



DM SERIES TECHNICAL MANUAL

RELIABLE WHENEVER NEEDED



SACRED SUN

SHANDONG SACRED SUN POWER SOURCES CO.,LTD
No.1,Shengyang Road,Qufu City,Shandong
Province,273100,P.R.China
Tel: 0086-537-4438666-6028
Fax: 0086-537-4411936
E-mail: sales@sacredsun.cn



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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.

- ▲ Only professionals shall be allowed to open and maintain the battery with insulated tools; Any metal objects to be put on top of the battery shall be strictly prohibited;
- ▲ Used battery is recyclable and shall be proper disposed following relative regulations and laws. Improper disposal of battery may be great hazardous to the environment and health;
- ▲ 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;
- ▲ Please do not use any organic solvent to clean batteries;
- ▲ Please do not smoke or set out fire near batteries.

Notice

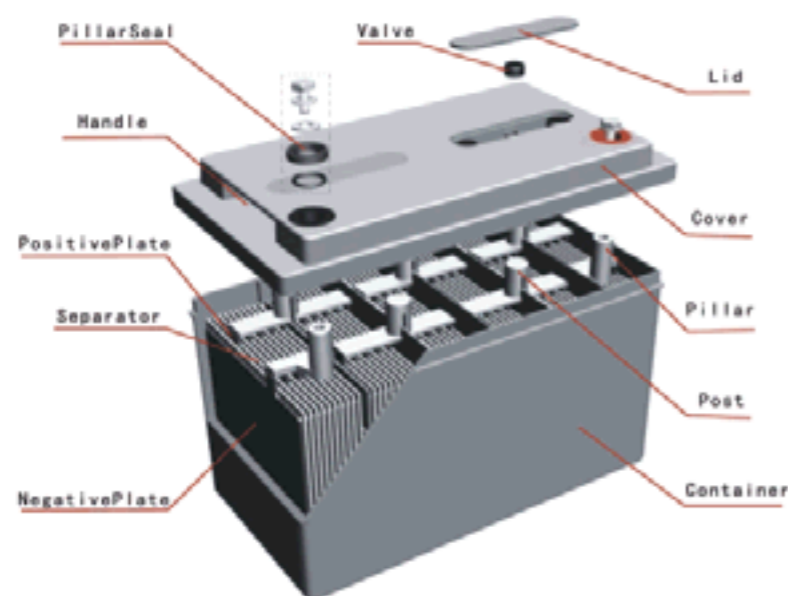
				
Warning	Electricity shock	Protecting eyes	No short circuit	With adults custody
				
Read instructions	No flames and sparks	Recycled	Proper disposal	UL Certificate



Chapter One Product Characteristics

Safety and sealing

Reliable terminal sealing design prevents acid leakage from the terminal and ensures good connection of cable and terminal.



Maintenance free

The performance is mainly determined by Separator and Alloy. Acid proof, high porous and absorptive rate AGM separator and lead-calcium-tin Alloy ensure gas recombination on negative electrode effectively.

Security

Each valve will be carried out in-coming inspection to ensure battery consistency. The opening pressure is 10-25Kpa and closing pressure is 6-20Kpa.

Consistency

The equalizing process in plate producing ensures cell consistency; accurate electrolyte design and precise automatic acid filling equipment fills in sufficient electrolyte.

Low self-discharge rate

Made of novel lead-calcium alloy and ultra purity materials produced cleaner environment producing process limits impurity content in the battery.

Small cubic volume, large capacity, high specific energy

Due to our Innovative construction design, these batteries deliver more capacity and more power for same volume and footprint compared to competition.

Long cyclic life

- ⊙ The plates are made from lead base alloy without cadmium, which provides excellent corrosion resistance performance and extremely low hydrogen evolution, so the batteries are friendly for environment.
- ⊙ Special paste ensures not only the capacity but also the cyclic performance during service life.
- ⊙ High temperature and humidity plate curing technique makes the plate high oxydation extent and strong combination capability.
- ⊙ Specific electrolyte saturation.

Wide operating temperature

The battery can be operated in the ambient temperature of $-20\text{ }^{\circ}\text{C} \sim +50\text{ }^{\circ}\text{C}$.



