



VALVE REGULATED SEALED LEAD ACID BATTERY

REX Series

Renewable Energy Storage Battery

OPERATION MANUAL

Version: V1.2

NARADA POWER SOURCE CO., LTD


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Safety and Warning


Please read this manual! It provides very important direction for fix and operation, which can make best capability for the equipment, and elongate the using life.


- For your safety, please do not try to dismantle or open the equipment. The equipment does not contain any spare parts for you. The maintain work can only be done by specially trained service persons.
- As a result of the batteries' latent endanger to heath and environment, they should be only changed in our authorization service center. If you need to change the battery or maintain the equipment, please call the nearest service center.
- Batteries can be reclaimed, if it could not be carefully handled, it will do great harms to environment and heath. Please check local laws and regulations to get the validity handle ways or send the equipment to authorized service center.
- The replacement of battery can only be done by persons who know well about the danger and the prevention. When changing the battery, please use the same model and type of sealed lead acid 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 may bombed。

 Warning—do not open batteries, it contains electrolyte, which can hurt the skin and eyes.

 Warning—There may happen shock or short circuit 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 eye	Watch Short-circuits	With adults custody	Do not put batteries into dustbin
					
Read the manual	Fire forbidden	Circle used	The product has past the UL authentication	The product has past the CE authentication	

Chapter One Product introduction

1. Features and Benefits

- ▶ Long life design for both cyclic and float application
 - Grid alloy with special patented formula
 - Extra-thick and massive plate design
 - High density microporous glass mat with low electrical resistance
- ▶ Superb security and reliability
 - Reliable seal performance, no acid spillage, recombination efficiency reach 99.0%
 - Patented post sealing structure
 - “Labyrinth” patented security valve
 - Optimised lead usage
- ▶ Robust design inside and out
 - High strength ABS and reinforced grid in corrosion-resistant alloy
- ▶ Excellent deep discharge recovery fast recharge performance
 - Very low PAM and NAM utilization ratio
 - More capacity is reserved after each discharge, significantly increased cycle life
- ▶ Extra long back-up times
 - Optimised lead usage and Very low PAM and NAM utilization ratio
- ▶ More cost effective than nearest equivalent

2. Main applications

- Renewable energy source such as solar and wind power
- Telecom exchange and transmission system
- Mobile communication system
- Power plant and power transformer system
- Navigation aid signaling system
- Radio and broadcasting station
- Emergency lighting system
- Other standby, cyclic system

3. Configuration



Fig. 1-1 Configuration

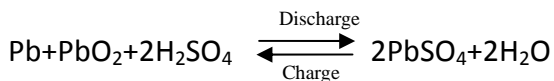
4. Types and Dimensions

Table 1-1 type specifications

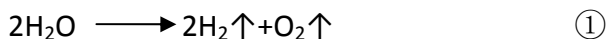
Type	Nominal voltage (V)	Rated capacity (Ah)		Dimensions (mm)				Weight (kg)
		C ₁₀	C ₁₂₀	Length	Width	Height	Total Height	
REX-200	2	200	240	227	96	291	303	17.5
REX-300	2	300	360	227	133	291	303	24.5
REX-400	2	400	480	227	170	291	303	32
REX-500	2	500	600	231	155	396	408	39.5
REX-600	2	600	720	231	180	396	408	47
REX-800	2	800	960	231	231	396	408	62
REX-1000	2	1000	1200	231	282	396	408	76
REX-1200	2	1200	1440	232	264	502	514	90
REX-1500	2	1500	1800	232	322	502	514	110
REX-2000	2	2000	2400	232	456	502	514	155

5. Working Principle

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



Following by-reaction ① takes place in ordinary lead acid battery:



This by-reaction makes water loss gradually and pure water need to be added regularly to keep the battery operate normally.

REX battery adopts a design of barren-liquor and utilizes AGM (micro porous glass fiber) separator. Thus there is a path existing between the positive and the negative. Also special alloy grid is chosen to increase vent hydrogen over-potential gassing on the negative plate, which prevents generation of hydrogen. Otherwise, the oxygen generated from positive diffuses through separator to the negative and the oxygen gas reacts quickly and is recombined into water. The reactions are as follows::

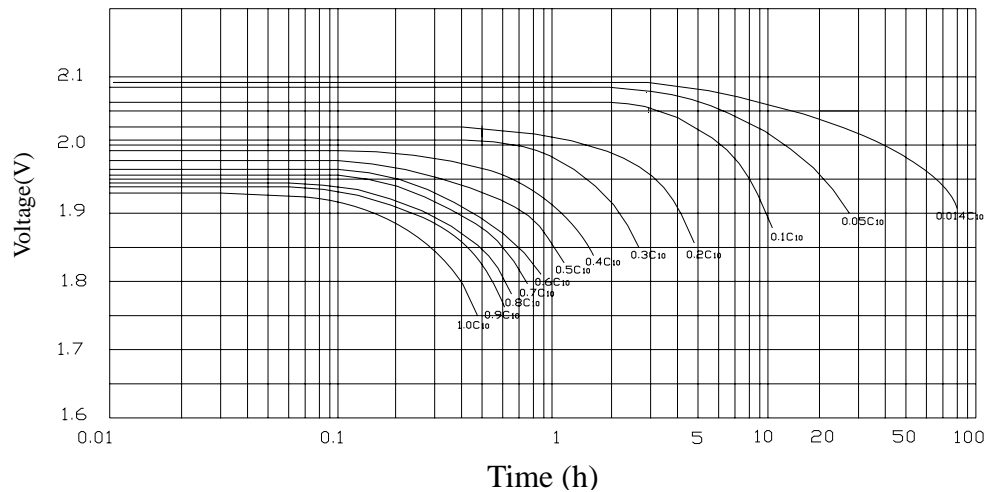


So it is possible to build REX battery in sealed structure.

