Narada®

VALVE REGULATED SEALED LEAD ACID BATTERY

6V & 12V Series

OPERATION MANUAL

Version V2.0

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CONTENTS

Safety and Warning Chapter Notes

Please read this operation manual carefully. It offers very important safety instructions, installation and operation guide, which will ensure the best performance of your equipment and prolong their service life.

- For the sake of your safety, please do not attempt to remove the components of the battery. The maintenance of the battery can only be carried out by service engineers specially trained by the Principal.
- Considering the potential harm of the lead components to the health and environment, the battery can be replaced only by the service center authorized by the manufacturer. To replace the battery or maintenance equipment, please call the after-sales service hotline for information of the nearest service center.
- Please check the local regulations on the correct way of battery disposal or send the battery to the authorized service center for replacement.
- Battery replacement should be operated or supervised by engineers who are experienced and aware of the preventive measures on the potential harm of the battery.

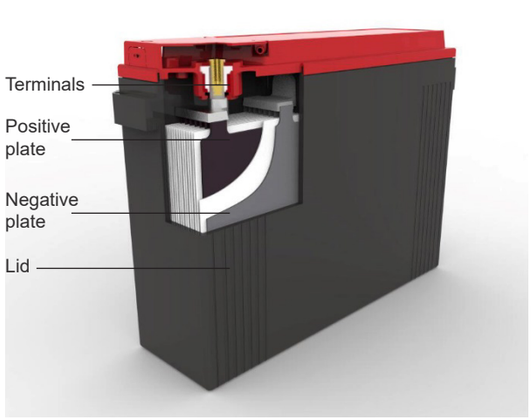
Warning—do not smoke or use fire near batteries.
Warning—do not use organic solvent to wash batteries.
Warning—dot not put batteries into the fire, or it could be exploded.
Warning—do not dismantle batteries, it contains electrolyte, which can do harm to the skin and eyes.
Warning—shock or short circuit could be caused when replacing the batteries. Please operate with tools with insulated handles.

Please take care of the following marks in using

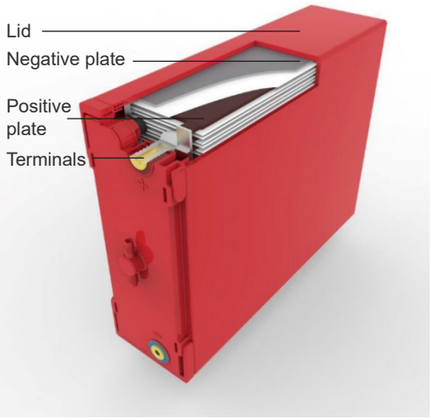
				
Warning	Electricity danger	Protecting your eyes	Watch Short-circuits	With adults custody
				
Read the manual	Fire forbidden	Circle used	Do not put batteries into dustbin	The product has passed the UL authentication

Product Introduction Chapter One/01

Product Features



2×3 structure (front terminal)



1×6 structure (front terminals)

Main application

- Telecom exchange and transmission system
- Mobile communication system
- Power plant and power transformer system
- Navigation aid signaling system
- Solar energy system
- Radio and broadcasting station
- Emergency lighting system
- Other standby, cycling system

Working principle

The chemical reaction-taking place in lead acid battery is as follows:

$$Pb+PbO_2+2H_2SO_4 \underset{\text{Charge}}{\overset{\text{Discharge}}{\rightleftharpoons}} 2PbSO_4+2H_2O$$

Following side reaction ① takes place in ordinary lead acid battery:

$$2H_2O \longrightarrow 2H_2\uparrow+O_2\uparrow \qquad ①$$

This side reaction makes water loss gradually and distilled water need to be added regularly to keep the battery operate normally.