Chapter Two Main Applications

- Sightseeing tour cars
- Golf cars
- Electrical cruising cars and boats
- Municipal engineering cars
- Electrical traction material handling vehicles
- Electrical sweeping and scrubber machines
- Aerial platform
- Real estate maintenance cars
- Electrical van
- Other electrical powered vehicles

Chapter Three Battery Construction

Electrode

Positive and negative plates are made from grid and paste. The grid is the carrier of paste and conductor. Positive paste is mainly composed by PbO_2 and negative by active lead through the electrochemical reaction. Capacity is provided during the discharge.

AGM separator

The separator is used to separate positive and negative plates and prevent short circuit caused by direct contact. High porous rate acid-proof AGM separator allows oxygen from positive plate going through separator to negative plate to recombine hydrogen into water while

Electrolyte

High purity and low density electrolyte is evenly absorbed by the AGM separator to react active material of positive and negative plates.

Battery cover and container

The container and cover is made of ABS material which is of explosive proof, acid proof and anti-shock performance. Flame retardant material is optional.

Terminals

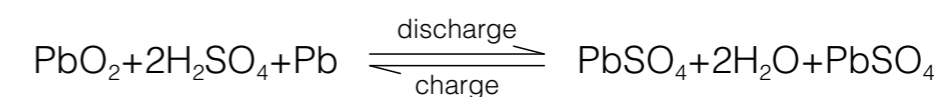
Terminals are made of lead-tin alloy with copper insert, so as to conduct electricity safely and reliably.

Relief valve

The pressure maintaining ability of relief valve can promote the inner gas recombination, meanwhile prevent foreign matters getting into the battery or contain bulge caused by overcharge. Once the battery inner pressure increases to the restricted value, the relief valve would open to release the excess gas; when the inner pressure returns to the normal set value, relief valve restores and seals automatically.

Chapter Four Working Principle

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

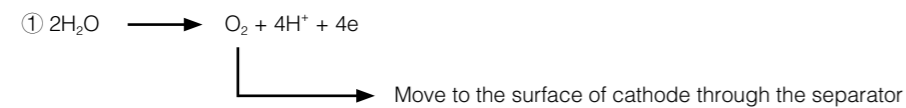


In charging process, lead dioxide generated in positive plate and spongy lead generated in negative plate. In the final stage of charging, there will be a little oxygen gas generated in positive plate, but quite little in negative plate because of the high hydrogen evolution potential of the alloy. Oxygen reaches the negative plate through separator pores and reacts with active materials and electrolyte of negative plate, resulting in negative plate in depolarized state, and inhibiting the generation of hydrogen.

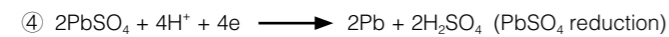
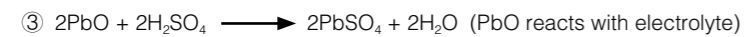
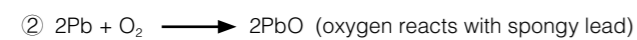
The working principle of electrochemical reaction to realize sealing as follows:



○ The reaction in the anode (generating oxygen):



○ The reaction in the cathode:

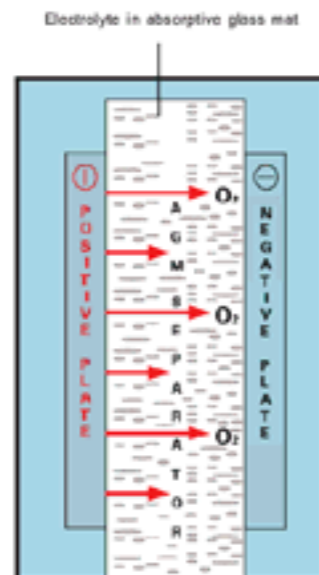


○ The whole reaction in the cathode is: $\textcircled{2} + \textcircled{3} + \textcircled{4} : \text{O}_2 + 4\text{H}^+ + 4\text{e} = 2\text{H}_2\text{O}$

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

In general, the generated gas in charging process could quickly reach the cathode and recombine into water, no gas escape and water loss, realizing the sealing and free maintenance of the battery.