Chapter Two Technical characteristic

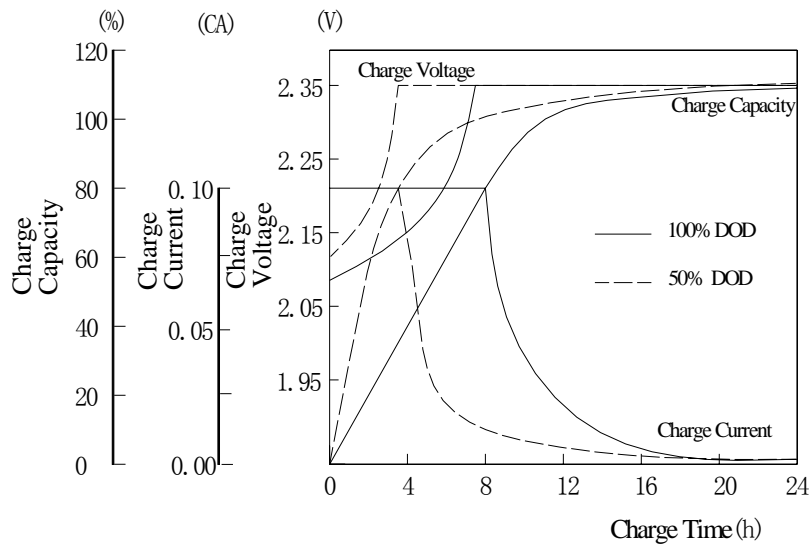
1. Discharge Curve

Fig. 2-1 Discharge Performance Curves at Different Discharge Rates (25℃)



2. Charge Curve

Fig.2-2 Recharge characteristics of REX battery with current of $0.1C_{10}A$ and limit voltage of 2.35V/cell (25℃). The 100% DOD battery can be recharged 105% of capacity after charging for 24 hours.



3. Discharge characteristic

Table2-1 Constant current discharge characteristic (A, 25℃)

REX-200	15min	30min	60min	3hour	5hour	8hour	10hour	12hour	20hour	24hour	48hour	72hour	120hour
1.70V	245	183	119	53.6	37.1	25.6	21.4	18.1	11.1	9.51	4.93	3.37	2.14
1.75V	231	170	113	52.0	36.1	25.3	21.1	17.9	11.0	9.39	4.85	3.32	2.11
1.80V	218	159	106	50.4	35.3	24.8	20.6	17.4	10.8	9.24	4.74	3.25	2.06
1.83V	205	151	99.2	48.8	34.4	24.4	20.2	17.1	10.6	9.04	4.64	3.18	2.02
1.85V	194	142	95.6	47.8	34.1	24.1	20.0	17.0	10.4	8.93	4.62	3.16	2.00
1.90V	164	121	84.9	44.8	32.8	23.2	19.4	16.5	10.2	8.74	4.46	3.05	1.94
REX-300	15min	30min	60min	3hour	5hour	8hour	10hour	12hour	20hour	24hour	48hour	72hour	120hour
1.70V	367	274	178	80.5	55.7	38.4	32.1	27.2	16.6	14.3	7.39	5.06	3.21
1.75V	347	254	170	78.0	54.2	37.9	31.6	26.8	16.5	14.1	7.28	4.98	3.16
1.80V	327	238	159	75.6	52.9	37.2	30.9	26.1	16.2	13.9	7.12	4.87	3.09
1.83V	307	227	149	73.1	51.7	36.5	30.2	25.7	15.8	13.6	6.97	4.77	3.02
1.85V	290	212	143	71.7	51.1	36.1	30.1	25.5	15.7	13.4	6.92	4.74	3.01
1.90V	245	182	127	67.3	49.2	34.8	29.0	24.8	15.3	13.1	6.69	4.58	2.90
REX-400	15min	30min	60min	3hour	5hour	8hour	10hour	12hour	20hour	24hour	48hour	72hour	120hour
1.70V	489.0	365.0	237.3	107.3	74.3	51.2	42.8	36.3	22.1	19.0	9.85	6.74	4.28
1.75V	462.9	339.3	226.2	104.0	72.2	50.6	42.1	35.7	22.0	18.8	9.71	6.64	4.21
1.80V	436.5	317.4	211.9	100.8	70.5	49.6	41.2	34.8	21.5	18.5	9.49	6.49	4.12
1.83V	409.8	302.2	198.4	97.5	68.9	48.7	40.3	34.3	21.1	18.1	9.29	6.35	4.03
1.85V	387.0	283.0	191.3	95.6	68.2	48.2	40.1	34.0	20.9	17.9	9.23	6.32	4.01
1.90V	327.3	242.8	169.8	89.7	65.6	46.3	38.7	33.1	20.4	17.5	8.92	6.10	3.87
REX-500	15min	30min	60min	3hour	5hour	8hour	10hour	12hour	20hour	24hour	48hour	72hour	120hour
1.70V	611.3	456.3	296.6	134.1	92.8	64.0	53.5	45.3	27.6	23.8	12.3	8.43	5.35
1.75V	578.7	424.1	282.7	129.9	90.3	63.2	52.7	44.6	27.4	23.5	12.1	8.30	5.27
1.80V	545.6	396.8	264.9	126.0	88.2	62.0	51.5	43.5	26.9	23.1	11.9	8.12	5.20
1.83V	512.3	377.8	248.0	121.9	86.1	60.9	50.4	42.9	26.4	22.6	11.6	7.94	5.10
1.85V	483.8	353.8	239.1	119.5	85.2	60.2	50.1	42.6	26.1	22.3	11.5	7.90	5.01
1.90V	409.1	303.5	212.3	112.1	82.0	57.9	48.4	41.4	25.5	21.8	11.2	7.63	4.84
REX-600	15min	30min	60min	3hour	5hour	8hour	10hour	12hour	20hour	24hour	48hour	72hour	120hour
1.70V	733.5	547.6	355.9	160.9	111.4	76.8	64.2	54.4	33.2	28.5	14.8	10.1	6.42
1.75V	694.4	508.9	339.3	155.9	108.3	75.8	63.2	53.6	32.9	28.2	14.6	9.96	6.32
1.80V	654.7	476.2	317.8	151.2	105.8	74.4	61.8	52.3	32.3	27.7	14.2	9.74	6.18
1.83V	614.7	453.3	297.6	146.3	103.3	73.1	60.5	51.4	31.7	27.1	13.9	9.53	6.10
1.85V	580.6	424.6	286.9	143.4	102.3	72.3	60.1	51.1	31.3	26.8	13.8	9.48	6.01
1.90V	490.9	364.3	254.7	134.5	98.4	69.5	58.1	49.6	30.6	26.2	13.4	9.16	5.81
REX-800	15min	30min	60min	3hour	5hour	8hour	10hour	12hour	20hour	24hour	48hour	72hour	120hour
1.70V	869.9	661.8	469.0	219.3	148.6	101.7	84.4	72.2	44.4	38.0	19.4	13.3	8.44
1.75V	818.7	610.3	442.8	214.3	146.0	100.3	83.6	71.8	44.1	37.7	19.3	13.2	8.36

