

# NAGOYA<sup>®</sup>

## FirstPower<sup>®</sup>

DEEP CYCLE SERIES



**VRLA (AGM) DEEP CYCLE BATTERY**



valve are 100% visually inspected before the final assembly process.

1.4 Exceptional Deep Discharge Recovery

FirstPower batteries have exceptional deep discharge recovery and charge acceptance, even after deep or prolonged discharge.

1.5 Low Self-discharge

Because of the use of lead calcium grids alloy and highly purity materials. FirstPower VRLA battery can be stored long periods of time without recharge. The rate of FirstPower VRLA battery self-discharge on open circuit is less than 2% per month at 20°C/68°F to 25°C/77°F.

1.6 Long Service Life

The FirstPower VRLA battery has long life in standby or cyclic service.

1.7 Solid Copper Terminals

Ensures highest current carrying capability.

1.8 Tank-formed Plates

The initial capacity will be 100% and optimize cell voltage balance, due to the tank formation of the plates.

1.9 Computer-aided Design and Manufacturing

Ensures quality products through control of processes and standards.

1.10 UL and CE Recognized.

UL approval, file No. MH28204

CE approval, file No. G2M20201-0102-E-16

# VRLA(AGM) BATTERY

## 1 Features of FirstPower VRLA(AGM) Battery

1.1 Nonspillable

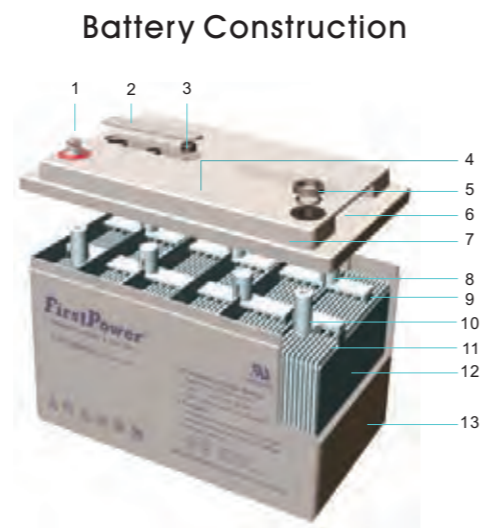
The FirstPower VRLA battery uses an absorbed electrolyte system. All of the electrolyte is absorbed into the positive plates, negative plates, and the separators. Coupled with the use of special sealing epoxies, and long sealing paths for posts, FirstPower VRLA batteries have exceptional leak resistance, and can be used in any position.

1.2 Sealed and Maintenance-free Operation

There is no corrosive gas generation during normal use and no need to check the specific gravity of the electrolyte or to add water during the service life.

1.3 High Quality and High Reliability

The FirstPower VRLA battery has stable and reliable capacity. The battery can withstand overcharge, over discharge, vibration, and shock. To assure this high quality and reliability, the batteries are 100% tested on production line for voltage, capacity, seals and the safety



- 1. Terminal
- 2. Top cover
- 3. Valve
- 4. Date Code
- 5. Pillar Seal
- 6. Handle
- 7. Cover
- 8. Post
- 9. Positive Plate
- 10. Pillar
- 11. Separator
- 12. Negative Plate
- 13. Container

## 2 Applications

- Telecommunication equipments
- Electronic instruments
- Alarm and security systems
- Emergency lighting
- Cable Television
- Computers
- Electronic cash registers
- Geophysical equipment
- Marine equipment
- Medical equipment
- Power tools
- Toys
- Portable cine and video lights
- Solar power systems
- Wind power systems
- Television and video recorders
- Vending machine
- Uninterruptible power supplies





### 3 General Characteristics

#### 3.1 Discharging

##### 3.1.1 Final Discharging Voltage

The final discharging voltage is the battery terminal voltage in close circuit voltage per cell to which a battery discharging safely and maximize battery life. The higher discharging current is, the lower final discharging voltage of battery should be .

Discharging Current	Final Discharging Voltage (vpc)
Up to 0.1CA	1.75
0.11-0.17CA	1.70
0.18-0.25CA	1.67
0.26-1CA	1.60
Above 1.1CA	1.30

##### 3.1.2 Battery Discharging Characteristics:

The discharging capacity of battery depends on the discharge rate being used and ambient temperature.