Gas recombination illustration



Chapter Five Specifications and Performance

Specifications

Model	Rated voltage (V)	Rated capacity (AH)	Dimension (mm)				Weight (kg)	Reference resistance (mΩ)
		5hr	L	W	H	TH		
3-DM-185	6	185	260	180	245	253	30.0	1.5
3-DM-200	6	200	260	180	245	253	32.5	1.3
3-DM-220	6	220	243	188	275	275	34.5	1.2
4-DM-146	8	146	260	182	295	301	35.0	2.5
6-DM-76	12	76	261	174	221	224	28.0	6.0

Discharge parameter

The discharge capacity of battery is closely related to discharge current, end voltage and discharge temperature. The smaller discharge current, the lower end voltage; the higher temperature, the larger discharge capacity.

3-DM-185 Discharge performance

Constant current discharge parameter (at 25°C ,77 °F) — Ampere (A)											
End voltage (V/cell)	Discharge time (minute)										
	10	20	30	45	60	90	120	180	300	600	1200
1.60	450	315	221	182	135	99.0	75.0	63.0	39.4	20.9	11.4
1.65	441	304	216	178	131	95.6	74.3	60.8	39.2	20.8	11.3
1.70	432	293	212	173	126	92.3	73.6	58.5	37.8	20.7	11.3
1.75	425	281	207	169	122	88.9	73.1	56.3	37.0	20.7	11.3
Constant power discharge parameter (at 25°C ,77 °F) — Watt (W) / cell											
End voltage (V/cell)	Discharge time (minute)										
	10	20	30	45	60	90	120	180	300	600	1200
1.60	797	572	404	335	251	184	140	120	74.8	38.9	21.6
1.65	781	551	395	327	242	178	139	115	74.4	38.5	21.5
1.70	765	531	387	319	234	172	138	111	71.8	38.0	21.5
1.75	753	510	379	311	226	166	137	107	70.5	37.6	21.4



3-DM-200 Discharge performance

Constant current discharge parameter(at 25°C ,77°F) —— Ampere (A)											
End voltage (V/cell)	Discharge time (minute)										
	10	20	30	45	60	90	120	180	300	600	1200
1.60	480	336	235	194	144	106	80.0	67.2	42.0	21.8	12.1
1.65	470	324	230	190	139	102	79.2	64.8	41.8	21.7	12.1
1.70	461	312	226	185	134	98.4	78.5	62.4	40.3	21.6	12.0
1.75	454	300	221	180	130	94.8	78.0	60.0	40.0	21.6	12.0
Constant power discharge parameter(at 25°C ,77°F) —— Watt (W) / cell											
End voltage (V/cell)	Discharge time (minute)										
	10	20	30	45	60	90	120	180	300	600	1200
1.60	850	610	430	358	268	197	149	128	79.8	41.5	23.1
1.65	833	588	422	349	259	190	148	123	79.3	41.0	23.0
1.70	816	566	413	340	250	183	147	119	76.6	40.6	22.9
1.75	803	545	404	331	241	177	146	114	75.2	40.1	22.8

4-DM-146 Discharge performance

Constant current discharge parameter(at25°C ,77°F) —— Ampere (A)											
End voltage (V/cell)	Discharge time (minute)										
	10	20	30	45	60	90	120	180	300	600	1200
1.60	360	252	176	146	108	79.2	59.0	50.4	31.5	16.4	9.11
1.65	353	243	173	142	104	76.5	58.6	48.6	31.3	16.2	9.07
1.70	346	234	169	139	101	73.8	58.0	46.8	30.2	16.0	9.04
1.75	340	225	166	135	97.2	71.1	57.5	45.0	29.2	16.0	9.00
Constant power discharge parameter(at 25°C ,77°F) —— Watt (W) / cell											
End voltage (V/cell)	Discharge time (minute)										
	10	20	30	45	60	90	120	180	300	600	1200
1.60	637	457	323	268	201	148	112	95.8	59.9	31.1	17.3
1.65	624	441	316	262	194	143	109	92.3	59.5	30.8	17.2
1.70	612	425	310	255	187	137	105	88.9	57.5	30.4	17.2
1.75	602	408	303	248	181	132	101	85.5	56.4	30.1	17.1

