OutBack POWER™

an EnerSys company

NorthStar NSB BLUE+®

Owner's Manual

About OutBack Power

OutBack Power is a leader in advanced energy conversion technology. OutBack products include true sine wave inverter/chargers, maximum power point tracking charge controllers, and system communication components, as well as circuit breakers, batteries, accessories, and assembled systems.

Applicability

These instructions apply to NorthStar NSB BLUE+® series batteries only.

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Date and Revision

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Part Number

900-00264-01-001 Rev A

Table of Contents

Important Safety Instructions

READ AND SAVE THESE INSTRUCTIONS!

This manual contains important safety instructions for the NorthStar NSB BLUE+® battery. These instructions are in addition to the safety instructions published for use with all OutBack products. Read all instructions and cautionary markings on the NorthStar NSB BLUE+® battery and on any accessories or additional equipment included in the installation. Failure to follow these instructions could result in severe shock or possible electrocution. Use extreme caution at all times to prevent accidents.

WARNING: Personal Injury

- Some batteries can weigh in excess of 100 lb (45 kg). Use safe lifting techniques when lifting this equipment as prescribed by the Occupational Safety and Health Association (OSHA) or other local codes. Lifting machinery may be recommended as necessary.
- Wear appropriate protective equipment when working with batteries, including eye or face protection, acid-resistant gloves, an apron, and other items.
- Wash hands after any contact with the lead terminals or battery electrolyte.

WARNING: Explosion, Electrocution, or Fire Hazard

- Ensure clearance requirements are strictly enforced around the batteries.
- Ensure the area around the batteries is well ventilated and clean of debris.
- Never smoke, or allow a spark or flame near, the batteries.
- Always use insulated tools. Avoid dropping tools onto batteries or other electrical parts.
- Keep plenty of fresh water and soap nearby in case battery acid contacts skin, clothing, or eyes.
- Wear complete eye and clothing protection when working with batteries. Avoid touching bare skin or eyes while working near batteries.
- If battery acid contacts skin or clothing, wash immediately with soap and water. If acid enters the eye, immediately flood it with running cold water for at least 20 minutes and get medical attention as soon as possible.
- Never charge a frozen battery.
- Insulate batteries as appropriate against freezing temperatures. A discharged battery will freeze more easily than a charged one.
- If a battery must be removed, always remove the grounded terminal from the battery first. Make sure all devices are de-energized or disconnected to avoid causing a spark.
- Do not perform any servicing other than that specified in the installation instructions unless qualified to do so and have been instructed to do so by OutBack Technical Support personnel.

Additional Resources

These references may be used when installing this equipment. Depending on the nature of the installation, it may be highly recommended to consult these resources.

Institute of Electrical and Electronics Engineers (IEEE) guidelines: IEEE 450, IEEE 484, IEEE 1184, IEEE 1187, IEEE 1188, IEEE 1189, IEEE 1491, IEEE 1578, IEEE 1635, IEEE 1657, and local code and jurisdictions (various guidelines for design, installation, maintenance, monitoring, and safety of battery systems)

Introduction

Audience

This manual is intended for use by anyone required to install and operate this battery. Be sure to review this manual carefully to identify any potential safety risks before proceeding. The owner must be familiar with all the features and functions of this battery before proceeding. Failure to install or use this battery as instructed in this manual can result in damage to the battery that may not be covered under the limited warranty.

NorthStar NSB BLUE+®

The NorthStar NSB BLUE+® (pure lead carbon) is a front terminal 12Vdc battery combining advanced Thin-Plate Pure Lead VRLA AGM technology with high-grade carbon added to the negative active material (NAM). This carbon additive extends the battery's life, boosts cyclic performance and reduces the size of sulfate crystals on the negative plate during partial state of charge (PSoC). The NorthStar NSB BLUE+® can withstand a very high rate of charge/discharge as well as elevated temperatures. Specially designed for today's demanding off-grid and self-consumption applications, the NSB BLUE+® requires no periodic watering and no retightening of terminal connections.