Figure 1,2 and 3 show the different discharging current corresponding to discharging capacity at 20 °C(68°F) to 25°C(77°F) for FP, LFP and CFP types batteries. They show that the rated capacity of a battery is reduced when it is discharged at a value of current that exceeds its 10-hours or 20-hours rate.

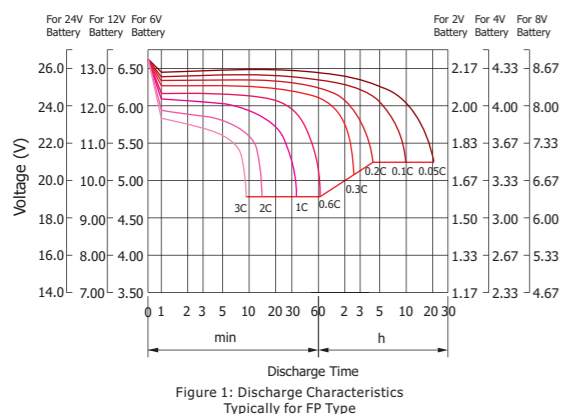


Figure 1: Discharge Characteristics Typically for FP Type

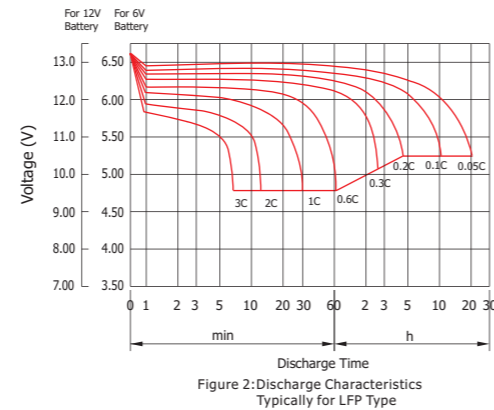


Figure 2: Discharge Characteristics Typically for LFP Type

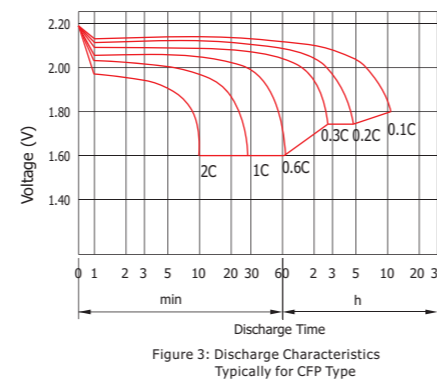


Figure 3: Discharge Characteristics Typically for CFP Type

##### 3.1.3 Temperature Effects in Relation to Battery Capacity.

At a higher temperature, the capacity of battery increases and conversely at a lower temperature, the capacity of battery decreases. Figure 4 shows the effects of different temperature in relation to battery capacity.

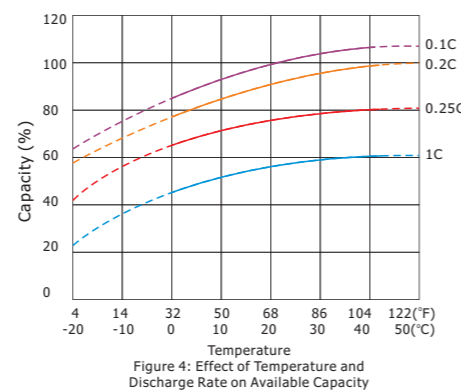


Figure 4: Effect of Temperature and Discharge Rate on Available Capacity

Can calculate the batteries' rated capacity as following formula if the ambient temperature of tested battery is not 20°C-25°C(68°F-77°F).

$$C = \frac{C_t}{1 + k(t-25)}$$

Note:

- C: rated capacity
- C<sub>t</sub>: the tested capacity on t
- t: the ambient temperature of the tested battery
- k: the coefficient of temperature. It will be increased if the discharge current increased.  
k=0.006 20 hours and 10 hours rated capacity testing,  
k=0.01 3 hours and 1 hours rated capacity testing.

#### 3.2 Charging

##### 3.2.1 Charging Methods

Correct charging is one of the most important factors to consider when using valve regulated lead acid batteries. Battery performance and service life will be directly affected by the charging methods.

