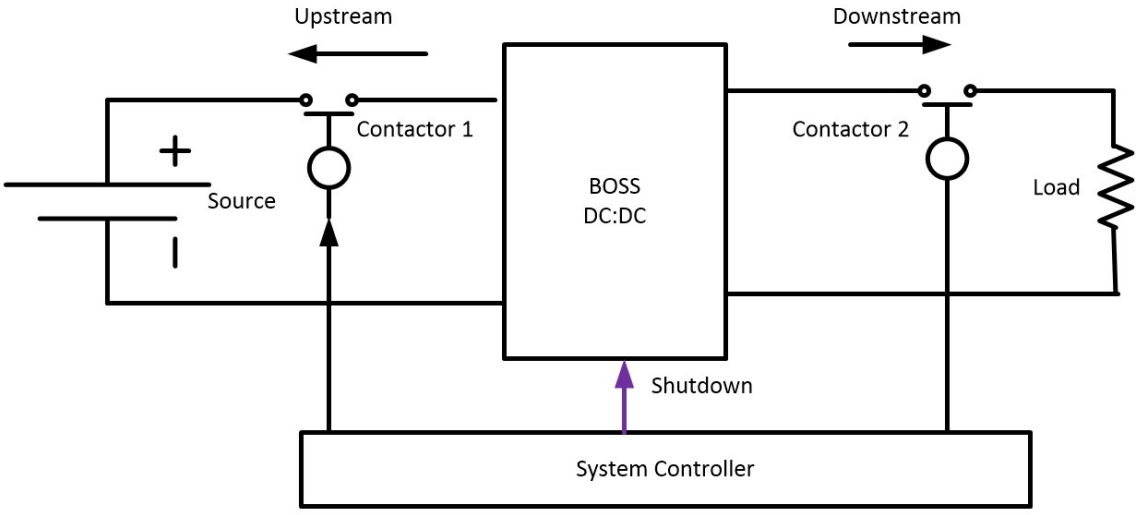


FIGURE 21: BOSS DCDC WITH UPSTREAM AND DOWNSTREAM CONTACTORS

The over-voltage damage to BOSS may be prevented in three different ways:

1. Where possible, the BOSS should always be put into SHUTDOWN state, by sending a Shutdown command through the PODD user interface or SCADA controller, before relays or disconnects between the BOSS and its source/load are opened. This will ensure the converter is idle and sources will be isolated while equipment is electrically disconnected.
2. If the BOSS cannot be Shutdown, the "upstream" Contactor 1 should be disconnected before the "downstream" Contactor 2, so that the BOSS is isolated from its power source first.
3. If no control over the disconnect process is possible, install capacitors C1 and C2 upstream and downstream (see Figure 22). The value of the capacitor is specified as C1 = C2 = n * 150 µF, where n is the number of BOSS DCDCs (4 per BOSS unit) connected to the same DC load.

