VALVER REGULATED SEAL LEAD ACID BATTERY

MP Series

OPERATION MANUAL

Version：V3.5

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Contents

Security Instructions

Please read this manual! It provides very important information for security, installation and operation. The information will allow your equipment give a better performance and longer service life.

■ Do not try to take apart batteries. The spare parts are not inside the battery. Maintenance works should be done by professionals.

■ The replacement should be made or supervised by professionals with suitable protection. The batteries for replacement should be same as the old ones in model and type.

■ Warning——Do not smoke or use fire near batteries.

■ Warning——Do not use any organic cleanser to clean batteries.

■ Warning——Do not put the batteries on fire, or they will explode

■ Warning——Do not cut open the batteries. They contain electrolyte which is toxic to skin and eyes.。

■ Warning——Batteries may cause shock and short. Please remove the watch and jewelry such as rings when replace the battery. Also please operate with insulating tools.

Please take care of the following marks in using

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

Chapter One Product Introduction

1. Features

1.1. Long life

1.1.1. 4BS paste technology

1.1.2. Special Paste Formula

1.1.3. Special Patented grid alloy

1.1.4. Thick Plate Design

1.2. Reliable Seal Technology

1.2.1. High precise ABS heat heal technology；

1.2.2. The seal recombination efficiency reaches up to 99.0%；

1.2.3. Reliable post seal structure；

1.2.4. Integrated valve design to ensure precise and reliability.

1.3. Excellent high rate discharge performance

1.3.1. Through-the-portion Welding and low internal Resistance.

1.3.2. Radical Grid Design.

1.3.3. Patented Paste Technology.

1.3.4. Silver Coated Flexible Connector

1.4. Front terminal rack design

1.4.1. Excellent Heat Dispersing Ability

1.4.2. Positive and Negative Terminals on the Same Side .Easy for Monitoring and Maintenance.

1.4.3. Flexible Connector for Flexible installation.

1.4.4. Acid Filtering Structure

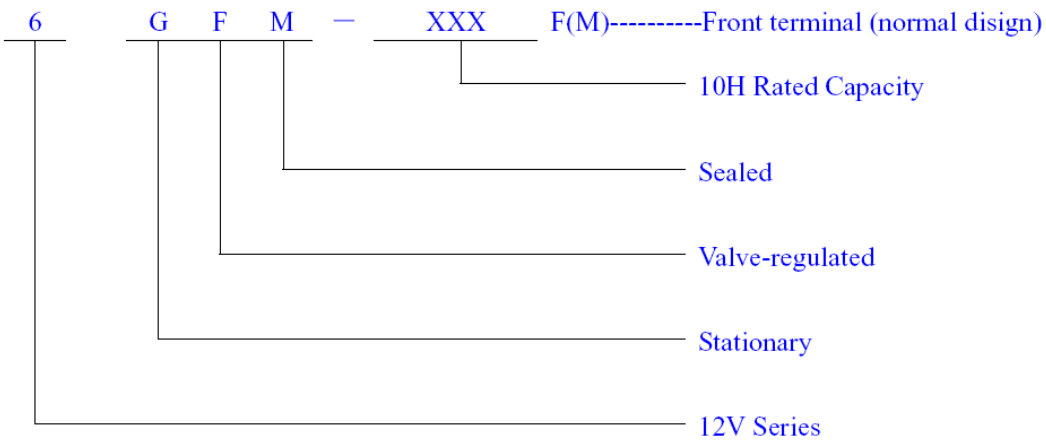
2. Main Applications

2.1. Communication System

2.2. UPS

2.3. Electricity Power System

3. Indication of type



4. Types and Dimensions

Tab.1-1 Types and Dimensions

Type	Normal Voltage (V)	Rated Capacity C_{10}(Ah)	Dimensions(mm)			Weight (Kg)
			Length	Width	Height	
6-GFM-50F	12	50	390	105	227	21.5
6-GFM-65F	12	65	395	105	270	24.5
6-GFM-85F	12	85	395	105	270	30
6-GFM-100F	12	100	558	125	227	39
6-GFM-105F	12	100	511	110	238	34
6-GFM-125F	12	125	558	125	270	49
6-GFM-150F	12	150	558	125	310	53
6-GFM-155F	12	155	559	125	283	54
6-GFM-170F	12	170	558	125	310	56
6-GFM-200M	12	200	498	259	238	74.5

5. Working Principal

$$Pb + PbO_2 + 2H_2SO_4 \underset{CHA}{\overset{DCH}{\rightleftharpoons}} 2PbSO_4 + 2H_2O$$

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

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

$$2H_2O \rightarrow H_2 \uparrow + O_2 \uparrow \text{.....A}$$

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

MP battery adopts 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 prevent 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 B and C:：

$$2Pb + O_2 \rightarrow 2PbO\text{.....B}$$

$$PbO + H_2SO_4 \rightarrow PbSO_4 + H_2O\text{.....C}$$

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

Chapter Two Technical Characteristics

1. Charge Characteristics Curve

Fig. 2-1 Recharge characteristics curve of with initial 0.1C_{10}A current and limit voltage 2.40V/cell (25℃).The fully discharged battery can be charged 110% capacity after 24 hours.