1.80V	763.6	571.4	420.6	209.5	142.7	98.4	82.5	71.0	43.3	36.9	19.0	13.0	8.25
1.83V	702.8	533.3	396.8	203.2	140.5	97.8	82.1	70.4	43.2	36.9	18.9	12.9	8.21
1.85V	649.5	502.3	371.4	192.2	133.7	94.4	79.2	67.9	41.8	35.8	18.2	12.5	8.00
1.90V	512.8	417.4	307.1	171.7	121.1	85.6	72.1	62.6	38.9	33.5	16.6	11.4	7.21
REX-1000	15min	30min	60min	3hour	5hour	8hour	10hour	12hour	20hour	24hour	48hour	72hour	120hour
1.70V	1087.3	827.3	586.3	274.1	185.7	127.1	105.4	90.2	55.5	47.5	24.3	16.6	10.5
1.75V	1023.4	762.8	553.5	267.8	182.5	125.4	104.6	89.8	55.1	47.1	24.1	16.5	10.5
1.80V	954.4	714.2	525.7	261.9	178.4	123.0	103.2	88.8	54.1	46.1	23.8	16.3	10.3
1.83V	878.5	666.6	496.0	253.9	175.6	122.3	102.7	88.0	54.0	46.1	23.7	16.2	10.3
1.85V	811.9	627.9	464.2	240.2	167.1	118.0	99.0	84.8	52.3	44.8	22.8	15.6	10.0
1.90V	641.0	521.8	383.9	214.6	151.4	107.0	90.2	78.3	48.6	41.8	20.8	14.2	9.02
REX-1200	15min	30min	60min	3hour	5hour	8hour	10hour	12hour	20hour	24hour	48hour	72hour	120hour
1.70V	1304.8	992.8	703.5	328.9	222.8	152.5	126.5	108.2	66.6	57.0	29.2	19.9	12.7
1.75V	1228.1	915.4	664.2	321.4	219.0	150.4	125.5	107.7	66.1	56.5	28.9	19.8	12.5
1.80V	1145.3	857.1	630.9	314.3	214.0	147.6	123.8	106.5	64.9	55.3	28.5	19.5	12.4
1.83V	1054.2	799.9	595.2	304.7	210.7	146.7	123.2	105.6	64.8	55.3	28.4	19.4	12.3
1.85V	974.2	753.5	557.1	288.3	200.6	141.7	118.7	101.8	62.7	53.7	27.4	18.7	12.0
1.90V	769.2	626.1	460.7	257.5	181.7	128.4	108.2	93.9	58.4	50.2	24.9	17.1	10.8
REX-1500	15min	30min	60min	3hour	5hour	8hour	10hour	12hour	20hour	24hour	48hour	72hour	120hour
1.70V	1631.0	1241.0	879.4	411.2	278.5	190.6	158.2	135.3	83.3	71.3	36.4	24.9	15.8
1.75V	1535.1	1144.2	830.3	401.8	273.8	188.0	156.8	134.7	82.7	70.7	36.1	24.7	15.7
1.80V	1431.7	1071.3	788.6	392.8	267.5	184.5	154.7	133.2	81.2	69.2	35.7	24.4	15.5
1.83V	1317.8	999.9	744.0	380.9	263.4	183.4	154.0	132.1	80.9	69.2	35.5	24.3	15.4
1.85V	1217.8	941.9	696.4	360.3	250.7	177.1	148.4	127.2	78.4	67.2	34.2	23.4	15.0
1.90V	961.5	782.7	575.8	321.9	227.1	160.5	135.3	117.4	73.0	62.7	31.2	21.3	13.5
REX-2000	15min	30min	60min	3hour	5hour	8hour	10hour	12hour	20hour	24hour	48hour	72hour	120hour
1.70V	2174.6	1654.6	1172.5	548.2	371.4	254.2	210.9	180.4	111.0	95.1	48.6	33.2	21.1
1.75V	2046.8	1525.7	1107.0	535.7	365.0	250.7	209.1	179.5	110.2	94.2	48.2	33.0	20.9
1.80V	1908.9	1428.5	1051.5	523.8	356.7	246.0	206.3	177.6	108.2	92.2	47.5	32.5	20.6
1.83V	1757.1	1333.2	992.0	507.9	351.2	244.5	205.3	176.1	107.9	92.2	47.3	32.4	20.5
1.85V	1623.7	1255.8	928.5	480.4	334.3	236.1	197.9	169.6	104.6	89.6	45.6	31.2	20.0
1.90V	1281.9	1043.6	767.8	429.2	302.8	214.0	180.3	156.6	97.3	83.6	41.5	28.4	18.0

Table2-2 Constant power discharge characteristic (Watts/cell, 25℃)