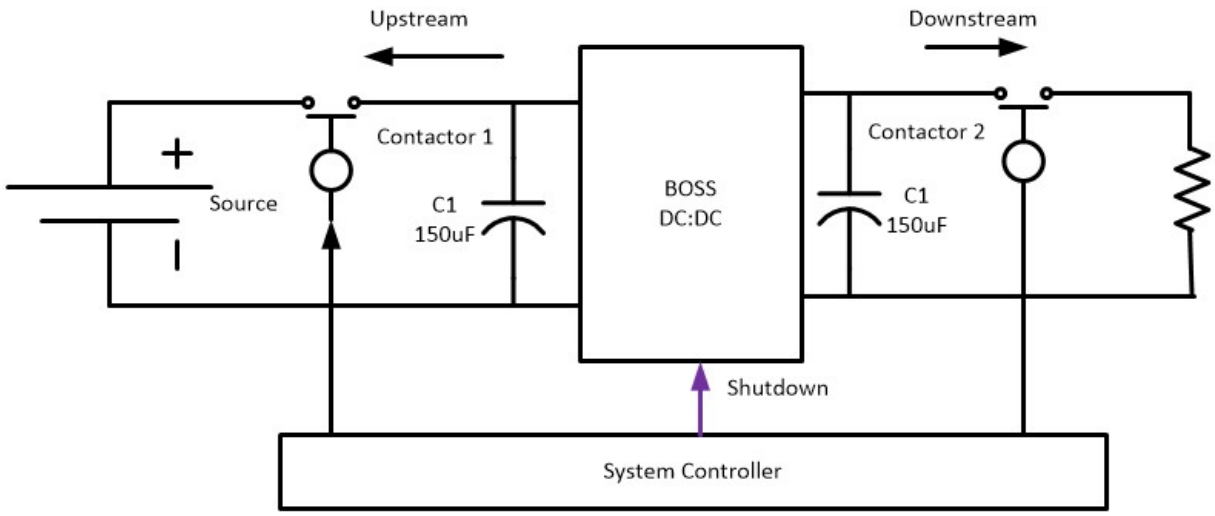


FIGURE 22: BOSS WITH CAPACITORS C1 AND C2

12.2.1 Snubber Circuit Option

Some inverters may have a DC contactor before their capacitor and may lack the circuitry to pre-charge their internal DC capacitor. In this scenario the inverter may see inrush current in excess of what it was designed for when it closes its contactor between the external capacitor added to protect the BOSS and the inverter's own internal DC capacitor.

To avoid this issue the capacitor added to protect the BOSS can be converted to a snubber circuit which allows it to have the same protection function to rising voltage while eliminating the ability to source a large inrush current if the inverter closes a contactor between the bus and the inverter's discharged DC capacitor.

To avoid the danger of exposure to a fully charged large capacitor, a 'bleeding' resistor can be added in parallel to the capacitor of the snubber circuit. See circuit diagram below in Figure 23.

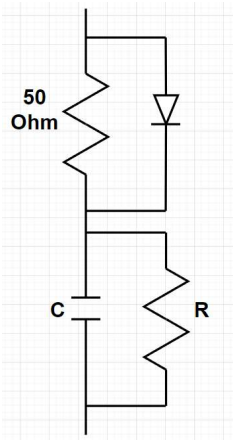


FIGURE 23: SNUBBER CIRCUIT SCHEMATIC

For more information see Alencon Tech Note: Avoiding Harmful Overvoltage Events on the BOSS

11.3 Commissioning your BOSS Device

The first time installing and turning ON the BOSS device, may be a different process than turning OFF and ON as desired for maintenance, troubleshooting or other reasons after the system is fully deployed.

Commissioning the BOSS includes:

1. Mounting the BOSS (Section 10.4) and accessory devices.
2. Installing any additional safety hardware as required (Section 11.3)
3. Connecting properly to Primary and Secondary (Section 10.6)
4. Connecting comms between BOSS unit(s) and the PODD (Section 10.7)
5. Turning ON the BOSS (Section 11.1)
6. Establishing communications with a PODD device (see PODD user manual)
7. Implementing final configuration changes (contact Alencon technical support if necessary).
8. Controlling the system to begin operating (Section 12).

Alencon offers live commissioning support for all system deployments using the BOSS device. Please discuss this with your Alencon Systems representative if interested.

12 BOSS Operation

This section explains the operation of a BOSS device. Distinguishing between typical and atypical BOSS operation is a key function in troubleshooting your system.

12.1 STATE Machine

Each DCDC operates as a state machine, where most state transitions are autonomous with the option of intervention using control commands sent over Modbus:

Main states may have lower-level state machines incorporated within. Arrows and diamonds indicate the conditions of transfer from command to state or state to state. Commands can be issued from the Alencon PODD UI or the system controller via Modbus at any time.

Find explanations of the statuses, commands, and conditions below. To avoid confusion in the following sections, statuses will be CAPITALIZED, commands will be **bolded**, and conditions will be *italicized*.

