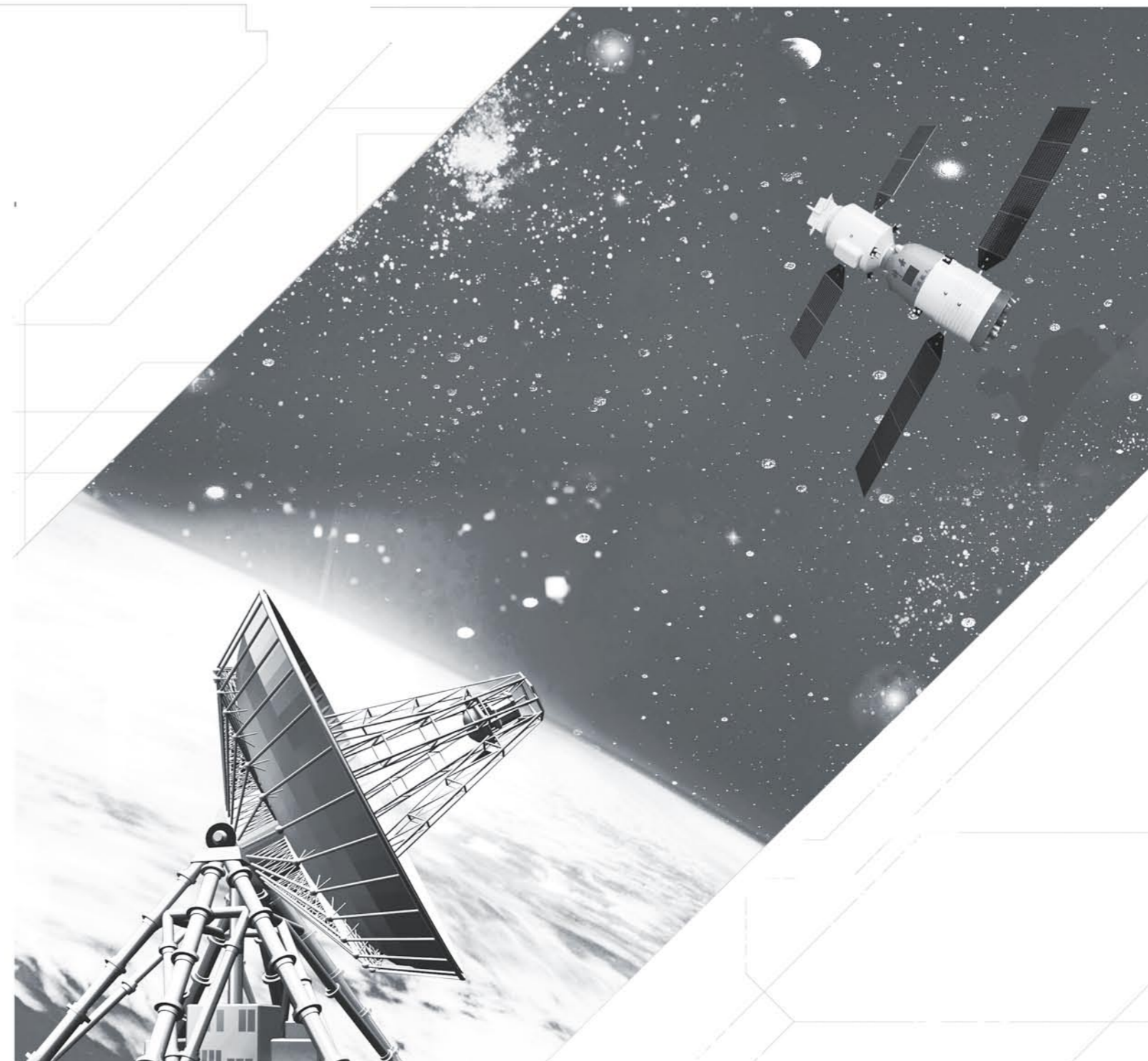




GFM SERIES TECHNICAL MANUAL

RELIABLE WHENEVER NEEDED



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Security Instruction

Please read these instructions carefully in order to make correct, safe, and effective operation. This manual provides you with very important installation and operation guidelines, which will guarantee your equipment an optimal performance and longer service life.

- ▲ For your safety, please do not open battery by yourself, only professionals shall be allowed to open and maintain the battery;
- ▲ Due to battery be potential harmful to the environment and health, battery shall be replaced by manufacturer's service center. If there is need to replace and maintain, please contact after-sale service center.
- ▲ Used battery is recyclable, and improper disposal of battery may be great harmful to the environment and health. So, used battery shall be proper disposed following relative regulations and law or shall be returned to our company for disposal.
- ▲ Please choose the batteries of the same model for replacement, and batteries produced by different manufacturers shall be strictly forbidden for connecting in one system.

Notices

				
Warning	Electricity shock	Protecting eyes	With adults custody	No short circuit
				
No flame and spark	Recycled	Proper disposal	Read instructions	UL certificate

Chapter One Product Introduction

Product Characteristics

✧ Basic Characteristics

GFM-C battery adopt super thin glass mat AGM separator, poor electrolyte design, there is gas passway between positive and negative plate, during charge process, the oxygen generated on positive plate reaches negative plate through the pores of separator recombined into water, gas recombination is achieved. Grid is made of multielement lead-calcium without antimony special alloy, separator out of hydrogen is restrained, thus achieve no water loss. So, during the whole battery operation period, there is no need to add water and acid.

Sealing reaction efficiency could be more than 99%, no acid fog escape, no corrosion to equipment, battery could be installed together with equipments.

Low self-discharge rate, optimize alloy formula, adopt high purity raw and subsidiary material, clean production environment, ensure low self-discharge rate, month average self-discharge $\leq 1\%$.

Compact structure, good shock proof performance, high specific energy.

✧ Long service life

Positive grid adopt high-tin-low-calcium multielement alloy, crystal nucleus more equal than normal tin-calcium alloy, crystal particle connected tightly, preventing crystal boundary corrosion.

Patent international advanced primary and secondary grid structure design, current distributing in grid will be more equal and reasonable.

Positive plate solidity adopt high temperature and humidity technic, form long life $4PbO \cdot PbSO_4 \cdot H_2O$ structure.

Special assembling equipment, achieve plate sets assembled tightly, ensure the excellent cycle application performance.

GFM-C series batteries positive and negative plate adopt optimize design, the design life is 15 years for 2V batteries, normal floating charge application life is 10 years; the design life is 10 years for 6V and 12V batteries, normal floating charge application life is 6~8 years.

✧ Reliable sealing technology

Safety valve adopt Patent labyrinth type, two-layer and explosion-proof acid filter valve design, the valve will open automatically for decompression when battery inner pressure reach a certain value, and the valve will close when battery inner pressure come back to normal level, acid filter in valve

preventing acid fog escape and preventing out flame in when depression.