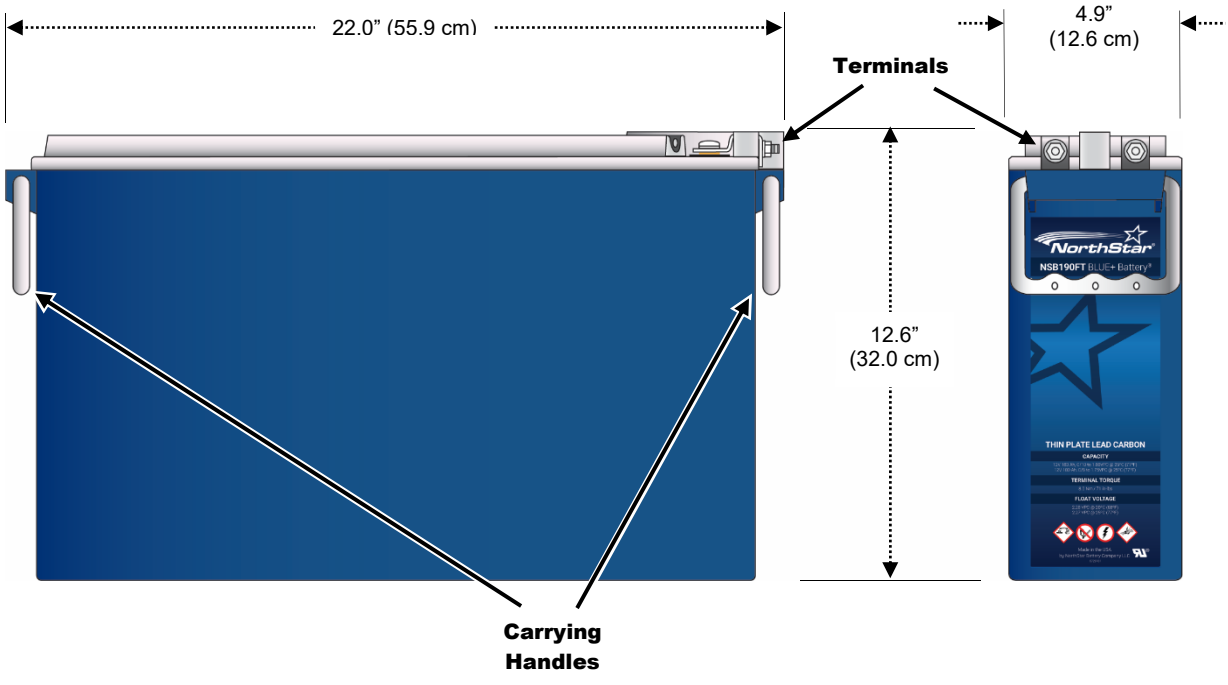

Figure 1 Nominal Dimensions for NorthStar NSB BLUE+® (NSB190FT Model)

Materials Required

Tools (use insulated tools only)

- Digital voltmeter
- Socket wrench
- Torque wrench calibrated in inch-pounds
- Box end wrench
- Battery lifting equipment (handles) and fork lift to lift pallets of batteries
- Rubber gloves
- Full face shield
- Plastic apron
- Portable eyewash
- Spill kit
- Fire extinguisher (class C)

Accessories

- Interconnect bar (included)
- Terminal cover (included)
- Hardware (included)
- Interconnect cables as needed

CAUTION: Fire Hazard

Install properly sized battery cabling and interconnect cables. The cable ampacity must meet the needs of the system, including temperature, deratings, and any other code concerns.

Storage and Environment Requirements

Temperatures

- Optimal operating temperature is 68° to 86° F (20° to 30°C); maximum temperature range is –40° to 149°F (–40° to 65°C).
- Do not allow a discharged battery to freeze, as this will damage them and could result in leakage.
- Do not expose batteries to temperature variations of more than 5°F (3°C). This leads to voltage imbalance between multiple batteries (or between battery cells if there is a temperature differential).
- Batteries should be stored in a cool, dry location.

Self-Discharge

All NorthStar NSB BLUE+® batteries will discharge over time once charged, even in storage. Higher storage temperatures increase the rate of self-discharge. Fully charged, the natural ("rest") voltage of all NorthStar NSB BLUE+® batteries is approximately 13.0 Vdc. A battery should have a freshening charge (see page 16) if its rest voltage is below 12.2 Vdc per battery (2.03 Vdc per cell or VpC). A battery should not be used if its rest voltage is 12.0 Vdc or lower upon delivery. Contact OutBack Power upon receiving a battery in this state.

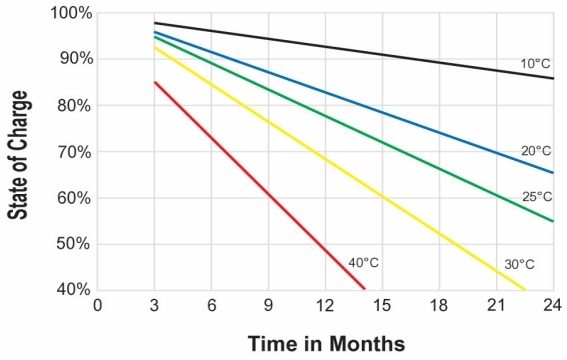

Figure 2 State of Charge vs. Time

Storing NorthStar NSB BLUE+® Batteries

The NorthStar NSB BLUE+® batteries must be given a freshening charge every 24 months when stored at 77°F (25°C). If stored in higher temperatures, the charge should be more often.

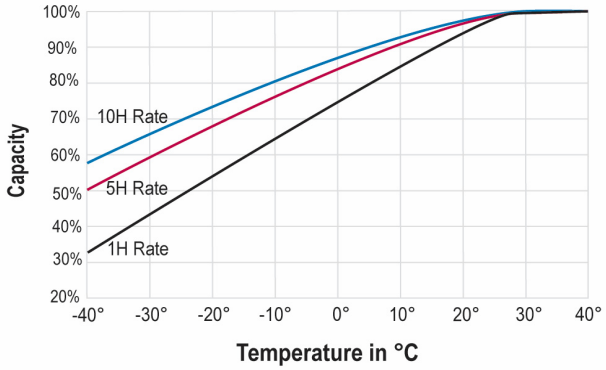

Figure 3 Temperature vs. Capacity

Capacity

Battery capacity is given in ampere-hours or amp-hours (Ah). This is a current draw which is multiplied by the duration of current flow. A draw of *X* amperes for *Y* hours equals an accumulation of *XY* amp-hours.

Because a lead-acid battery's chemical reaction constantly releases energy, its amp-hour capacity is affected less by lighter loads. The battery has greater capacity under lighter loads.