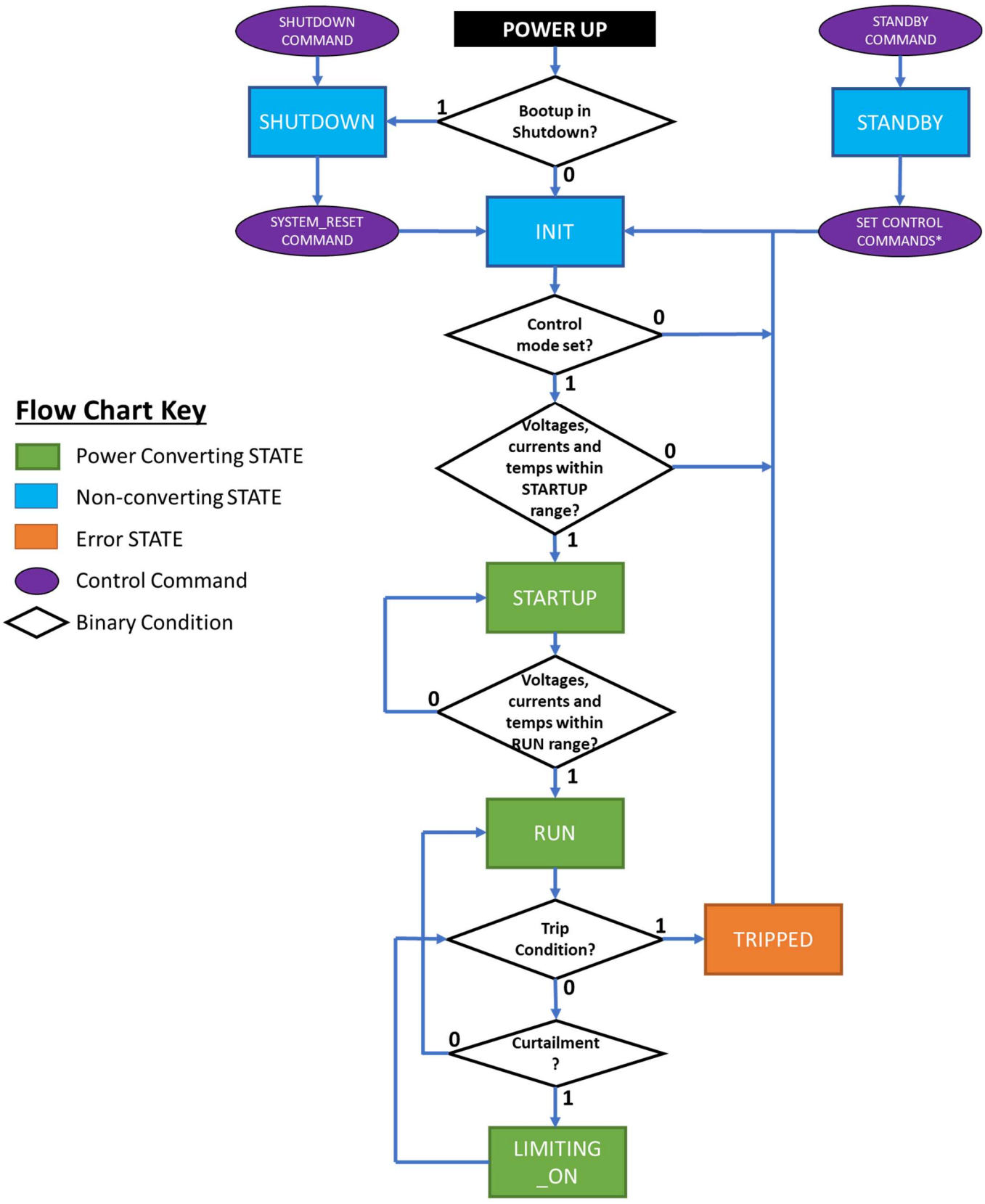


FIGURE 24: STATE SPACE FLOW CHART

12.1.1 States

SHUTDOWN

From any state (excluding STANDBY) the DCDC can be transferred into SHUTDOWN state upon receiving a **Shutdown** command. In the SHUTDOWN state the operation of the DCDC is ceased and transfer of power is stopped. The enable flag is set to 0. The DCDC stays in the SHUTDOWN state until a **System Reset** command sets the enable flag = 1.

STANDBY

The DCDC converter is not producing power. It is ready to produce power but not all *startup limits* are satisfied, or *control mode* has not been set. Does not require **System Reset** to exit.

INIT

The microcontroller is initialized. It checks whether, enable flag = 0 (state to SHUTDOWN) or enable flag = 1 (state to RUN)

STARTUP

In the STARTUP state, the DCDC prepares the load for the RUN state. First the DCDCs charge the connected output BUS (inverter and other connected electronics) to the operating voltage defined in the configuration file. When *run limits* are satisfied, the DCDC transitions to the RUN state unless a fault occurs mid-transition.

RUN

Operates in current/power control mode, maintaining a consistent setpoint as requested from the controller. Setpoint can be changed without leaving RUN mode. If the control mode or direction are changed, BOSS will go to INIT state. Alternatively, in MPPT mode, BOSS operates constantly adjusting to maintain maximum power.