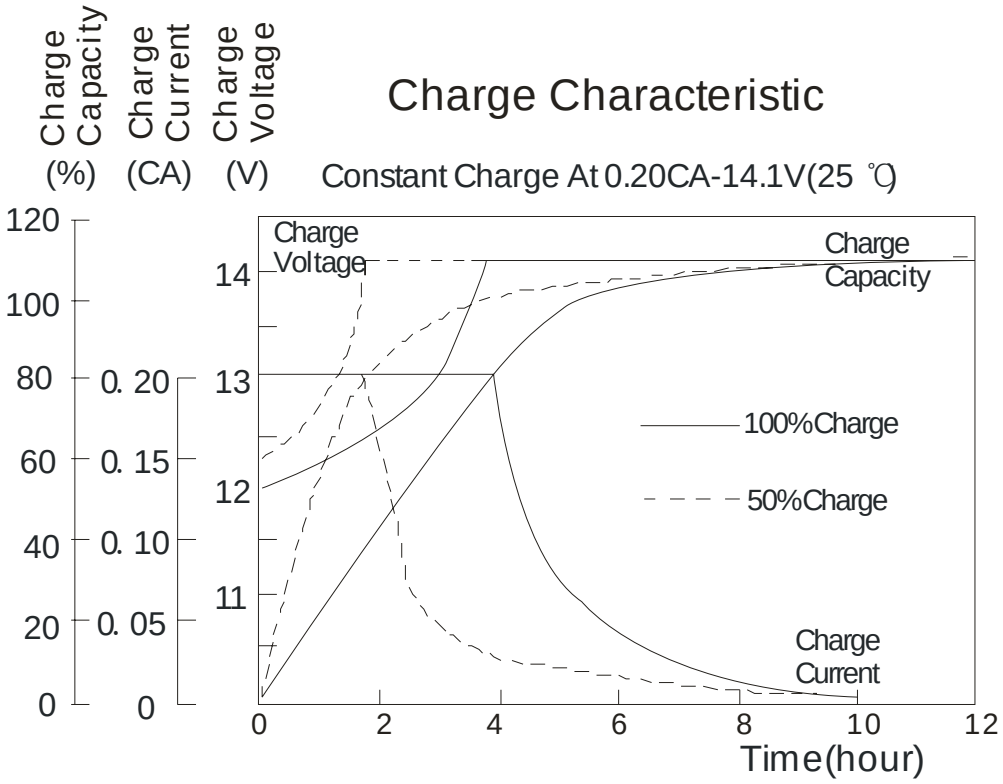


Fig. 2-1 Constant Voltage Limit Current Charge Curve

2. Discharge Characteristics Curve

Fig.2-2、2-3 are the discharge performance curves with different current（0.1C_{10}～1.0C_{10}） at 25 ℃. The end voltage is 1.75V/cell.

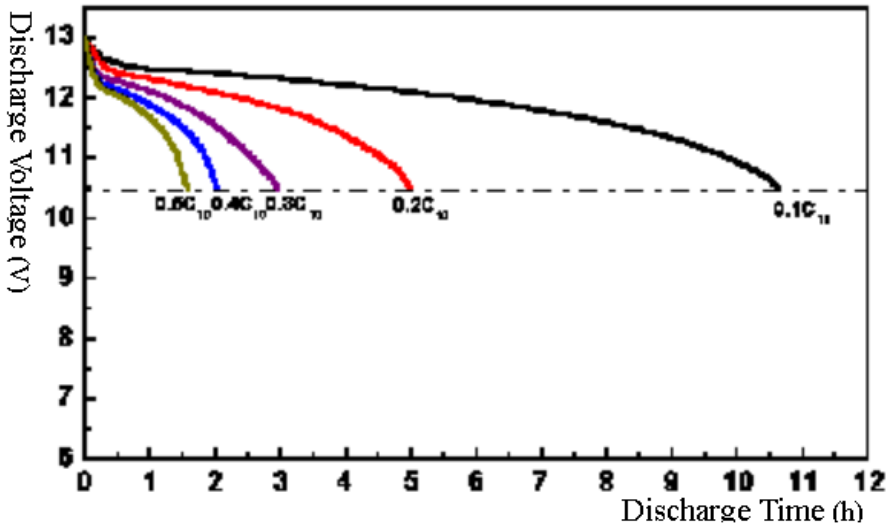


Fig. 2-2 Discharge Curve with the current of 0.1 C_{10}～0.5 C_{10}A（25℃）

Explanation for fig. 2-1：let us make 6-GFM-110F battery as an example. The C_{10} of 6-GFM-110F is 110Ah，so when discharge with $0.2C_{10}$, i.e.0.2×110＝22A，The discharge voltage and discharge time is shown by $0.2C_{10}$ curve.

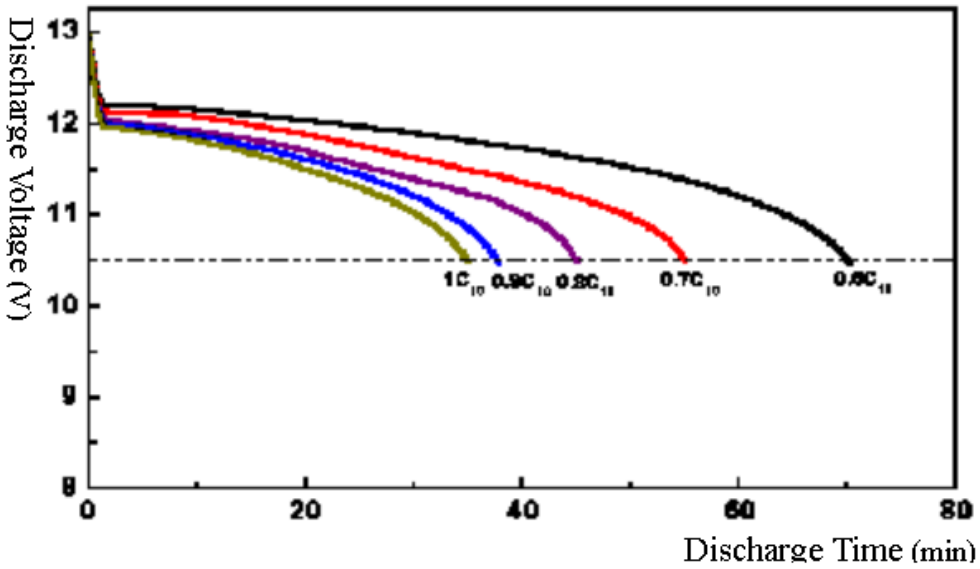


Fig. 2-3 Discharge Curve with the current of 0.6 C_{10}～1.0 C_{10}A（25℃）

Explanation for fig. 2-3：let us make 6-GFM-110F battery as an example. The C_{10} of 6-GFM-110F is 110Ah，so when discharge with $0.8C_{10}$, i.e.0.8×110＝88A，The discharge voltage and discharge time is shown by $0.8C_{10}$ curve.