GFM-C series batteries terminal sealing adopt patent multi-layer design, resist mechanism impact, resist high temperature aging, improving acid corrosion endurance performance, prolong acid leakage track, ensure sealing reliability during battery service life.

Batteries could endure 80kPa inner pressure without any abnormality.

◇ Good consistency

For suring battery capacity and floating charge voltage consistency, during plate production, cell assembling and finished products test, one homogenization procedure added in each process, open circuit voltage variance for 2V batteries is $\leq \pm 10\text{mV}$, and for 6V/12V batteries $\leq \pm 25/50\text{mV}$. Thus ensuring battery quality consistency.

◇ Good large current discharge performance

With radial grid structure and special active material formula improving large current discharge performance and charge acceptance ability, be suitable for large current discharge application demand.

Copper insert terminal structure design with low resistance is good for large current discharge application.

◇ Convenient installation

Batteries are connected by tinning copper core multistrand soft cable or short circuit proof tinning red copper bar. Connecting is convenient and the voltage loss is small.

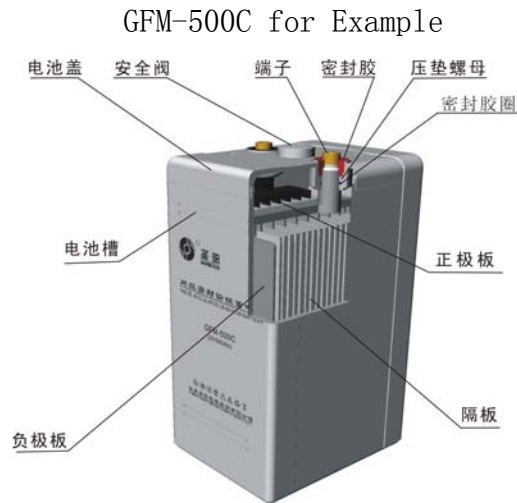
◇ Applicable for wide temperature range

Special electrolyte formula and special active substance formula, enhance good high and low temperature performance, battery could be used in a wide temperature range as $-20^{\circ}\text{C} \sim +45^{\circ}\text{C}$, and the recommended application temperature range is $25 \pm 5^{\circ}\text{C}$.

Main Applications

- ◇ Telecommunication exchange and transmission system;
- ◇ Aviation;
- ◇ Mobile telecommunication system;
- ◇ Data and TV signal transmission system;
- ◇ Power generation station power transmission and substation;
- ◇ Power direct current system;
- ◇ UPS/EPS and IT.

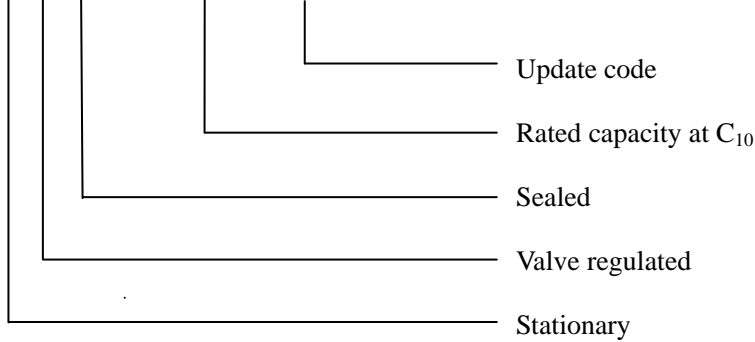
Battery Structure



Type and Dimensions

◇ 2V series

G F M - X X X X C



◇ 6V/12V series

X G F M - X X X X

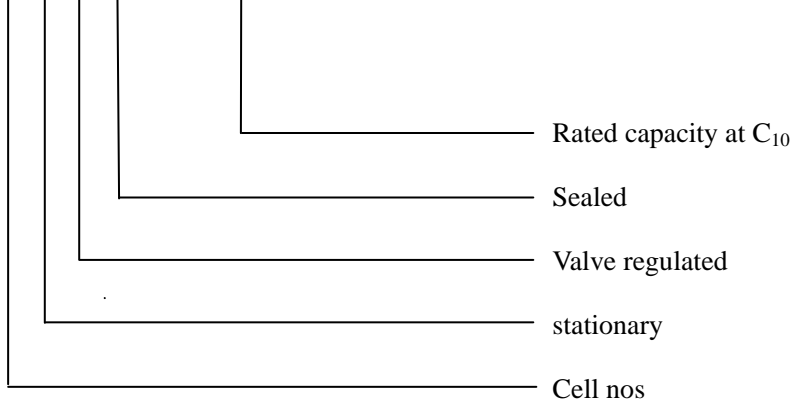


Table 1-1 GFM-C(2V) series battery type and dimensions

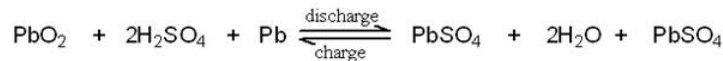
Battery Type	Rated Voltage (V)	Rated Capacity (Ah)			Dimensions (mm)				Weight (kg)
		C ₁₀ End voltage 1.80V/cell	C ₃ End voltage 1.80V/cell	C ₁ End voltage 1.75V/cell	Length	Width	Height	Total Height	
GFM-100C	2	100	78	57	74.5	174.0	210.0	223.0	5.70
GFM-200C	2	200	150	110	98.5	174.0	348.5	357.5	13.5
GFM-300C	2	300	225	165	141.0	174.0	348.5	357.5	19.0
GFM-400C	2	400	300	220	175.0	174.0	348.5	357.5	24.0
GFM-500C	2	510	375	275	213.5	174.0	348.5	357.5	30.0
GFM-600C	2	600	450	330	252.0	175.0	348.5	357.5	36.0
GFM-800C	2	800	600	440	350.0	173.0	338.0	347.0	49.0
GFM-1000C	2	1000	750	550	430.0	173.0	338.0	347.0	59.5
GFM-1200C	2	1200	900	660	510.0	175.0	338.0	347.0	71.5
GFM-1500C	2	1500	1125	825	318.0	341.0	341.0	351.0	86.5
GFM-2000C	2	2000	1500	1100	433.0	342.0	341.0	351.0	118.0
GFM-3000C	2	3000	2250	1650	629.0	346.0	341.0	351.0	174.0

Table 1-2 GFM(6V/12V) series battery type and dimensions

Battery Type	Rated Voltage (V)	Rated Capacity (Ah)			Dimensions (mm)				Weight (kg)
		C ₁₀ End voltage 1.80V/cell	C ₃ End voltage 1.80V/cell	C ₁ End voltage 1.75V/cell	Length	Width	Height	Total Height	
3GFM-200	6	200	153	115	375	170	211	240.0	33.0
6GFM-80	12	80.0	60.9	47.6	329	172	216	223	29.3
6GFM-100	12	100	76.5	56.0	407	173	222	231.5	36.5
6GFM-150	12	150	114	84.0	497	203	228	237.5	53.6
6GFM-200	12	200	153	115	497	259	228	237.5	70.0

Working Principle

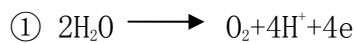
The electrochemical reaction of batteries in charge and discharge process as follows:



In the final stage of charge process, active substance in positive plate transformed to lead dioxide, negative plate has not reached fully charged stage, the process of active substance in negative plate transformed to spongy lead has not finished, oxygen gas generated in positive plate reaches the negative plate through separator pores and reacts with active substance in negative plate, resulting in a depolarized state in negative plate, and restraining the generation of hydrogen.