LIMITING_ON

If *curtailment* is enabled and the DCDC is operating within the predefined *curtailment limits*, the DCDC will go to LIMITING_ON status. DCDC continues to operate at reduced power throughput, according to the application specific droop curve that has been pre-configured. If operating conditions return to standard *run limits*, the DCDC will return to RUN status.

For more information see the Alencon Whitepaper on DCDC curtailment.

TRIPPED

If, while in RUN or LIMITING_ON status, voltage, current or temperature exceed the pre-configured limits on any DCDC (i.e., hit a *trip condition*) it will enter TRIPPED state and move automatically to INIT state. When the TRIPPED state is entered, the DCDC stops all power conversion. Entering TRIPPED does not remove the c*ontrol mode* or set the enable flag = 0.

12.1.2 Commands

The following list contains the most common and useful commands that can be given to the BOSS from the PODD UI or external controller via Modbus. For full details on available Modbus commands and registers, please request Modbus Maps from Alencon Systems.

- **Clear Error** – remove error code flags from the UI, by resetting error code register. This has no effect on the state machine/operational flow of the BOSS.
- **Shutdown** – set the DCDC converter to the SHUTDOWN state and cease all power production.
- **System Reset** – initialize the DCDC converter to accept operating commands, which can be actively or automatically delivered.
- **Set Control** – Issue operating commands for how the BOSS should convert power. Including control mode, direction of conversion, setpoint, and setpoint timeout.
    - Options for **control mode** include:
        - STANDBY – idle state with no power conversion
        - Constant power – requires actively choosing the primary or secondary power setpoint
        - Constant current – requires actively choosing the primary or secondary current setpoint
        - MPPT – autonomous operation, doesn't require setpoint
    - Options for **direction** of conversion include:
        - Primary to Secondary (currents will display as positive values)
        - Secondary to Primary (currents will display as negative values)
    - **Setpoint** can be given as any positive value from zero to the pre-defined maximum. If requested setpoint exceeds the maximum, BOSS will not accept that command.
    - **Setpoint timeout** controls a heartbeat function wherein the BOSS will go to STANDBY mode if a new setpoint is not received every X seconds, where X is the value given to this parameter. A setpoint timeout of 0 will disable the function.

12.1.3 Conditions

Bootup in shutdown

If evaluated as true, BOSS goes automatically to SHUTDOWN state when turned on. By default, the BOSS will be configured to evaluate as true, but this can be changed if necessary.

Control mode set

This is set to Primary Current mode as default for most BOSS units. In some cases, different control modes will be used on the BOSS including:

- Primary current
- Secondary current
- Primary power
- Secondary power
- MPPT

For *control mode set* to evaluate as true; the control mode, the direction, the setpoint, and the setpoint timeout must be written (except when control mode = MPPT).

Note: Primary Voltage and Secondary Voltage control modes are not currently available on the BOSS.

Voltages, currents, temps within STARTUP range (Startup limits)
Tests operating conditions are in the permissible startup range as defined in the config file, including:

- On board temperature
- Transistor temperature
- Input and Output Voltages

Voltages, currents, temps within RUN range (Run limits)
Tests operating conditions are in the permissible run range as defined in the config file, including:

- On board temperature
- Transistor temperature
- Input and Output Voltages
- Input and Output Currents

Trip condition
Tests operating conditions don't exceed the operating boundaries as defined in the config file, including:

- On board temperature
- Transistor temperature
- Input and Output Voltages
- Input and Output Currents

Curtailment (Curtailment enabled & curtailment limits)
Tests operating conditions have entered the curtailment zone as defined in the config file. Corresponding curtailment options must be enabled within the config file as well, there are many curtailment options available. For more information see the Alencon Whitepaper on DCDC curtailment.

13 BOSS Firmware Protections

13.1 Primary/Secondary Protection

Protective functions as triggered by measurements on the primary or secondary side of the DC-to-DC converter. The trip conditions are configurable, project specific and pre-defined in the BOSS memory, they can be modified to some degree, if necessary, during deployment.

13.1.1 Under voltage

The primary/secondary voltage is too low for normal operation. BOSS will TRIP and enter STANDBY mode.

13.1.2 Over voltage

The primary/secondary voltage is too high for normal operation. BOSS will TRIP and enter STANDBY mode.

13.1.3 Current Limit

Operational current magnitude is limited to protect from hardware damage. If limit is exceeded, BOSS will TRIP and enter STANDBY mode.