3-DM-220 Discharge performance

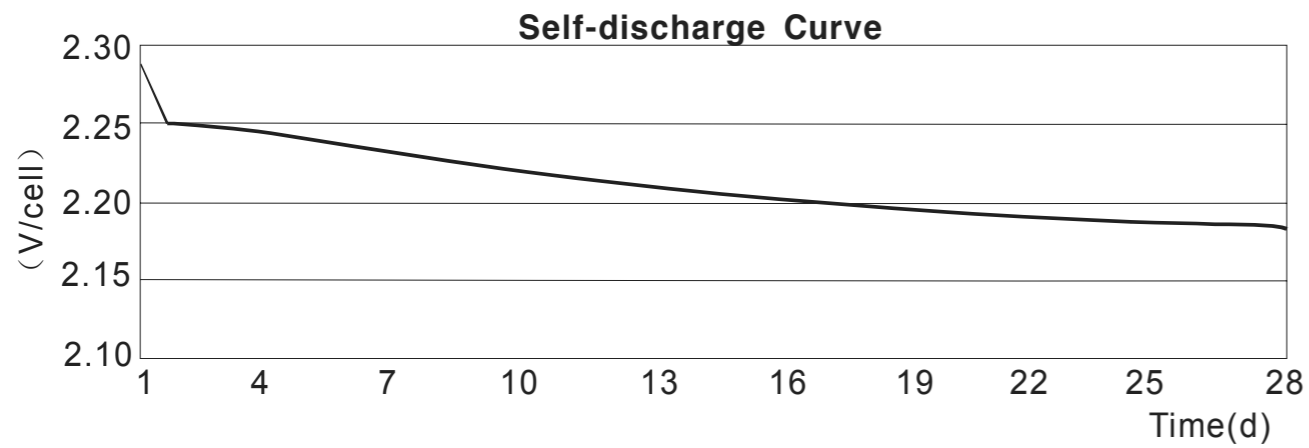
Constant current discharge parameter(at 25°C ,77°F) —— Ampere (A)											
End voltage (V/cell)	Discharge time (minute)										
	10	20	30	45	60	90	120	180	300	600	1200
1.60	530	371	260	215	159	117	88.0	74.2	46.4	24.1	13.4
1.65	519	358	254	209	154	113	87.5	71.6	46.1	23.9	13.4
1.70	509	345	249	204	148	109	86.7	68.9	44.5	23.6	13.3
1.75	501	331	244	199	143	105	86.1	66.3	44.0	23.5	13.3
Constant power discharge parameter(at 25°C ,77°F) —— Watt (W) / cell											
End voltage (V/cell)	Discharge time (minute)										
	10	20	30	45	60	90	120	180	300	600	1200
1.60	938	673	475	395	295	217	165	141	88.1	45.8	25.5
1.65	919	649	466	385	286	210	164	136	87.6	45.3	25.4
1.70	901	625	456	375	276	202	162	131	84.6	44.8	25.3
1.75	887	601	446	366	266	195	161	126	83.1	44.3	25.2

6-DM-76 Discharge performance

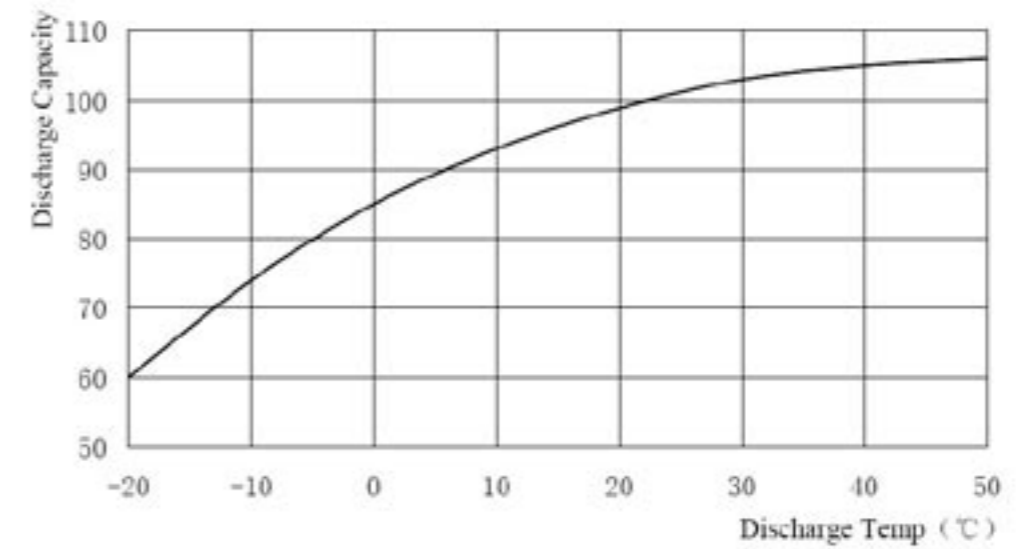
Constant current discharge parameter(at 25°C ,77°F) —— Ampere (A)											
End voltage (V/cell)	Discharge time (minute)										
	10	20	30	45	60	90	120	180	300	600	1200
1.60	205	145	100	83	60	45	30	25.6	17	9.6	4.7
1.65	202	140	99	81	58	42	29.2	24.8	16.4	9.2	4.7
1.70	198	134	96	79	56	38	26	24	15.8	8.8	4.6
1.75	196	129	95	77	54	36	25.2	23.4	15.2	8.5	4.6
Constant power discharge parameter(at 25°C ,77°F) —— Watt (W) / cell											
End voltage (V/cell)	Discharge time (minute)										
	10	20	30	45	60	90	120	180	300	600	1200
1.60	382	258	192	156	113	83	56	48.1	32.2	18	9.7
1.65	376	252	186	151	109	79	53	46	31	17.3	9.4
1.70	370	246	182	147	105	75	50	44.6	29.8	16.6	9
1.75	362	240	178	142	101	72	48	42	28.7	16	8.7