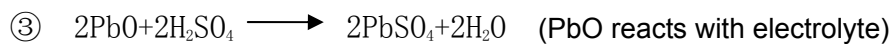
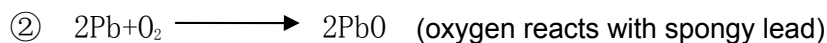
The working principle of electrochemical reaction to realize sealing as follows:

(1) The reaction in positive plate (oxygen generated)



↳ Move to the surface of negative plate through the separator

(2) The reaction in negative plate (oxygen absorbed)

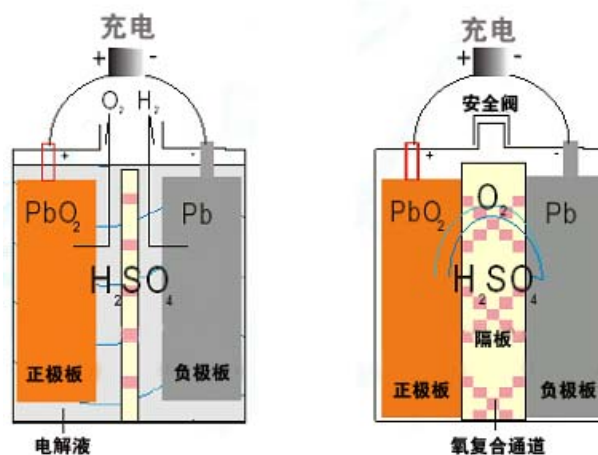


(3) The whole reaction in the negative plate is: $\textcircled{2} + \textcircled{3} + \textcircled{4}$: $\text{O}_2 + 4\text{H}^+ + 4\text{e}^- = 2\text{H}_2\text{O}$

The final production returns to $\textcircled{1}$, and recycles like this.

In general, in charging process oxygen gas generated in positive plate could quickly reach the negative plate and recombine into water through reaction with active substance in negative plate, no gas escape and water loss, achieving the sealing.

Gas recombination illustration



Chapter Two Technical Characteristics

Discharge Characteristic Curve and Discharge Data

The battery capacity is directly related to the discharge current, end voltage and discharge temperature. In general, the smaller discharge current, the lower end voltage, the higher temperature will cause larger discharge capacity. Figure 2-1 is the discharge curves of GFM-C Series at different discharge rate at ambient temperature 25°C. Table 2-2 and 2-3 is constant current discharge data, customers could choose battery accordingly.

Figure 2-1 Discharge characteristic curve under different discharge rates (25°C)

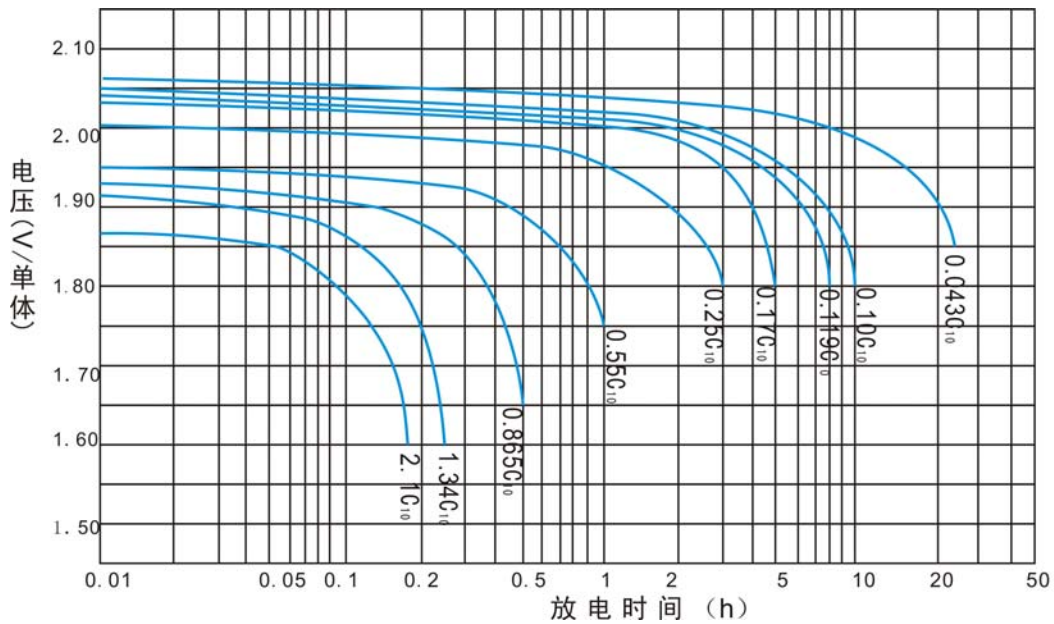


Table 2-1 GFM-C series battery end voltage at different discharge rate (25°C)