There are four major methods of charging.

- Constant voltage charging.
- Constant current charging.
- Two stages constant voltage charging.
- Taper current charging.

##### 3.2.1.1 Constant Voltage Charging

This is the recommended method of charging for VRLA batteries. It is necessary to closely control the actual voltage to ensure that it is with the limits advised.

Standby service:

2.23-2.30 vpc at 20°C(68°F) to 25°C(77°F)

Cycle service:

2.40-2.50 vpc at 20°C(68°F) to 25°C(77°F)

It is suggested that the initial current be set within 0.4CAmps. Figure 5 and 6 indicate the time taken to fully recharge the battery. It is also seen that the charging current is decreased to approx 0.5-4mA/Ah under charging voltage 2.30 vpc, and 3-10mA/Ah under charging voltage 2.40vpc when the

battery is fully charged at 20°C(68°F) to 25°C(77°F).

Note: it is necessary to ensure that the voltage is correctly set. The charging voltage set too high will increase the corrosion of the positive plates causing loss of capacity and ultimately shortening the life of the battery.

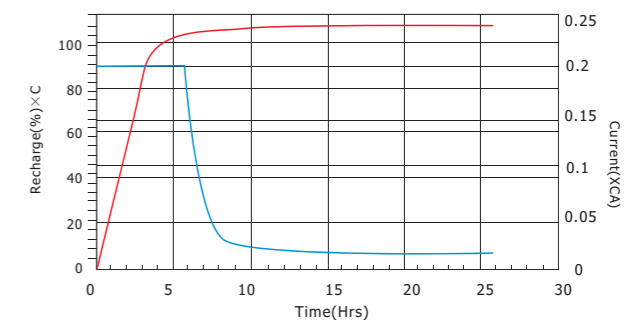


Figure 6: Charge 0.2C AMP Limit & 2.40 V/C Following Full Discharge

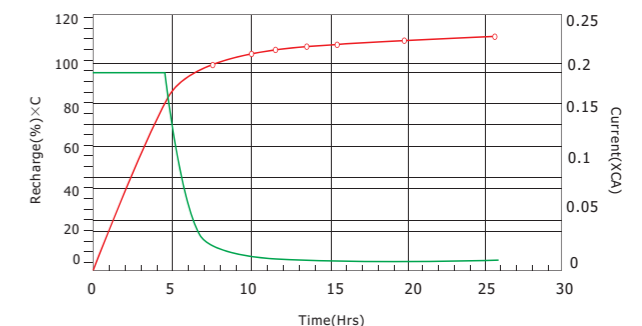


Figure 5: Charge 0.2C AMP Limit & 2.30 V/C Following Full Discharge

##### 3.2.1.2 Constant Current Charging

This method of charging is generally not recommended for VRLA batteries. It is necessary to understand that if the batteries are not removed from the charger as soon as possible after reaching a state of full charge. Considerable damage will occur to the batteries due to over charging. The required recharged capacity is 1.07 to 1.15 times as discharged capacity.

##### 3.2.1.3 Two Stages Constant Voltage Charging

This method should not be used where the battery and load are corrected in parallel, however, if this method is to be used, it is suggested that the FirstPower technical department be contacted.

##### 3.2.1.4 Taper Current Charging

This method is not recommended for VRLA

batteries, however, if this method is to be used it is suggested that the First Power technical department be contacted.

### 3.2.2 Effect of Temperature on Charging Voltage

As temperature rises, electrochemical activity in the battery increases. Similarly, as temperature falls, electrochemical activity decreases. Therefore, as temperature rises, charging voltage should be reduced to prevent overcharge, as temperature falls, charging voltage should be increased to avoid undercharge. In general, to assure optimum service life, use of a temperature compensated charger is recommended. The recommended compensation factor for FirstPower VRLA batteries is  $\pm 3\text{mV}/^\circ\text{C}$  Cell (standby use) and  $\pm 4\text{mV}/^\circ\text{C}$  cell(cyclic use). The standard central point for temperature compensation is  $20^\circ\text{C}/68^\circ\text{F}$ . Figure 7 shows the relationship between temperatures and charging voltages in both cyclic and standby applications.