13.1.4 Ground Leak Protection (Primary only)

The BOSS monitors leakage to ground and shuts down if excessive ground leakage current is detected. This functionality is only available if the Leak Locator® option has been purchased.

13.2 Environmental Protection

The BOSS has software functions designed to protect it from extreme external conditions of high temperature and moisture. The trip conditions are configurable, project specific and pre-defined in the BOSS memory, though they can be modified as necessary during deployment.

13.2.1 Temperature on Power Semiconductor

Monitors the temperature of the Power Semiconductors. BOSS enters STANDBY mode if the limit is exceeded.

13.2.2 Microcomputer Temperature

Monitors the temperature on the Microcomputer. BOSS enters STANDBY mode if the limit is exceeded, to prevent the DCDC converter from failure.

13.2.3 Control Board Temperature

Monitors the temperature on the PCB. BOSS enters STANDBY mode if the limit is exceeded.

13.2.4 Humidity

Monitors the humidity inside sealed electronic compartment. BOSS enters STANDBY mode if the limit is exceeded.

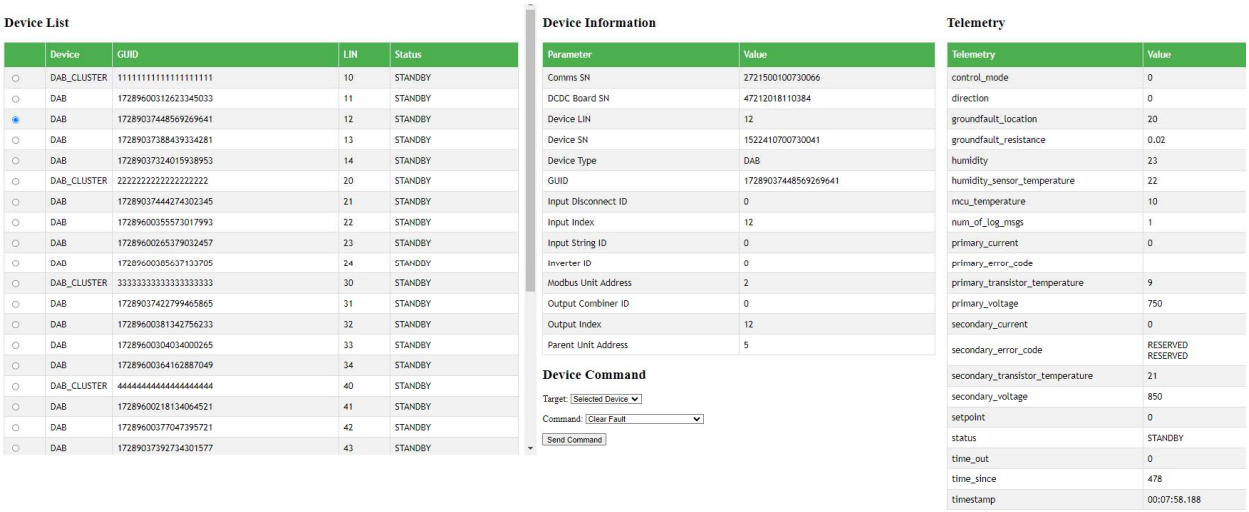
14 Interfacing with the BOSS

This section covers BOSS operating procedure and the various test procedures while interfacing with the BOSS. Use this information in conjunction with the PODD User manual (Section 16) for full information.

As soon as the BOSS has been turned on, the PODD UI can be used to access BOSS control functions and telemetry data. To ensure proper operation and communication of the BOSS with the PODD, two files are required:

- *metadata File*
- *config File*

Both these files would be pre-loaded onto the PODD or be provided by Alencon via secure file transfer.



Device List

	Device	GUID	LIN	Status
○	DAB_CLUSTER	1111111111111111111	10	STANDBY
○	DAB	17289600312623345033	11	STANDBY
◉	DAB	17289037448569269641	12	STANDBY
○	DAB	17289037388439334281	13	STANDBY
○	DAB	17289037324015938953	14	STANDBY
○	DAB_CLUSTER	2222222222222222222	20	STANDBY
○	DAB	17289037444274302345	21	STANDBY
○	DAB	17289600355573017993	22	STANDBY
○	DAB	17289600265379032457	23	STANDBY
○	DAB	17289600365637133705	24	STANDBY
○	DAB_CLUSTER	3333333333333333333	30	STANDBY
○	DAB	17289037422799465865	31	STANDBY
○	DAB	17289600381342756233	32	STANDBY
○	DAB	17289600304034000265	33	STANDBY
○	DAB	17289600364162887049	34	STANDBY
○	DAB_CLUSTER	4444444444444444444	40	STANDBY
○	DAB	17289600218134064521	41	STANDBY
○	DAB	17289600377047395721	42	STANDBY
○	DAB	17289037392734301577	43	STANDBY