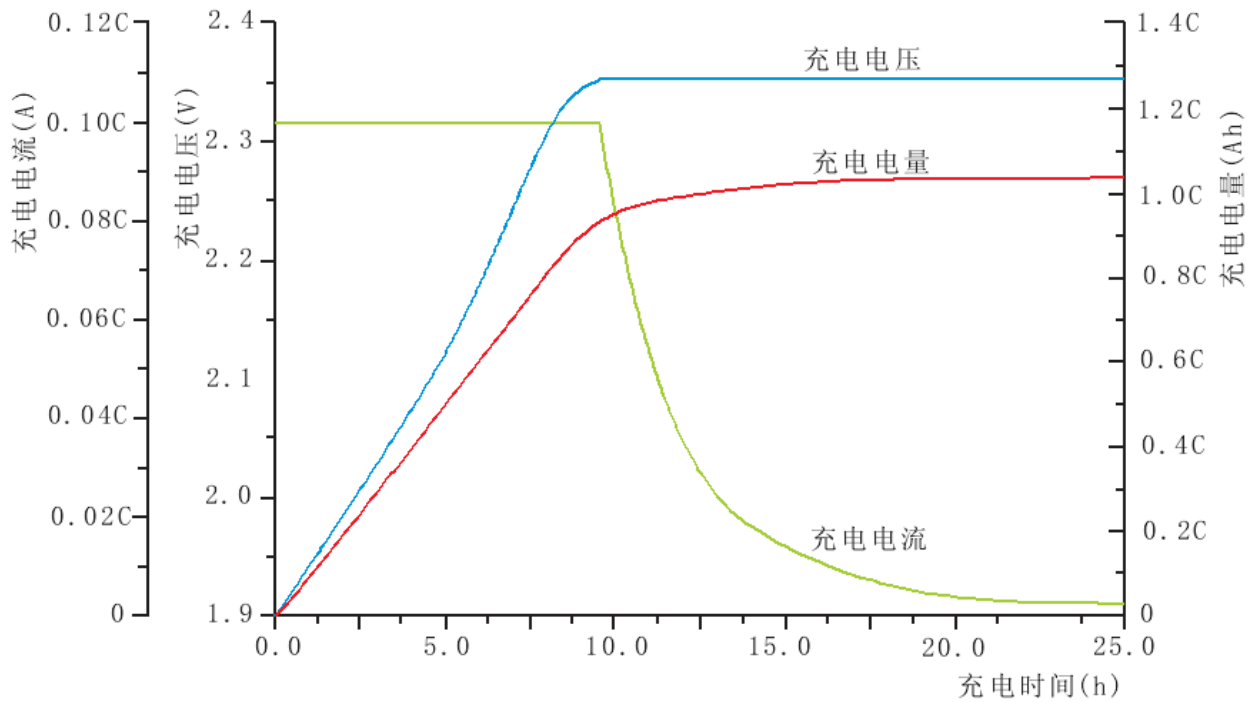
Discharge Rate (A)	End Voltage (V)
$I \leq 0.01C_{10}$	1.95
$0.01C_{10} < I \leq 0.05C_{10}$	1.90
$0.05C_{10} < I \leq 0.09C_{10}$	1.85
$0.09C_{10} < I \leq 0.25C_{10}$	1.80
$0.25C_{10} < I \leq 0.55C_{10}$	1.75
$0.55C_{10} < I \leq 0.65C_{10}$	1.65

Charge Characteristic Curve

Figure 2-2 is the battery charge characteristic curves with constant voltage of 2.36V / cell, limited

current of 0.1C10 A, Charge the battery for 25 hours after fully discharged battery and the charged capacity can be as high as the 104% of the discharged capacity.

Figure 2-2 Charge characteristic curve



Discharge Data

Table 2-2 GFM-C Battery Constant Current Discharge Data Sheet (Amperes, 25 °C)

GFM-100C	5min	10min	15min	20min	30min	1hr	2hr	3h	5h	6h	8h	10h	24h
1.60V	318	232	169	136	99.7	60.0	37.6	27.6	17.8	15.5	12.3	10.3	4.41
1.65V	299	219	159	128	94.5	59.0	37.0	27.3	17.6	15.4	12.2	10.2	4.38
1.70V	282	206	150	120	89.6	58.0	36.4	26.9	17.4	15.2	12.1	10.15	4.35
1.75V	264	196	143	115	86.8	57.0	35.7	26.5	17.2	15	12.0	10.1	4.33
1.80V	242	186	137	111	83.9	56.0	34.9	26.0	17.0	14.8	11.9	10.0	4.30
GFM-200C	5min	10min	15min	20min	30min	1hr	2hr	3h	5h	6h	8h	10h	24h
1.60V	420	324	268	231	183	116	72.2	53.3	35.7	31.0	24.7	20.6	8.82
1.65V	382	297	248	215	173	114	71.0	52.5	35.2	30.7	24.4	20.4	8.76
1.70V	349	273	230	201	163	111	69.7	51.8	34.9	30.4	24.2	20.3	8.71
1.75V	305	251	216	191	158	110	68.5	50.9	34.4	30.0	24.0	20.1	8.65
1.80V	268	232	204	182	152	105	66.9	50.0	34.0	29.7	23.7	20.0	8.59
GFM-300C	5min	10min	15min	20min	30min	1hr	2hr	3h	5h	6h	8h	10h	24h
1.60V	630	487	403	347	275	174	108	79.9	53.5	46.6	37.0	30.9	13.2
1.65V	573	446	372	323	260	171	107	78.8	52.9	46.1	36.6	30.7	13.1
1.70V	523	409	344	301	245	166	105	77.7	52.3	45.6	36.3	30.4	13.1
1.75V	457	377	324	287	236	165	103	76.4	51.6	45.1	36.0	30.2	13.0
1.80V	402	349	306	274	228	157	100	75.0	51.0	44.5	35.6	30.0	12.9
GFM-400C	5min	10min	15min	20min	30min	1hr	2hr	3h	5h	6h	8h	10h	24h
1.60V	840	649	537	462	367	232	144	107	71.3	62.1	49.4	41.2	17.6
1.65V	764	594	496	431	346	228	142	105	70.5	61.4	48.9	40.9	17.5