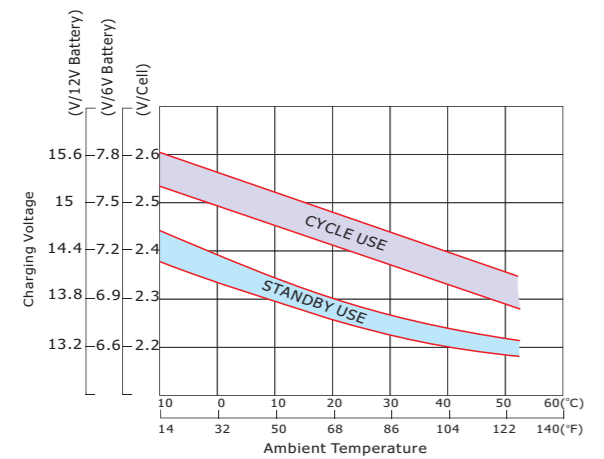


Figure 7: Relationship Between Charging Voltage and Temperature

### 3.2.3 Charging Time

The time required to complete each charge depends on the discharge condition of battery, characteristics of charge used, or the temperature during charge. For cyclic use, using constant voltage charging, this time can be estimated by the following expression at  $25^\circ\text{C}/77^\circ\text{F}$ .

- (1) Discharge current: Larger than 0.25CA  
 $T_{ch} = C_{dis}/I + 3 \sim 5$
- (2) Discharge current: Less than 0.25CA  
 $T_{ch} = C_{dis}/I + 6 \sim 10$   
 $T_{ch}$ : time required for charge (hours)  
 $C_{dis}$ : ampere-hour discharged before charge started(Ah)  
 $I$ : initial charging current(A).

Complete charge time for float service will be slightly more than 24 hours.

Note: The minimum recharge capacity should be 1.02~1.05 times of discharge capacity

## 3.3. Battery Life

Battery life depends on a number of key factors. These include:

Operating temperature of the battery;

Method of charging utilized;

Actual use of the product i.e.: standby or cycle service etc.

### 3.3.1 Cyclic Life

Giving due consideration to the above factors, the actual life of a battery in cycle service is dependent on the depth of discharge of each cycle. The greater the depth of discharge of each cycle, the less the number of cycles available from the battery.

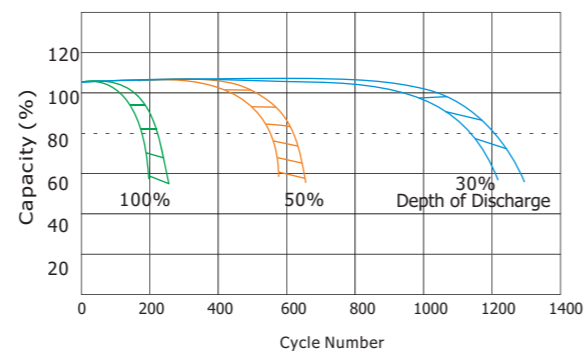


Figure 8: Cycle Life Vs Depth of Discharge For Standard Series FP, LFP, Long Life, CFP Types

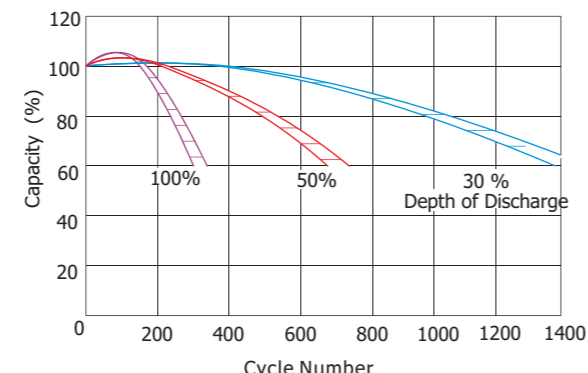


Figure 9: Cycle Life Vs Depth of Discharge For Deep Cycle Series FP, LFP Types

### 3.3.2 Standby Life

The estimated life under float service of FP type is 7 years at  $20^\circ\text{C}/68^\circ\text{F}$ ; LFP type is 12 years at  $20^\circ\text{C}/68^\circ\text{F}$ ; CFP type is more than 20 years at  $20^\circ\text{C}/68^\circ\text{F}$ . The float service life is affected by the factors listed above and the number of discharging, the depth of discharging the battery suffers during its life time. The more discharges suffered and the deeper the discharges, the shorter the battery life. The higher the temperature, the shorter the battery life. If the battery temperature remains at an elevated level for an extended period of time, the expected life is reduced by 50% for each 8 to  $10^\circ\text{C}$  of constant temperature above  $20^\circ\text{C}/68^\circ\text{F}$ .