Thus there is a path existing between the positive and the negative for O2 recombination. Also special alloy grid is chosen to increase over-potential of hydrogen evolution on the negative plate, which minimize generation of Hydrogen. The reactions are as follows:

$$2Pb+O_2 \longrightarrow 2PbO \qquad ②$$

$$PbO+H_2SO_4 \longrightarrow PbSO_4+H_2O \qquad ③$$

So it is possible to build EOS series battery in sealed structure.

Technical Characteristic Chapter Two/02

Discharge performance

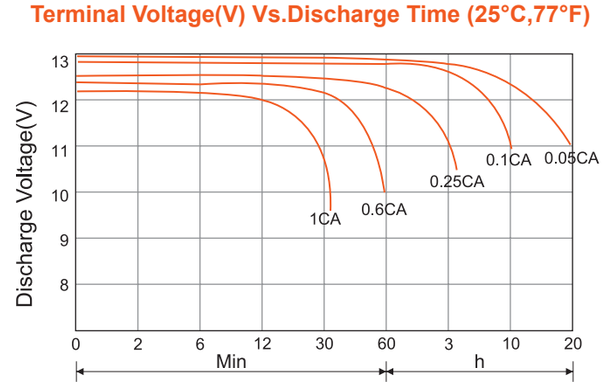


Fig.2-1 the terminal voltage vs discharge time curves at different current at 25°C

Note:

- Discharge current is larger, the actual discharge capacity is much less.
- Discharge end voltage is varying with discharge current, voltage should not lower than specified value.

Charge Performance

Figure 2-2 is the battery charging characteristics curve of 6V & 12V series battery with constant voltage and limited current ($0.1C_{10}A$ current, voltage limit 2.35V/cell), fully discharged battery charges for 24 hours, and the charge power up to 105%. The dotted line is the 50% charge curve.

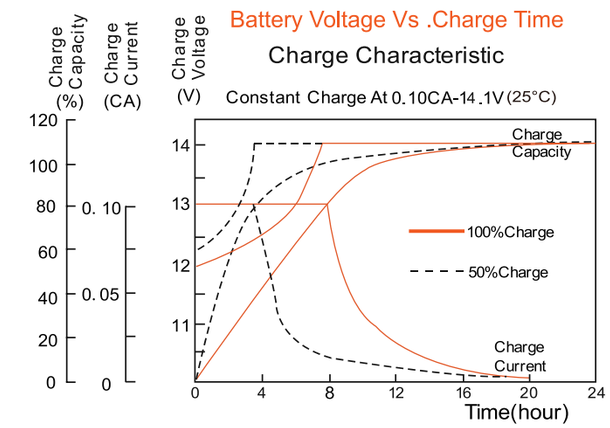


Fig.2-2 the battery voltage vs charge time curves at 25°C

Floating voltage and temperature

The specific floating voltage is selected to operate the battery in its best condition. If the floating voltage is too high, the floating charge current will increase, and the corrosion speed of the grid will be accelerated, thereby reducing the service life of the battery. When the floating voltage is too low, the battery cannot maintain a fully charged state, resulting in sulfation, capacity decrease, and shorten the battery life.

At 25°C, the float voltage of each series of Narada is shown in Table 2-1 below, and the temperature compensation coefficient is -3mV/°C/cell.

Table 2-1 Floating Voltage of Each Series (25°C)

Battery serials	Floating voltage (V)
MP/MPG	2.25
Acme/AcmeG	2.25
GP/GPG	2.25
ICS	2.25
UDS	2.25
DT	2.25
12REXC	2.25
HRL	2.27
HTB/HTB-F	2.27

The floating voltage calculation formula at different temperatures is:

$V_T=V_{25}-(T-25)\times0.003$

V_T—Floating voltage at T temperature;

V_{25}—Floating voltage at 25°C;

Equalization charge voltage and temperature

VRLA batteries need to be charged on a regular basis in order to ensure normal operation of the battery. At 25°C, the average charging voltage for each series of batteries is shown in Table 2-2. Similarly, the average charging voltage needs to be adjusted with the ambient temperature, and the temperature compensation coefficient of the battery charging voltage is -5 mV/°C/cell.