1.70V	697	545	459	401	326	221	139	104	69.7	60.8	48.4	40.5	17.4
1.75V	610	502	432	382	315	220	137	102	68.8	60.1	48.0	40.3	17.3
1.80V	535	465	408	365	303	210	134	100	68.0	59.3	47.4	40.0	17.2
GFM-500C	5min	10min	15min	20min	30min	1hr	2hr	3h	5h	6h	8h	10h	24h
1.60V	1050	811	671	578	459	290	181	133	91.3	77.6	61.7	52.5	22.0
1.65V	955	743	620	538	433	285	178	131	90.2	76.8	61.1	52.1	21.9
1.70V	872	682	574	502	408	277	174	129	89.2	76.1	60.5	51.7	21.8
1.75V	762	628	540	478	394	275	171	127	88.0	75.1	59.9	51.3	21.6
1.80V	669	581	510	456	379	262	167	125	87.2	74.1	59.3	51.0	21.5
GFM-600C	5min	10min	15min	20min	30min	1hr	2hr	3h	5h	6h	8h	10h	24h
1.60V	1260	973	805	693	550	348	217	160	107	93.1	74.0	61.8	26.5
1.65V	1145	891	744	646	519	342	213	158	106	92.2	73.3	61.3	26.3
1.70V	1046	818	689	602	489	332	209	155	105	91.3	72.6	60.8	26.1
1.75V	915	753	648	574	473	330	205	153	103	90.1	71.9	60.4	26.0
1.80V	803	697	612	547	455	314	201	150	102	89.0	71.1	60.0	25.8
GFM-800C	5min	10min	15min	20min	30min	1hr	2hr	3h	5h	6h	8h	10h	24h
1.60V	1680	1298	1074	924	734	464	289	213	143	124	98.7	82.4	35.3
1.65V	1527	1189	993	861	692	456	284	210	141	123	97.7	81.7	35.1
1.70V	1395	1091	918	802	653	443	279	207	139	122	96.9	81.1	34.8
1.75V	1220	1005	864	765	630	440	274	204	138	120	95.9	80.5	34.6
1.80V	1071	930	816	729	607	419	268	200	136	119	94.9	80.0	34.4
GFM-1000C	5min	10min	15min	20min	30min	1hr	2hr	3h	5h	6h	8h	10h	24h
1.60V	2100	1622	1342	1156	917	580	361	266	178	155	123	103	44.1
1.65V	1909	1486	1241	1077	865	570	355	263	176	154	122	102	43.8
1.70V	1743	1363	1148	1003	816	553	349	259	174	152	121	101	43.5
1.75V	1525	1256	1081	956	788	550	342	255	172	150	120	101	43.3
1.80V	1339	1162	1020	912	759	524	334	250	170	148	119	100	43.0
GFM-1200C	5min	10min	15min	20min	30min	1hr	2hr	3h	5h	6h	8h	10h	24h
1.60V	2520	1947	1611	1387	1101	696	433	320	214	186	148	124	52.9
1.65V	2291	1783	1489	1292	1038	684	426	315	211	184	147	123	52.6
1.70V	2092	1636	1377	1204	979	664	418	311	209	183	145	122	52.3
1.75V	1830	1507	1297	1147	946	660	411	306	206	180	144	121	51.9
1.80V	1606	1395	1224	1094	910	629	401	300	204	178	142	120	51.5
GFM-1500C	5min	10min	15min	20min	30min	1hr	2hr	3h	5h	6h	8h	10h	24h
1.60V	3150	2433	2014	1733	1376	870	542	400	268	233	185	155	66.1
1.65V	2864	2228	1861	1615	1298	855	533	394	264	230	183	153	65.7
1.70V	2615	2045	1721	1505	1223	830	523	388	261	228	182	152	65.3
1.75V	2287	1884	1621	1434	1182	825	514	382	258	225	180	151	64.9
1.80V	2008	1744	1530	1368	1138	786	502	375	255	222	178	150	64.4
GFM-2000C	5min	10min	15min	20min	30min	1hr	2hr	3h	5h	6h	8h	10h	24h
1.60V	4200	3245	2685	2311	1834	1160	722	533	357	310	247	206	88.2
1.65V	3818	2971	2481	2153	1731	1140	710	525	352	307	244	204	87.6
1.70V	3486	2727	2295	2006	1631	1107	697	518	349	304	242	203	87.1
1.75V	3050	2512	2161	1912	1576	1100	685	509	344	300	240	201	86.5
1.80V	2677	2325	2040	1824	1517	1048	669	500	340	297	237	200	85.9

GFM-3000C	5min	10min	15min	20min	30min	1hr	2hr	3h	5h	6h	8h	10h	24h
1. 60V	6300	4867	4027	3467	2752	1740	1084	799	535	466	370	309	132
1. 65V	5727	4457	3722	3230	2596	1710	1065	788	529	461	366	307	131
1. 70V	5230	4090	3443	3009	2447	1660	1046	777	523	456	363	304	131
1. 75V	4575	3767	3242	2868	2364	1650	1027	764	516	451	360	302	130
1. 80V	4016	3487	3060	2735	2276	1571	1003	750	510	445	356	300	129

Table 2-3 GFM (6V/12V) Battery Constant Current Discharge Data Sheet (Amperes, 25 °C)

3GFM-200	5min	10min	15min	20min	30min	1hr	2hr	3h	5h	6h	8h	10h	24h
1. 60V	604.0	437.3	350.7	295.0	214.0	127.3	72.00	54.0	36.00	35.5	25.1	20.90	8.82
1. 65V	544.0	404.0	333.3	285.0	207.5	122.7	70.00	53.1	35.50	33.1	24.5	20.80	8.76
1. 70V	504.0	377.3	317.3	273.0	200.7	117.0	67.50	52.1	34.90	32.0	24.2	20.70	8.70
1. 75V	437.3	357.3	297.3	260.0	194.0	113.0	64.90	51.6	34.20	30.8	23.8	20.50	8.66
1. 80V	410.7	330.7	277.3	246.0	185.0	110.0	62.00	51	33.30	29.6	23.6	20.00	8.60
6GFM-80	5min	10min	15min	20min	30min	1hr	2hr	3h	5h	6h	8h	10h	24h
1. 60V	251.0	185.0	142.0	116.0	81.9	49.4	29.2	21.6	14.4	14.1	10.56	8.50	3.56
1. 65V	241.0	181.0	138.0	113.0	81.1	49.3	29.1	21.2	14.1	13.7	10.32	8.40	3.53
1. 70V	229.0	175.0	133.0	110.0	80.0	48.8	28.9	20.9	13.7	13.4	10.08	8.30	3.51
1. 75V	215.0	165.0	128.0	105.0	78.1	47.6	28.6	20.6	13.3	12.6	9.84	8.20	3.49
1. 80V	195.0	153.0	122.0	99.0	75.3	46.4	28.1	20.3	12.8	11.9	9.60	8.00	3.47
6GFM-100	5min	10min	15min	20min	30min	1hr	2hr	3h	5h	6h	8h	10h	24h
1. 60V	307.0	233.0	185.0	157.0	106.0	62.0	35.0	27.0	18.0	16.1	13.0	10.5	4.42
1. 65V	282.0	212.0	178.0	150.0	102.0	60.0	33.0	26.5	17.0	15.8	12.6	10.4	4.39
1. 70V	262.0	192.0	169.0	142.0	98.0	58.0	31.0	26.1	16.0	15.5	12.3	10.3	4.37
1. 75V	252.0	187.0	160.0	132.0	94.0	56.0	30.0	25.8	15.0	15.2	12.1	10.2	4.35
1. 80V	232.0	182.0	151.0	120.0	89.0	55.0	29.0	25.5	14.0	14.8	11.9	10.0	4.31
6GFM-150	5min	10min	15min	20min	30min	1hr	2hr	3h	5h	6h	8h	10h	24h
1. 60V	453.0	328.0	263.0	227.0	165.0	95.5	54.5	40.5	27.0	23.5	19.1	15.9	6.75
1. 65V	408.0	303.0	250.0	221.0	160.0	90.5	52.5	39.8	26.0	23.0	18.8	15.7	6.7
1. 70V	378.0	283.0	238.0	215.0	155.0	85.5	50.5	39.1	25.0	22.5	18.5	15.5	6.65
1. 75V	328.0	268.0	223.0	205.0	150.0	84.0	48.5	38.7	24.0	22.0	18.2	15.3	6.6
1. 80V	308.0	248.0	208.0	185.0	145.0	82.5	46.5	38.0	23.0	21.5	17.8	15.0	6.5
6GFM-200	5min	10min	15min	20min	30min	1hr	2hr	3h	5h	6h	8h	10h	24h
1. 60V	604.0	437.3	350.7	303.3	220.7	127.3	72.7	54.0	40.0	35.5	25.2	21.3	8.82
1. 65V	544.0	404.0	333.3	295.3	214.0	123.3	70.0	53.1	37.3	33.1	24.6	20.8	8.76
1. 70V	504.0	377.3	317.3	287.3	207.3	119.0	67.3	52.1	36.0	32.0	24.3	20.5	8.70
1. 75V	437.3	357.3	297.3	274.0	200.7	115.0	64.7	51.6	34.7	30.8	23.9	20.2	8.66
1. 80V	410.7	330.7	277.3	247.3	194.0	110.0	62.0	51.0	33.3	29.6	23.7	20.0	8.60