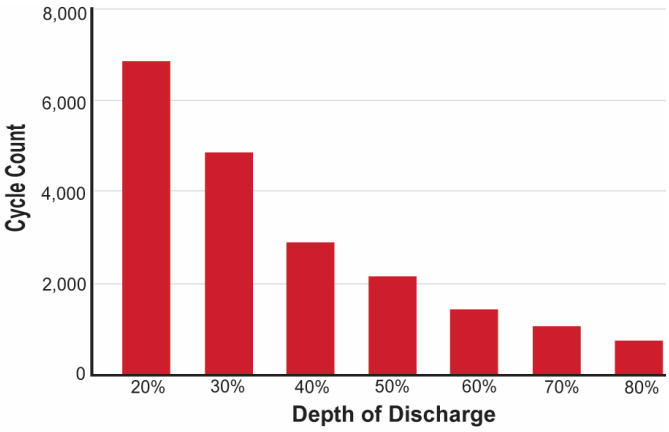

Figure 4 Cycle Endurance

For example, if the NSB190FT BLUE+® is discharged at the 20-hour rate to a voltage of 1.75 VpC (a load expected to effectively drain 100% of its capacity in 20 hours), it will be measured to have 202.4 amp-hours. However, at the 2-hour rate, a heavier load, only 152.2 amp-hours will be measured. For all tested discharge rates and amp-hours, see Table 3 on page 26.

State of Charge

The NorthStar NSB BLUE+® state of charge (SoC) can be determined by two methods. One is to measure its voltage. This method is typically used when batteries are in storage. This is accurate only if the batteries are left at rest (no charging or loads) for 12 hours at room temperature (77°F or 25°C). **If these conditions are not met, then voltage checks may not yield accurate results.** If they are met, then on average, a battery at 13.0 Vdc will be at 100% SoC. A rest voltage of 12.2 Vdc represents roughly 50% SoC.

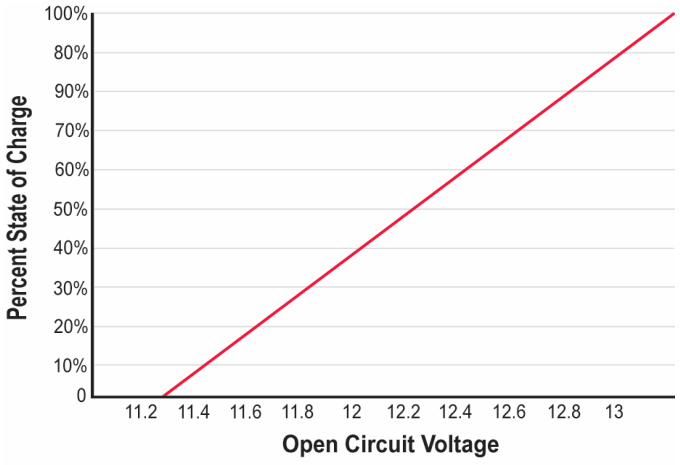

Figure 5 State of Charge vs. Open Circuit Voltage (OCV)

The second method is when batteries are in use, the most accurate method to measure SoC is to use a battery monitor such as the OutBack FLEXnet DC. Using a sensor known as a shunt, the monitor observes the current through the battery. It keeps a total of amp-hours lost or gained by the battery and can give accurate SoC readings.

The NorthStar NSB BLUE+® can be discharged and recharged (cycled) regularly to a level as low as 50% depth of discharge (DoD). This is common in a cycling application such as an off-grid system. However, for optimal life, the best practice is to avoid ever discharging below 50%. Lower DoD levels can shorten the cycle life.

If operated in a range with consistent charge and discharge to no more than 50% DoD, the NorthStar NSB BLUE+® will typically have a life of 2,050 cycles. With consistently lighter discharge (10 to 30% DoD with proper recharge), the battery may have significantly more cycles.

System Layout

CAUTION: Fire Hazard

Failure to ventilate the battery compartment can result in the buildup of hydrogen gas, which is explosive.

- The battery enclosure or room must be well-ventilated. This ventilation protects against accidental gas buildup. All NorthStar NSB BLUE+® batteries are valve-regulated and do not normally emit noticeable amounts of gas. However, in the event of accidental leakage, the enclosure must not allow the leaked gas to become concentrated.
- The battery enclosure or room must have adequate lighting. This is necessary to read terminal polarity, identify cable color, and view the physical state of the battery as required.
- The battery should be installed with a minimum 2" for airflow and 36” (91.4 cm) clearance in front of batteries or cabinet. This allows access for testing, maintenance, and any other reasons.
- Multiple batteries should have a minimum of ¼” (12.7 mm) clearance on either side (½" recommended).

Battery Configurations

Series String (24 Vdc) Series String (48 Vdc)

Batteries are placed in series (negative to positive) for additive voltages. Batteries in series are known as a "string". A string of two NorthStar NSB BLUE+® batteries has a nominal voltage of 24 Vdc and can be used for 24-volt loads. A string of four has a nominal voltage of 48 Vdc. Other voltages are possible. However, batteries in series do not have additive amp-hours. A single string of any voltage (as shown above) has the same amp-hours as a single battery.

When replacing batteries, a new battery should not be placed in series with old batteries. This will cause severe stress and shorten the life of all batteries. All batteries in a string should be replaced at the same time.

Figure 6 Series String Configurations

Batteries are placed in parallel (positive to positive, negative to negative) for additive amp-hour capacity. Three batteries in parallel have three times the amp-hours of a single battery. However, batteries in parallel do not have additive voltages. A single set of batteries in parallel (as shown in this figure) have the same voltage as a single battery.

NOTE: Use caution when designing or building systems with more than three NorthStar NSB BLUE+® batteries or strings in parallel. The extra conductors and connections used in larger paralleled systems can lead to unexpected resistances and imbalances between batteries. Without proper precautions, these factors will reduce the system efficiency and shorten the life of all batteries. For systems beyond three strings, contact an OutBack representative.