Self-discharge



Discharge capacity Vs. Temperature



The impact of temperature on battery performance

Temperature affects capacity of the battery: the higher temperature, the larger capacity discharged.

The following figure is the available capacity curve related to ambient temperature. If the ambient temperature when discharging is not 25°C, calculate the capacity C₂₅ at 25°C according to the following formula.

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

In the formula: T stands for the ambient temperature in discharging

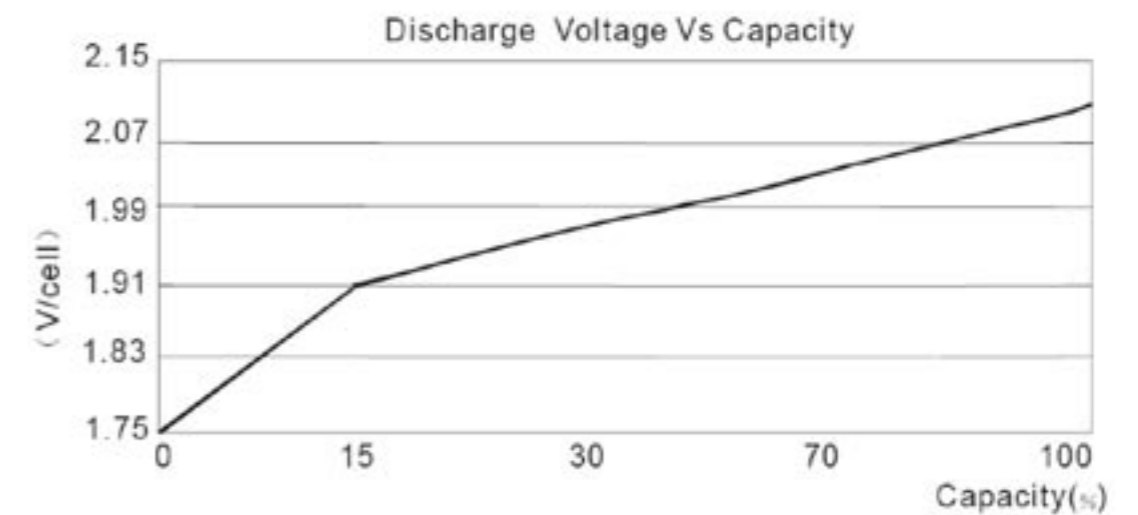
C_T stands for the discharged capacity at temperature T