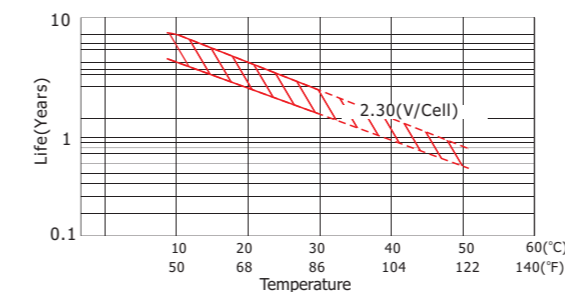


Figure 10: Effect of Temperature on Long Term Float Life (FP Type)

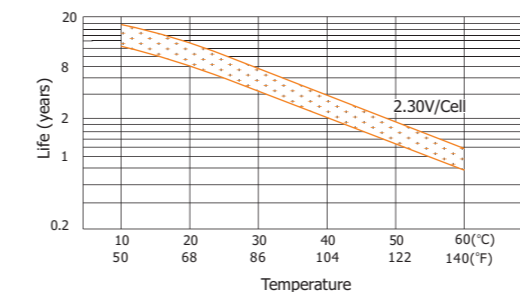


Figure 11: Effect of Temperature on Long Term Float Life (LFP Type)

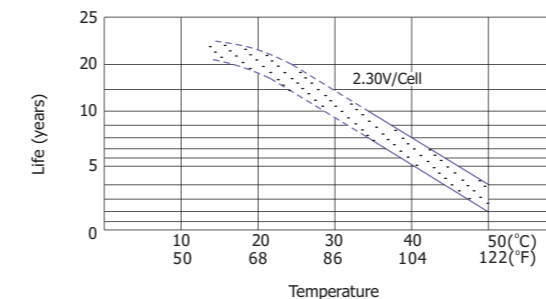


Figure 12: Effect of Temperature on Long Term Float Life (CFP Type)

## 3.4. Battery Storage

### 3.4.1 General Storage Conditions:

The battery should be stored under the following conditions.

- (1) Low humidity
- (2) 5 to  $122^\circ\text{F}$ (-15 to  $50^\circ\text{C}$ )
- (3) Clean, and avoid direct sunlight.

### 3.4.2 Capacity after Long Term Storage

After long term storage, all batteries deliver less than rated capacity on first cycle. In cyclic application, full capacity may be obtained through several charge/discharge cycles, typically 2-3 cycles.

### 3.4.3 Refresh Charge

When batteries are placed in extended storage, it is recommended that they receive a refresh charge at recommended intervals as following;

Storage Ambient:	Recommended Interval
Below $20^\circ\text{C}$ ( $68^\circ\text{F}$ ):	12 months
$20$ to $30^\circ\text{C}$ ( $68$ to $86^\circ\text{F}$ ):	6 months
$30$ to $40^\circ\text{C}$ ( $86$ to $104^\circ\text{F}$ ):	3 months

Refresh charging method:

3 to 5 hours of constant current 0.1C Amps or 12 to 16 hours at constant voltage of 2.45V/cell

### 3.4.4 "Self Life"- typical capacity vs. time

Self-discharge rate is very much dependent on the storage temperature as shown in Figure 13. Lower temperatures allow the battery to be stored for longer periods. (Each ten degree centigrade drop results in a halving of self-discharge rate and doubles storage time.)