Fig.2-4 are the curves at different discharge rate (20～50 hours rate) at 25℃. The end voltage is 1.85V/cell and 1.80V/cell

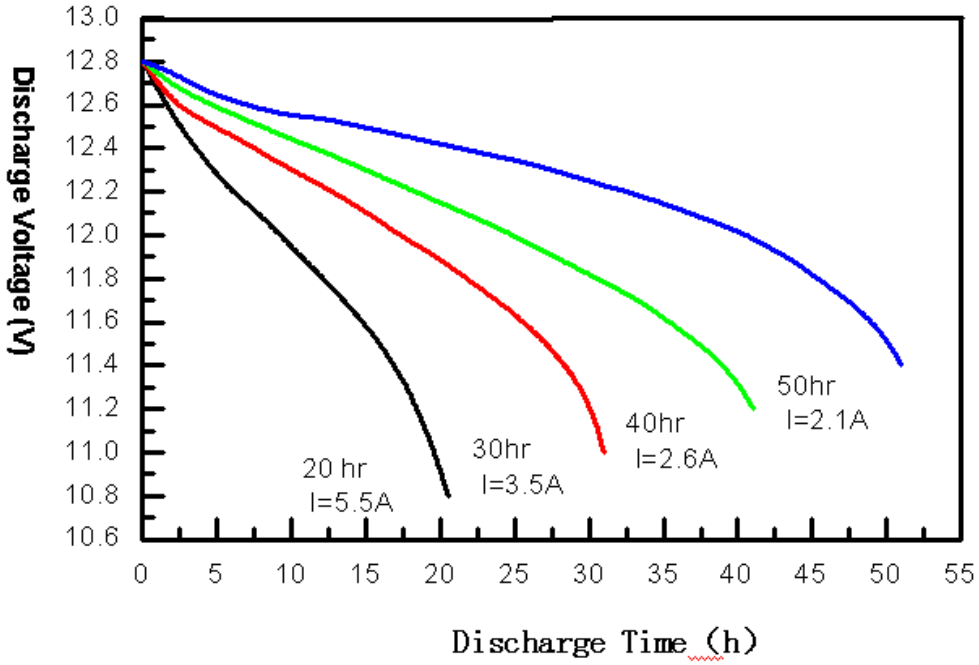
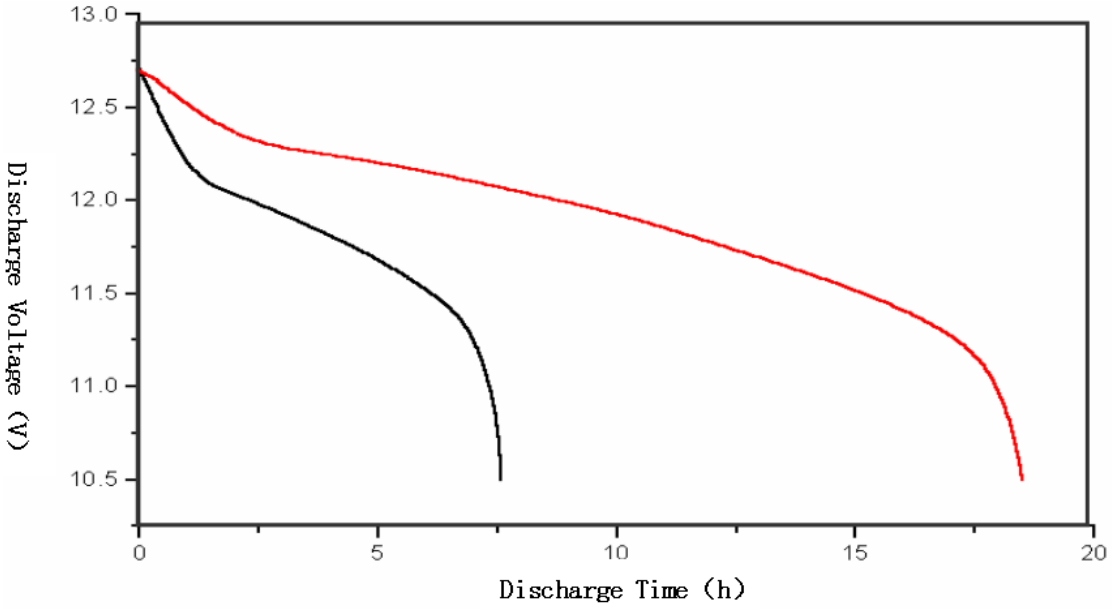


Fig.2-4 Discharge Curve at 20～50 hours rate（25℃）

Fig.2-5 are the discharge time curves at different discharge current (10A～5A) at -15℃.



The end voltage is 1.75V./cell.

Fig.2-5. Discharge Curves with Current of 5A、10A at low temperature（-15℃）

3. 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 2-1 shows the internal resistance and short circuit current in fully charged state

Table 2-1 Internal resistance and short circuit (25℃)

Type	Internal Resistance(mΩ)	Short Circuit Current (A)
6-GFM-50F	8.32	1491
6-GFM-65F	5.40	1990
6-GFM-85F	6.73	1884
6-GFM-100F	4.88	2388
6-GFM-105F	5.40	2344
6-GFM-125F	3.88	3160
6-GFM-150F	4.46	2831
6-GFM-155F	3.00	3240

6-GFM-170F	3.22	3881
6-GFM-200M	2.80	4200

Note: Short circuit current will decrease the voltage of the battery to 0V, and damage the internal components of the battery.