Device Information

Parameter	Value
Comms SN	2721500100730066
DCDC Board SN	47212018110384
Device LIN	12
Device SN	1522410700730041
Device Type	DAB
GUID	17289037448569269641
Input Disconnect ID	0
Input Index	12
Input String ID	0
Inverter ID	0
Modbus Unit Address	2
Output Combiner ID	0
Output Index	12
Parent Unit Address	5

Device Command

Target: Selected Device

Command: Clear Fault

Send Command

Telemetry

Telemetry	Value
control_mode	0
direction	0
groundfault_location	20
groundfault_resistance	0.02
humidity	23
humidity_sensor_temperature	22
mcu_temperature	10
num_of_log_msgs	1
primary_current	0
primary_error_code	
primary_transistor_temperature	9
primary_voltage	750
secondary_current	0
secondary_error_code	RESERVED RESERVED
secondary_transistor_temperature	21
secondary_voltage	850
setpoint	0
status	STANDBY
time_out	0
time_since	478
timestamp	00:07:58.188

FIGURE 25: POPULATED PODD UI DEVICES PAGE

14.1 Soft Pre-Charge of BOSS – Typical Startup Procedure

The BOSS is a bi-directional optimizer, so it can pre-charge the primary or secondary side if necessary for the connected source/load.

To pre-charge the load, you will need to first establish the direction of power flow, Primary-to-Secondary or Secondary-to-Primary. Applied voltage will show up in the telemetry data on the PODD UI.

- When the Primary is the source, the "Primary Voltage" header will display the commensurate source voltage applied
- When the Secondary is the source, the "Secondary Voltage" will display the commensurate source voltage applied

Telemetry

Telemetry	Value
control_mode	0
direction	0
groundfault_location	20
groundfault_resistance	0.02
humidity	23
humidity_sensor_temperature	22
mcu_temperature	10
num_of_log_msgs	1
primary_current	0
primary_error_code	
primary_transistor_temperature	9
primary_voltage	750
secondary_current	0
secondary_error_code	RESERVED RESERVED
secondary_transistor_temperature	21
secondary_voltage	850
setpoint	0
status	STANDBY
time_out	0
time_since	131
timestamp	00:02:11.534

FIGURE 26: PODD UI – BOSS TELEMETRY DATA

1. **System Reset** Command – This command puts the BOSS in INIT allowing it to accept power conversion commands.

Device Command

Target: Selected Device

Command: System Reset

Send Command

FIGURE 27: RESET COMMAND

2. To start power conversion through the BOSS, use the **Set Control** command.
3. When selected, the command window will expand to show additional control parameters (see figure 25). Each of these parameters; **Control Mode**, **Setpoint**, **Direction**, and **Setpoint Timeout** must be specified before command is sent.

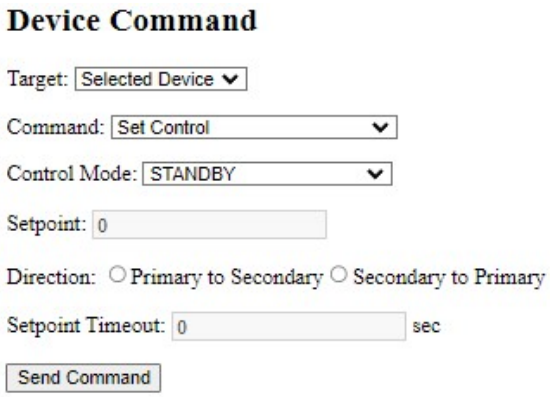


FIGURE 28: HUB BOSS DATA

4. Once the four parameters are set, the capacitors will begin to pre-charge to a pre-configured voltage setpoint. This voltage setpoint may be different for each direction option.
5. After pre-charging the capacitors to the desired output voltage, the DCDCs should transition to RUN, adjusting the frequency to obtain the desired current set point.