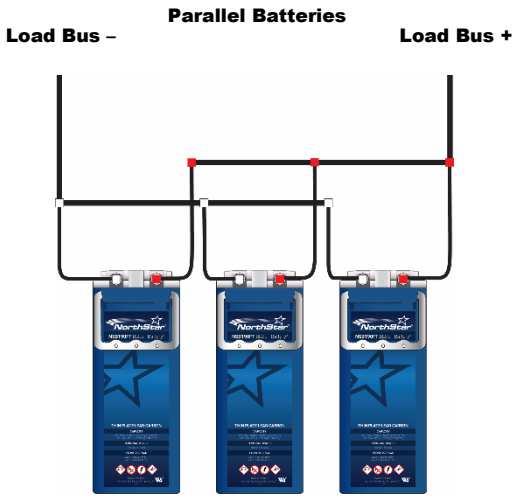

Figure 7 Parallel String Configuration

Batteries are placed in both series and parallel for both additive voltage and amp-hour capacity. Series strings placed in parallel have the same nominal voltage as each string. They have the same amp-hour capacity of each string added together. Two parallel strings of two NorthStar NSB BLUE+ batteries in series have a nominal voltage of 24 Vdc, twice the nominal voltage. They also have double the amp-hour capacity of a single battery. Two parallel strings of four batteries in series have a nominal voltage of 48 Vdc at double the amp-hour capacity of a single battery.

In a series-parallel bank, it is not recommended to connect the load to the positive and negative terminals of a single string. Due to cable resistance, this will tend to put more wear on that string. Instead, it is recommended to use “reverse-return” or “cross-corner” wiring, where the positive cable is connected to the first string and the negative is connected to the last. This will allow current to flow evenly among all strings.

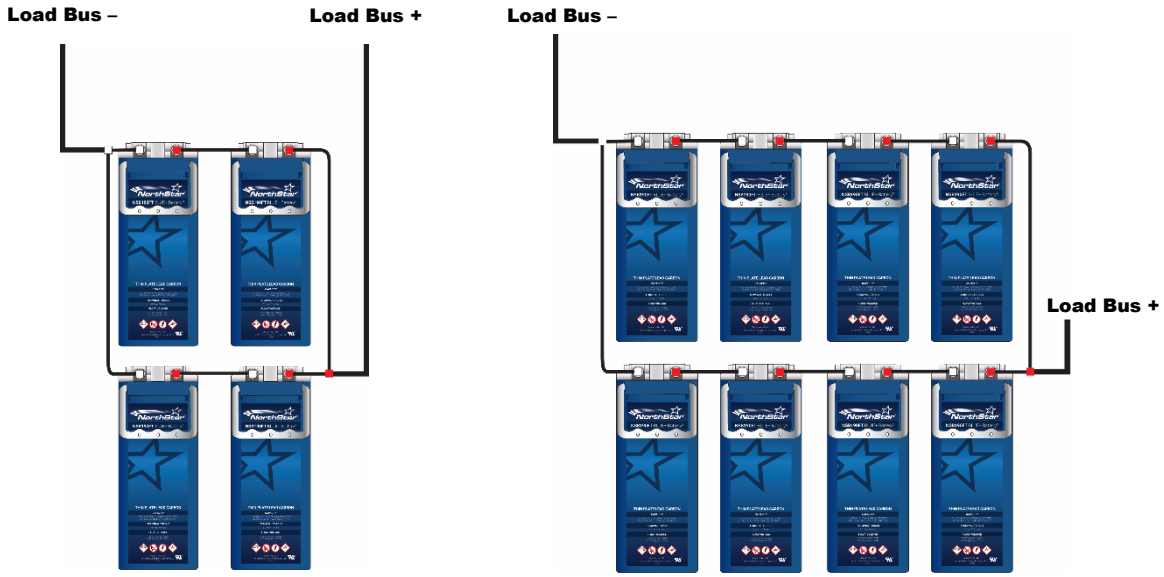

Figure 8 Series/Parallel String Configurations

DC Wiring

CAUTION: Equipment Damage

Never reverse the polarity of the battery cables. Always ensure correct polarity.

CAUTION: Fire Hazard

Always install a circuit breaker or overcurrent device on the DC positive conductor for each device connected to the batteries.

CAUTION: Fire Hazard

Never install extra washers or hardware between the mounting surface and the battery cable lug or interconnect. The decreased surface area can build up heat.

Terminal Hardware

NorthStar NSB BLUE+® battery terminals consist of a threaded stud which receives a nut. Terminal hardware is assembled as shown in below.

NOTE:

- Install the cable lugs (or interconnects) and all other hardware in the order illustrated. The lug or interconnect should be the first item installed. It should make solid contact with the mounting surface. Do not install hardware in a different order than shown.
- To avoid corrosion, use plated lugs on cable terminations. When multiple cables are terminated, use plated terminal bus bars.
- Tighten the terminals to a torque value of 71 in-lb (8 Nm).

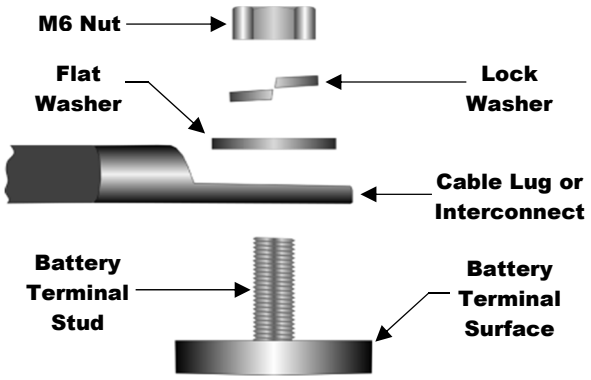

Figure 9 Terminal Assemblies

Cleaning Battery Terminals

To minimize contact resistance, it is important that the brass terminals of the batteries are cleaned of any oxidation that may have occurred during transportation and storage. It is most convenient to clean them prior to placing them on the rack.