4. The discharge data of MP series

Table 2-2 Constant current discharge characteristic Units: Amperes(25℃)

End voltage per cell	5min	15min	30min	45min	1h	2h	3h	4h	5h	6h	8h	10h	12h	20h	24h
6-GFM-50F															
1.60V	163	87.4	53.0	38.4	31.0	17.8	13.9	10.7	9.60	8.06	6.26	5.15	4.38	2.72	2.27
1.67V	153	84.3	52.0	38.1	30.8	17.7	13.7	10.6	9.50	8.02	6.19	5.08	4.33	2.70	2.25
1.70V	151	82.8	51.3	37.8	30.6	17.6	13.6	10.6	9.40	8.02	6.19	5.09	4.29	2.69	2.25
1.75V	139	80.2	50.8	37.5	30.2	17.1	13.4	10.5	9.30	7.96	6.13	5.05	4.29	2.68	2.25
1.80V	125	74.8	48.7	36.0	29.4	17.0	13.4	10.4	9.05	7.80	6.09	5.00	4.26	2.66	2.24
1.83V	119	68.5	47.7	34.8	28.1	16.7	12.9	9.94	8.76	7.53	5.94	4.81	4.08	2.65	2.21
1.85V	111	66.4	44.4	33.4	27.2	16.1	12.6	9.81	8.55	7.37	5.75	4.78	4.06	2.60	2.19
6-GFM-85F															
1.60V	314	169	102	74.2	60.0	34.4	24.9	19.6	16.5	14.2	10.9	8.96	7.55	4.73	3.95
1.67V	295	163	101	73.6	59.6	34.2	24.5	19.5	16.4	14.1	10.8	8.87	7.54	4.69	3.92
1.70V	292	160	99.2	73.1	59.2	33.9	24.4	19.4	16.2	14.0	10.8	8.83	7.47	4.68	3.92
1.75V	269	155	98.3	72.6	58.3	33.1	24.1	19.1	16.1	13.8	10.7	8.78	7.47	4.67	3.91
1.80V	241	145	94.1	69.6	56.8	32.8	23.9	19.1	15.8	13.6	10.6	8.70	7.40	4.62	3.91
1.83V	230	132	92.3	67.3	54.3	32.4	23.1	18.2	15.2	13.1	10.3	8.38	7.04	4.61	3.84
1.85V	215	128	85.8	64.6	52.6	31.2	22.5	18.0	14.9	12.8	10.0	8.31	6.96	4.52	3.81
6-GFM-105F															
1.60V	372	200	121	87.8	71.0	40.7	29.5	23.2	19.6	16.8	12.9	10.6	8.94	5.60	4.68
1.67V	350	193	119	87.2	70.6	40.5	29.0	23.0	19.5	16.7	12.8	10.5	8.93	5.55	4.64
1.70V	346	190	117	86.5	70.0	40.2	28.8	22.9	19.2	16.5	12.7	10.5	8.84	5.54	4.64
1.75V	318	184	116	85.9	69.0	39.1	28.5	22.7	19.1	16.4	12.6	10.4	8.84	5.53	4.63
1.80V	285	171	111	82.4	68.0	38.8	28.3	22.6	18.7	16.1	12.5	10.3	8.77	5.47	4.62
1.83V	272	157	109	79.7	64.3	38.3	27.4	21.6	18.0	15.5	12.2	9.92	8.34	5.46	4.55
1.85V	255	152	102	76.5	62.3	36.9	26.6	21.3	17.6	15.2	11.8	9.84	8.24	5.36	4.51
6-GFM-125F															
1.60V	406	218	132	95.9	77.5	44.5	34.8	26.7	24.0	20.1	15.7	13.0	10.9	6.80	5.68
1.67V	382	211	130	95.2	77.1	44.2	34.2	26.6	23.8	20.1	15.5	12.9	10.8	6.74	5.63
1.70V	378	207	128	94.5	76.5	43.9	34.0	26.4	23.5	20.1	15.5	12.7	10.7	6.72	5.63
1.75V	347	201	127	93.8	75.4	42.8	33.6	26.1	23.2	19.9	15.3	12.6	10.7	6.71	5.62