Internal Resistance and Short Circuit Current

The internal resistance is dynamic nonlinear parameter, it continuously varies with the temperature, charge state and service duration. The internal resistance is the lowest when the battery is fully charged. Table 2-4 present the internal resistance and short circuit current of the battery which the internal resistance is measured by "HIOKI 3551 BATTERY HITESTER" resistance tester at an ambient temperature of $25\pm 5^{\circ}\text{C}$, in the fully charged state.

Table 2-4 The internal resistance and short-circuit current (25 °C)

Battery Type	Reference Internal Resistance (mΩ)	Short Circuit Current (A)	Battery Type	Reference Internal Resistance (mΩ)	Short Circuit Current (A)
GFM-100C	0.65	3050	3GFM-200	1.5	4000
GFM-200C	0.50	3100	6GFM-80	6.2	1935
GFM-300C	0.43	3900	6GFM-100	5.0	2400
GFM-400C	0.36	4900	6GFM-150	3.8	3150
GFM-500C	0.34	5200	6GFM-200	2.9	4120
GFM-600C	0.30	6000			
GFM-800C	0.19	7200			
GFM-1000C	0.17	8600			
GFM-1200C	0.16	9900			
GFM-1500C	0.18	11500			
GFM-2000C	0.10	13400			
GFM-3000C	0.09	20000			

Chapter Three Operation and maintenance

Parameters

GFM-C series batteries could be used in ambient temperature of $-20^{\circ}\text{C} \sim +45^{\circ}\text{C}$, and the recommended operation temperature is $25 \pm 5^{\circ}\text{C}$, higher or lower temperature will shorten battery service life.

Table 3-1 Backup power supply parameter setting

(GFM-200C ~ 3000C series batteries)

Parameters	48V/24 pcs batteries	24V/12 pcs batteries
Floating charge voltage (V) (25°C)	54.00~55.20	27.00~27.60
Equalizing charge voltage (V) (25°C)	56.40~58.80	28.20~29.40
Equalizing charge period	Battery operation in floating charge for every 3 months, or more than two batteries with a voltage lower than 2.18V in a battery bank.	
Current for floating charge and equalizing charge change (A)	0.005C ₁₀ ~0.01C ₁₀	
Charge limited current (A)	≤0.15C ₁₀ (limited current could be raised to 0.18C ₁₀ under special situation)	
Discharge protection voltage	44.46V	22.23V

Table 3-2 Backup power supply parameter setting

(GFM-100C/3GFM/6GFM series batteries)

Parameters	48V system	24V system
Floating charge voltage (V) (25°C)	54.0~55.2	27.0~27.6
Equalizing charge voltage (V) (25°C)	57.12~58.08	28.56~29.04
Equalizing charge period	Battery operation in floating charge for every 3 months, or more than two batteries with a voltage lower than 2.18V in a battery bank.	
Current for floating charge and equalizing charge change (A)	0.005C ₁₀ ~0.01C ₁₀	

Charge limited current (A)	$\leq 0.15C_{10}$ (limited current could be raised to $0.20C_{10}$ under special situation)	
Discharge protection voltage	44.46V	22.23V

Table 3-3 Switch power supply parameter setting
(GFM-200C ~ 3000C series batteries)

Parameters	220V/104 pcs batteries	110V/52 pcs batteries
Floating charge voltage (V) (25°C)	234.00~239.20	117.00~119.60
Equalizing charge voltage (V) (25°C)	244.40~254.80	122.20~127.40
Equalizing charge period	Battery operation in floating charge for every 3 months, or more than two batteries with a voltage lower than 2.18V in a battery bank.	
Current for floating charge and equalizing charge change (A)	0.005C ₁₀ ~0.01C ₁₀	
Limited current (A)	$\leq 0.15C_{10}$ (limited current could be raised to $0.18C_{10}$ under special situation)	

Table 3-4 Switch power supply parameter setting
(GFM-100C/3GFM/6GFM series batteries)

Parameters	220V/104 pcs batteries	110V/52 pcs batteries
Floating charge voltage (V) (25°C)	234.00~238.16	117.00~119.08
Equalizing charge voltage (V) (25°C)	247.52~251.68	123.76~125.84
Equalizing charge period	Battery operation in floating charge for every 3 months, or more than two batteries with a voltage lower than 2.18V in a battery bank.	
Current for floating charge and equalizing charge change (A)	0.005C ₁₀ ~0.01C ₁₀	
Limited current (A)	$\leq 0.15C_{10}$ (limited current could be raised to $0.2 C_{10}$ under special situation)	

The floating charge voltage, equalizing charge voltage showing in Table 3-1~3-4 is the setting data under ambient temperature of 25°C, for other temperature please refer to Table 3-5.

Factors Influencing capacity

Quantity of electricity battery discharge under certain condition is called battery capacity, symbol is "C", normal unit is Ampere Hour, in short is Ah. Usually discharge rate is indicated through the suffix of "C", such as C10 means capacity at 10 hours discharge rate. C3 means capacity at 3 hours discharge rate.

Battery capacity contains rated capacity and actual capacity, for GFM-C series battery rated capacity please refer to Table 1-1 and Table 1-2. Actual capacity is fact quantity of electricity battery discharge under certain condition, it equal to discharge current multiply discharge time, unit is Ah.

The battery capacity is directly related to the discharge current, end voltage and discharge temperature. In general, the smaller discharge current, the lower end voltage, the higher temperature will cause larger discharge capacity.