Applying Grease to Terminals

Electrical grade conductive grease is applied directly to the battery terminals as a corrosion preventative measure during manufacturing. In typical indoor installations no additional grease is required to protect the terminals and other electrical connections after installation. The bus bars and other hardware provided with the batteries are plated to protect from corrosion.

Voltage Check

Before connecting the batteries in series, the voltage variation must be checked and the voltages recorded. If the voltage varies more than 0.15 Vdc between the highest and the lowest battery voltage, the batteries should be charged individually before being connected in series. Alternatively the batteries may be matched in each string so that all the batteries have a voltage spread of less than 0.15 Vdc.

To make the DC connections:

Make certain to clean all terminals and contact surfaces as described above.

1. If installing batteries in a rack or cabinet, always begin with the lowest shelf for stability. Place all batteries with terminals facing to the most accessible side of the rack. If terminal protectors are present, remove and save them.
2. In common configurations, the battery on one end will be the positive (+) output for that string. This battery should be designated [**1**]. Proceeding to the other end, adjacent batteries in that string should be designated [**2**], [**3**], and so on.

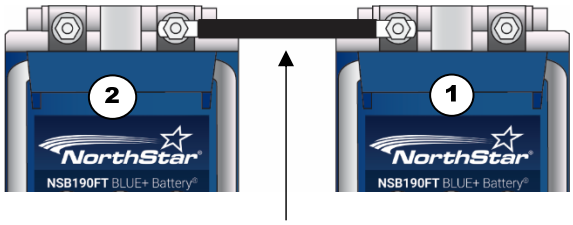

Figure 10 DC Connections

3. If more than one string is present, designate the first string as A, the second as B, and so on. This should be done regardless of whether the strings are on the same shelf or higher shelves. Number the batteries in subsequent strings just as in step 2.
4. Install cables or bus bars for DC loads. Size all conductors as appropriate for the total loads. See the manual for the battery rack or cabinet if necessary.
5. Repeat the process as appropriate for batteries [**2**], [**3**], and any others in the string. Connect the proper number of batteries in series for the nominal voltage of the load.
6. If multiple series strings will be used, repeat this process for strings B, C, and so on.
7. Install parallel connections. Parallel connections are made from the positive terminal of one battery or string to the positive of the next; negative connections are made similarly. (See Figure 4 on page 7.) External cables or bus bars must be provided. Interconnecting bars cannot make parallel connections.
8. Use a digital voltmeter (DVM) to confirm the nominal system voltage and polarity. Confirm that no batteries or strings are installed in reverse polarity.
9. Install series connections. If an interconnecting bar was supplied, it should connect from the negative (left) side of battery [**1**] to the positive (right) side of battery [**2**] as shown above (see arrow). Top-terminal batteries require short interconnecting cables to be provided. Tighten interconnect hardware “hand tight” only.
10. Before making the final battery connection, ensure the main DC disconnect is turned off. If this is not possible, then do not make the final connection within the battery enclosure. Instead, make the

connection at the load or elsewhere in the cable system so that any resulting spark does not occur in the battery enclosure.

11. Once hardware is installed and batteries are properly aligned, torque all connections to the appropriate value for the battery model. (See the requirements on page 25.) Lightly coat the surfaces with battery terminal grease. Reinstall the terminal covers if present.

IMPORTANT:

Before using the battery bank, commission the batteries as described below.

Commissioning

The commissioning charge applies when the batteries have been in transit or in storage for 24 months or more. (This applies at a storage temperature of 25°C or 77°F. The interval is shorter at higher temperatures.) It is also needed when the battery system is intended for use at the minimum float charging voltage or when the number of cells in series is greater than 24. Under any of these conditions, it is recommended that the battery system is given a freshening charge at 2.35 volts average per cell for 16 hours. This will assure higher initial performance and will reduce the time period required for the cells to achieve proper voltage balance between the individual units.

To apply a freshening charge:

1. Confirm the freshening (equalization) voltage from the charger/rectifier is set to a value equal to the Absorb Charging Voltage shown on page 15.
2. Close the circuit from the charger to the battery and confirm that the battery accepts current.
3. Monitor the battery periodically and note that the operation is proceeding normally. Make certain that the current acceptance is declining and that the batteries are not overheating (within ±5°F or ±2.8°C of each other and the ambient temperature). Make certain that the individual battery voltages on equalization charge are 14.1 ± 0.50 Vdc.
4. Terminate the freshening charge in the case of any extraordinary situation or after 16 hours.

NOTE:

Never charge batteries in their packaging — always unpack and position with space between batteries before charging.

OCV Recharge Time

Depending on the state of charge of the batteries it may take some time before they reach full state of charge. See recommended charge times below based on OCV values of the batteries:

>12.80 Vdc	3 day charge 2.27 VpC
12.6 to 12.8 Vdc	3 day charge 2.27 VpC
12.3 to 12.6 Vdc	1 day charge 2.41 VpC
12.1 to 12.3 V dc	1 day charge 2.41 VpC

NOTES:

Charging

NorthStar NSB BLUE+® batteries are usually charged using a “three-stage” charging cycle: bulk stage, absorption stage, and float stage. However, not all chargers are designed or programmed the same way. The settings should be checked and changed to match the recommendations below if necessary.

Charging Voltages

- **Absorb Charging Voltage**: 14.1 Vdc
- **Equalize Charging Voltage**: 14.4 Vdc (4 hours every 12 months)
- **Float Voltage**: 13.6 Vdc

Bulk Stage

The bulk stage is a constant-current stage. The charge current is maintained at a constant high level. The battery voltage will rise as long as the current flows. This battery has a minimum recommended charge current of (2 × I10-hour) with no maximum limit (per battery).