1.80V	311	187	122	90.0	73.4	42.4	33.4	26.1	22.6	19.5	15.2	12.5	10.6	6.64	5.61
1.83V	297	171	119	87.0	70.2	41.9	32.3	24.8	21.9	18.8	14.8	12.0	10.2	6.63	5.52
1.85V	278	166	111	83.5	68.1	40.3	31.4	24.5	21.4	18.4	14.4	11.9	10.1	6.50	5.47
End voltage per cell	5min	15min	30min	45min	1h	2h	3h	4h	5h	6h	8h	10h	12h	20h	24h
6-GFM-150F															
1.60V	567	305	185	134	108	62.1	45.0	35.3	29.8	25.6	19.7	16.2	13.6	8.54	7.13
1.67V	533	294	182	133	108	61.7	44.2	35.1	29.7	25.4	19.5	15.9	13.6	8.47	7.07
1.70V	528	289	179	132	107	61.2	44.0	34.9	29.2	25.2	19.4	15.9	13.5	8.45	7.07
1.75V	485	280	177	131	105	59.7	43.4	34.5	29.0	25.0	19.2	15.9	13.5	8.42	7.06
1.80V	435	261	170	126	102	59.2	43.2	34.4	28.4	24.5	19.1	15.7	13.4	8.34	7.05
1.83V	414	239	167	121	98.0	58.4	41.7	32.9	27.5	23.7	18.6	15.1	12.7	8.32	6.93
1.85V	388	232	155	117	95.0	56.3	40.6	32.4	26.8	23.1	18.1	15.0	12.6	8.16	6.88
6-GFM-155F															
1.60V	504	271	164	119	96.1	55.1	43.2	33.1	28.9	25.0	19.4	16.0	13.6	8.43	7.04
1.67V	473	261	161	118	95.6	54.8	42.4	32.9	28.7	24.9	19.2	15.7	13.4	8.36	6.98
1.70V	469	257	159	117	94.9	54.4	42.2	32.8	29.3	24.9	19.2	15.8	13.3	8.34	6.98
1.75V	431	249	158	116	93.5	53.0	41.7	32.4	28.8	24.7	19.0	15.7	13.3	8.32	6.97
1.80V	386	232	151	112	91.1	52.6	41.4	32.3	28.1	24.2	18.9	15.5	13.2	8.24	6.96
1.83V	368	212	148	108	87.1	51.9	40.1	30.8	27.2	23.3	18.4	14.9	12.7	8.22	6.85
1.85V	345	206	137	104	84.4	50.0	39.0	30.4	26.5	22.8	17.8	14.8	12.6	8.06	6.79
6-GFM-170F															
1.60V	621	334	202	147	119	68.0	49.3	38.7	32.7	28.1	21.5	17.7	14.9	9.35	7.82
1.67V	584	322	199	146	118	67.6	48.4	38.5	32.5	27.8	21.4	17.5	14.9	9.27	7.75
1.70V	578	316	196	144	117	67.1	48.2	38.3	32.0	27.6	21.3	17.5	14.8	9.25	7.74
1.75V	531	307	194	143	115	65.4	47.6	37.8	31.8	27.4	21.1	17.4	14.8	9.23	7.74
1.80V	476	286	186	138	112	64.8	47.3	37.7	31.1	26.8	21.0	17.2	14.6	9.14	7.72
1.83V	454	262	182	133	107	64.0	45.7	36.0	30.1	25.9	20.4	16.6	13.9	9.12	7.60
1.85V	426	254	170	128	104	61.6	44.5	35.5	29.4	25.3	19.8	16.4	13.8	8.94	7.53
6-GFM-200M															
1.60V	650	350	212	153	124	71.1	55.7	42.8	38.4	32.2	25.1	20.6	17.5	10.9	9.09
1.67V	611	337	208	152	123	70.8	54.7	42.5	38.0	32.1	24.8	20.3	17.3	10.8	9.01
1.70V	605	331	205	151	122	70.2	54.4	42.3	37.6	32.1	24.8	20.4	17.2	10.8	9.00
1.75V	556	321	203	150	121	68.4	53.8	41.8	37.2	31.8	24.5	20.2	17.2	10.7	8.99
1.80V	498	299	195	144	117	67.8	53.4	41.7	36.2	31.2	24.4	20.0	17.0	10.6	8.98
1.83V	475	274	191	139	112	67.0	51.7	39.8	35.0	30.1	23.8	19.3	16.3	10.6	8.83
1.85V	445	266	177	134	109	64.5	50.3	39.2	34.2	29.5	23.0	19.1	16.2	10.4	8.76
6-GFM-100F															
1.60V	325	175	106	76.7	62.0	35.6	27.9	21.4	19.2	16.1	12.5	10.4	8.75	5.44	4.54
1.67V	305	169	104	76.2	61.7	35.4	27.4	21.3	19.0	16.1	12.4	10.3	8.67	5.39	4.50

1.70V	302	166	103	75.6	61.2	35.1	27.2	21.1	18.8	16.0	12.4	10.2	8.58	5.38	4.50
1.75V	278	160	102	75.1	60.3	34.2	26.9	20.9	18.6	15.9	12.1	10.1	8.58	5.37	4.50
1.80V	249	150	97.4	72.0	58.7	33.9	26.7	20.8	18.1	15.6	12.0	10.0	8.51	5.31	4.49
1.83V	238	137	95.5	69.6	56.2	33.5	25.8	19.9	17.5	15.1	11.9	9.63	8.17	5.30	4.42
1.85V	223	133	88.7	66.8	54.4	32.2	25.1	19.6	17.1	14.7	11.5	9.55	8.12	5.20	4.38

Table 2-3 Discharge data with constant power Units: Watts per cell(25℃)

End voltage per cell	5min	15min	30min	45min	1h	2h	3h	4h	5h	6h	8h	10h	12h	20h	24h
6-GFM-50F															
1.60V	272	153	95.7	72.0	58.3	33.6	26.5	20.5	18.4	15.5	12.2	9.98	8.47	5.38	4.51
1.67V	262	151	94.9	71.6	58.0	33.5	26.1	20.5	18.3	15.5	12.0	9.90	8.41	5.37	4.51
1.70V	260	149	94.9	71.4	57.8	33.3	26.1	20.4	18.1	15.5	12.0	9.85	8.33	5.35	4.50
1.75V	243	148	94.5	71.3	57.0	33.2	25.9	20.4	18.0	15.4	11.9	9.82	8.32	5.34	4.50
1.80V	227	140	92.3	69.6	56.8	33.1	25.8	20.3	17.6	15.3	11.9	9.78	8.30	5.34	4.49
1.83V	219	128	91.2	67.5	54.5	32.7	25.2	19.6	17.3	14.8	11.8	9.53	8.13	5.33	4.46
1.85V	207	125	84.7	64.8	52.8	31.6	24.5	19.3	16.8	14.5	11.4	9.46	8.08	5.23	4.42
6-GFM-85F															
1.60V	525	297	185	139	113	64.9	47.4	37.6	31.7	27.3	21.1	17.4	14.6	9.37	7.85
1.67V	506	291	184	138	112	64.7	46.8	37.5	31.7	27.1	21.0	17.3	14.6	9.34	7.84
1.70V	503	288	183	138	112	64.5	46.8	37.4	31.2	26.9	20.9	17.1	14.5	9.31	7.83
1.75V	475	286	183	138	110	64.1	46.3	37.3	31.2	26.9	20.7	17.1	14.5	9.29	7.83
1.80V	436	270	178	135	110	63.9	46.2	37.2	30.7	26.6	20.6	17.0	14.4	9.29	7.82
1.83V	423	248	176	131	105	63.1	45.1	35.9	30.0	25.8	20.5	16.6	14.0	9.27	7.76
1.85V	400	242	164	125	102	61.1	43.9	35.4	29.3	25.3	19.8	16.5	13.9	9.09	7.70
6-GFM-105F															
1.60V	622	351	219	165	133	76.8	56.1	44.5	37.5	32.3	25.0	20.6	17.3	11.1	9.29
1.67V	599	345	217	164	133	76.6	55.4	44.4	37.5	32.1	24.9	20.4	17.3	11.1	9.29
1.70V	595	341	217	164	132	76.3	55.4	44.2	37.0	31.9	24.7	20.2	17.2	11.0	9.27
1.75V	563	339	216	163	130	75.9	54.8	44.2	37.0	31.8	24.5	20.2	17.1	11.0	9.27
1.80V	516	320	211	159	130	75.7	54.6	44.1	36.3	31.5	24.4	20.1	17.1	11.0	9.25
1.83V	500	293	209	155	125	74.7	53.4	42.5	35.5	30.6	24.2	19.6	16.6	11.0	9.19
1.85V	474	286	194	148	121	72.3	51.9	41.9	34.7	30.0	23.5	19.5	16.4	10.8	9.11
6-GFM-125F															
1.60V	679	384	239	180	146	83.9	66.2	51.3	46.0	38.7	30.4	25.2	21.2	13.5	11.3
1.67V	654	377	237	179	145	83.7	65.3	51.2	45.8	38.8	30.0	25.1	21.0	13.4	11.3