REX-200	15min	30min	60min	2hour	3hour	4hour	5hour	6hour	7hour	8hour	10hour	12hour	24hour
1.70V	440.5	349.5	237.7	155.2	111.0	89.6	76.4	65.7	57.4	50.9	41.8	38.0	19.3
1.75V	424.0	337.6	228.4	149.7	106.9	87.7	74.5	64.1	55.8	49.1	41.2	37.5	19.1
1.80V	404.1	325.7	223.1	147.0	103.1	84.9	72.4	62.3	54.0	47.8	40.6	36.9	18.8
1.83V	385.6	307.2	215.1	141.0	100.6	83.6	70.9	60.4	52.8	46.9	39.8	36.2	18.4
1.85V	368.1	289.6	202.9	135.0	97.7	81.6	69.1	59.0	51.5	46.2	39.0	35.5	18.0
1.90V	319.4	244.3	174.8	117.2	90.6	76.0	64.5	55.1	48.9	43.2	36.2	32.9	16.7
REX-300	15min	30min	60min	2hour	3hour	4hour	5hour	6hour	7hour	8hour	10hour	12hour	24hour
1.70V	660.8	524.3	356.5	232.9	166.5	134.4	114.6	98.5	86.0	76.4	62.7	57.1	29.0
1.75V	636.0	506.4	342.6	224.6	160.4	131.6	111.8	96.2	83.7	73.6	61.8	56.2	28.6
1.80V	606.2	488.5	334.6	220.4	154.7	127.3	108.7	93.4	80.9	71.7	60.8	55.4	28.1
1.83V	578.4	460.7	322.7	211.5	150.9	125.5	106.4	90.6	79.2	70.3	59.7	54.3	27.6
1.85V	552.1	434.4	304.3	202.6	146.5	122.4	103.6	88.4	77.3	69.3	58.5	53.2	27.0
1.90V	479.1	366.4	262.1	175.8	135.8	114.0	96.8	82.6	73.3	64.9	54.2	49.4	25.1
REX-400	15min	30min	60min	2hour	3hour	4hour	5hour	6hour	7hour	8hour	10hour	12hour	24hour
1.70V	881.1	699.1	475.3	310.5	222.0	179.2	152.8	131.3	114.7	101.9	83.6	76.1	38.7
1.75V	848.0	675.2	456.8	299.5	213.8	175.5	149.0	128.3	111.6	98.1	82.4	75.0	38.1
1.80V	808.3	651.4	446.2	293.9	206.3	169.8	144.9	124.5	107.9	95.6	81.1	73.8	37.5
1.83V	771.2	614.3	430.3	282.0	201.2	167.3	141.9	120.7	105.7	93.7	79.6	72.4	36.8
1.85V	736.1	579.2	405.8	270.1	195.3	163.3	138.1	117.9	103.0	92.4	78.0	71.0	36.1
1.90V	638.8	488.5	349.5	234.3	181.1	152.0	129.0	110.2	97.7	86.5	72.3	65.9	33.4
REX-500	15min	30min	60min	2hour	3hour	4hour	5hour	6hour	7hour	8hour	10hour	12hour	24hour
1.70V	1101.4	873.8	594.1	388.1	277.5	224.0	191.0	164.1	143.4	127.3	104.6	95.1	48.4
1.75V	1060.0	844.0	571.0	374.3	267.3	219.3	186.3	160.4	139.5	122.6	103.0	93.7	47.6
1.80V	1010.3	814.2	557.7	367.4	257.8	212.2	181.1	155.6	134.9	119.5	101.4	92.3	46.9
1.83V	964.0	767.9	537.9	352.5	251.6	209.1	177.3	150.9	132.1	117.1	99.4	90.5	46.0
1.85V	920.2	724.0	507.2	337.6	244.2	204.1	172.6	147.4	128.8	115.6	97.5	88.7	45.1
1.90V	798.5	610.7	436.9	292.9	226.4	190.0	161.3	137.7	122.2	108.1	90.4	82.3	41.8
REX-600	15min	30min	60min	2hour	3hour	4hour	5hour	6hour	7hour	8hour	10hour	12hour	24hour
1.70V	1321.6	1048.6	713.0	465.7	333.0	268.8	229.2	197.0	172.1	152.8	125.5	114.1	58.0
1.75V	1272.0	1012.8	685.1	449.2	320.7	263.2	223.6	192.4	167.4	147.2	123.6	112.5	57.2
1.80V	1212.4	977.1	669.3	440.9	309.4	254.7	217.3	186.8	161.9	143.4	121.7	110.7	56.3
1.83V	1156.8	921.5	645.4	423.0	301.9	250.9	212.8	181.1	158.5	140.6	119.3	108.6	55.2
1.85V	1104.2	868.8	608.7	405.1	293.0	244.9	207.2	176.9	154.5	138.7	117.0	106.4	54.1
1.90V	958.2	732.8	524.3	351.5	271.7	228.0	193.6	165.3	146.6	129.7	108.5	98.8	50.2
REX-800	15min	30min	60min	2hour	3hour	4hour	5hour	6hour	7hour	8hour	10hour	12hour	24hour
1.70V	1567.3	1277.0	933.4	586.4	451.2	363.8	307.4	270.1	242.3	221.6	184.3	153.6	85.2
1.75V	1499.8	1200.5	880.2	560.8	442.5	357.5	301.9	262.1	235.5	216.9	182.7	152.3	84.5
1.80V	1414.0	1122.1	810.3	540.2	429.0	351.9	293.9	256.6	231.0	212.1	179.5	149.6	83.0

