

# ***NorthStar***

## ***Pure Lead AGM***

### **Automotive and Marine Application Manual**



# 1 Introduction

The NorthStar (NSB) range of automotive and marine batteries are made with Valve Regulated Lead-Acid (VRLA) Absorbed Glass Mat (AGM) technology. Consequently, one package can provide an excellent cycle life, as well as extreme power capability in a wide range of applications. Utilizing NSB technology, we can now combine engine start, truck and RV power, marine, auto-audio and deep cycle applications into the one package. This has been achieved by using advanced designs, highest quality materials, and highly automated manufacturing processes.

NSB automotive and marine batteries excel at providing both short duration high amperage pulses, low rate long duration deep discharges and high cyclic capabilities.

## 1.1 Flooded vs. NSB AGM

Flooded batteries can generate and vent explosive gases and must be vented to the outside world. These batteries can also acid "mist" during charging leading to corrosion of terminals and cables.

In NSB AGM technology the electrolyte is fully absorbed in a very fine glass mat which allows for the recombination of any gas generated during the charging process. Furthermore because the electrolyte is fully absorbed the batteries under normal operation cannot leak thereby eliminating any corrosion concerns at the terminal and connecting links.

## 1.2 Discharge Rate

In this document, the charge and discharge rates (amps) are expressed as multiples of I10, where I10 is the current for a 10-hour discharge to 100% depth-of-discharge (DOD). These values serve to normalize data across a range of battery sizes. Consider the following example:

10-h discharge capacity NSB 100FT = 100 Ah (EODV = 1.80 VPC @ 25°C).

1 x I10 = 1 x (10-h discharge current)

1 x I10 (NSB 100FT) = 1 x 10A = 10 A

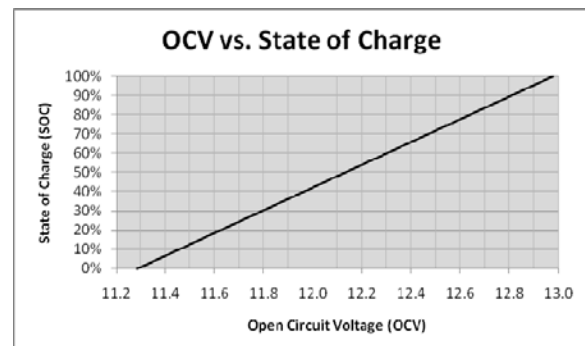
2 x I10 (NSB 100FT) = 2 x 10A = 20 A

# 2 Charge

## 2.1 Determining State of Charge (SOC)

For batteries in storage for long periods, or prior to being employed in a marine application, it is desirable to fully recharge the battery. Refer to section 3.1 for details. The SOC of a fully recharged battery is 100%. An estimate of the SOC can be obtained by measuring the Open Circuit Voltage (OCV) of the battery. The OCV of a battery is the voltage measured between its positive and negative terminals without the battery connected to an external circuit (load). It is very important to take OCV reading at least 3 hours after a charge period, or at least 10 min after a discharge event. Measurements will be inaccurate if these rest times are too short. A good quality voltmeter is all that is required to measure the OCV.

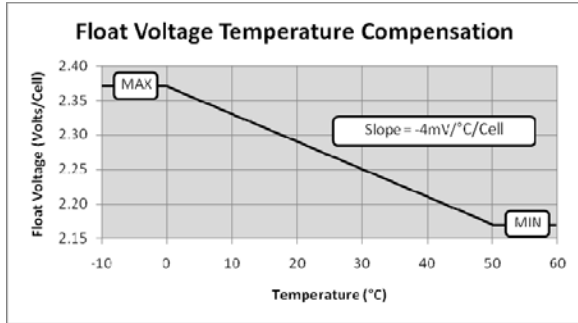
The chart below shows the relationship between OCV and SOC for the NSB automotive and marine batteries.



The graph shows that a healthy, fully charged NSB automotive and marine battery will have an OCV of approximately 13.0 V.

## 2.2 Thermal Compensation

The optimum level for float charging the NSB automotive and marine batteries is 2.27 volts/cell at +25°C (+77°F). If the battery temperature increases above this level, a thermal compensation of -4 mV/cell/°C is recommended. Conversely, if the temperature decreases below 25°C, the voltage should be increased by 4 mV/cell/°C. The graph below shows values for an individual cell.