k stands for temperature coefficient

k=0.007/°C when discharge in 5 hours rate

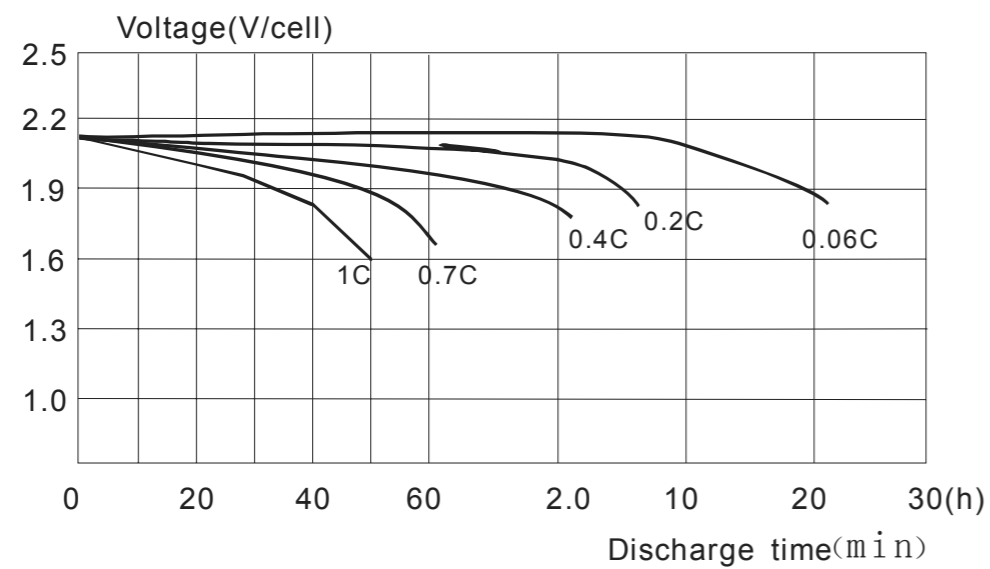
k=0.008/°C when discharge in 2 hours rate

The corresponding relation of voltage and remaining capacity in discharge process