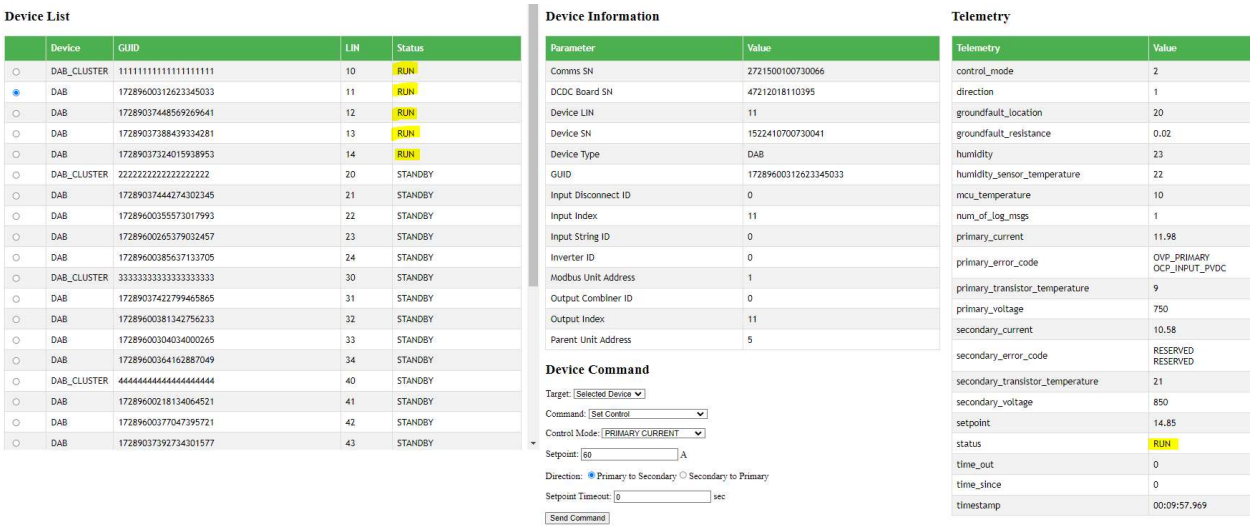


FIGURE 29: ALENCON'S HMI – THE PODD SITE

Note: Do not change direction of power flow if your DC source cannot act as a load. If this is the case, you will have to manually swap primary and secondary cable connections.

15 Maintenance and Servicing

15.1 General Maintenance

If the BOSS is not operating as expected, attempt the following basic troubleshooting methods to regain proper operation:

- Check primary and secondary power sources for proper function.
- Check any fuses for continuity. If any fuses are blown, BOSS should be turned OFF (Section 11.2), fuse replaced and then BOSS can be turned back ON (Section 11.1)
- Use the controller to send a **Shutdown** command, followed by a **System Reset** command, give the BOSS a few minutes to restart power conversion.
- Us the disconnect switch to turn OFF and ON the BOSS, give it a few minutes to restart power conversion.

If BOSS still does not operate as expected, please contact Alencon Systems technical support for assistance with troubleshooting (see Appendix C).

15.2 Service and Repair

Due to the UL rating of the BOSS, it is **not a field serviceable device,** in most instances. If your BOSS is determined to be damaged, it will need to be returned to Alencon systems.

If the BOSS requires servicing, disconnect it following the turn OFF procedure (Section 11.2) and request an RMA (return merchandise authorization) from Alencon Systems technical support. Then following the RMA process, the damaged BOSS will be returned to Alencon Systems or an authorized Alencon service agent.

16 Alencon Communication Environment (ACE)

For more information refer to the PODD User Manual

16.1 System Overview

Alencon's Communications Environment, the ACE, is an Internet of Things (IoT) hardware and software solution for controlling and monitoring your alternative energy assets utilizing Alencon's PODD device. The PODD can be used with other Alencon products including the SPOT, GARD and BOSS. The PODD acts as a gateway to integrate Alencon's power electronics with your plant level control systems or as a standalone controller and troubleshooting device.