1.83V	1322.6	1048.6	757.8	520.3	419.4	342.4	286.0	249.4	226.4	206.5	176.4	147.0	81.6
1.85V	1235.3	969.1	694.3	500.5	405.1	332.8	278.0	242.3	218.9	200.0	170.0	141.7	78.6
1.90V	1000.9	792.4	588.6	451.2	369.4	308.2	259.8	228.8	204.2	187.5	160.0	133.3	74.0
REX-1000	15min	30min	60min	2hour	3hour	4hour	5hour	6hour	7hour	8hour	10hour	12hour	24hour
1.70V	1959.1	1596.2	1166.7	733.1	564.0	454.8	384.3	337.6	302.9	277.0	230.4	192.0	106.5
1.75V	1874.7	1500.6	1100.2	701.0	553.1	446.8	377.3	327.7	294.4	271.1	228.4	190.3	105.6
1.80V	1767.5	1402.6	1012.8	675.2	536.2	439.9	367.4	320.7	288.8	265.1	224.4	187.0	103.8
1.83V	1653.3	1310.7	947.3	650.4	524.3	428.0	357.5	311.8	283.0	258.2	220.4	183.7	102.0
1.85V	1544.1	1211.4	867.9	625.6	506.4	416.1	347.5	302.9	273.6	250.0	212.5	177.1	98.3
1.90V	1251.1	990.5	735.8	564.0	461.7	385.3	324.7	286.0	255.2	234.3	200.0	166.7	92.5
REX-1200	15min	30min	60min	2hour	3hour	4hour	5hour	6hour	7hour	8hour	10hour	12hour	24hour
1.70V	2351.0	1915.4	1400.1	879.7	676.8	545.7	461.1	405.1	363.4	332.4	276.4	230.4	127.9
1.75V	2249.7	1800.8	1320.3	841.2	663.7	536.2	452.8	393.2	353.3	325.3	274.1	228.4	126.8
1.80V	2121.0	1683.1	1215.4	810.3	643.4	527.9	440.9	384.9	346.5	318.1	269.3	224.4	124.5
1.83V	1984.0	1572.9	1136.8	780.5	629.1	513.6	429.0	374.2	339.6	309.8	264.5	220.4	122.3
1.85V	1852.9	1453.7	1041.4	750.7	607.7	499.3	417.0	363.4	328.3	300.0	255.0	212.5	117.9
1.90V	1501.4	1188.6	882.9	676.8	554.1	462.3	389.6	343.2	306.2	281.2	240.0	200.0	111.0
REX-1500	15min	30min	60min	2hour	3hour	4hour	5hour	6hour	7hour	8hour	10hour	12hour	24hour
1.70V	2938.7	2394.3	1750.1	1099.6	846.0	682.2	576.4	506.4	454.3	415.6	345.6	288.0	159.8
1.75V	2812.1	2250.9	1650.3	1051.6	829.6	670.3	566.0	491.5	441.6	406.6	342.6	285.5	158.4
1.80V	2651.2	2103.9	1519.2	1012.8	804.3	659.8	551.1	481.1	433.1	397.7	336.6	280.5	155.7
1.83V	2479.9	1966.1	1420.9	975.6	786.4	642.0	536.2	467.7	424.5	387.3	330.7	275.5	152.9
1.85V	2316.1	1817.1	1301.8	938.4	759.6	624.1	521.3	454.3	410.3	375.0	318.7	265.6	147.4
1.90V	1876.7	1485.7	1103.7	846.0	692.6	577.9	487.1	429.0	382.8	351.5	300.0	250.0	138.7
REX-2000	15min	30min	60min	2hour	3hour	4hour	5hour	6hour	7hour	8hour	10hour	12hour	24hour
1.70V	3918.3	3192.4	2333.5	1466.1	1128.0	909.6	768.6	675.2	605.7	554.1	460.7	383.9	213.1
1.75V	3749.5	3001.3	2200.4	1402.1	1106.2	893.7	754.7	655.4	588.8	542.2	456.8	380.6	211.3
1.80V	3535.0	2805.1	2025.7	1350.4	1072.4	879.8	734.8	641.5	577.5	530.2	448.8	374.0	207.6
1.83V	3306.6	2621.4	1894.6	1300.8	1048.6	855.9	714.9	623.6	566.0	516.3	440.9	367.4	203.9
1.85V	3088.1	2422.8	1735.7	1251.1	1012.8	832.1	695.1	605.7	547.1	500.1	425.0	354.2	196.6
1.90V	2502.3	1981.0	1471.6	1128.0	923.5	770.5	649.4	572.0	510.4	468.7	400.0	333.3	185.0

4. Internal resistance and short circuit current

The internal resistance of the battery is a dynamic nonlinear parameter that is continuously changed along with the temperature and discharge state. The internal resistance is the lowest when battery is fully charged. The table 2-2 shows the internal resistance and short circuit current of Narada battery in fully charged state according to the IEC60896 standard. Pay attention to the battery to short-circuit causes the battery voltage to reduce to 0V, and will cause the battery internal component damaged.

Table2-3 Internal resistance and short circuit current (25℃)

Type	Internal Resistance (mΩ)	Short Circuit Current (A)
REX-200	0.55	3700
REX-300	0.39	4752
REX-400	0.30	6107
REX-500	0.28	7211
REX-600	0.23	8614
REX-800	0.18	10873
REX-1000	0.15	12835
REX-1200	0.14	13874
REX-1500	0.12	16882
REX-2000	0.10	20660

Chapter Three Operation and Maintenance

1. Parameters Setup

Table3-1 Switching power supply parameter setup table (48V system)

Parameter name	Normal power supply	Tough power supply
Floating Voltage (V)	54	54
Equalization Voltage (V)	56.4	56.4
Charging Current (A)	0.1C ₁₀	0.1C ₁₀
Limited Current For Charge (A)	0.20C ₁₀	0.20C 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
LVLD (V)	45.6	46.5
LVBD (V)	Please refer to table 3-2	
LVBD 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)	35	35

1. The voltage in above table is at 25°C. Please adjust the data according to table 3-3 at other temperature.
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 (LVBD) based on different load current to make the battery life longer. Please refer to table 3-2.

Table 3-2 Voltage setup parameter of LVBD and LVLD

Load current (A)	End voltage (V/cell)	LVBD for 48V system (V)	LVLD 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

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.