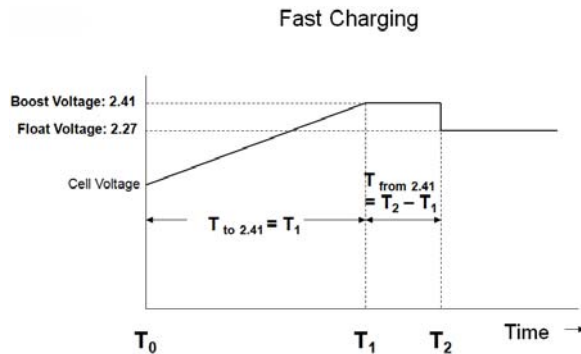


### 2.3 Fast Charging

If the charging system is properly sized, a fast charging regime will serve to minimize the time needed to recharge NSB automotive and marine batteries. This can be beneficial, for maximizing the cycle life of the product.

In a fast charging regime, the charging system is assumed to be adequately sized to provide the power needed (see Section 2.4). Charge voltage is increased which results in increased charge current. This in turn causes a discharged battery bank to fully recharge in a shorter time.

The increased voltage setting is known as boost voltage. In a fast charging regime the boost voltage shall be 2.41 Volts/Cell provided that the temperature is a nominal +25°C (+77°F). The following graph shows the recommended charging profile following a 100% DOD cycle:

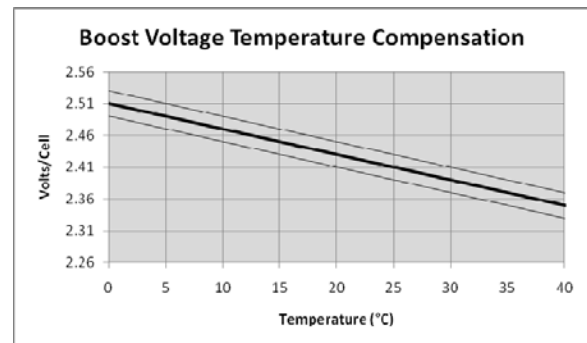


Standard Product Charge Rate	Time to recharge from 100% DoD		
	$T_{to\ 2.41}$ ( $T_1$ )	$T_{from\ 2.41}$ ( $T_2 - T_1$ )	Total ( $T_2$ )
1xI10	10	4	14
2xI10	4	4	8
4xI10	1.8	4	5.8

The table above shows the time needed to recharge following a 100% DOD cycle,

depending on the maximum charge current available. If the DOD is less than 100%, the total recharge time will be less. To prevent overcharge, the duration from  $T_1$  to  $T_2$  (i.e. the time at 2.41 Volts/Cell) should always be limited to 4 hours, and then the rectifier voltage returned to the recommended float voltage.

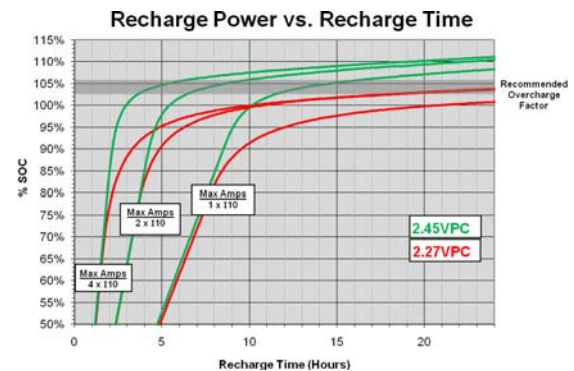
If the battery temperature increases above +25°C (+77°F), a thermal compensation of -4 mV/cell/°C to boost voltage is recommended. Conversely, if the temperature decreases below 25°C, the boost voltage should be increased by 4 mV/cell/°C. The graph below shows values for an individual cell:



### 2.4 Recharge Power

Depending on the charging system, recharge times can vary greatly following an outage. If the recharge power is relatively low, it will take longer to fully recharge a battery. It is recommended to provide a regular overcharge factor of between 103% and 106% SOC after a discharge.

The following chart shows the time required to fully recharge an NSB automotive and marine battery from a complete 100% DOD discharge, as a function of rectifier voltage and available current.