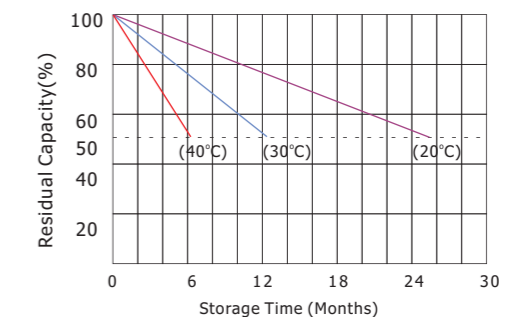


Figure 13: Self Life vs Storage Temperature

## Standard Battery Series ( LFP Type ) Specifications

Voltage: 6V, 8V, 12V Capacity: 33AH to 280AH  
 Designed floating service life : 12 Years at 20°C/68°F to 25°C/77°F

Model	Nominal Voltage (V)	Capacity (Ah)	Internal Resistance (mΩ)	Length		Width		Height		Total Height		Terminal		Weight Kg
				mm	in	mm	in	mm	in	mm	in	Type	Position	
LFP636	6	36	4.5											5.5
LFP642	6	42	4.2	162	6.4	88	3.5	164	6.5	170	6.7	T2	B	6.2
LFP645	6	45	4											6.4
LFP6100	6	100	3	194	7.6	170	6.7	205	8.1	210	8.3	T9	A	15.5
LFP6100A	6	100	3	281	11.1	128	5	189	7.4	204	8	T11	B	15.5
LFP6150	6	150	2.5											23.5
LFP6180B	6	180	2.3	260	10.24	180	7.09	245	9.65	250	9.84	T11	B	28
LFP6200B	6	200	2											30
LFP6200	6	200	2	321	12.64	176	6.93	226	8.9	246	9.69	T5/T11	A	30.5
LFP6225	6	225	1.8											32
LFP6180	6	180	2.2	307	12.1	169	6.7	220	8.7	225	8.9	T11	B	27.5
LFP6200A	6	200	2	307	12.1	169	6.7	220	8.7	225	8.9	T11	B	29
LFP6190	6	190	2.2	243	9.6	187	7.4	253	10	276	10.9	T11	B	28.5
LFP6220	6	220	2											32
LFP6300	6	300	1.5	295	11.61	178	7.01	345	13.58	348	13.7	T11	B	47
LFP8180	8	180	3	260	10.24	182	7.17	295	11.61	298	11.73	T11	C	36.5
LFP1233	12	33	10	195	7.7	130	5.1	155	6.1	180/166	7.1/6.7	T7/T9	C	10
LFP1235	12	35	9											10.5
LFP1234	12	34	11	310	12.2	77	3	166	6.5	172/180	6.8/7.1	T2/T3	D	9.5
LFP1238	12	38	9											12.3
LFP1240	12	40	8.5	197	7.8	165	6.5	170	6.7	170/170	6.7/6.7	T4/T9	D	12.8
LFP1245	12	45	8											14
LFP1240A	12	40	8.5	197	7.8	165	6.5	175	6.9	182/175	7.2/6.9	T6/T9	D	12.8
LFP1245A	12	45	8											14
LFP1240B	12	40	8.5	197	7.8	166	6.5	170	6.7	170	6.7		D	12.8
LFP1250	12	50	7.5	229	9	138	5.4	208	8.2	230/211	9.1/8.3	T5/T9	C	16.3
LFP1255	12	55	6.5											17.3
LFP1260B	12	60	6	250	9.8	160	6.3	178	7	200	7.9	T5	C	19
LFP1260C	12	60	6	220	8.66	121	4.76	247	9.72	250	9.84	T9	D	19.5
LFP1260	12	60	7											19
LFP1270	12	70	6.5											22
LFP1275	12	75	6	260	10.2	168	6.6	211	8.3	233/214	9.2/8.4	T5/T9	C	22.5
LFP1280A	12	80	5.5											23.5
LFP1285	12	85	5											24.7
LFP1265	12	65	6											20.8
LFP1270S	12	70	5.5											21.5
LFP1275S	12	75	5.4	350	13.78	167	6.57	179	7.05	186	7.32	T5/T9	C	22.2
LFP1278	12	78	5											23
LFP1280	12	80	4											23.5
LFP1265A	12	65	6.5	350	13.8	166	6.5	174	6.9	174	6.9	T17/T9	D	21
LFP1265B	12	65	6	330	13	173	6.8	167	6.6	170	6.7	T9	D	20.8
LFP1290A	12	90	5											27
LFP12100	12	100	4.5	330	13	171	6.7	214	8.4	224/220	8.8/8.7	T5/T9	C	30.5
LFP12120A	12	110	4											32.5
LFP1290	12	90	5.5											27
LFP1295	12	95	5	306	12.05	169	6.65	211	8.31	233	9.17	T5/T9	C	27.5
LFP12100V	12	100	4											30
LFP12100A	12	100	4.5	406	15.98	173	6.81	208	8.19	238	9.37	T19/T5/T11	C	31
LFP12120C	12	120	4											35
LFP12100C	12	100	4.5	330	12.99	220	8.66	160	6.3	165	6.5	T9	C	30
LFP12100S	12	100	4.5	409	16.1	176	6.93	225	8.86	225	8.86	T5/T11	C	31
LFP12120	12	120	4											35
LFP12120B	12	120	4	443	17.4	167	6.58	204	8.03	224	8.82	T5	D	35
LFP12110	12	110	4	281	11.1	267	10.5	207	8.1	210	8.3	T11	B	33
LFP12134	12	134	3.8	342	13.46	172	6.77	280	11.02	285	11.22	T11	C	42
LFP12150C	12	150	3.2											46