The charge rate (amps) is expressed as I10, where I10 is the current for a 10-hour discharge to 100% depth-of-discharge (DoD). For example:

- The 10-hour discharge capacity for the NSB190FT = 184.2 Ah (1.75 VpC@25ºC)
- I10, the 10-hour discharge rate = 184.2 Ah ÷ 10 hours = 18.4 Adc
- 2 x I10 = 2 x 18.4 Adc = 36.8 Adc

Absorption Stage

Absorption is a constant-voltage stage. It is established upon reaching the Absorb voltage setting. The charger limits the current flow to only what is necessary to maintain this voltage. A high current is required to raise the voltage to the absorption level, but less is required to maintain it there. As long as the absorption level is maintained, the requirement tends to decrease, causing a tapering current. The amount of absorption current will vary with conditions, but will typically decrease to a very low number. This “tops off the tank”, leaving the battery at 100% SoC.

The battery is considered full when the charge current tapers down to 0.5 to 1% of the C20 rate (unlike traditional batteries, which are considered full when charge current reaches 2 to 3%, the BLUE+® charge current will drop even lower because of the purity of metals used). This represents 100% SoC. The charger can then exit the absorption stage.

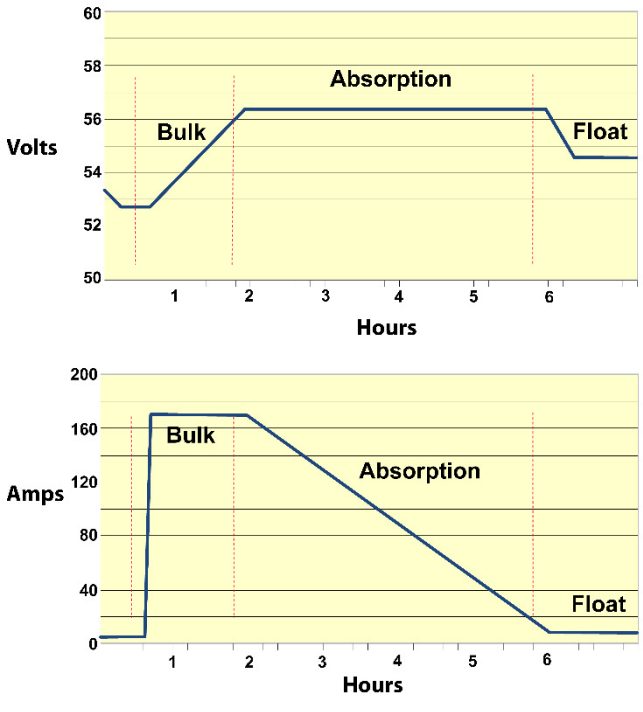

Figure 11 Three-stage Charging

Not all chargers measure this in amperes. Many chargers hold the absorption for a timed period (often two hours), assuming that the current will taper down by then. However, if the charge ends before the current tapers to the desired level, the battery may not reach 100% SoC. Repeated failure to charge the batteries to 100% will result in decreased battery life. If possible, use a DC amp meter to observe and time the current as it tapers down. The absorption timer can then be set accordingly.

Float Stage

The float stage maintains the battery at a full state of charge, counteracting the natural tendency of a fully-charged battery to slowly discharge when sitting idle. During the float stage, the battery is supplied with a constant voltage of 13.6 Vdc to keep it "topped off" at 100% SoC.

Equalization

To maintain optimal battery health, an equalization charge should be performed every 12 months. Equalize at 14.4 Vdc for 4 hours.

Freshening Charge

A maintenance or “freshening” charge should be given to batteries that have been in storage. The freshening charge must be appropriate to the battery model. All charging should be temperature-compensated (see page 17). With a multi-stage charger, the voltages for each stage are set as noted on page 15.

Notes on NorthStar NSB BLUE+® Charging

The current requirements for the absorption stage are usually minimal; however, this will vary with conditions, with battery age, and with battery bank size. (Larger banks tend to have higher exit current values for the absorption stage, but they also have higher float current.) Any loads operated by the battery while charging will also impact the requirements for the charger, as the charger must sustain everything.

If using a battery monitor device such as an OutBack FLEXnet DC, program the charge efficiency to 97%; return amps to 1% of capacity; and charge voltage to 0.4 Vdc below absorption. It is highly recommended to use the NSB BLUE+® batteries in conjunction with a battery monitor such as the FLEXnet DC and OPTICS RE for proper monitoring and data recording. The programming may be used with the following settings:

Amp-Hours: Based on the 20-hour capacity
Charge Time: 1 minute
Charge efficiency: 97%
Return Amps: 1% Adc
Charge voltage: 13.7 Vdc

Temperature Compensation

Battery performance will change when the temperature varies above or below room temperature (77°F or 25°C). Temperature compensation adjusts the charging to correct for these changes.

When a battery is cooler than room temperature, its internal resistance goes up, the voltage changes more quickly, and the charger reaches its voltage set points more easily. However, it will not deliver all the required current and the battery will tend to be undercharged. Conversely, when the battery is warmer than room temperature, its internal resistance goes down, the voltage changes more slowly, and the charger does not reach its voltages as easily. It will continue to deliver energy until the set points are reached, but this tends to be far more than required. The battery will be overcharged. (See **Improper Use** on the next page.)

To compensate for these changes, a charger used with the NorthStar NSB BLUE+® battery must have its voltages raised by a specified amount for every degree below room temperature. They must be similarly lowered for every degree above room temperature. This factor is multiplied if additional batteries are in series. Failure to compensate for significant temperature changes will result in undercharging or overcharging which will shorten battery life.