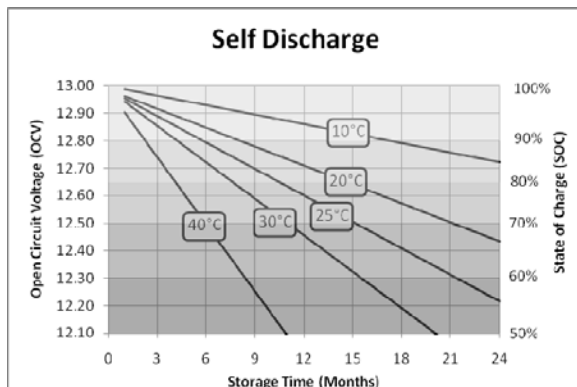


### 3 Discharge

#### 3.1 Storage and Self Discharge

Lead-acid batteries experience self-discharge during storage. The rate of this process is related to several factors, with the two most important being (i) the purity of the materials used during construction, and (ii) the storage temperature. As NSB batteries are manufactured from the highest purity components, they have one of the lowest self-discharge rates in the industry. As the rate of self discharge increases with temperature, it is recommended that batteries be stored at as low a temperature as possible above freezing.

Approximatley every 10°C (18°F) increase in temperature, increases the self discharge by a factor of 2 and cuts the storage time in half. Thus at low temperatures (below 25°C), the battery may be stored for up to two years, although it is recommended that a conditioning charge be delivered if the battery drops below 50% SOC any time during storage. The chart below shows how the self discharge changes with time and temperature for the NSB automotive and marine batteries.



#### 3.2 End of Discharge Voltage (EODV)

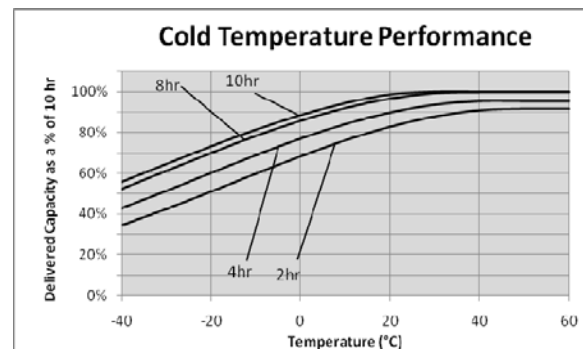
In the event of a deep discharge, a recommended minimum end-of-discharge voltage (EODV) should be used to avoid over discharge. A value of 1.80 Volts/cell is common, but this value should be adjusted based on the discharge rate. The following table provides a guide for EODVs at various discharge rates.

Discharge Rate (hours)	EODV (Volts/Cell)
20	1.85
10	1.80
5	1.75
1	1.70

EODV can be controlled using a Low Voltage Disconnect (LVD) as part of the load circuit.

#### 3.3 Cold Temperature Performance

Colder temperatures can prolong battery life because corrosion processes within the positive plates of the battery slow down as the temperature decreases. Unfortunately, lower temperatures also lower the capacity of lead-acid batteries. As battery temperature drops below the recommended operating temperature of +25° C (+77°F), the battery capacity decreases. However, the NSB automotive and marine battery was designed and built to have a very low internal resistance. As a result, its performance at low temperatures and high current loads is still relatively high. Cold temperatures affect NSB automotive and marine battery capacity according to the following chart:



#### 3.4 Quiescent Discharge

Quiescent discharge occurs if the batteries are considered at rest or otherwise not in use, but small amounts of power are still required by parasitic accessories in the application. An example of this situation would be clocks and other electrical equipment in the vehicle whilst the vehicle is dormant. Also, batteries powering security systems experience low but consistent loads, as do trucks and vans which have to sit at rest for months between uses. A current of 10

mA is quite common in such situations, and whilst it does not sound like much, it can fully discharge a 20 Ah battery in approximately 80 days.

These low level consistent loads on batteries can result in the total discharge of battery systems over time. This results in a total lack of power necessary for the required task (e.g. starting the vehicle or boat engine.) Overdischarge, as a result of a parasitic load, can also damage the battery if severe enough.