1.70V	650	373	237	179	145	83.4	65.3	51.0	45.4	38.7	30.0	24.6	20.8	13.4	11.3
1.75V	607	370	236	178	142	82.9	64.7	50.9	45.1	38.6	29.7	24.5	20.8	13.3	11.3
1.80V	567	349	231	174	142	82.7	64.5	50.8	44.1	38.2	29.7	24.4	20.7	13.4	11.2
1.83V	546	320	228	169	136	81.6	63.0	49.0	43.1	37.1	29.4	23.8	20.3	13.3	11.2
1.85V	518	313	212	162	132	79.0	61.3	48.3	42.1	36.4	28.5	23.6	20.2	13.1	11.1
End voltage per cell	5min	15min	30min	45min	1h	2h	3h	4h	5h	6h	8h	10h	12h	20h	24h
6-GFM-150F															
1.60V	948	536	334	251	203	117	85.6	67.8	57.2	49.3	38.2	31.3	26.4	16.9	14.2
1.67V	913	526	331	250	202	117	84.4	67.7	57.2	49.0	37.9	31.1	26.4	16.8	14.2
1.70V	907	520	331	249	202	116	84.4	67.4	56.4	48.6	37.7	30.9	26.1	16.8	14.1
1.75V	858	516	330	249	199	116	83.6	67.4	56.3	48.5	37.3	30.8	26.1	16.8	14.1
1.80V	787	488	322	243	198	115	83.3	67.2	55.4	48.0	37.3	30.7	26.1	16.8	14.1
1.83V	763	447	318	236	190	114	81.4	64.7	54.2	46.6	36.9	29.9	25.3	16.7	14.0
1.85V	723	436	296	226	184	110	79.2	63.9	52.8	45.7	35.8	29.7	25.0	16.4	13.9
6-GFM-155F															
1.60V	842	476	297	223	181	104	82.1	63.6	57.1	48.0	37.7	30.9	26.3	16.7	14.0
1.67V	811	467	294	222	180	104	81.0	63.5	56.8	48.0	37.3	30.7	26.1	16.6	14.0
1.70V	806	462	294	221	179	103	81.0	63.2	56.2	48.0	37.2	30.5	25.8	16.6	14.0
1.75V	752	458	293	221	177	103	80.2	63.2	55.9	47.8	36.8	30.4	25.8	16.6	14.0
1.80V	703	433	286	216	176	103	79.9	63.0	54.7	47.4	36.8	30.3	25.7	16.6	13.9
1.83V	678	397	283	209	169	101	78.1	60.7	53.5	46.0	36.4	29.5	25.2	16.5	13.8
1.85V	642	388	263	201	164	98.0	76.0	59.9	52.2	45.1	35.3	29.3	25.0	16.2	13.7
6-GFM-170F															
1.60V	1038	587	366	275	223	128	93.7	74.3	62.7	54.0	41.8	34.3	28.9	18.5	15.5
1.67V	1000	576	363	273	222	128	92.5	74.2	62.7	53.7	41.6	34.1	28.9	18.5	15.5
1.70V	994	570	363	273	221	127	92.5	73.9	61.7	53.3	41.3	33.8	28.6	18.4	15.5
1.75V	928	565	361	273	218	127	91.5	73.8	61.7	53.1	40.9	33.8	28.6	18.4	15.5
1.80V	851	534	353	266	217	126	91.3	73.6	60.7	52.6	40.8	33.6	28.5	18.4	15.5
1.83V	813	490	348	258	208	125	89.2	70.9	59.4	51.0	40.4	32.8	27.7	18.3	15.3
1.85V	760	478	324	248	202	121	86.7	70.0	57.9	50.0	39.2	32.5	27.4	18.0	15.2
6-GFM-200M															
1.60V	1087	614	383	288	233	134	106	82.0	73.6	62.0	48.6	39.9	33.9	21.5	18.0
1.67V	1047	603	380	286	232	134	105	81.9	73.3	61.9	48.1	39.6	33.6	21.5	18.0
1.70V	1040	596	380	286	231	133	105	81.6	72.6	62.0	48.0	39.4	33.3	21.4	18.0
1.75V	971	592	378	285	228	133	103	81.5	72.2	61.7	47.5	39.3	33.3	21.4	18.0
1.80V	907	559	369	278	227	132	103	81.3	70.5	61.1	47.5	39.1	33.2	21.4	18.0
1.83V	874	512	365	270	218	131	101	78.3	69.0	59.4	47.0	38.1	32.5	21.3	17.8
1.85V	828	500	339	259	211	126	98.0	77.3	67.3	58.2	45.6	37.8	32.3	20.9	17.7