NorthStar NSB BLUE+® Required Compensation

The factor is 2 mV per cell (0.024 Vdc or 24 mV per battery) per degree C above or below room temperature (77°F or 25°C) when the battery is regularly cycled.

Remote Temperature Sensor

OutBack inverter/chargers and charge controllers are equipped with the Remote Temperature Sensor (RTS) which attaches to the battery and automatically adjusts the charger settings. When the RTS is used, it should be placed on the battery sidewall, as close to the center of the battery (or to the center of the bank) as possible. See Figure 12. The RTS should be checked periodically.

The charger determines the RTS compensation factor. All OutBack chargers are preset to a compensation of 5 mV per cell. Currently, only the FLEXmax 100 and SkyBox products can make system-wide adjustments to permit the 2 mV setting. If an RTS is not present or if a different charger is in use, temperature compensation may not work correctly. It may be necessary to adjust the main charger settings manually.

Figure 12 Remote Temperature Sensor Location

Improper Use

	**CAUTION: Equipment Damage** Read all items below. Maintenance should be performed as noted on page 22. Failure to follow these instructions can result in battery damage which is not covered under the NorthStar NSB BLUE+® warranty.
	**CAUTION: Equipment Damage** Do not exceed the specified absorption voltage when charging any NorthStar NSB BLUE+® battery. Excessive voltage could result in battery damage which is not covered under the NorthStar NSB BLUE+® warranty.

For any NorthStar NSB BLUE+® battery, if the charger settings are too high or too low, this will cause premature aging of the battery, including loss of electrolyte due to gassing. The result will be permanent loss of some battery capacity and decreased battery life. This is also true for battery charging that is not compensated for high temperatures.

“Thermal runaway” can result from high ambient temperatures, charging at higher voltages over extended time, incorrect temperature compensation, or shorted cells. When the buildup of internal heat exceeds the rate of cooling, the battery’s chemical reaction accelerates. The reaction releases even more heat, which in turn continues to speed up the reaction. Thermal runaway causes severe heat, gassing, lost electrolyte, and cell damage. It usually requires battery replacement. The process can be halted by turning off the charger. However, if cell damage has occurred, shorted cells may continue to generate heat and gas for some time.

If a NorthStar NSB BLUE+® battery is not charged completely (or if the settings are too low), it will not reach 100% SoC. Its total capacity will not be available during the next discharge cycle. This capacity will become progressively less and less over subsequent cycles. Long-term undercharging will result in decreased battery life. This is also true for battery charging that is not compensated for low temperatures.

Battery Voltage Records

	Date:	Date:	Date:
Battery 1			
Battery 2			
Battery 3			
Battery 4			
Battery 5			
Battery 6			
Battery 7			
Battery 8			
Battery 9			
Battery 10			
Battery 11			
Battery 12			
Battery 13			
Battery 14			
Battery 15			
Battery 16			
Battery 17			
Battery 18			
Battery 19			
Battery 20			
Battery 21			
Battery 22			
Battery 23			
Battery 24			

	Date:	Date:	Date:
Battery 1			
Battery 2			
Battery 3			
Battery 4			
Battery 5			
Battery 6			
Battery 7			
Battery 8			
Battery 9			
Battery 10			
Battery 11			
Battery 12			
Battery 13			
Battery 14			
Battery 15			
Battery 16			
Battery 17			
Battery 18			
Battery 19			
Battery 20			
Battery 21			
Battery 22			
Battery 23			
Battery 24			

Troubleshooting and Maintenance

Table 1 Troubleshooting

Category	Symptom	Possible Cause	Remedy
Performance	Reduced operating time	Normal life cycle	Replace battery bank when (or before) capacity drops to unacceptable levels.
		Defective cells	Test and replace battery as necessary.
	Excessive voltage drop upon applying load	Excessively cold battery	Carefully warm up the battery.
		Undersized cabling	Increase cable ampacity to match loads.
		Loose or dirty cable connections	Check and clean all connections. Physical damage on terminals may require the battery to be replaced. Replace hardware as necessary.
		Undersized battery bank	Add additional batteries to match loads.
		Defective cells	Test and replace battery as necessary.
External Inspection	Swollen or deformed battery casing; “rotten-egg” or sulfurous odor; battery is hot	Thermal runaway **NOTE**: A modest amount of swelling (or concavity) on the battery case is normal.	**NOTE:** Thermal runaway is a hazardous condition. Treat the battery with caution. Allow the battery to cool before approaching. Disconnect and replace battery as necessary. Address the conditions that may have led to thermal runaway (see page 17).
	Damaged battery casing	Physical abuse	Replace battery as necessary.
	Heat damage or melted grease at terminals	Loose or dirty cable connections	Check and clean all connections. Physical damage on terminals may require the battery to be replaced. Replace hardware as necessary.
Voltage testing	Fully-charged battery displays low voltage	High temperature	Carefully cool the battery. An overheated battery may contribute to thermal runaway.
	Fully-charged battery displays high voltage	Low temperature	Carefully warm up the battery.
	Individual battery charging voltage will not exceed 13.3 Vdc; high float current; failure to support load	Shorted cell	Test and replace battery as necessary. A shorted cell may contribute to thermal runaway.
	Individual battery float voltage exceeds 14.5 Vdc; failure to support load	Open cell	Test and replace battery as necessary.
Current testing	Charging current to series string is zero; failure to support load	Open connection or open battery cell in string	Check and clean all connections. If battery appears to have an open cell, test and replace as needed. Replace hardware as necessary.
	Charging current to series string remains high over time	Batteries require additional time to charge	Normal behavior; no action necessary.
	Charging current to series string remains high with no corresponding rise in voltage	Shorted cell	Test and replace battery as necessary. A shorted cell may contribute to thermal runaway.