2. Capacity and Influence Factor

The capacity of battery is the capacity that battery can be discharged in the established conditions, expressed as signal C. The usual unit of capacity is ampere-hour, shortened as AH. The rated time is marked in the right and low corner of C, i.e. C_{10} is the capacity at 10 hours rate; C_3 is the capacity at 3 hours rate.

The capacity can be expressed in Rated Capacity or Actual Capacity. For Rated Capacity of REX battery, please see Table 1-1. The Actual Capacity is the actual output capacity in certain discharge conditions, which is equal to product of the discharge current and the discharge time, the unit is AH. The actual capacity is effected by discharge rate, discharge mode, end voltage and temperature.

3. Ambient Temperature vs. Battery

The recommendation temperature for REX battery is $15^{\circ}\text{C} \sim 25^{\circ}\text{C}$. Used at high or low temperature, battery performance will be affected. Table 3-3 is the working temperature range for battery.

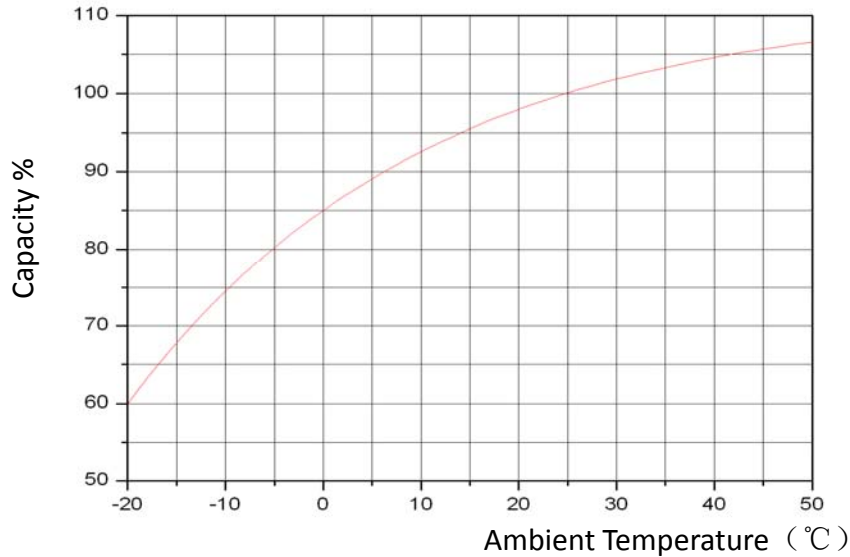
Table 3-3 Working temperature range for battery

Working condition	Temperature range	Recommended temperature
Discharge	$-40^{\circ}\text{C} \sim 50^{\circ}\text{C}$	$15^{\circ}\text{C} \sim 25^{\circ}\text{C}$
Charge	$-20^{\circ}\text{C} \sim 50^{\circ}\text{C}$	$15^{\circ}\text{C} \sim 25^{\circ}\text{C}$
Storage	$-20^{\circ}\text{C} \sim 40^{\circ}\text{C}$	$15^{\circ}\text{C} \sim 25^{\circ}\text{C}$

Temperature affects capacity of the battery. Fig. 3-1 is the available capacity (10h rated, end voltage 1.80Vpc) curve vs. ambient temperature. When the temperature is low, the capacity will decrease, for example, the capacity will decrease 20% if temperature decreases form 25°C to 0°C ; And too low temperature will cause battery long term insufficient charged, also will make negative plates sulfate and make battery unable to discharge.

The capacity will increase at some range when temperature rises. For example the capacity will increase 5% if temperature raises from 25℃ to 35℃. But when the temperature go up further, the capacity will increase slowly, and at last stop increasing. However, high temperature will quicken up plates' corrosion and cause water loss, thus shortens battery's life.

Fig.3-1 Available Capacity (10h rate) Curve VS. Ambient Temperature



3.1 Temperature and Floating Voltage, Equalization Voltage

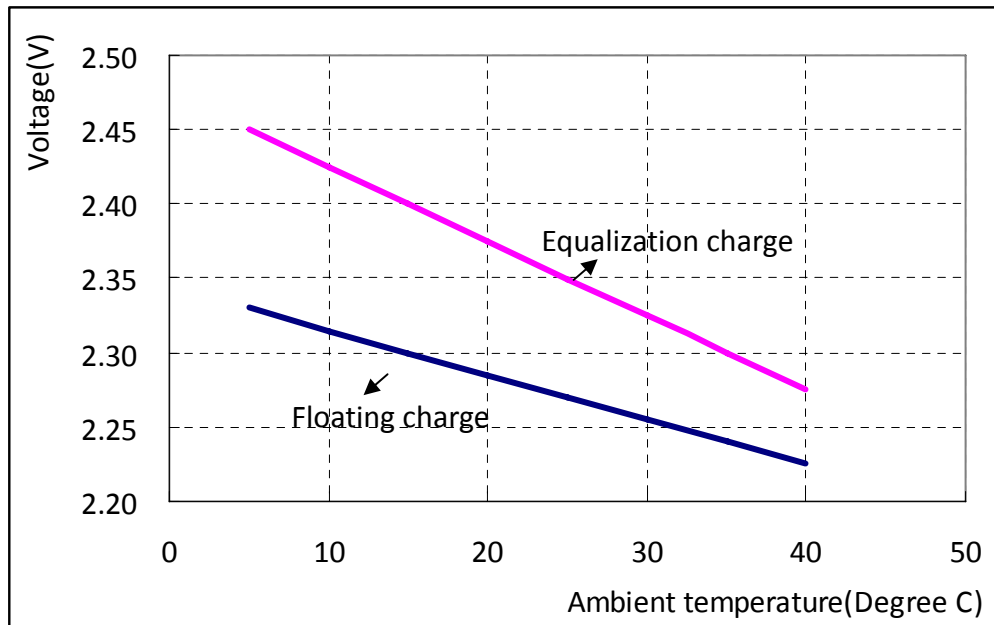
The purpose to select certain floating voltage is making the battery operate in best conditions. If the floating voltage is higher, the floating current is also higher; it will accelerate the corruption of grids and shorten the life of the battery. If the floating voltage is lower, the battery can't be kept in fully charged state, this will crystallize $PbSO_4$, decrease the capacity, and also shorten the life of the battery. At 25℃, the floating voltage is 2.25V, at other temperature, please adjust according to Table 3-4. The temperature compensation coefficient for float charge is $-3mV/°C/cell$. Valve regulated sealed lead acid battery need to be equalized charge regularly, in order to guarantees the battery normal operation. At 25℃, REX battery's Equalization voltage is 2.35V. It need to be adjusted by ambient temperature, the temperature compensation coefficient for equalizing charge is $-5mV/°C/cell$.