Table 2-2 Equalization charging Voltage of Each Series (25°C)

Battery serials	Equalization voltage (V)
MP/MPG	2.35
Acme/AcmeG	2.35
GP/GPG	2.35
HRL	2.35
HTB	2.35
HTB-F	2.35
ICS	2.35
UDS	2.35
DT	2.35
12REXC	2.30

The Equalization voltage calculation formula at different temperatures is:

$V_T=V_{25}-(T-25)\times0.005$

V_T—The charging voltage at T temperature;

V_{25}—Average charge voltage at 25°C;

Note:

(1) Please refer to the formula for each series, and calculate separately.

(2) The temperature compensation is not recommended for Narada 12V series batteries when floating voltage is lower than 2.20V or higher than 2.30V/cell, and equalization voltage is lower than 2.28V/cell or higher than 2.43V/cell, please refer to followed table.

Table 2-3 Temperature and voltage setting

Temperature(°C)	Floating voltage(V/cell)		Equalization voltage(V/cell)	
	MP, MPG, Acme, AcmeG, GP, GPG, HRL, ICS, UDS, DT, 12REXC	HTB, HTB-F,	MP, MPG, Acme, AcmeG, GP, GPG, HRL, HTB, HTB-F, ICS, UDS, DT	12REXC
≤10	2.30	2.32	2.43	2.38
15	2.28	2.30	2.40	2.35
20	2.27	2.29	2.38	2.33
25	2.25	2.27	2.35	2.30
30	2.24	2.26	2.33	2.28
35	2.22	2.24	2.30	2.25
40	2.21	2.23	2.28	-
≥45	-	2.21	-	-

Charge requirement

Charge requirement	Charge mode	Note
More than two battery voltages in the battery string are lower than 2.18V in floating operation	Charge current: Limited current I_{10}~$2.5I_{10}$	Equalization charge
Recommend charging if float charge for more than three months	Charge voltage: Limited voltage 2.35V/cell	Equalization charge
Battery storage for more than 6 months		Complement charge
Before the battery is installed and applied in the site.	Charge time: 24 hours	Complement charge
After the battery discharged		

Note:

(1) When the depth of discharge is large (usually more than 5~10% C_{10}), it is recommended to use the equalization voltage, so that this charge mode is more adequate. When charges for 24 hours or the current drops below $0.005C_{10}A$, and the current value is substantially constant for three consecutive hours, the charge is considered complete.

(2) The battery needs to be fully charged as soon as possible, the charge current can be increased appropriately, but it cannot be higher than recommend value.

(3) If the battery is not recharged in time after discharge, or the power is off again during recharge, the insufficient-charged batteries will be frequently discharge, thus the batteries will lose part of capacity in short period. And it may cause capacity loss at initial stage and the batteries will be rejected if the situation is serious.

Battery recharge method

Step 1: Connect the batteries in series, and ensure that the bolts and screws are fastened.

Step 2: Connect the positive and negative poles of the battery to the positive and negative poles of the charging device.

Step 3: Turn on the charging power supply, set the charging current limit value and charging voltage value according to the supplementary power requirements;

Operation and Maintenance Chapter Three/03

Parameter settings

Table 3-1 Switching power supply parameter setup table (48V system, 25°C)