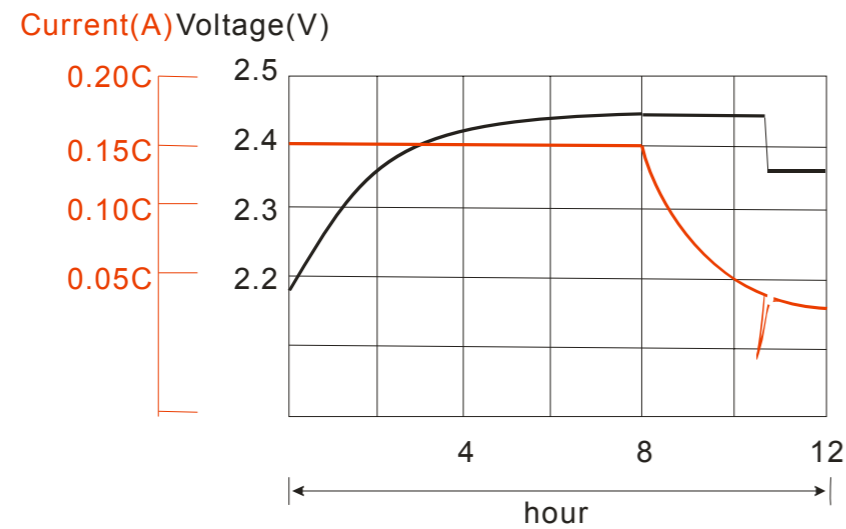


Discharge curves under various discharge rate



Charging curve

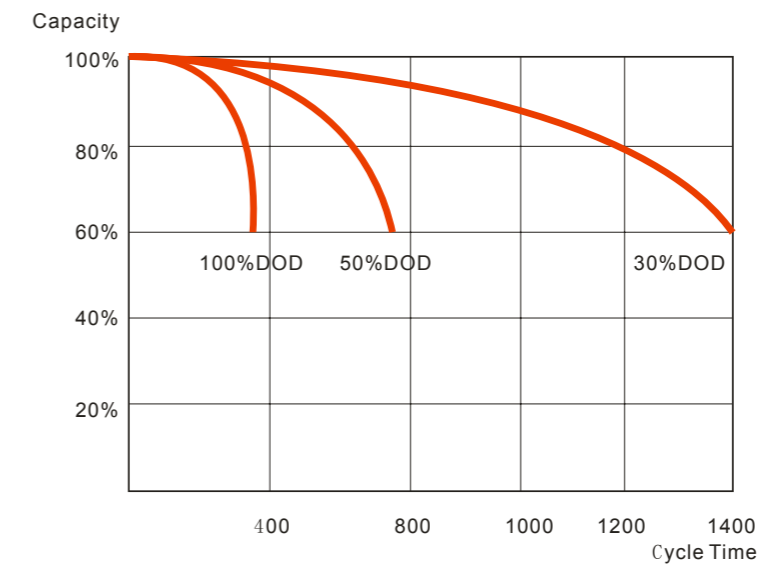
General charge curve



Low capacity batteries charge

Generally speaking, for the battery have low capacity in battery pack, can maintenance it by charging it single, the charging voltage can get 2.55~2.60V/cell, and the charging current get 0.12~0.15CA, the charge time get more than 12 hours. The battery capacity can get higher step by step after discharge-charge-discharge-charge cycles.

The cycle time related to different depth of discharge



Chapter Six Operation of Battery

Operating condition

The battery can be operated in environment with $-20^{\circ}\text{C} \sim +50^{\circ}\text{C}$ ambient temperature, and the optimal temperature range is $15^{\circ}\text{C} \sim 30^{\circ}\text{C}$.

Battery selection

Model/specifications	3-DM-185	3-DM-200	3-DM-220	4-DM-146	6-DM-76
Maximum power of motor/piece	500W	500W	600W	500W	500W
Recommended power configure/piece	120 ~ 400W	120 ~ 400W	150 ~ 500W	120 ~ 400W	120 ~ 400W



	3-DM-185	3-DM-200	3-DM-220	4-DM-146	6-DM-76
24V	4 blocs in series, 1.6kW	4 blocs in series, 1.6kW	4 blocs in series, 2.0kW	3 blocs in series, 1.2kW	2 blocs in series, 0.8kW
36V	6 blocs in series, 2.4kW	6 blocs in series, 2.4kW	6 blocs in series, 3.0kW	/	3 blocs in series, 1.2kW
48V	8 blocs in series, 3.2kW	8 blocs in series, 3.2kW	8 blocs in series, 4.0kW	6 blocs in series, 2.4kW	4 blocs in series, 1.6kW

Note: The table just show the non-parallel circuit, two-way parallel power is 2 times the single-power

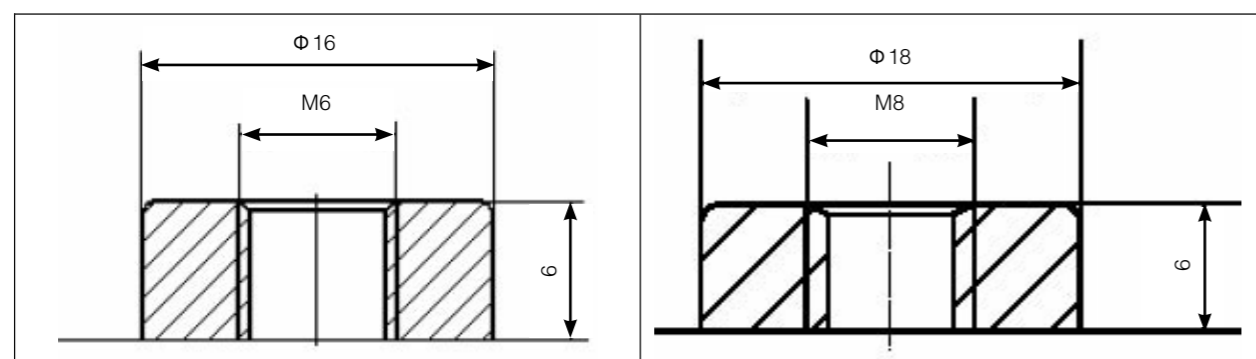
Installation

- The red terminal with positive polarity, while the black (or blue) with negative polarity.
- Flexible cable is recommended to connect, watch the correct of polarity in connection.
- The battery should be placed upright, and upside down is forbidden.
- The battery tank should be well ventilated , the interval of batteries is not less than 2mm.
- Guard against short-circuit in connection process.

Terminal type and torque values

Model	3-DM-185	3-DM-200	3-DM-220	4-DM-146	6-DM-76
Terminal type	M6 x 16	M6 x 16	M8 x 16	M6 x 16	M6 x 16
Maximum torque	8~10N · m	8~10N · m	12~16N · m	8~10N · m	8~10N · m

Terminal layout



Charging

○ Initial charge

The battery should be charged for 4~8 hours when first used.