Table 3-4 Relationship of ambient temperature and voltage

Ambient Temperature (°C)	Float Voltage (V/cell)	Equalization voltage (V/cell)
≤5	2.32	2.45
10	2.31	2.43
15	2.30	2.40
20	2.28	2.38
25	2.27	2.35

30	2.25	2.33
35	2.24	2.30
≥40	2.22	2.28

Fig. 3—2 The Voltage Setting Curve Vs. Ambient Temperature



3.2 Ambient temperature vs. Battery Life

The high temperature will damage the battery, reduce the battery life. When temperature exceeds 25°C, the battery life will decrease half per 10°C temperature raise. For example, the design life of battery is 10 years at 25°C, if the battery is operate at 35°C for long term, the life will be 5 years. Below is the formula:

$$L_{25} = L_T \times 2^{(T-25)/10}$$

Notes: T the actual ambient temperature;

L_T is designed life at T ambient temperature

L_{25} is designed life at 25°C ambient temperature

Ambient temperature elevating, also will accelerate the battery grids corrosion and the battery water loss, thus will greatly reduce the battery life. So it is important to control the ambient temperature. When heat is accumulated to a certain degree, it will damage the battery, seriously even lead to thermal run away. If indoor temperature reaches too high, please improve the ambient temperature by making room ventilated, etc. The battery spacing cannot to be less than 10mm, at the same time regulating cell floating and equalization voltage value according to handbook's request.

3.3 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. If there are several pairs of post, please test on nearest pair of post.

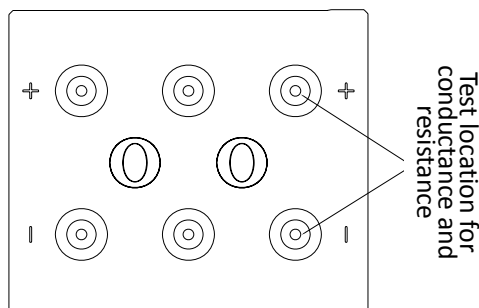


Figure 3-3 Test location for conductance and resistance

4. Choose battery

If you choose Narada REX Series battery, please refer to diagram 3-3 monomer lectotype curve for selecting battery capacity.

4.1 Firstly, confirm the end-of-discharge voltage. For example, end voltage for single cell is 1.80V.

4.2 Secondly, confirm the continuous working period of battery group and its discharge current. For example, it is required to reach 125A of constant flow output during the power supply period of battery group for continuous 3 hours; then according to the corresponding curve in diagram 2-3, the minimum capacity requirement will be REX-500.

4.3 Lastly, confirm the ambient temperature. At room temperature of 25°C, please choose REX-500; Otherwise, please refer to diagram 3-1 to confirm the temperature coefficient, i.e., if temperature bellows 0°C, the capacity will reach 80% while it is around 25°C, in that case, please divided by 0.8.

4.4 In order to assure the service life of battery, the depth of discharge should not be too deep every time, that is to say, it's better not to exceed more than 80%. Especially for those areas that use battery more frequently. It is necessary that the batteries have spare capacity every time after discharge, in order to prevent the damage caused by long-term of insufficient charge.

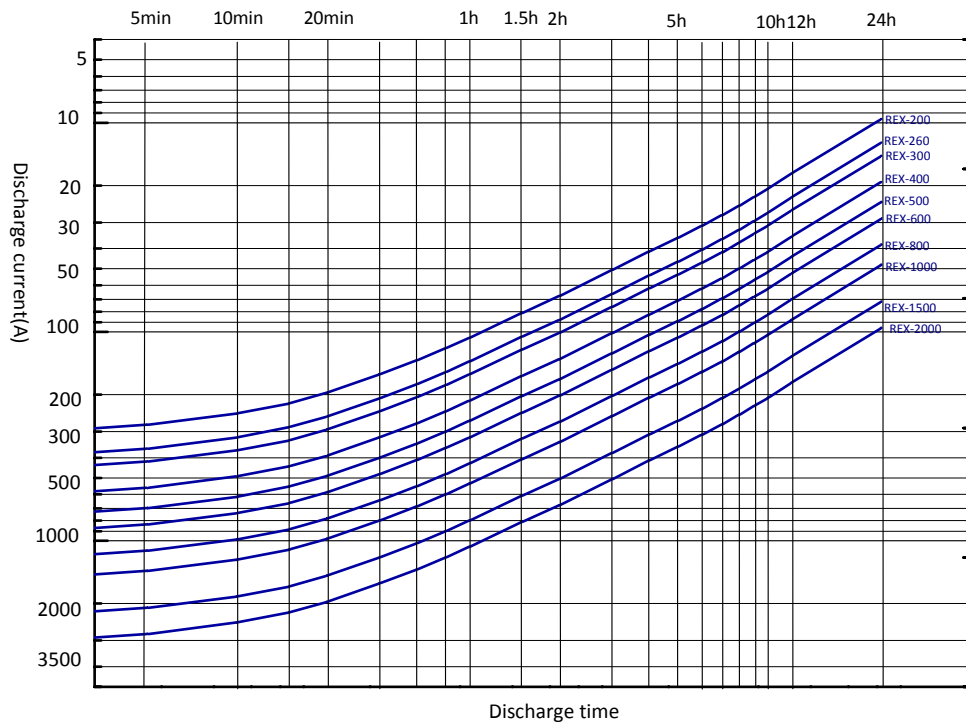


Fig. 3-4 Battery Selection Mode (end voltage 1.80Vpc)

5. Requirement for Charge

5.1 Periodically Equalization Charge

The battery needs an equalization charge after floating operation over three months, or the voltage of at least two batteries are lower than 2.18V. The method of equalization charge is constant current and limited voltage, as follows: charge with constant current of $0.1C_{10}A \sim 0.20C_{10}A$ till the average voltage reaches equalization charge voltage of 2.35Vpc (25°C), then keep charging with equalization charge voltage, meanwhile, the current is reduced, till the charge finished. The charging time is 24 hours.