Temperature VS battery capacity

Temperature affect battery capacity. Figure 3-1 is capacity (C_{10}) and temperature curve, for example, temperature fall from 25°C to 0°C, capacity will be 80% of rated capacity, meanwhile, low temperature will cause long term charge shortage, negative plate will be vitriolization, finally, there will be not any capacity. If discharge temperature is not 25°C, you could convert the capacity to $C_{25^\circ\text{C}}$ according to following formula.

$$C_{25^\circ\text{C}} = \frac{C_T}{1 + k (T - 25)}$$

In formula: T—Discharge temperature

C_T —Capacity at temperature of T

k—Temperature coefficient

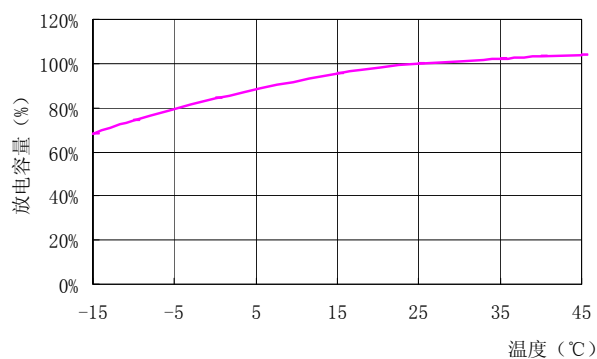
k=0.006/°C at C_{10} discharge

k=0.008/°C at C_3 discharge

k=0.01/°C at C_1 discharge

Along with temperature rise, battery capacity will be larger among certain range, for example, temperature rise from 25°C to 35°C, capacity will be about 105% of rated capacity, but temperature continue rise, capacity rise will be slow, finally, capacity will maintain no change.

Figure 3-1 GFM-C series battery discharge capacity and temperature curve



Temperature and Floating Charge Voltage/Equalizing Charge Voltage

Choose suitable floating charge voltage is for reaching perfect service life and rated capacity,if floating charge voltage is over high,floating current will be large accordingly,that will enhance plate corrosion speed and battery water loss,then shorten battery service life;if floating charge voltage is over low,battery can not maintain fully charged state,irreversible vitriolization will be caused easy,capacity reduced accordingly,then shorten battery service life as well.

Floating charge application,charge voltage could be adjusted according to ambient temperature,temperature compensation coefficient is $-3.0\text{mV}/^{\circ}\text{C}/\text{cell}$.The same way to adjust equalizing charge voltage.Please refer to Table 3-5.

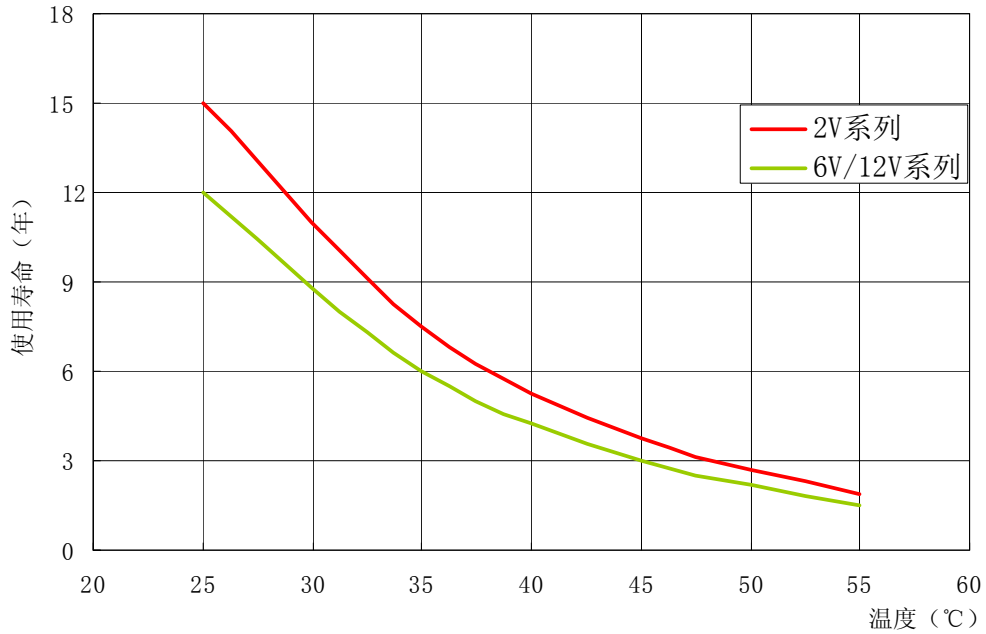
Table 3-5 Voltage Setting at Different Temperature

Temperature ($^{\circ}\text{C}$)	GFM-200C~3000C		GFM-100C/3GFM/6GFM	
	Floating Charge Voltage (V/cell)	Equalizing Charge Voltage (V/cell)	Floating Charge Voltage (V/cell)	Equalizing Charge Voltage (V/cell)
-20	2.41	2.53	2.41	2.54
-10	2.39	2.52	2.39	2.52
0	2.36	2.48	2.36	2.49
10	2.32	2.45	2.32	2.45
20	2.29	2.42	2.29	2.42
25	2.27	2.40	2.27	2.40
30	2.25	2.37	2.25	2.38
35	2.24	2.35	2.24	2.37
40	2.21	2.33	2.22	2.35
45	2.19	2.30	2.20	2.33

Temperature and Battery Service Life

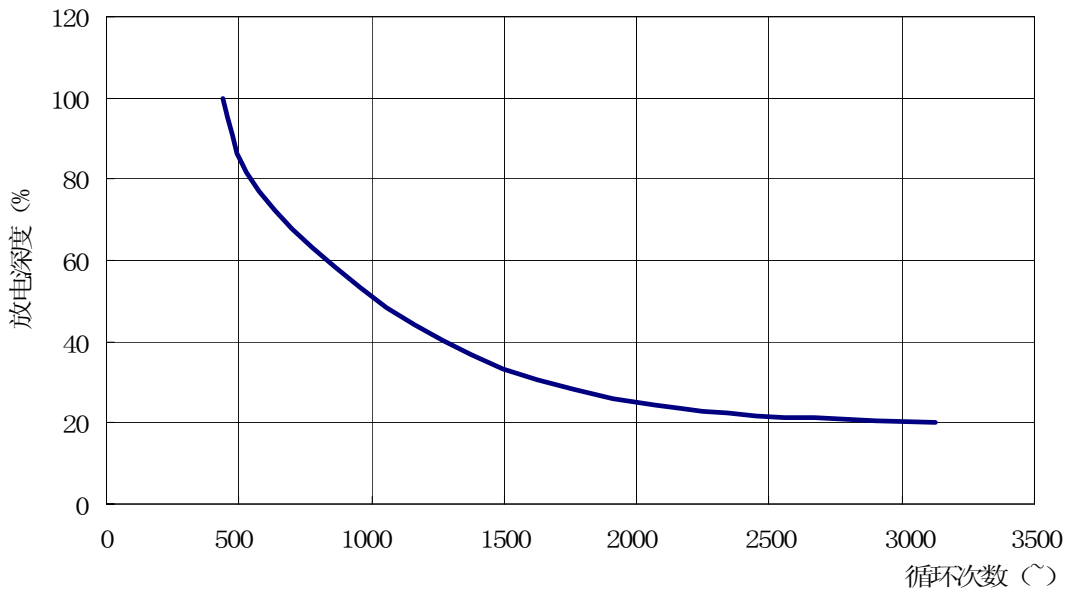
Higher temperature will speed up the battery grid corrosion and water loss, thus greatly shorten the battery life, when the temperature is over 25°C , the service life of the battery will be shortened by half as the temperature increasing by 10°C , shown in Figure 3-2 .