Parameter name	Normal power supply (Floating operation)	Tough power supply (Cyclic operation)
Floating Voltage(V)		
Acme, AcmeG, MP, MPG, GP, GPG, 12REXC, ICS, UDS, DT	54.0	54.0
HRL, HTB,HTB-F	54.4	54.4
Equalization Voltage(V)		
Acme, AcmeG, MP, MPG, GP, GPG, ICS, UDS, DT, HRL, HTB,HTB-F	56.4	56.4
12REXC	55.2	55.2
Charging Current(A)	$0.1C_{10}$	$0.2C_{10}$
Limited Current For Charge (A)	$0.25C_{10}$	$0.25C_{10}$
Equalization Charge Cycle(day)	90	30
Equalization Charge Time(h)	24	24
Condition to Change Float Charge To Equalization Charge(mA/Ah)	>50	>50
Condition To Change Equalization Charge To Float Charge(mA/Ah)	<5	<5
LLVD (V) BLVD (V)	Please refer to table 3-2	
BLVD Recover Voltage(V)	49	50
High Voltage Warning(V)	57.6	57.6
Low Voltage Warning(V)	46	47
Temperature Compensate Ratio With Floating Voltage(mV/°C per cell)	-3	-3
Temperature Compensate Ratio With Equalization Voltage(mV/°C per cell)	-5	-5
High Temperature Warning(°C)		
Acme, AcmeG, MP, MPG, GP, GPG, 12REXC, ICS, UDS, DT	35	35
HRL, HTB,HTB-F	45	45

1. The voltage in above table is at 25°C.
2. Please contact the manufacture about standard for normal power supply or tough power supply.
3. Above are standard setup parameters in table 3-1. We suggest you to set up end voltage (BLVD) based on different load current to make the battery life longer. Please refer to table 3-2.

Table 3-2 Voltage setup parameter of BLVD and LLVD

Load current(A)	End voltage(V/cell)	BLVD for 48V system(V)	LLVD for 48V system(V)
$I<0.025C_{10}$	1.97	47.3	47.3
$0.025C_{10}\leq I<0.05C_{10}$	1.92	46.1	46.1
$0.05C_{10}\leq I<0.1C_{10}$	1.87	44.9	45.6
$0.1C_{10}\leq I<0.2C_{10}$	1.83	44	45.6
$0.2C_{10}\leq I<0.5C_{10}$	1.75	42	45.6

Operation Condition

Acme, AcmeG, MP, MPG, GP, GPG, HRL, 12REXC, ICS, UDS, DT serials

Ambient temperature: optimum temperature is 15°C~25°C, the higher and lower temperatures will impact battery performance.

Table 3-3 Operation temperature range

Operation status	Temperature range	Optimum temperature
Discharge	-40°C~50°C	15°C~25°C
Charge	-20°C~50°C	15°C~25°C
Storage	-20°C~40°C	15°C~25°C

HTB, HTB-F Serials

Ambient temperature: Acme series optimum temperature is 15°C~35°C, the higher and lower temperatures will impact battery performance.

Table3-4 Operation temperature range

Operation status	Temperature range	Optimum temperature
Discharge	-40°C~65°C	15°C~35°C
Charge	-20°C~65°C	15°C~35°C
Storage	-20°C~45°C	15°C~35°C

Ambient humidity: ≤95%

Cabinet ventilation conditions: meet the standard EN 50272-2:2001

Capacity and influence factors

The capacity can be expressed in Rated Capacity or Actual Capacity. The Actual Capacity is the product of discharge current (A) and discharge time (h). The usual unit of capacity is ampere-hour, shortened as Ah.

The Influence Factors of Actual Capacity

The actual capacity is mainly related with the battery's construction, manufacturing process and operation circumstance. During operation, the factors are discharge rate, end voltage and ambient temperature.

Discharge Rate

If the discharge rate (hour rate) is smaller, the discharge current is larger, and the discharge duration is shorter, then the capacity, which can be discharged, is less. For example, the discharge current of 3 hours rate is larger than that of 10 hours rate; and the capacity of 3 hours rate is smaller than that of 10 hours rate.

End Voltage

The end voltage is the lowest working voltage below which the battery cannot be discharged any more. Usually the end voltage of 6V & 12V range battery is 10.8V per block. The capacity cannot be discharged more even if the end voltage drops, because of the characteristics of lead acid battery. The lower end voltage will harm the battery, especially when the voltage drops to 0V and the battery cannot be recharged in time. It will shorten the life of the battery greatly.