6-GFM-100F															
End voltage per cell	5min	15min	30min	45min	1h	2h	3h	4h	5h	6h	8h	10h	12h	20h	24h
1.60V	543	307	191	144	117	67.1	53.0	41.0	36.8	31.0	24.3	20.2	16.9	10.8	9.02
1.67V	523	301	190	143	116	67.0	52.3	41.0	36.6	31.0	24.0	20.1	16.8	10.7	9.02
1.70V	520	298	190	143	116	66.7	52.3	40.8	36.3	31.0	24.0	19.7	16.7	10.7	9.00
1.75V	485	296	189	143	114	66.3	51.7	40.8	36.1	30.9	23.5	19.6	16.6	10.7	9.00
1.80V	453	280	185	139	114	66.1	51.6	40.6	35.3	30.6	23.4	19.6	16.6	10.7	8.98
1.83V	437	256	182	135	109	65.3	50.4	39.2	34.5	29.7	23.5	19.1	16.3	10.7	8.92
1.85V	414	250	169	130	106	63.2	49.0	38.6	33.7	29.1	22.8	18.9	16.2	10.5	8.85

Chapter Three Operation and Maintenance

1. Operation Condition

Ambient Temperature: -40℃～＋55℃(Best temperature 20℃～25℃)

Ambient Humidity: ≤95%

2. Capacity

2.1.Capacity of battery

The capacity of battery is the capacity that battery can be discharged on the established conditions, expressed as signal C. The usual unit of capacity is ampere hour, shortened as AH.

The capacity can be expressed in Rated Capacity or Actual Capacity. The Rated Capacity of MP battery please see Table 1-1. The Actual Capacity is the product of the discharge current and the discharge time, the unit is AH.

2.2. The Influence Factor of the Actual Capacity

The actual capacity is mainly related with the positive and negative active materials and their utilization ratio. The utilization ratio of the materials is mainly influenced by the DOD, the structure of the battery and manufacture technology. In using process the factors that influence the actual capacity are discharge rate, depth of discharge, end voltage and temperature.

2.3. Discharge Rate

The discharge rate is often described as hour-rate and multiple rates.

If the discharge rate is higher and the discharge current is larger, then the discharge time is shorter, and the capacity which can be discharged is less.

2.4. End voltage

The end voltage is the lowest working voltage below which the battery can't be discharged any more or it will harm the battery. Usually the 10hr rate end voltage of MP battery is 1.80V/cell. The batteries are not able to discharge more capacity even if the end voltage is lower because of characteristics of lead acid battery, yet the low end voltage makes great harm to the battery. It will greatly shorten batteries' life especially to discharge the battery to 0V while not to recharge in time. Thus the end voltage should not be lower than what is described in table 3-1, or it will cause over-discharge and make recharge fail after several times of over-discharge.

Table 3-1 Discharge End-voltage

Discharge Current（A）	Discharge End Voltage（V/Cell）
I＜0.2C	1.80
0.2C≤I＜0.5C	1.70
0.5C≤I＜1.0C	1.55
I≥1.0C	1.30

3. Temperature

3.1. Available Capacity Vs. Ambient Temperature

Temperature affects capacity of the battery. Fig. 3-1 is the available capacity curve vs. ambient temperature. if the temperature drops, the capacity will decrease, for example, the capacity will decrease to 80% of rated capacity if temperature decreases from 25℃ to 0℃; and too low temperature will cause battery long term insufficient charged, also will cause no discharge and negative plates sulfate.

Though VRLA battery can be operated at -15℃, the standard data is the test result at 25℃.

The capacity will increase when temperature raises. For example the capacity will increase to 102% of rated capacity if temperature increase from 25℃ to 50℃. But it will quicken plates' corrosion and water loss if temperature raises, and shorten battery's life.

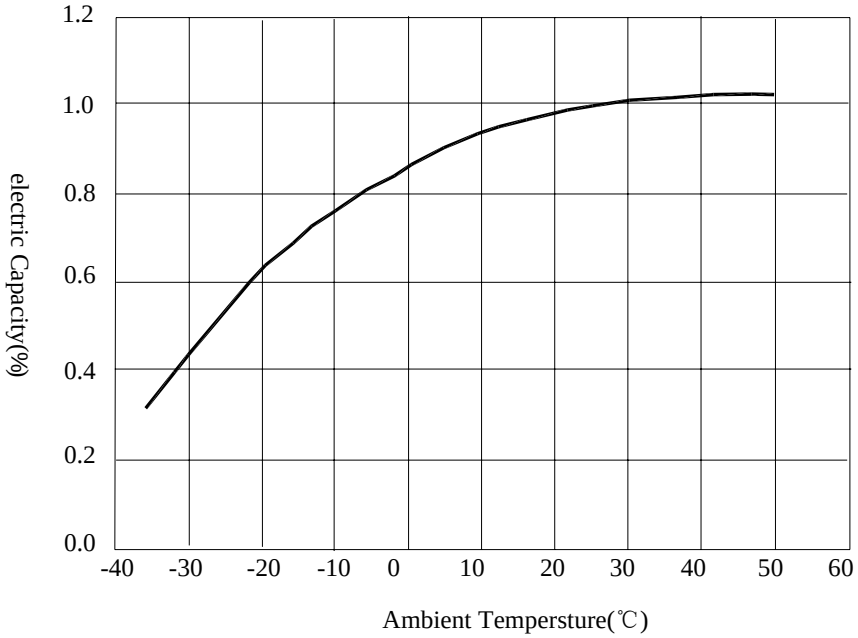


Fig.3-1 Available Capacity VS. Ambient Temperature

3.2. Temperature and Floating Voltage

The purpose of choosing proper floating voltage is to make the battery operate in a best condition. If the floating voltage is higher, then the floating current is also higher, it will accelerate corruption of the grid and shorten 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 proper floating voltage for MP series is 2.25V/cell. And temperature compensate coefficient is -3mV/℃/cell.