Figure 3-2 GFM-C series battery service life and temperature curve



Discharge depth and Battery cycle times

Figure 3-3 GFM-C series discharge depth and cycle times curve



Battery Selection

Select specific capacity of Sacred Sun GFM-C Series according to the table 2-2, 2-3 with the following procedures.

Step 1: confirm the end voltage, for example, the battery end voltage is 1.8V / cell.

Step 2: confirm the continuous operation time of battery bank and discharge current, according to

the table 2-2, 2-3.

Step 3: confirm ambient temperature, according to Figure 3-1 to determine the temperature coefficient, calculate the required battery capacity, and select battery according to the capacity calculation.

In order to ensure the battery service life, the depth of discharge can not be too deep for each time, preferably no more than 80%. Particularly in areas of intensive use of electricity, the battery capacity should be redundant after discharge to prevent the damage to battery of long-term low capacity.

Or to select according to the battery selection procedure of IEEE 845.

Charge Requirement

✧ Equalizing Charge and Supplementary Charge

Equalizing charge or supplementary charge is needed in the following cases:

- After finish installation, before the battery system is put into operation, the battery bank should be supplementary charged.
- Running in full-floating operation for three months, or when there are more than two batteries with voltage of lower than 2.18V.
- The battery is out of work beyond 3 months.

Recommended charge method as follows:

2.40V / cell for GFM-200 ~ 3000C with limited current of $0.15 C_{10}$ (A), 2.40V / cell for GFM-100C/3GFM/6GFM series with limited current of $0.2 C_{10}$ (A), charge for 16 to 20 hours. Temperature compensation coefficient is $-3.0\text{mV} / \text{cell} / ^\circ\text{C}$.

Notes:

- Above charge time is subject to temperature range of $20\sim 30^\circ\text{C}$, if temperature is fall, charge time should be proper prolong, if temperature is rise, charge time should be proper shortened accordingly.
- After equalizing charge, for batteries with voltage lower than 2.18V / cell, we should make the battery discharged in $0.1 C_{10}$ A for 3-4 hours, and then charge the battery with constant voltage of 2.36V / cell (2.40V / cell for GFM-100C/3GFM / 6GFM Battery) and limited current of $0.1 C_{10}$ A.

✧ Recharge

Recharge the battery immediately after complete or partial discharge according to the below method:

Charge the battery with constant current of $0.1 C_{10} \sim 0.15 C_{10}$ A until the battery voltage rises to 2.35~2.45V / cell (2.38~2.42V / cell for GFM-100C/3GFM/6GFM battery), then change to constant voltage charge of 2.34~2.38V / cell (2.38~2.42V / cell for GFM-100C/3GFM/6GFM battery) until the charge completed. Any of the following two items can be regarded as the fully charged symbol.

- Refer to the required time as table 3-4.
- In Constant voltage case, the charge current keep unchanged for 3 hours in the final stage of charge.

Under some special conditions, battery need fast charged, fast charge method could be adopted.

- GFM-200~3000C batteries: limited current of $0.18 C_{10}$ (A), charge voltage of 2.35~2.45V/cell;
- GFM-100C/3GFM/6GFM batteries: limited current of $0.2 C_{10}$ (A), charge voltage of 2.38~2.42V/cell

Table 3-6 Required charge time in different depth of discharge

Depth of discharge (%)	Charge current of constant current charge (A)	Time for changing constant current charge to constant voltage charge (h)	Charge voltage of constant voltage charge (V)	Charge time (h)
20	0.10C ₁₀	1.6	2.36	12
	0.15C ₁₀	1.2	2.36	10
50	0.10C ₁₀	4.3	2.36	18
	0.15C ₁₀	3.3	2.36	16
80	0.10C ₁₀	6.8	2.36	20
	0.15C ₁₀	5.5	2.36	18
100	0.1C ₁₀	8.7	2.36	24
	0.15C ₁₀	6.8	2.36	22

✧ Floating charge

Floating operation is the best operation condition for battery. In floating operation, the battery keep fully charged state, under this condition, battery could reach the longest service life. For floating operation, the charge voltage should be suitable adjusted according to ambient temperature as shown in Table 3-5.

Storage

- The battery can be stored at -20~45°C before installation; the storage time shall not exceed 6 months and 3 months at -20~30°C and 31~45°C respectively. Battery that has been stored for a long time shall be charged and the longest storage time shouldn't exceed 18 months.
- The battery should be stored in clean, ventilate, and dry environment with dustproof, moisture proof, anti-collision and other protective measures. To place the battery in closed containers is strictly prohibited.
- The used battery shall be charged fully before storage, then store the battery following the storage requirements.

Maintenance

To ensure the performance of battery, the battery should be correctly inspected and maintained. The maintenance methods are recommended as follows.

✧ Monthly Maintenance:

- Keep the battery space clean.
- Measure and record the ambient temperature of the battery-room and battery container temperature.

- Check battery cleanliness,terminal damage and heating track,container and lid damage and over heating track.
- Check battery and battery rack connection,spring mat and bolts connected tight or not,input terminal heating or not,connected terminal between layer heating or not.
- Check the container sealing,leakage/potential leakage or not in terminal,valve and container position
- Check charger temperature compensation function in normal or not,parameters setting correct or not,equalizing charge voltage,floating charge voltage period and other parameters reasonable setting or not
- Measure and record the total voltage and floating current of the battery system.

✧ Quarterly Maintenance:

- Repeat every item of monthly inspection.
- Measure and record the floating voltage of each on-line battery. After temperature emendation,if more two batteries with a voltage of lower than 2.18V, the battery system needs equalizing charge.If the problem is not solved,go on annually maintenance even three yearly maintenance items.All the above methods fail,please contact our after-sale service center.

✧ Annually Maintenance:

- Repeat every item of quarterly maintenance and inspection.
- Check weather the battery beyond service expiry or not.
- Perform a discharge test to check the exact load every year, discharge 30%~40% of the rated capacity.

✧ Maintenance notes

- Please use insulated tools when operation and maintenance,any metal objects to be put on top of the battery shall be strictly prohibited;
- Please do not use any organic solvent to clean batteries;
- Please do not take down safety valve or add any substance into battery
- Please do not smoke or set out fire near batteries.
- Please keep battery fully charged within 24 hours after discharge,avoid capacity affected
- Check whether safety valve twisted tightly or not,but please do not take down it.
- Stored battery performance could be in degeneration,please put the battery in operation early.
- Only professionals shall be allowed to maintain the battery