Table 3-5 discharge end voltage at different current

Discharge Current(A)	Discharge End Voltage(V/Cell)
I<0.2C	1.80
0.2C≤I<0.5C	1.80
0.5C≤I<1.0C	1.70
I≥1.0C	1.60

Ambient Temperature

VRLA batteries can be used in very low or high temperature. Yet all standard data (such as capacity, life, floating voltage) are measured under standard temperature of 20°C-25°C. The capacity will decrease under lower temperature as Fig. 3-1:

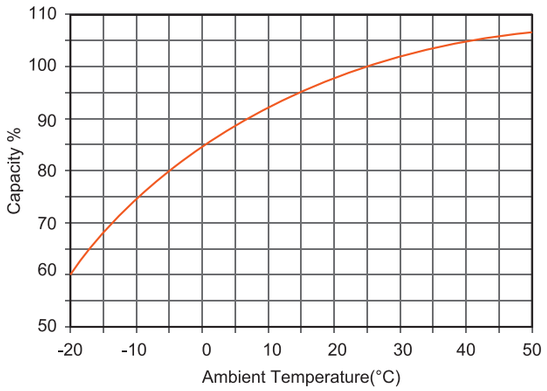


Fig.3-1: Ambient Temperature VS Available Capacity

The capacity will decrease if the temperature is too low. The reason is that the negative plates is passivated at lower temperature, then it causes the battery to be failed to recharge and the negative active material sulfation.

The capacity will increase as the temperature increases. However, the higher temperature will accelerate the corrosion of the grid and cause water loss inside the battery, thus shorten the life of the battery.

Conductance, Resistance vs. Capacity

There is a certain corresponding relationship between conductance & resistance and battery capacity. We suggest to test battery conductance and resistance data at difficult stage with same type instruments from same factory. Conductance and resistance data is only a reference to judge whether battery is good. These data cannot replace loading test to judge whether battery is good. We recommend to test these data on the surface or side of battery post.

Lifetime and influence factors

Battery life is the battery operation life, it is influenced by many factors. The factors are charge mode, discharge mode, ambient Temperature and so on.

Main failure	Main factors	Normal Value	Note
Charge mode	Voltage	Floating voltage Equalization voltage	(1) The charge voltage is too high, it will accelerate corruption of the grid and shorten life of the battery. (2) The charge voltage is too low, the battery will be insufficient.
	Current	≤ $0.25C_{10}$ A	If the current is too high, the battery temperature will be higher, then it will cause water loss, thermal runaway.
	Time	The Equalization charge time is 24h	The charge time is only aimed at the equalization charge procedure, it can ensure the battery can be fully charged.
Discharge mode	End voltage	1.80V/cell per block at 10h rate.	If the end voltage is too low, it will be difficult to recharge the battery and decrease the charge efficiency, thus reduce the life of battery.
Ambient temperature	/	15~25°C	When temperature exceeds 25°C, the battery life will decrease half per 10°C temperature raise. $t25\sim35=t_T\times2^{(T-25)/10}$ Notes: T the actual ambient temperature; T_T is designed life at T ambient temperature T_{25} is designed life at 25°C ambient temperature
Mixed operation	/	/	(1) Different brands of battery cannot be installed in one bank; (2) Different group no. of battery cannot be installed in one bank or in the same parallels.
Replace the failure battery	/	/	If the capacity is failed, the failed battery should be replaced timely.

Storage

The 6V & 12V batteries require ventilation, drying, and avoid direct sunlight. The batteries experience self-discharge in open circuit state, the result is that open circuit voltage decreases, and the capacity also decreases. The self-discharge rate is related with ambient temperature. The self-discharge rate is smaller when the ambient temperature is lower, otherwise is larger. If the open circuit voltage is lower than 2.10V/cell, or storage period reach 6 months shown in following table, the batteries should be recharged to avoid damage caused by self-discharge.