FIGURE 30: PODD - POINT OF DATA DISTRIBUTION DEVICE

Appendix A - Safety Precautions

A.1 Degree of Danger Symbols

	***Warning!***	*Warnings indicate conditions, which if not observed, can cause personal injury!*
	***Caution!***	*Cautions are included to help you avoid damaging hardware or losing data.*
	***Note!***	*Notes provide optional additional information.*

A.2 Electrical hazards

A.2.1 Electric shock from live voltage

 High voltages are present at the equipment and its components. Some maintenance work must be done when voltage is present. Failure to adhere to the safety messages may lead to severe or lethal injuries due to electric shock. To avoid electric shock from live voltage:

- Wear class 2 personal protective equipment.
- Always perform work in compliance with the regulations specified in 29 CFR, Chapter XVII, Part 1910 (OSHA), NEC, and NFPA 70E.
- Do not touch any live components of the equipment or the medium-voltage grid.
- Follow all instructions precisely.
- Observe safety messages.
- Before performing any work on the equipment, always disconnect the equipment if voltage is not
- absolutely necessary.
- After disconnecting the equipment, wait at least 10 minutes for the equipment's capacitors to discharge completely.
- Before performing work on the equipment, ensure that no voltage is present (with a Voltmeter or other measuring instrument).

A.2.2 Danger due to Battery Voltage

 BOSS may be connected to high voltage batteries on both primary and secondary sides of the equipment. Before beginning to work on the BOSS, disconnect the power sources on both primary and secondary sides.

A.2.3 Electric shock caused by ground fault

 If a ground fault occurs, plant sections that are supposedly grounded may in fact be live. Failure to adhere to the safety messages may lead to severe or lethal injuries due to electric shock. To avoid electric shock from ground faults:

- Ensure that no voltage is present before touching any components.
- Wear class 2 personal protective equipment.

A.2.4 Electric shock due to damaged equipment

 Operating damaged equipment can lead to hazardous situations that may result in serious or lethal injuries caused by electric shock. To avoid electric shock from damaged equipment:

- Only operate the equipment if it is in safe and technically faultless working order.
- Only operate the equipment if there is no visible damage.
- Regularly check the equipment for visible damage.
- Make sure that all external safety equipment is always freely accessible.
- Make sure that all safety equipment is in good working order.

A.3 Environmental hazards

A.3.1 Danger to life due to blocked escape routes

In hazardous situations, blocked escape routes can lead to serious injury or death. To avoid harm from blocked escape routes:

- An escape route of at least 3 ft. (915 mm) wide must always be available.
- Do not place any objects in the escape route area.
- Remove all tripping hazards from the escape routes.

A.3.2 Damage to the equipment caused by dust or moisture penetration

 Dust intrusion or moisture penetration can damage and impair the functionality of the equipment. To avoid damage from dust or moisture penetration:

- Do not open the equipment when it is raining or when humidity exceeds 95%.
- Perform maintenance on the BOSS-BOX only when the environment is dry and free of dust
- Always cover electrical bus channel prior activating the equipment.

A.3.3 Danger to life due to electric shock when the equipment is unlocked

Unlocked equipment can be opened by unauthorized persons. This means that unauthorized persons have access to components on which lethal voltages are present. To avoid danger from unlocked equipment:

- Ensure that unauthorized persons have no access to the equipment.
- Always lock the equipment
- Keep the electrical bus channel covered

Appendix B – Glossary

Word(s)/Acronyms	Definition
ALS	ALENCON Systems, LLC
DC	Direct Current
ESD	Electrostatic Discharge
ESS	Energy Storage System
FEED	Fused Electrical Disconnect
GFDI	Ground-Fault Detection
GND	System Ground Potential
HV / LV	High Voltage / Low Voltage
IP	Internet Protocol
LD	Leak Detector
PODD	Point of Data Distribution
RTU	Remote Terminal Unit. Microprocessor controlled electronic protocol to exchange data with other devices
SCADA	Supervisory Control and Data Acquisition system. Performed by transmitting telemetry data to a master system and by using messages from the master supervisory system to control connected objects
SPOT	String Power Optimizer and Transmitter
SPOT-BOX	Container with (1) to (4) SPOT units and Junction Box
BOSS	Bidirectional Optimizer for Storage Systems
BOSS-BOX	Container with (1) to (4) BOSS units and Junction Box
GARD	Ground and Arc fault Rapid Disconnect
UI	User Interface

Appendix C – Technical Support and Assistance

Visit the Alencon Systems web site at www.alenconsystems.com where you can find the latest information about the product. Contact your distributor, sales representative, or Alencon Systems' technical support if you need additional assistance. Please have the following information ready before you call:

- Product name, serial number, and LIN (all can be located on the product label)
- Description of your peripheral attachments including fusing and cables

For technical support please email: support@alenconsystems.com or call **+1 (215) 816-3366**