### 3.4.5 "Self Life"-storage time vs. temperature

Figure 14 shows the time for the capacity to decrease to 50% of nominal capacity at each temperature during storage. If the storage temperature is known, the graph may be used for finding the most useful recommended refresh charge intervals.

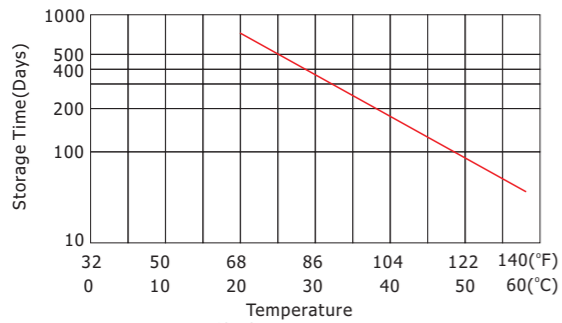


Figure 14: Self Life-Storage Time Temperature

### 3.4.6 Open Circuit Voltage and Residual Capacity

Residual capacity can be estimated by measuring the open circuit voltage as shown in Figure 15.

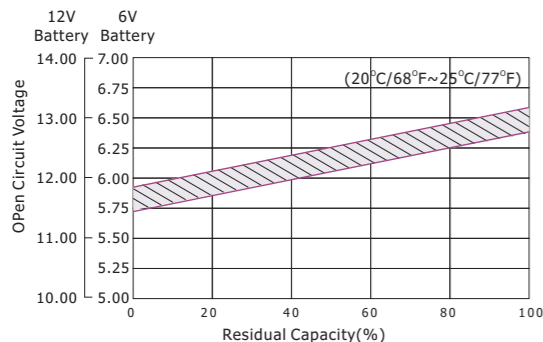


Figure 15: Open Circuit Voltage vs Residual Capacity

### 3.5 Battery Internal Resistance

The internal resistance of a battery is lowest when the battery is in a fully charged state. The battery internal resistance will be increased gradually during discharge.

Figure 16 shows the changing of internal resistance of FP1272(12V7.2Ah) battery during different rated discharging

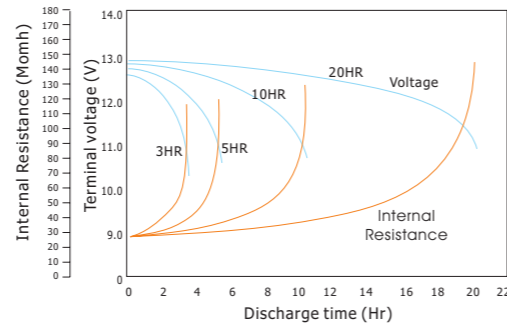


Figure 16: Internal resistance VS discharging

## 4 Battery Capacity Selection

The individual battery model specification sheet(www.efirstpower.com) can be used to determine the minimum battery size, exper in Ampere hours of capacity if know the discharging current(power) and the discharging time. The battery life(cycle service life or floating service life) should be considered for final battery capacity selection.