5.2 Charge after discharge

After discharge, the batteries should be charged in time. The charge method is constant current limit voltage as follows: charge with constant current of $0.1C_{10}A \sim 0.20C_{10}A$ till the average voltage reaches a certain voltage, then keep charging with this voltage, meanwhile, the current is reduced, till the charge finished.

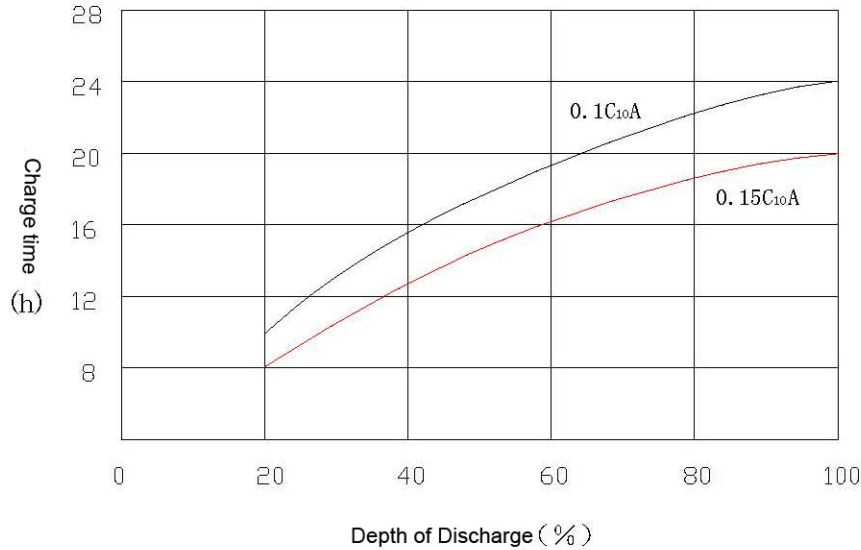
The certain voltage could be equalization voltage or float voltage. When the depth of discharge is larger (normally larger than 10%), equalization voltage is recommended so as to give fully charge to the battery. We can also determine charge voltage according to initial current. When the current is larger than $0.05C_{10}A$ (reference current to change to equalization charge), equalization voltage is recommended. The charge time is 24 hours. We can also setup the charge voltage according to different DOD, different charge current shown in figure 3-4, or we can judge according to charge current value.

Normally, the batteries are fully charged when the value of charge current is not changed

for continuous three hours at the stage of constant voltage charge,

Sometimes, we need to charge a battery in a short time, we can raise charge current, but not higher than $0.25C_{10A}$.

Fig .3-4 The relationship between DOD and charge time



6. Storage

The storage area must be clean, ventilated, dry and without direct sunshine. All lead acid batteries lose capacity when standing on open circuit because of self-discharge. The result is that the voltage of open circuit is decreased, and the capacity also decreased. The self-discharge rate is related with ambient temperature. The self-discharge degree is smaller when the ambient temperature is lower, otherwise is larger. Batteries should be supplementary charged if they have been stored for six months or the open circuit voltage is lower than 2.10V/Cell. The equalization charge method should be adopted. All batteries, which are ready to store, should be fully charged before storage. It's suggested to record storage time in periodic maintenance record and record the time when another necessary supplementary charge should be made. The quality certificates of REX batteries record the latest charge time of the batteries, next charge time can be calculated according to this charge time.

7. Maintenance

In order to assure service life, the batteries should be correctly inspected and maintained. The maintenance methods of REX batteries are recommended as follows:

7.1 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.

7.2 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.
-

7.3 Yearly Maintenance

- Repeat quarterly maintenance and inspection.
- Check whether connectors are loose or not every year and tight them
- 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.

7.4 Operation and Maintenance Precautions

Insufficient Charge

If the floating voltage is not set correctly (too low or not compensate according to temperature), the battery system will in an insufficient charge state for a long period of time. When the electricity is out, the battery may not be able to work because the acid is satirized and the capacity is decreased.

Over Charge

If we neglect the performance of rectifier to transfer floating charge to equalization charge. If the rectifier cannot transfer charge modes because of its wrong performance or no adjustment, the battery system is always in an equalization charge state. Thus may cause serious problems for battery, such as water loss, life decrease, thermal runaway, deformation, etc.

Too low or too high temperature

We have mentioned that too low temperature will affect the capacity of battery. While too high temperature will also cause problems, such as water loss, life decrease, thermal runaway, deformation, etc.

Too low end voltage

The end voltage is also an important parameter for battery. The battery shall stop discharge when reach a certain voltage (The normal end voltage is 1.8Vpc for 10 hours rated). 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.

Long time storage after discharge

If the battery is put aside without charge for a long time after discharge, it will affect the capacity and life of the battery, because some large size PbSO_4 will be created in the negative, which are difficult to transfer to active Pb. Thus it will affect battery life and capacity

After-sales Service / Customer Service Hotline

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E-mail: intl@narada.biz

Website: www.naradabattery.com

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Tel: +65-6848 1191

Fax: +65-6749 3498

E-mail: sales@narada.com.sg

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:	