Storage temperature	Max. Storage period
Above 30°C	3 months
Below 30°C	6 months

It's suggested to record the storage time in the periodic maintenance record and record the time when another necessary supplemental charge should be made. The quality certificates and packages of 6V & 12V series batteries record the latest charge time of the batteries, next charge time can be calculated according to this charge time.

Maintenance
Chapter Four/04

General

Proper maintenance will prolong the life of a battery and will aid in assuring that it is capable of satisfying its design requirements. A good battery maintenance program will serve as a valuable aid in determining the need for battery replacement. The users must consider their particular application and reliability needs if maintenance procedures, other than those recommended in this document, are used. Battery maintenance should be performed by personnel knowledgeable of batteries and the safety precautions involved.

Inspection

Monthly Maintenance

- Keep the battery-room clean.
- Measure and record the ambient temperature of the battery-room.
- Check each battery's cleanness; check damage and overheating trace of the terminal, container and lid.
- Measure and record the total voltage and floating current of the battery system.

Quarterly Maintenance

- Repeat monthly inspection.
- Measure and record floating voltage of every on-line battery. If more than two cells' voltage is less than 2.18Vpc after temperature compensation, the batteries need to be equalization charged.

Yearly Maintenance

- Repeat quarterly maintenance and inspection.
- Check whether connectors are loose or not every year.
- Make a discharge test to check with exact load every year, discharging 30-40% of rated capacity. Make an 80%DOD capacity test every year after three years' operation.

Special inspections

If the battery has experienced an abnormal condition (such as a severe discharge, overcharge, or extreme high ambient temperature), an inspection should be made to assure that the battery has not been damaged. Include the requirements for the yearly inspection.

Corrective actions

Immediate

a) If connection resistance readings are more than 20% above a ceiling value established by the Narada, or if loose connections are noted, retorqu. If terminal corrosion is noted, clean the corrosion and check the resistance of the connection. If retested resistance value remains unacceptable, the connection should be disassembled, cleaned, reassembled, and retested.

b) If any electrolyte is found, determine source and institute corrective action. Clean excessive dirt on cells or connectors when noted. Use extreme care when cleaning battery systems to prevent ground faults.

c) When the float voltage, measured at the battery terminals, is outside of its recommended operating range, the charger voltage should be adjusted. The out-of-range condition may have been caused by a defective charger and may need to be investigated.

Routine

The following items indicate conditions that, if allowed to persist for extended periods, can reduce battery life. They do not necessarily indicate a loss of capacity. Therefore, the corrective action may be accomplished before the next quarterly inspection, provided that the battery condition is monitored at regular intervals:

a) If any cell/unit voltage is below its respective critical minimum voltage as specified by the manufacturer, corrective action should be given. Do not charge at rates above the recommendation for the specific ambient temperature involved.

b) When cell temperatures deviate more than 3 °C from each other during a single inspection, determine the cause and correct. If sufficient correction cannot be made, contact the Narada for allowances that must be taken.

c) Other abnormalities.

Annex 1

VRLA Battery Regular Maintenance Record

Type		Place			
Status		Number of battery			
Total Voltage(V)		Current (A)		Temperature	

No.	Voltage(V)	No.	Voltage(V)
1		13	
2		14	
3		15	
4		16	
5		17	
6		18	
7		19	
8		20	
9		21	
10		22	
11		23	
12		24	
Check by sight			
Result:			
Tester		Date	

Annex 2

Maintenance stock tools

Following tools and equipments are necessary at least to maintenance and troubleshooting VRLA batteries.

- Digital multimeter
- Wrenches insulated
- Adjustable wrench insulated
- Torque wrench
- Rubber gloves
- Full set of masks
- Plastic apron
- Portable eyedrops
- Fire extinguishers (C grade)

The following equipment is optional according to the type of maintenance.

- Resistance tester
- Charger and discharger special for storage battery (portable)

After-sale Services

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