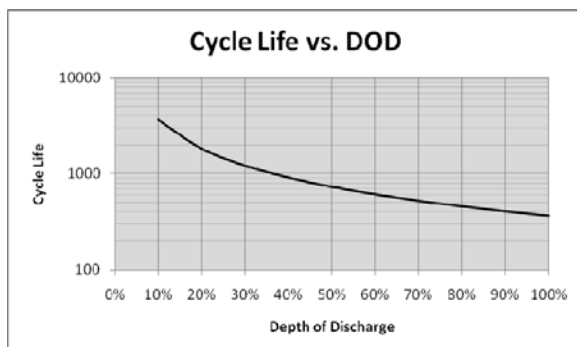
## 4 Useful Life

### 4.1 Shelf Life

NSB automotive and marine batteries may be stored for up to 2 years, provided that the SOC is maintained above 50%. Failure to provide the required maintenance charging (see Section 3.1) may lead to irreversible capacity loss.

### 4.2 Cycle Life vs. Depth of Discharge

One factor which influences the cycle life of a battery is the depth-of-discharge (DOD). DOD is expressed as a percentage of rated capacity delivered during discharge. For example, if a 100 Ah battery delivers 10 Ah, the DOD would be 10%. As the DOD per cycle increases, the cycle life of the battery will decrease. The following chart can be used to estimate the cycle life of a NSB automotive and marine battery if the DOD per cycle is known.



## 5 Frequently Asked Questions

### 5.1 Is the NSB a gel battery?

No, the NSB battery is AGM technology which means the electrolyte is held within glass mat separators wedged between the plates. In gel batteries, the acid is thickened into a paste by the addition of very fine silica. This paste is then viscous enough to remain between the plates, even when the battery is placed on its side. AGM designs typically provide a better performance at higher rates of discharge than gel equivalent, because AGM designs have thinner plates and a far lower gap (pitch) between the positive and negative plates.

### 5.2 What is the Ah rating?

The ampere-hour (Ah) rating defines the capacity of a battery. A battery rated at 100Ah at the 10-hour rate of discharge will deliver 10A for 10 hours before the terminal voltage drops to a standard value such as 10.02 volts for a 12V battery.

### 5.3 Does mishandling the battery void the warranty?

The warranty applies to manufacturing defects and workmanship issues and does not cover damages as a result of mishandling by the customer.

### 5.4 What is a CCA rating?

The cold cranking ampere (CCA) rating refers to the number of amperes a battery can deliver for 30 seconds at a temperature of 18°C (0°F) before the voltage drops to 1.20 volts per cell, or 7.20 volts for a 12V battery. A 12V battery that has a rating of 550 CCA means that the battery will provide 550 amps for 30 seconds at 18°C (0°F) before the voltage falls to 7.20V.

### 5.5 What is impedance?

The impedance of a battery is a measure of its internal resistance. The lower the battery impedance the more power is available. The

impedance of the NSB battery is considerably less than that of a conventional automotive and marine battery. The high rate discharge capability of NSB automotive and marine batteries is significantly higher than that of a conventional automotive and marine battery.

### **5.6 What is the MCA rating?**

The marine cranking ampere (MCA) rating refers to the number of amperes a battery can deliver for 30 seconds at a temperature of 0°C (32°F) until the battery voltage drops to 7.20 volts for a 12V battery. A 12V battery that has a MCA rating of 725 MCA means that the battery will give 725 amperes for 30 seconds at 0°C (32°F) before the voltage falls to 7.20V. The MCA is sometimes called the cranking amperes or CA.

### **5.7 What is a HCA rating?**

The abbreviation HCA stands for hot cranking amps. It is the same as MCA, CA or CCA, except that the temperature at which the test is conducted is 26.7°C (80°F).

### **5.8 What is the PHCA rating?**

Unlike CCA and MCA the pulse hot cranking amp (PHCA) rating does not have an “official” definition; however, we suggest that for true automotive and marine purposes, a 30-second discharge is unrealistic. The PHCA, a short duration (about 3-5 seconds) high rate discharge, is more realistic. Because the discharge is for such a short time, it is more like a pulse.

### **5.9 What is reserve capacity rating?**

The reserve capacity of a battery is the number of minutes it can support a 25-ampere load at 27°C (80°F) before its voltage drops to 10.50 volts for a 12V battery. A 12V battery with a reserve capacity rating of 100 will deliver 25 amps for 100 minutes at 80°F before its voltage drops to 10.5V.

### **5.10 What is the short-circuit current of these batteries?**

Typically thousands of amps. As mentioned before, the NSB batteries have a very low internal resistance, which means that the short circuit current is very high. For specific values, please refer to the Product Data Sheet.

## **6 Technical Specifications**

For detailed technical specifications, please refer to the Product Data Sheet or Contact:

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