Periodic Evaluation

Upon replacement of a battery, all interconnect hardware should be replaced at the same time.

To keep track of performance and identify batteries that may be approaching the end of their life, perform the following tests during on a quarterly basis following commissioning (see page 13). Tests must be made with a high-quality digital meter. Voltages must be measured directly on battery terminals, not on other conductors. All connections must be cleaned, re-tightened, and re-torqued before testing. If a battery fails any test, it may be defective. If this occurs under the conditions of the warranty, the battery will be replaced according to the warranty terms.

Bring the batteries to a full state of charge before performing the following test.

Monthly Battery Inspection

- General appearance and cleanliness of battery, battery rack and battery area.
  - Inspect for contamination by dust.
  - Inspect for loose or corroded connections.
  - If necessary, isolate the string/battery and clean with a damp soft cloth. Do not use solvents or scouring powders to clean the batteries.
- Cracks in cell containers or leakage of electrolyte.
- Any evidence of corrosion at cell terminals, connectors or racks.
- Ambient temperature and condition of ventilation equipment.
- Current and voltage during charge cycle. Measure individual battery voltages at the battery terminal. The measurements should be within 5% of the average.
- Voltage at end of charge cycle. Measure individual battery voltages at the battery terminal. The measurements should be within 5% of the average.
- End of discharge voltage measured at the battery. Measure individual battery voltages at the battery terminal. The measurements should be within 5% of the average.
- Record findings clearly. List the dates for all entries.

Quarterly Battery Inspection

This should include the monthly observations, plus:

- End of charge voltage of every cell and battery terminal voltage measured at battery.
- End of discharge voltage of every cell and battery terminal voltage measured at battery.
- Electrolyte temperature in representative cell(s), typically one cell/tier distributed throughout battery.
- Record findings clearly. List the dates for all entries.

Annual Battery Inspection

This should include the monthly and quarterly observations, plus:

- Inter-cell / inter-unit connection integrity.
- Retighten terminals to specified torque values. See page 25 for specifications.
- Record findings clearly. List the dates for all entries.
- Perform an equalization (see page 16 for details).

Cleaning

Batteries shall only be cleaned using a dry soft cloth or cloth moistened with water — any other substances should not be used or sprayed on the batteries. The plastic used for the batteries is sensitive to many solvents and other substances. Avoid pesticides or insect repellent as these are known to have caused the plastic to severely crack.

Determining Battery Manufacturing Date

The battery serial numbers are located in two places on the battery case. The first location is on the front of the battery. The manufacturing date is also located on this label below the serial number.

Figure 13 Battery Manufacturing Date

The second serial number location is on the positive terminal side of the battery, towards the rear.

Figure 14 Battery Serial Number Location

Manufacturing codes are limited to 12 alphanumeric digits. The first two digits specify the model of the battery. The remaining ten digits are a random, non-sequential serial number which is unique to this particular battery and will not be duplicated.

NOTES:

Specifications

Table 2 Specifications

	NorthStar NSB BLUE+®				
Cells Per Unit	6				
Nominal Voltage	12 Vdc				
Cycle Life (50% DoD)	2,050 cycles				
Absorb Voltage (25°c)	14.1 Vdc				
Absorb Time	4 hours				
Float Voltage (25°c)	13.6 Vdc				
Float Time	Continuous				
Equalize Voltage & Frequency	14.4 Vdc for 4 hours every 12 months				
Re-Bulk voltage	12 Vdc				
Max. Charge Current (per battery)	No Limit				
Minimum Charge Current (per Battery)	2 x I10-hour rate				
Max. Operating Temperature (w/Temperature Compensation)	–40° to 65°C				
Temp-Comp Factor (charging)	±2 mV per degree C per cell				
Self-Discharge Time	24 months at 25°C (77°F) before a freshening charge is required				
Terminal Hardware Torque	8.0 Nm (71 in-lb)				
Warranty	3 years				
	NSB40FT	NSB100FT	NSB170FT	NSB190FT	NSB210FT
Terminal Type	M8	M8	M6	M6	M6
Weight	~31 lb (~14 kg)	~74 lb (~33 kg)	~132 lb (~60 kg)	~136 lb (~62 kg)	~152 lb (~69 kg)
Dimensions	9.8 × 3.8 × 8.2″ (24.9 × 7.6 × 20.8 cm)	15.6 × 4.2 × 11.3″ (39.6 × 10.6 × 28.7 cm)	22 × 4.9 × 12.6″ (55.9 × 12.5 × 32 cm)	22 × 4.9 × 12.6″ (55.9 × 12.5 × 32 cm)	22 × 4.9 × 12.9″ (55.9 × 12.5 × 32 cm)

Specifications

Table 3 12V Ampere Hour Capacity to 1.75 Volts Per Cell at 77°F (25°C)

Discharge in Hours:	1	2	3	4	5	8	10	20	100
Northstar NSB40FT BLUE+®	29.5	32.4	33.9	34.8	35.6	37.1	37.8	40.4	40.4
Northstar NSB100FT BLUE+®	75.6	86	91	94.1	96.3	100	101.5	105.3	105.3
Northstar NSB170FT BLUE+®	117.4	136.9	147.3	154.1	159	168.2	172.1	182.3	182.3
Northstar NSB190FT BLUE+®	134.9	152.2	160.7	166.2	170.4	179.5	184.2	202.4	202.4
Northstar NSB210FT BLUE+®	148.1	168.9	178.6	184.6	188.9	179.5	201.6	216.5	216.5

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