Charging method: constant voltage of 2.45V/cell, limited current of $0.15C_5$ (A) , C_5 referring to the rated capacity, the same in the following.

○ General charging method 1

Charge in constant current of $0.15C_5$ (A) till the voltage up to 2.45V/cell, then charge in constant voltage of 2.45V/cell till the current decrease to $0.01C_5$ (A) , then continue to charge in constant voltage of 2.35V/cell for 3~4 hours. And the total charge time mustn't more than 12 hours.

Notice: This method is preferably recommended for customers.

○ General charging method 2

The initial charge current is $0.15C_5$ (A) . When the voltage reaches to 2.45V/cell, change the current to $0.05C_5$ A to continual charging for 4~8hours (the voltage do not exceed 2.50V/cell in the whole charging process), the total charging capacity is 1.15~1.25 times of the discharging capacity.

Notice: This method is recommended for professionals to do the capacity test.

○ Quick charge method

Charging in constant current of $0.4C_5$ (A) until the voltage up to 2.45V/cell, and then charging in the current of $0.1C_5$ (A) for 1 hour.

Notice: The method is only used in the emergency, by which only about 90% of capacity is charged. It is not recommended in normal condition.

Discharging

- In the using process;
- Maximum discharge current(start current) $\leq 1C_5$ (A);
- Normal working current $\leq 0.4C_5$ (A);
- Discharge protecting voltage is 1.75~1.83V/cell, we recommended 1.83V/cell;
- Notice



Chapter Seven Battery Maintenance

- The battery is fully charged when dispatched, and it is recommended to charge for 4 ~ 8 hours before operation to make up the loss of capacity due to self discharge during storage and transportation. Self discharge is caused by internal and external factors including manufacturing, environment etc.
- The battery must be installed by professionals.
- Avoid using too much electrical power and overloading.
- It is a normal phenomenon that the capacity drops with temperature decrease in winter, and the capacity at -10 °C is 70% ~ 80% of nominal capacity at 25°C .

The relationship between the discharge capacity and temperature

Temperature (°C)	Discharge capacity
Below -20°C	Less than 60% of the rated capacity
-20°C ~0°C	60%~85% of the rated capacity
0°C ~20°C	85%~100% of the rated capacity
20°C ~50°C	100%~110% of the rated capacity

Users guidance

Generally, if the battery is discharged more than 60% of it' s capacity, it can be defined as deep discharge. At this moment, the battery shall be charged immediately instead of recharging after a day or longer, which can cause internal dendrite short circuit. In practice the battery users can charge the battery after 3 or 4 days use if the power consumption per day is minimum 10% to 20%, but if the power consumption per day is much like 40%, please remember charge the battery immediately after 2 days use.

The battery users often discharge the battery according to coulomb meter, so when the coulomb meter passes the half, the users should charge the battery as soon as possible.

Even the power consumption value is low, the battery shall be stored after being charged if the vehicle is not used for a period. Moreover, the battery need to be charged every 1 or 2 months.

Chapter Eight Transport, Storage and Disposal

Transport

- The battery is fully charged with electrolyte when dispatched, so short-circuit, shocks with hard objects and falling shall be avoided during transport.
- Do not touch terminals and safety valve during the transit of the battery.
- When opening the battery, first examine the outside appearance of the battery to make sure no scratch, no dirt nor liquid in the container surface. Replace or repair the invalid battery immediately if any crack and leaking.
- During operation, check all battery cables and their connections per month. Please tight or replace the battery cables as soon as

Storage

- Storage requirement
- Store the battery in a dry, clean and preferable ventilated location at the ambient temperature of 0°C~ 40°C , preventing direct sunlight, and keeping away from heat sources.
- The relative protection as dust-proof, damp-proof and impact-proof are necessary for the battery. Placing the battery in sealing container is forbidden.
- Supplementary charge in storage
- The battery has a certain self-discharge rate during storage, so supplementary charge every 1 ~ 2 month is recommended. Long time storage will reduce battery performance and shorten its service life.

Disposal of used batteries

- The used battery still retains a certain electricity, so short circuit and electrical flame should be prevented, or it will cause explosion.
- Used battery should be taken back in registered place or reclaimed by authorized companies, and cannot be thrown casually.