The formula to calculate float voltage at different temperature:

V_T=2.25-(T-25)×0.003

V_T—Floating charge voltage at T temperature

Table 3-2 Floating charge voltage at different temperature

Ambient Temperature （℃）	Floating Voltage （V/Cell）
0	2. 33

5	2. 31
10	2. 30
15	2. 28
20	2. 27
25	2. 25
30	2. 24
35	2. 22
40	2. 21

3.3. Temperature and equalization charge

VRLA battery needs equalization charge periodically to guarantee normal operation. At 25℃, the proper equalization voltage for MP series is 2.4V/cell. And temperature compensate coefficient is -5mV/℃/cell.

The formula to calculate equalization voltage at different temperature:

V_T=2.4-(T-25)×0.005

V_T—Equalization charge voltage at T temperature

3-3 Equalization charge voltage at different temperature

Ambient Temperature（℃）	Equalization charge Voltage（V/Cell）
0	2. 53
5	2. 50
10	2. 48
15	2. 45
20	2. 43
25	2. 40
30	2. 38
35	2. 35
40	2. 33

3.4. **Ambient Temperature Vs. Battery Life**

Higher temperature will harm the battery and reduce battery life. When temperature exceeds 25℃, the battery life will decrease half per 10℃ temperature raise. For example, the designed life of battery at 25℃ is 5 years, when battery operates at 35℃, the actual life is only 2.5 years.

$t_{25}=t_T\times 2^{(T-25)/10}$

Notes：T the actual ambient temperature;

t_T is designed life at T ambient temperature

t_{25} is designed life at 25℃ ambient temperature

The heats disseminate performance of VRLA battery is bad, it's liable to cause thermal run away when heat accumulates. Please improve ventilation and temperature condition when room temperature is high. The distances between batteries should not be smaller than 10mm. Please also adjust the float voltage and equalization voltage according the manual.

4. Charge and discharge requirements

4.1. Equalization charge

Equalization charge is needed in following conditions:

－ The voltage of at least two batteries are lower than 2.18V/cell

－ Floating operation for more than three months

The method of equalization charge is: First charge the batteries on the constant current of not more than $0.25C_{10}$A till the average voltage of the batteries increases to 2.40V/cell（25℃), then charge the batteries with constant voltage of 2.40V/cell, the time of equalization charge is 24 hours.

4.2. Charge

Charge the batteries in following conditions. The method is same as that of equalization charge.

－ After discharge

－ Finish installation

－ Storage time is above three months and open circuit voltage is lower than 2.10V/cell.

If battery need to be fully charged as soon as possible, then fast charge method can be adopted: limit current less than $0.25C_{20}$A, charge voltage 2.40V/cell（25℃）.

Whether the batteries are fully charged can be decided according to any one of two standards as follows:

－ The charge time is 18-24 hours (the charge time can be shortened when the batteries were not deep discharged, e.g., the charge time of 20%DOD batteries can be shortened to 10

hours).

－ On condition of constant voltage, the value of charge current hasn't varied for continuous three hours.

5. Storage

All lead acid batteries experience self-discharge in open circuit. The result is that open circuit voltage decreases, and the capacity also decreases. During storage please note:

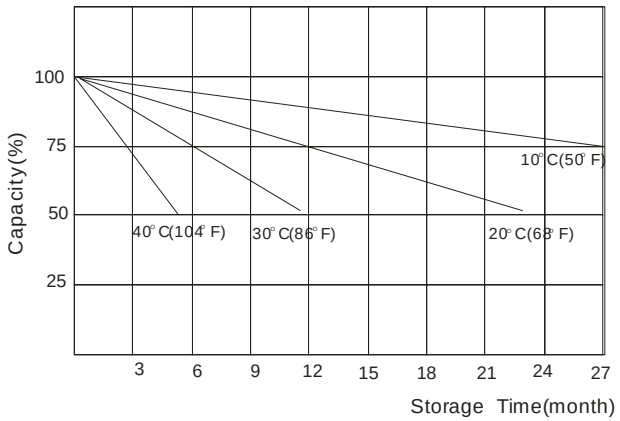
－ The self-discharge rate is related with ambient temperature. The self-discharge rate is smaller when the ambient temperature is lower, otherwise is larger. The required temperature of MP batteries' storage environment is from 0℃ to 35℃. The storage place must be clean, ventilated and dry.

－ An important parameter in storage is open circuit voltage, which is related with density of the electrolyte. If the open circuit voltage is lower than 2.17V/cell, or have been stored for three months, the batteries should be supplemental charged to avoid damage caused by self discharge.

－ All batteries, which are ready to store, should be fully charged before storage. 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 MP batteries record the latest charge time of the batteries, next charge time can be calculated according to this charge time.

Fig. 3-2 Available Capacity VS. Storage Time at Different Ambient Temperature。



6. Maintenance

In order to assure service life, the batteries should be correctly inspected and maintained.

The maintenance methods of MP batteries are recommended as follows

6.1. **Monthly Maintenance**

Implement following inspection every month:

— 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.

6.2. **Quarterly Maintenance**

— Repeat monthly inspection.

— Measure and record floating voltage of every on-line battery. If more than two cells' voltage is less than 2.17V/cell after temperature adjustment, the batteries need to be equalization charged. If the problem still exists after adopting above-mentioned measures, the batteries need yearly maintenance or even three years' maintenance. If all methods are ineffective, please contact us.

6.3. **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.

6.4. **Three-year Maintenance**

Make an 80% capacity test every year after three years' operation.

6.5. **Operation and Maintenance Precautions**

－ Insufficient Charge

If the floating voltage is not set correctly (too low or not amend 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

Please do not neglect the performance of rectify to transfer floating charge to equalization charge. If the rectify 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, heat out of control, 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, heat out of control, 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 1.80V/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.

－ Put the battery aside 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 create in the negative which are difficult to transfer to active Pb.

After-sales Service / Customer Service Hotline

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Annex 1

VRLA Battery Regular Maintenance Record

Type		Place	
Test Status		Qty	
Total Voltage（V）	Current(A)	Room 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	